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*) The power for the electrical, instrument, radio, radar and armament equipment is supplied initially by two, type 519, 28V/300 amp. engine-driven generators, connected in parallel, which also charge the aircraft battery. They are located in the inboard leading edge of each wing and are fitted with voltage regulators to control the system at 28 volts.

(*b*) The voltage regulators contain an equalising coil; thus as long as both generators are on-line, if the load on No. 1 generator exceeds that on No. 2 the load on No. 1 generator will be reduced and that on No. 2 increased until a state of voltage balance is reached. The converse applies if the load on No. 2 generator exceeds that on No. 1.

(*c*) Over-voltage protection is provided so that in high-voltage fault conditions the offending generator is disconnected from the bus-bar and the corresponding failure warning light comes on.

(*d*) The generators cut-in at an engine speed of approximately 1,700 RPM and cut out slightly below this speed. Full output is maintained at RPM in excess of 3,000.

2 AC supplies—inverters

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

◀(*a*) *No.* 2 *inverter* (*Type* 103*A*)
This is the main inverter. It supplies 115v/400 cs 3-phase AC power for the items below. Items marked with an asterisk are supplied by No. 1 inverter if No. 2 is not running:—

*G4B compass

*Artificial horizon

*Oil pressure indicators

*Mk. 19 altimeter vibrator units ▶

*Mk. 22F altimeter amplifier

Bombsight head and computer. No. 5 inverter regulator blower motors

Roller map

Radio compass (AD 722).

(*b*) *No.* 1 *inverter* (*Type* 100*A*)

No. 1 inverter acts as a standby for No. 2 but supplies only the starred items given in sub-para. (*a*).

(*c*) *No.* 5 *inverter* (*Type* 201)

No. 5 inverter supplies single-phase 115V/1600 c/s power for IFF 10. A supply for use in conjunction with LABS is also available from this inverter.

(*d*) *Nos.* 6 *and* 7 *inverters*

No. 6 inverter supplies single-phase AC at 115V/400 c/s to LABS. This is the NORMAL LABS supply. No. 7 inverter acts as a standby to No. 6.

NOTE: Post Mods. 4330/1 or 4347/8, Nos. 6 and 7 inverters are not installed.

(*e*) *No.* 9 *inverter* (*Type* 103*A*)

No. 9 inverter provides 3-phase 300 c/s AC for the Blue Silk equipment.

3 Aircraft battery

Four 12-volt, 40-amp. hour batteries, connected in series parallel are 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 to OFF before an external supply is connected. With Mod. 4279 embodied a separate external electrical power supply is provided for pre-heating of the Decca crystal ovens. The power supply plug is in the starboard main-wheel well bay.

5 Emergency battery

Two 12-volt, 4-amp. hour batteries, connected in series, completely independent of the main electrical system, are under the pilot's floor. They are utilised to operate the canopy and elevator control detonators, turn-and-slip indicator and emergency lighting in the event of electrical failure. Under full load a fully charged battery should last approximately 3 hours.

6 Circuit breakers and fuses

Circuit breakers, on a panel aft of the entrance door, protect the circuits to ILS, Nos. 1, 4 and 5 inverters, and external lighting. All other circuit breakers are covered with the equipment they serve. Fuses for individual services are on fuse panels aft of the entrance door, on the cockpit starboard wall, and to the right of the navigator's table. A list of 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 and generators from the electrical system, with the exception of the following emergency circuits, irrespective of the setting of the battery master switch:—

Inertia crash-switch circuits
Fire extinguisher circuits
Bomb/flare jettison circuits
Canopy } detonator circuits.
Elevator control }

8 Armament safety break

An armament safety break, in the cabin above the entrance door, controls the normal release circuits to the armament stores with the exception of the flares. Until it is connected the dropping/firing controls remain ineffective.

Controls and Indicators

9 Generator controls

Each generator has a NORMAL/OFF LINE switch on the port console; there are no other generator controls accessible in flight. A field circuit breaker for each generator is on the main electrical panel in the starboard lower equipment bay. Warning lights, one for each generator, are on the flight instrument panel and a DC voltmeter is on the cockpit starboard wall. The lights illuminate when the generators are off-line or to indicate a generator failure. The DC voltmeter registers the output of whichever supply is connected to the electrical system bus-bar, i.e. generator on line—a nominal 28 volts; aircraft battery—a nominal 24 volts; external battery—a nominal 24 volts; external power supply—a nominal 28 volts.

10 AC supplies—inverter controls

(*a*) *No.* 1 *and* 2 *inverters*

(i) *Normal controls and failure indicator*

No. 1 and No. 2 inverters are initially controlled by No. 1 and No. 2 engine MASTER STARTING switches respectively. No. 1 inverter starts immediately No. 1 engine MASTER STARTING switch is put ON, provided that the No. 1 inverter circuit breaker, aft of the entrance door is made. With the No. 2 master starting switch ON, No. 2 inverter will start as soon as either engine driven generator comes on line, and No. 1 inverter will then stop. When No. 2 inverter is running normally, the STANDBY INVERTER magnetic indicator on the main instrument panel shows black; the indicator shows white by day and fluorescent by night if No. 2 inverter stops.

(ii) *No.* 2 *inverter ground test switch*

No. 2 inverter may be tested on the ground with engines stopped by setting the starboard engine MASTER START switch and the FLT. INST. GROUND TEST SWITCH to ON. The test switch is on the ECP at the navigator's station.

(iii) Located above the ECP at the navigator's station are No. 1 and 2 inverter selector and frequency switches and frequency meter. These three items provide the means whereby the frequency of No. 1 and 2 inverters can be checked and, when checked, the inverter providing the best frequency for the operation of the Mk. 4B compass amplifier, from which signals are taken by the Blue Silk system, can be selected. If No. 1 inverter is selected for this purpose No. 2 inverter will continue to supply the non-transferable load connected to No. 2 inverter. Selecting No. 1 inverter by this means will also de-energise the STANDBY INVERTER magnetic indicator so that it will show white.

NOTE: Under normal operating conditions, i.e. with No. 2 inverter supplying the flight instruments, the INVERTER SELECTOR switch must always be left in the inverter No. 2 position.

▶◀

(*b*) *No. 5 inverter*

No. 5 inverter is controlled by three switches, a START switch, a STOP switch and the RADAR SUPPLIES switch on the navigator's ECP. The latter must be at NORMAL before the START switch is operated. No. 5 inverter is electrically interlocked with No. 2 inverter so that before it can be started No. 2 inverter must be running to operate No. 5 inverter regulator blower motor. If No. 2 inverter fails No. 5 inverter will be automatically stopped. A circuit breaker for No. 5 inverter is on a panel aft of the entrance door.

(*c*) *No. 6 and 7 inverters*

No. 6 and No. 7 inverters are controlled by a 3-position LABS A/C SUPPLY NORMAL / OFF / STANDBY inverter switch on the ECP. Two magnetic indicators adjacent to the switch, one for each inverter, show black when energised and white when de-energised.

(*d*) *No. 9 inverter*

No. 9 inverter is controlled by a BL. SILK INV. No. 9 ON/OFF switch on the navigator's ECP.

NOTE: The No. 5 and No. 9 inverters must not be run simultaneously unless both generators are charging. These inverters must not be started simultaneously, a short period being allowed to elapse between starting each of them.

11 Aircraft battery controls

The aircraft battery is controlled by a guarded battery master switch on the starter 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:—

Fire extinguisher circuits
Inertia crash-switch circuits
Bomb/flare jettison circuits
Elevator control } detonator circuits.
Canopy }

12 Emergency battery controls

The supply from the emergency battery to the emergency lighting is controlled by the Pilot's EMERG. LIGHTS switch on the coaming panel. The emergency supply to the turn-and-slip indicator is controlled by the T & S STANDBY SUPPLY switch on the flight instrument panel.

Normal Operation

13 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. During the external checks, ensure that the generator circuit breakers in the starboard electrical servicing bay, 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 the INVERTER SELECTOR switch in the cabin is at No. 2, the field circuit breaker for No. 1 inverter is closed, and that the armament safety break is disconnected. Ensure that the generator OFF LINE switches are at NORMAL. Test No. 1 and No. 2 inverters in the following manner:—

(*a*) Port engine master starting switch ON ...	Listen for the No. 1 inverter starting up
(*b*) Starboard master start switch and FLT. INST. GROUND TEST switch ON	The STANDBY INVERTER indicator should change from white to black
(*c*) FLT. INST. GROUND TEST switch OFF ...	The magnetic indicator should change to white thereby indicating that No. 1 has automatically taken over from No. 2 inverter

14 Starting-up

During start up the generators should cut in at approximately 1,700 RPM and the failure warning lights should go out. When a generator comes on line the No. 2 inverter will start up and the STANDBY INVERTER indicator will change to black. Maximum output from the generators can be obtained by increasing engine RPM to 3,000, but there is sufficient power available to allow the operation of all electrical equipment at 2,750 RPM.

15 Before flight

The operation of Nos. ▶◀ 5, 6, 7 and 9 inverters may be individually checked by the Navigator providing a generator is on line supplying 28 volts. The inverters must not be started on load, i.e. the various services that are supplied by these inverters must be switched OFF. The equipment supplied by these five inverters must not be switched on until the associated inverter has been running for at least 10 seconds, thereby ensuring that the voltage and frequency has stabilised. Nos. 5 and 9 inverters must not be started simultaneously, and must not be run together unless both generators are charging.

16 During flight

Frequent checks must be made in flight to ensure that both generators are on line maintaining 28 volts, and the STANDBY INVERTER indicator remains black. To prevent corrosion due to lack of use, all inverters should be run for a period during each flight.

17 After flight

After landing all inverters except those for the flight instruments may be switched off.

Malfunction

18 Generator failure

(*a*) *Single generator failure*

(i) If a generator fails, its warning light should illuminate and its protective devices should trip it off-line automatically, but the appropriate generator switch must ◀also be switched off. The average load on the remaining generator must not exceed 300 amps. After load has▶ been reduced, switch the generator on again, once only.

If the generator warning light goes out, resume operation of electrical services in stages. If the generator warning light remains on, switch the generator off again.

(ii) If an engine fails or is flamed out, its generator off-line switch must be switched off immediately and the electrical load reduced, because the generator may not immediately come off-line due to the windmilling engine; however, the voltage will be reduced and the equalizing coil will lower the voltage of the other generator, causing a drain on the aircraft battery. Once a generator is off-line the equalizing coil is inoperative.

(iii) In rare circumstances, not connected with engine failure or flame-out, it is possible for a failed generator to remain on line with its warning light out. Should, therefore, the voltmeter read less than 26 volts with both engines functioning normally, set the battery master switch and one generator switch to off. If this restores the voltage to 28, leave the faulty generator off, switch ON the battery and proceed as for single generator failure. If, however, the voltage remains low, reverse the generator switches; if this cures the fault, leave the generator switches as set, switch ON the battery and proceed as for single generator failure.

(*b*) *Double generator failure*

(i) *General*

If double generator failure occurs, switch off both generator switches and immediately reduce electrical load to the absolute minimum. No. 1 inverter will take over from No. 2 to supply the artificial horizon, Mk. 4B compass, altimeters and oil pressure indicators. After reducing load, attempt to regain each generator in turn as at sub-para. (*a*)(i) preceding. Land as soon as practicable.

(ii) *Fuel drill 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 Part I, Chapter 2, paragraph 13(*e*).

NOTE: There is a risk of double flame out, when the main battery is exhausted (LP pumps inoperative), if the LP cocks of an empty fuel tank are ON; consequently, consideration should be given to conserving sufficient battery power to switch OFF the LP cocks of tanks which are at very low fuel states.

◀(*c*) *Load shedding drill*

If a generator fails or is switched off, the average load on the remaining generator must not exceed 300 amps. This state can be achieved as follows:

(i) *Cruise condition*

1. Use not more than 2 fuel pumps continuously
2. Switch off *one* of Decca, Blue Silk inverter or No. 5 inverter.
3. Ensure No. 6/7 inverter off, if fitted

(ii) *Landing phase*

1. Use 2 fuel pumps per side
2. Switch off Blue Silk inverter, *or*, Decca and No. 5 inverter.
3. Confirm No. 6/7 inverter off, if fitted.

A table of approximate electrical loads is given in the Flight Reference Cards under ELECTRICAL SYSTEM FAILURES.▶

(*d*) *Overvolting*

Automatic protection against overvolting is provided. The voltage at which a generator will trip off line will depend on the load imposed on the system at the time, but under normal load conditions, an offending generator should come off line at 32 $\pm \frac{1}{2}$ volts. It may be possible to alleviate overvolting up to 32 volts by increasing or decreasing load in small stages.

19 No. 1 and No. 2 inverter failure

Failure of No. 2 inverter is shown by the STANDBY INVERTER indicator on the instrument panel showing white by day and fluorescent at night. At the same time No. 1 inverter automatically takes over the supply to the artificial horizon, Mk. 4B compass, altimeters and the oil pressure gauges. No. 5 inverter will also be switched off automatically by the breaking of the interlocking relay. If No. 1 inverter fails, check and, if necessary, reset, once only, its field circuit breaker. If it is vital, an attempt may be made to restart the No. 2 inverter in the following manner:—

(*a*) Ensure that No. 5 inverter control switch is OFF.

(*b*) Once only, switch the starboard master starting switch off for approximately one second, then on again. If the inverter starts up and is running normally the STANDBY INVERTER indicator should remain black. Normal operation of its associated equipment and the No. 5 inverter can then be resumed.

(*c*) If this procedure is unsuccessful, no further attempt should be made to restart the No. 2 or No. 5 inverter.

NOTE: If both No. 1 and No. 2 inverters fail, or there is a general power failure, there will be no supply to the AC operated flight instruments and the oil pressure gauges. In the unlikely event of general power failure it will be necessary to switch on the emergency turn-and-slip electrical supply if under instrument flight conditions. If under visual conditions, the battery should be conserved by leaving it switched off until 3-4 mins. before it is estimated that instrument flight conditions will be encountered.

20 No. 5 inverter failure

If No. 5 inverter fails, switch OFF IFF ▶◀. Put the RADAR SUPPLIES switch to EMERGENCY. If the No. 5 inverter circuit breaker has tripped, reset it, once only, and if it remains made, put the RADAR SUPPLIES ◀switch back to NORMAL. If the inverter now functions normally, supplies to IFF may be resumed. ▶

21 No. 6 inverter failure

If No. 6 inverter fails, move the LABS A/C SUPPLY switch to STANDBY to switch off No. 6 inverter and bring in No. 7 inverter.

22 No. 9 inverter failure

Failure of this inverter will render the Blue Silk equipment inoperative.

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 integral tanks*

An integral tank, divided into interconnected outboard and inboard compartments, is in each wing leading edge outboard of the engine. Each compartment has an electrically heated vent valve and a flush-fitting filler-cap on its upper surface.

(*c*) *Wing tip tanks*

(i) Jettisonable wing tip tanks may be fitted. No cocks or controls except the jettison push button are provided, 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 on the port forward panel above the undercarriage position indicator.

(*d*) *Overload tank*

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 for the booster pumps and cocks are on the fuel gauge panel and take-off panel respectively. Circuit breakers for each cock and pump circuit are on the circuit breaker panel.

2 Fuel tank capacities

The effective fuel capacities are approximately:—

	Gallons	*lb. @ 7·7 lb./gall.*	*lb. @ 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
Integral wing tanks ◀2 x 430 galls. ...	860	6,622	6,880
Total internal fuel ...	2,237	17,225	17,896▶

◀Wing tip tanks (2 x 244 gall.) ...	488	3,757	3,904
Total	2,725	20,982	21,800
Bomb bay overload tank	300	2,310	2,400
Total with overload ...	3,025	23,292	24,200▶

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

▶◀

3 Fuel recuperators

(*a*) 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 to the fuel delivery line between the integral tank and the engine. 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 then discharges its contents to the engine. The recuperator will recharge as soon as the booster pumps again start to deliver fuel. Reference to the simplified fuel system diagram will show that the integral LP cocks must be open for the recuperators to be effective and consequently the transfer cock must be shut (NORMAL). To prevent an air lock developing in the system, a constant fuel bleed from the fuel bag allows a small quantity of fuel to pass continuously through the recuperator to a pipe leading to No. 3 tank.

(*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 and one in each integral 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 pump; similarly, the pumps on the starboard side of the tanks feed the starboard engine HP pump. The pump in each integral tank feeds fuel either direct to its associated engine or to No. 3 tank, depending on the selected position of the transfer cock.

Controls and Indicators

5 Fuel cock controls

(*a*) A pair of electrically-operated LP cocks is fitted for each fuselage tank. Of each pair one serves the port engine and the other the starboard engine. Two electrically-operated cocks are fitted for each integral tank, one for normal delivery to the engine and the other for transferring fuel to No. 3 tank. The integral tank LP and transfer cocks are interconnected in such a way that when the transfer cock is open (i.e. to transfer fuel) the LP cock is closed.

(*b*) Each LP cock and transfer cock is controlled by one of twelve switches (appropriately labelled) on the take-off panel and their circuits are protected by circuit breakers on the circuit breaker panel.

6 Fuel booster pump controls

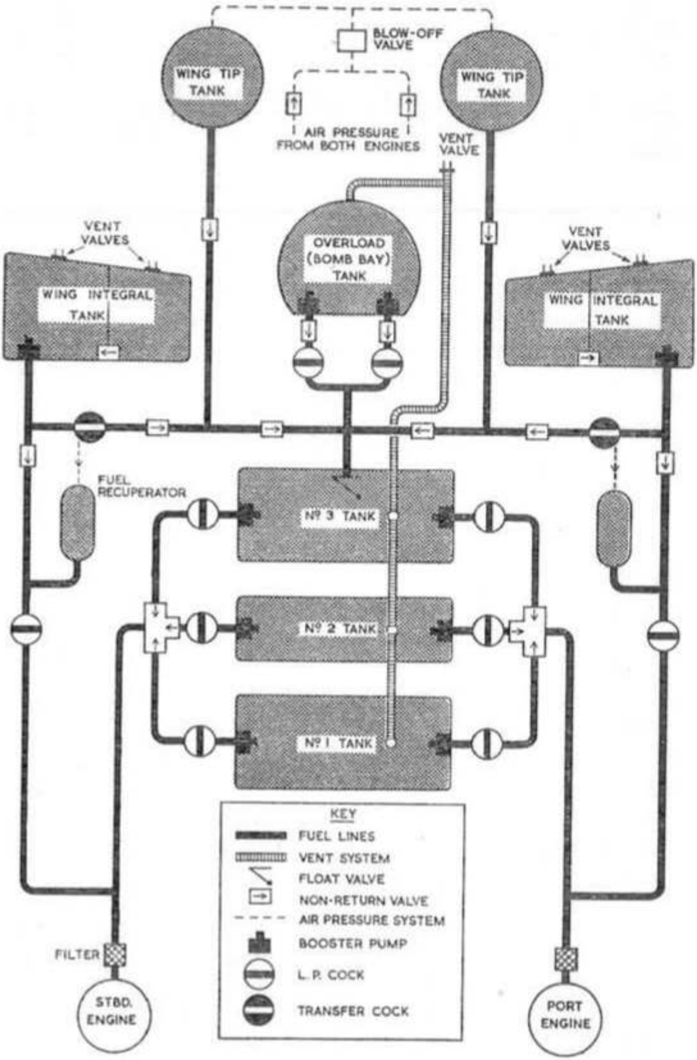
Each fuel booster pump is controlled by a switch on the fuel gauge panel and their circuits are protected by circuit breakers on the circuit breaker panel.

7 Fuel pressure warning indicators

Two fuel pressure warning indicators one for each engine, are on the engine instrument panel. Normally black, they ◀show white if fuel delivery pressure from the booster pumps falls below 6–6½ PSI due to pump failure, negative -G or shortage of fuel in the tanks in use. If the integral tank pumps are on and their cocks at NORMAL, the indicator(s) show white approximately 10 seconds before fuel flow ceases, otherwise the warning is brief. ▶

8 Fuel contents gauges

Five capacitor-type gauges, calibrated in lb., are on a fuel gauge panel, on the cockpit starboard wall. The two gauges at the forward end of the panel, indicate the contents of the wing integral tanks; the other three gauges from front to rear, indicate the contents of No. 1, No. 2 and No. 3



Fuel System Simplified

tanks. No contents gauges are provided for the wing-tip tanks, or the overload tank.

NOTE: 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

9 Checks before starting

First ensure that all fuel cock and pump circuit breakers are made. Check the operation of the LP cocks aurally and leave them ON. Set the transfer cocks to NORMAL. Check the operation of each LP pump both aurally and against the fuel pressure warning indicators. When an overload tank is in use, check its cocks and pumps aurally before start-up and leave its combined cock and pump switches OFF.

10 Fuel management drill

(*a*) Use No. 3 and integral tanks for start-up and taxying to minimise fuel venting from these tanks.

(*b*) Leave all fuel cocks (except overload tank cocks) ON throughout the flight and control the use of fuel by the transfer cocks and LP pumps in accordance with the fuel drill given at the end of this chapter.

(*c*) *General*

(i) Deviations from the correct fuel drill can readily result in an aft CG position. This applies particularly when making repeated circuits and landings with all pumps on.

(ii) For structural reasons the use of the integral tank fuel must be delayed until the latter part of the flight.

(iii) 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.

(iv) 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.

(v) 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.

(vi) 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.

(vii) *Fuel surge*

In a steep climb, or when rapid accelerations or manoeuvres are being made, there is a risk, at low fuel levels, 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.

▶◀

(*d*) *Use of integral tank transfer cocks*

(i) The integral tank transfer cocks must be left at NORMAL (shut), except when transferring fuel to No. 3 tank. Otherwise, with the cocks at TRANSFER, the recuperators are ineffective (see para. 3 above) ▶◀

(ii) If an engine fails and cannot be re-lit, the integral fuel on that side can be used for the other engine by selecting the integral tank LP pump ON and the NORMAL/TRANSFER cock to TRANSFER and then using the integral fuel through No. 3 tank.

(iii) When transferring fuel, as the integral tank LP cock will be closed (see para. 4 above), another booster pump on that side must be on to feed the engine.

(*e*) *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.

(*f*) *Use of overload fuel*

When the bomb bay overload tank is full it is important to use this fuel as early as possible. During the cruise after the wing-tip tanks are empty, use No. 3 tank until it is down to 2,500 lb. and then switch on the overload tank pumps and open the cocks. When the No. 3 tank contents gauge reads 3,500 lb. switch off the overload tank pumps and cocks. Repeat this procedure until the overload tank is empty. As there is no contents gauge for the overload tank the only indication that it is empty will be when the No. 3 tank contents gauge shows a steady decrease in contents when the overload tank pumps are on. Therefore, when transferring fuel make a frequent check of No. 3 tank contents gauge, and when this shows a steady drop, switch off the overload tank pumps and continue the fuel drill in the normal manner.

11 Unusable fuel

Unusable fuel is not gauged but is included in the basic weight of the aircraft.

12 Use of different fuels

◀See Pt. II, Chapter 1, paragraph 3. ▶

Malfunction

13 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 indicator for that side will show white. (See para. 7 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, shut down the engine, check that all LP cock and pump circuit breakers are made ◀and relight as described in Part III, Chap. 4, para. 3.▶ Fuel from the tank with failed pump, excepting the integrals, 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.*

14 Bombs hang-up

(i) 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.

(ii) 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.

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

(iv) If internal stores on the rear station hang-up when wing stores are being carried, wing stores or tip tanks must be jettisoned.

NOTES TO FUEL DRILL

NOTE 1: For sorties which require less than full fuel load the fuel load is adjusted by varying the contents of the fuselage and wing-tip tanks; the fuel carried in the fuselage tanks must be disposed proportionally to the tank capacities; the integral tanks must be filled for every sortie, except when carrying out flight trim checks in accord- ◀ance with the requirements of AP.4326H Vol. 1, Section 3, Chapter 4, Appendix 1. ▶

NOTE 2: When carrying out LABS manoeuvres each engine should be fed by at least two fuel booster pumps to avoid the possibility of flame-out if a booster pump fails. Revert to the normal fuel drill on completion of the manoeuvre.

▶◀

NOTE 3: If Mods. 3367 and 3391 are not embodied use of the rear fuselage tank alone is not advisable, because of the fuel gauge inaccuracy, when the indicated fuel level in this tank falls to 1,000 lb. or below. In these circumstances amend Stage 8 of the fuel drill to read "when No. 1 tank reads 500 lb. and No. 3 tank reads 1,000 lb."

FUEL MANAGEMENT DRILL FOR ALL SORTIES

(See Notes opposite)

CONDITION	TANK POSITION					
	Integrals		◀No. 1	No. 2	No. 3▶	Wing Tips
	Cocks	Pumps	Pumps	Pumps	Pumps	
1. Start-up and taxy	ON and NORMAL	ON	OFF	OFF	ON	Full
2. Take-off and climb	ON and NORMAL	ON	ON	ON	ON	Full
3. When No. 1 tank reads 3,500 lb. No. 2 tank reads 2,000 lb. and the integral tanks show a drop (switch off relevant pumps when figures reach those quoted)	ON and NORMAL	OFF	OFF	OFF	ON	Feeding
4. When No. 3 tank reads 3,500 lb. keep No. 1 and No. 3 tank contents equal.	ON and NORMAL	OFF	As reqd.	OFF	As reqd.	Empty
5. When No. 1 and No. 3 tanks read 1,000 lb.	ON and NORMAL	ON	OFF	OFF	OFF	Empty
6. When integrals read 500 lb.	ON and TRANSFER	ON	OFF	OFF	ON	Empty
7. When integrals are empty keep No. 1 and No. 3 tank contents equal.	ON and NORMAL	OFF	As reqd.	OFF	As reqd.	Empty
8. When No. 1 and No. 3 tanks read 500 lb. (See note 3)	ON and NORMAL	OFF	ON	ON	ON	Empty

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 port side of the upper equipment bay. A handpump 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. The wheel brakes hydraulic pressure gauge is on the cockpit starboard wall and that for the main system is fitted centrally, below the flight instrument panel.

2 Pumps and services

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

Undercarriage;
Flaps;
Wheel brakes;
Airbrakes;
Bomb doors.

(*b*) The handpump 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 handpump 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 handpump can be used to operate all services. The cock is normally wire-locked in the FLIGHT position.

(*c*) A second hydraulic GROUND/FLIGHT cock, situated in the battery compartment allows the nose wheel only to be raised for servicing purposes. The cock is normally wire-locked at FLIGHT.

3 Accumulators

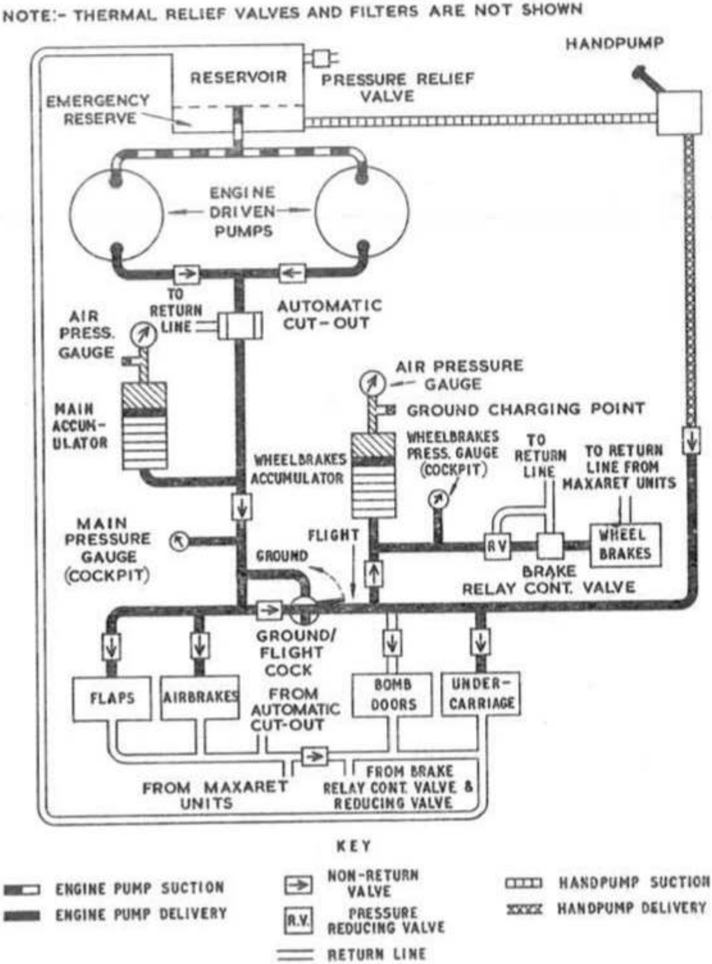
(*a*) There are two accumulators in the system; one for the wheel brakes is in the upper equipment bay and that for the undercarriage, flaps, airbrakes and bomb doors is in the starboard wing. The air pressure gauge for the brake accumulator is in the bomb bay on the forward bulkhead and that for the wing-mounted accumulator is in the starboard wheel well. These gauges should read 1,350 (+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 2,200 to 2,700 PSI while thermal relief valves in all circuits except the wheel brakes operate when pressure in the line to a service increases, for any reason, to more than 3,350 to 3,550 PSI.

Controls

4 Controls

The electrically-actuated selector valves for all services, other than that for the wheel brakes which is mechanically operated, are controlled by switches in the cockpit. If electrical failure occurs, provision is made for mechanical selection of undercarriage lowering and bomb doors opening. Details of these controls are given in Chapters 5 and 11.



Hydraulic system simplified

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 handpump against the wheel brake hydraulic pressure gauge.

7 Checks during starting

Start the port engine first and note that the pressures on the main and wheel brake pressure gauges rise to 2,700-2,750 PSI. Then operate a hydraulic service and note on completion of the operation that the hydraulic pressure builds up again to 2,700-2,750 PSI.

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

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 2,700-2,750 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 2,700-2,750 PSI.

Malfunction

10 Hydraulic failure

(*a*) A failure may be assumed if the reading on the pressure gauge is below 2,200 PSI and fails to build up. If hydraulic failure occurs the flaps and airbrakes will be inoperative. By using the hydraulic handpump, after making the appropriate selection, the undercarriage can be lowered and bomb doors opened, and wheel brake pressure can be obtained. Detailed emergency drills are given in the Flight Reference Cards.

◀(*b*) *Spurious warning of hydraulic failure*

Cases have occurred, particularly at high altitude, where the main hydraulic pressure gauge reading has dropped sufficiently to suggest that hydraulic failure has occurred; on returning to low altitude the reading may build up again. If the symptom appears, check the operation of the hydraulic handpump; if there are no other symptoms of hydraulic failure and there is firm resistance to operation of the handpump, it may be assumed that the hydraulic system is serviceable and the gauge faulty. ▶

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 4—ENGINE SYSTEMS AND CONTROLS

Contents

1 Avon Mk. 109

The Avon Mk. 109 is a turbo-jet aero-engine having a twelve-stage axial flow compressor directly coupled to a two-stage turbine; it gives 7,400 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 pump 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 effected 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.

(iii) Each pump of the dual pump units is capable of supplying sufficient fuel for full thrust at take-off.

3 Variable inlet 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 ◀7,400 RPM, the compressor is not operating at maximum efficiency. Better specific consumption, therefore, will be obtained by operating above 7,400 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 (turn clockwise to increase friction) on the side of the quadrant. The starboard throttle incorporates a press-to-transmit pushbutton.

5 High pressure (HP) fuel cocks

The HP cocks, one for each engine, are controlled by levers outboard of the throttles. They may be locked in either the ON (forward) or OFF position by the smaller of the two knurled knobs (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 pushbutton.

6 Engine starting, relighting and stopping controls

(*a*) *General*

Each engine is fitted with a triple-breech cartridge turbo-starter, using electrically fired cartridges, and high energy ignition units. The starting cycle is automatically controlled by cartridge selector switches and time-delay switches.

(*b*) *Starter loading*

(i) After checking that the MASTER START switches are off (down), unlock and open the starter fairings. Each breech cap is then unscrewed and the spent cartridge removed by unscrewing the cap, after releasing the locking ratchet by pressing on the spring-loaded stud in the 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 any work be carried out on the starter while the engine is turning.

NOTE: If Avon Mod. 843 (modified starter fairings) is not embodied do not fly the aircraft with live cartridges fitted if engine anti-icing is to be used.

(*c*) *Starting controls*

The main starting controls are on the engine starter panel on the cockpit starboard wall and for each engine consist of a MASTER START switch and IGNITION switch, and a STARTER pushbutton. The MASTER START switch must be on before either the STARTER pushbutton 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) Indexing and firing the cartridge to accelerate the engine to 1,300-1,500 RPM.

(ii) Energising the high energy ignition plugs to ignite the fuel spray and make the engine self-sustaining. The time delay switch holds the starter pushbutton in 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.

7 Oil system

Each engine has its own integral oil system of 19 pints capacity including 16 pints sump 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

RPM indicators, oil pressure gauges and 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, paras. 1 and 2.

10 Anti-icing system description and controls

(*a*) Hot air for engine anti-icing is ducted from the engine compressor to the double skin at the front of the engine cowl, the engine intake casing and the turbo-starter casing.

(*b*) The systems are controlled by two ON-OFF switches, one for each engine, on the port console. Magnetic indicators beside the switches show white when the systems are switched on and black when switched OFF.

(*c*) Use of engine anti-icing is covered in Part III, Chapter 2.

11 Engine handling procedures

Detailed information to cover particular aspects of engine handling on the ground and in flight is given in the relevant ◀chapters in Part III and in the Flight Reference Cards.▶

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 left-hand grip of the control column carries the F.95 camera control switch. The top of the right-hand grip carries, from left to right, the G.45 camera button, a flap which may be raised to unlock the trigger on the forward face of the grip, and the bomb/RP button which is covered by a guard. On the aft face of the grip is the tailplane trimmer, covered by a spring-loaded flap. 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 11.

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. One is a cut-in switch operated by the thumb flap which covers the tail-trim switch. The tail-trim switch cannot be operated without first operating the thumb flap 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 up to give a nose-down trim and down 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 on 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 spring-loaded switch on the port console.

(*b*) The aileron trim indicator is on the flight 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 two, three-position, LEFT-OFF-RIGHT switches, mounted on the port console. One switch controls the positive supply and the other the earth return so that it is necessary to operate both switches simultaneously to obtain rudder trim movement.

(*b*) The rudder trim indicator is on the flight instrument panel.

5 Control column snatch unit

(*a*) *Pre-mod.* 2687

A lever on the port console, shielded by a flap marked DANGER-DETONATORS-CONTROL COLUMN RE-

LEASE AND CANOPY JETTISON, controls canopy jettison and the control column snatch unit. Pulling the lever up to its full extent operates the following:—

(i) The canopy explosive retaining bolts, thus releasing the canopy.

(ii) A pneumatic jettison ram which forces the front of the canopy up into the airstream.

(iii) An explosive collar on the elevator control rod which is thus severed.

(iv) A spring in the snatch unit which pulls the control column forward thus ensuring adequate clearance for the pilot on ejection.

After the snatch unit has been operated longitudinal control can then only be effected by means of the tail-trim switch.

NOTE: 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 about half a degree of nose-up trim and an increased pull force necessary to unstick on take-off.

(*b*) The circuits operating these services are connected ◀through a CANOPY/SNATCH MASTER switch direct to the battery bus-bar and also to the separate emergency battery. Therefore, providing the CANOPY/SNATCH MASTER switch is ON, the circuits will function with▶ the battery isolating switch OFF, the inertia crash switches tripped or even if the aircraft battery has become damaged or disconnected.

(*c*) *Post-Mod.* 2687

(i) Post-Mod. 2687 the control column snatch unit is operated, and the canopy is also automatically jettisoned when either firing handle on the pilot's ejection seat is pulled. The stirrup handle on the port console is disconnected from the control column snatch unit and provides only a means of jettisoning the canopy independently of the ejection system.

(ii) The snatch unit consists of a tubular casing housing a hollow piston, which, when the unit is cocked, holds a main spring in compression against the rear end of the casing; the piston is held in position by a sear. A snatch rod, attached to the control column lever, passes through the main spring and piston. The snatch unit is operated initially by pulling either firing handle on the ejection seat; this action withdraws two sears in a time-release and breech unit on the rear of the seat guide rail. When the sear in the breech unit is withdrawn, a cartridge is fired to force gas under pressure through a narrow tube to a piston which releases the snatch unit sear. Release of the snatch unit sear causes a toggle switch to close, permitting current to flow to the elevator control tube explosive collar detonator; almost simultaneously the snatch unit spring is released, causing the snatch unit rod to pull the control column fully forward. ◀*The CANOPY/SNATCH MASTER switch on the cockpit starboard wall must be on before the elevator control tube explosive collar detonator will operate.*▶

6 Flying controls 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. Post-Mod. 099/RAFG the control lock stowage is moved to the cabin starboard wall forward of the entrance door.

(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 on the port front panel, control an electrical actuator for the undercarriage selector valve. A safety clip may be fitted behind the UP button when the aircraft is on the ground. 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 on the UP button clockwise to its stop before selecting undercarriage UP in the normal way; the collar may rotate through 60° or 90° according to the type fitted. 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 is fitted on the port front panel, or to the left of the main instrument panel and it must be LIVE (up) before undercarriage UP can be selected. At maximum RPM the undercarriage should normally retract in 15 seconds (max.) and at 6,000 RPM it should lower in approximately 12 seconds.

(*b*) *Undercarriage position indicator*

A standard undercarriage position indicator is on the port front panel outboard of the UP/DOWN pushbuttons. 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 black-and-yellow striped handle on top of the port front panel. Pulling the handle fully out until it is locked in position by a spring clip, operates the selector valve mechanically to the "down" position and opens an emergency down selector valve. Failure to lock the handle fully out may result in the selector valve taking up a neutral position, thus by-passing fluid to the return line and causing loss of hydraulic pressure. If a drop in hydraulic pressure occurs after the undercarriage is locked down by this method, check that the handle is *fully* out and locked. 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.

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

◀(*c*) Drills for operation of the undercarriage after malfunction are given in the Flight Reference Cards.▶

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 on the port front panel; the position indicator 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.

(*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 starboard side of the pilot's seat floor structure.

(*c*) At 6,000 RPM the flaps should normally retract in 16 seconds (approx.) and lower fully in 13 seconds (approx.).

10 Airbrakes control

A three-position, IN-MID-OUT switch controlling the actuator for the airbrakes is on the port coaming. The switch is fitted with a spring-loaded guard so that this must be moved before OUT can be selected. No provision is made for "in flight" operation of the airbrakes in the event of electrical or hydraulic failure.

11 Wheelbrakes control

(*a*) The hydraulically-operated wheelbrakes are controlled by a toe-pedal on each rudder pedal. Differential and progressive braking is obtained, irrespective of the position of the rudder bar, by varying the pressure applied to the toe-pedals. A separate parking brake lever is on the inboard side of the port front panel. It is held up to apply the brakes and is held in this position by a spring-loaded catch which must be squeezed before the lever can be released. When the parking brake is applied a single pressure of 1,500 PSI is fed to each wheel brake. Anti-skid (Maxaret) units are fitted to give efficient braking. (See ◀Part III, Chapter 3, para. 5). ▶

(*b*) The available pressure in the brakes accumulator is shown on a gauge on the cockpit starboard wall. Normally 2,200-2,700 PSI, this pressure allows approximately six full applications of brake if the hydraulic system has failed and in this event 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 handpump, provided that fluid is available.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 6—FLIGHT INSTRUMENTS

Contents

1 Compasses

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

The Mk. 4B compass operates whenever AC is supplied by either No. 1 or No. 2 inverter. The master indicator and the compass control panel are at the navigator's station. The pilot's repeater, on the main instrument panel may also be used as a directional gyro by setting the COMPASS-D. GYRO switch on the engine starter panel, to D. GYRO. On some aircraft a repeater may also be fitted at the nose station.

(*b*) *Magnetic stand-by compass*

An E.2 stand-by compass at the top centre of the windscreen is illuminated by a red lamp controlled by a switch on the port front coaming.

2 Pitot and static pressure system

An electrically-heated pressure head is 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 VSI, ASI's and altimeters. The heater element in the pressure head is controlled by a switch on the take-off panel.

3 Artificial horizon

An artificial horizon Mk. 4D is on the main instrument panel. The instrument will function whenever AC is being supplied by either No. 1 or No. 2 inverter.

4 Turn-and-slip indicator

A turn-and-slip indicator on the flight instrument panel is operated from duplicated 24-volt DC supplies having automatic changeover. Both supplies are primarily controlled by the MASTER START 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 the instrument may be connected to the emergency battery (see Part I, Chap. 1, para. 5) by putting the switch beside the indicator to ON; the OFF flag should then disappear.

5 Instrument landing system (ILS)

The ILS indicator and marker lamp are on the port side of ◀the flight instrument panel while the control unit, master switch and volume control are on the rear of the starboard▶ console. A circuit breaker on the wall aft of the entrance door must be made before the equipment can be operated.

▶◀

6 Altimeters

(*a*) *Radio altimeters*

A low-level radio altimeter and associated limit lights are on the flight instrument panel. An ON/OFF switch, controlling the DC power supply to the system is on the navigator's ECP. The height-band selector is on the cockpit starboard wall.

(*b*) *Barometric altimeters*

(i) Two Mk. 19 altimeters are mounted one each on the pilot's and navigator's instrument panels. With Mod. 3842 embodied, a vibrator unit is fitted to the rear of each instrument to improve its performance. Power supplies for the vibrator units are taken from No. 2 inverter with No. 1 as a standby.

(ii) Post Mod. 3897 the pilot's Mk. 19 altimeter is replaced by a Mk. 22F altimeter and amplifier unit. Pressure setting is affected by a serrated knob at the bottom of the face of the instrument. Three small windows at the top of the dial display the yellow/black striped power failure warning flag. Power supplies for the amplifier are from No. 2 inverter with No. 1 as a standby.

7 Accelerometer

An accelerometer is mounted on the front instrument panel to starboard of the flight instrument panel.

8 Outside air temperature gauge

An outside air temperature gauge is on the port side of the navigator's table. 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.

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*

Each engine is served by two fire extinguisher bottles; one dual-headed extinguisher is in each mainwheel well and one single-headed extinguisher is in the wing on the inboard side of each engine. Each bottle is fully discharged in one operation. The dual-headed extinguishers also serve the fuselage fuel bay in crash landing conditions (see sub-para. (*c*) following).

(ii) *Fire warning lights and pushbuttons*

Fire extinguisher pushbuttons incorporating fire warning lights, 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. A separate TEST ENG FIRE WARNING pushbutton is fitted to starboard of the pushbuttons for testing the warning lights.

(*b*) *Fuselage fire extinguishers*

A single-headed fire extinguisher bottle is above the aft end of the bomb bay for protection of the fuselage fuel tank bay and, under crash conditions, one head of each dual-headed engine fire extinguisher also discharges into the fuel tank bay.

(*c*) *Operation of fire extinguishers*

(i) *Engine fire extinguishers*

A fire warning light will illuminate when heat from a fire in the engine bay trips one or more of the re-setting fire detectors in the engine nacelles. Pressing the appropriate button will fully discharge both fire extinguishers into the affected engine. When the fire is extinguished the warning light will go out. All fire extinguishers will operate automatically if both inertia crash switches are tripped but part of the contents of the dual-headed extinguishers will be discharged to the fuselage fuel tank bay.

(ii) *Fuselage fire extinguishers*

The fuselage fire extinguisher can be discharged only by the tripping of the inertia crash switches. The dual-headed engine fire extinguishers also discharge part of their contents into the fuselage fuel tank bay when the crash switches are tripped.

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

◀A Type 34 BCF hand-operated fire extinguisher is on the cabin starboard wall aft of the entrance door. The contents of this extinguisher are non-conducting and virtually non-toxic. It may be used on all classes of 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 and generators from the electrical system with the exception of the emergency circuits quoted in Chap. 1, para. 7, irrespective of the setting of the battery master switch.

3 Emergency equipment

Stowages for asbestos gloves, a first-aid kit and a crash-axe are on the cabin forward starboard wall. Cabin pressure leak-stoppers are stowed on the roof at the navigator's station.

NOTE: Two survival pack stowage crates are in the rear fuselage. Access to them is through the rear camera-hatch, or by chopping through the fuselage at the points indicated.

4 Cabin window

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

5 External lighting

(*a*) All external lighting circuits are protected by a circuit breaker on the starboard wall aft of the entrance door.

(*b*) All external lighting switches are on the pilot's port console. They are, from the left;

(i) Navigation lights; this also controls the navigation lights on the nose of each wing-tip tank.

(ii) Taxying lamps switch.

(iii) Landing lamp OFF-HIGH-LOW switch.

(iv) Identification lights MORSE switch.

(v) Identification lights STEADY switch.

(vi) External lighting MASTER switch. This must be ON before any of the external lights will function.

(*c*) The taxying lamps are fitted one in each wing tip, the landing lamp is in the port mainplane under-surface and the downward identification light is in the leading edge of the aft camera hatch.

◀(*d*) White, flashing anti-collision lights are on the▶ upper and lower surfaces of the rear fuselage. They are controlled by an ON-OFF switch on the pilot's port console. If the flasher unit fails, the lights will remain on and steady, unless switched off.

6 Internal lighting

(*a*) *Cockpit, normal lighting*

(i) The port console, cockpit port wall and port front panel are illuminated by red floodlamps controlled by two dimmer switches on the cockpit port wall.

(ii) General illumination of the instrument panel is provided by red and u/v floodlamps controlled by four dimmer switches on the cockpit front coaming. Individual lamps for the standby compass and RPM indicators are controlled by two switches also on the cockpit front coaming.

(iii) The cockpit starboard wall and starboard console are illuminated by red and u/v floodlamps controlled by two dimmer switches on the cockpit starboard wall.

(*b*) *Cockpit, emergency lighting*
Two emergency lamps, illuminating the flight instrument panel, are supplied from the emergency battery. They are controlled by an ON/OFF switch on the cockpit front coaming. The switch has a luminous spot beside it for identification in the dark.

(*c*) *Cockpit anti-dazzle lamps*
Two anti-dazzle lamps, one each side of the flight instrument panel, are controlled by a BRIGHT/DIM switch on the cockpit front coaming. A further switch, on the starboard side of the navigator's nose station, also operates these lamps but only under the BRIGHT condition. When selected to BRIGHT 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.

(*d*) *Wander lamp*
Provision is made for fitting a wander lamp and the controlling switch for this is on the cockpit starboard wall.

(*e*) *Cabin lighting*
(i) General illumination of the cabin is provided by a dome lamp which is controlled by a switch on the electrical control panel. Individual panels are illuminated by red flood-lamps and adjustable lamps controlled by dimmer switches either on or adjacent to the panels. A wander lamp and associated dimmer switch are also provided at the navigator's normal station.
(ii) Two emergency amber lamps, one to illuminate the escape door mechanism and one for the navigator's parachute stowage are on the starboard wall at the navigator's station. Supplied from the 2·4V emergency battery, both lamps are illuminated simultaneously by the operation of either of two switches, one mounted on the bracket carrying the Blue Silk remote controller in the nose, and one attached to the bomb distributor structure.

7 Signal pistol

A signal pistol is mounted in the roof of the fuselage at the navigator's station. Stowages for cartridges are on the wall above the navigator's table.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 8—AIR CONDITIONING, PRESSURISING, HEATING AND DEMISTING SYSTEMS

Contents

1 Air conditioning system

(*a*) Hot air from the engine compressors is used for cabin air conditioning. The initial supply from each compressor is through an electrically operated gate-valve controlled by one of two ENGINE AIR switches on the take-off panel.

(*b*) The temperature of the air entering the cabin is governed by a mixing valve controlled by a COLD-off-HOT switch, spring-loaded to the mid (off) position, on the take-off panel. The setting of the mixing valve is shown on the indicator, labelled CABIN AIR, forward of the control switch.

(*c*) With the mixing valve set to fully HOT the hot air is passed direct to the cabin. By moving the mixing valve to COLD the hot air is passed through coolers, one in each inner plane leading edge, and a cold air unit in the port inner plane and thence into the cabin. The proportion of air can be varied between the two extremes by setting the mixing valve to any desired intermediate position.

(*d*) From the common delivery duct into the cabin the conditioned air is delivered to diffusers in various parts of the cabin. A perforated tube running along each side of the pilot's seat incorporates a three-position (shut-mid-on) cock on the port side. This tube also feeds two adjustable vents one on each side below the windscreen quarter panels. A similar tube and cock are at the navigator's normal station.

(*e*) *Air ventilated suit system*

(i) Mod. 3275 introduces an air ventilated suit system. The supply of air for this system is taken from a pipeline in the air conditioning system between the primary air cooler and the mixing valve. The pilot's supply pipe runs across the forward face of the pressure bulkhead to a control valve mounted on the port side of the navigator's take-off station head-rest. A flexible hose from the control valve terminates in a quick-release socket mounted in a bracket alongside the pilot's ejection seat; another flexible hose, clipped to the seat structure, connects with a quick-release socket on the pilot's ventilated suit.

(ii) Air supply points for the navigator's suit are provided at his take-off, normal and forward stations. Control valves are provided on the starboard side of the take-off seat, at the aft end of his chart table and on the starboard side at the prone position. A separate 2 ft. length of kink-proof hose is stowed in clips across the top of the navigator's crate and may be used at both his forward stations to allow him greater freedom of movement.

(iii) The flow of air to the AVS is controlled by the engine air switches and the mixing valve for the air conditioning system.

(iv) A connection for a ground supply of cooling air to the ventilated suit system is on the port side of the fuselage.

2 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 on the cockpit starboard wall.

(*b*) Electrical contacts in the master unit operate a warning horn if the cabin pressure drops excessively. A guarded warning horn override switch is on the take-off panel.

NOTE 1: No air will be supplied for either air conditioning or pressurising unless the engine air switches are ON.

NOTE 2: 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.

3 Use of air conditioning and pressurising systems

(*a*) *Pre-starting checks*

Check that the engine air switches are OFF and test the operation of the mixing valve over its full range.

(*b*) *Checks after starting engines*

Switch ON the engine air switches and set the mixing valve as required but see (*c*) following.

(*c*) *Use of mixing valve*

There is no restriction on the ground in the use of fully HOT but if any other selection is required this is restricted to a maximum of 10 minutes and the engines must not exceed 5,000 RPM continuously. If or when the 10 minute limit is reached either select the mixing valve to fully HOT or switch OFF the engine air switches until the aircraft is airborne. In the air there is no restriction in the use of the mixing valve.

(*d*) *Use of engine air switches in flight*

In flight always keep the engine air switches ON so that air-conditioning and pressurising is obtained. If an engine fails, or is shut-down, switch off its engine air switch.

(*e*) *Checks after landing*

After landing set the mixing valve to HOT, switch off the engine air switches and wait 2 minutes to relieve any residual cabin pressure before the entrance door is opened.

4 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 ◀25,000 ft. but it must be remembered that if the warning horn has been isolated a careful watch must be maintained to ensure that 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 25,000 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 25,000 ft. to avoid the effects of decom-▶ pression 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.

5 Camera bay and gun-pack heating

(*a*) *Camera bay*

Hot air from the air-conditioning system is ducted to a diffuser in the F.24 camera bay through an automatically-operated temperature control valve. The heating system also prevents misting of the camera window and camera lens.

(*b*) *Gun pack*

The gun pack is heated by disconnecting the supply to the camera bay and connecting it to the gun pack heater-pipe.

6 Demisting system

(*a*) *Canopy and nose stations*

(i) The pilot's canopy, the transparent nose fairing, the observation windows and the navigator's window are all provided with dry air demisting. Two separate air-drier circuits, each incorporating an electrically-driven blower motor, serve the pilot's canopy, the nose fairing and observation windows, respectively. A branch pipe from the suction side of the canopy circuit is connected to the navigator's window, but as there is no feed back to the window, its role in this respect is purely static. The CANOPY-DEMIST control switch is on the take-off panel and that for the nose circuit is on the nose port wall below the armament panel. The cartridge containing the drying agent for the canopy circuit is above the navigator's table and that for the nose circuit is just aft of the port observation window. Small indicator windows in the casings enable the drying agent to be seen; this will appear pink when unserviceable.

(ii) A static air drier for the transparent nose fairing is just aft of the fairing on the cabin roof port side.

▶◀

(*b*) *Windscreen quarter panels*

Two perforated tubes on the coaming below the windscreen quarter panels are fed with air from the air-conditioning system, this air being directed on to the inner surface of the panels. Each tube has a shut-off valve operated by a knob at the rear marked PUSH TO CLOSE. The interspace in the panels is also demisted from the canopy blower circuit.

(*c*) *Windscreen centre panel*

Hot air, to prevent misting and icing of the windscreen centre panel, is piped from the engine compressors to two diffusers in the windscreen interspace. The flow of air is thermostatically controlled and is automatically shut-off when the air in the interspace reaches a pre-determined temperature.

(*d*) *Nose station*

Two perforated pipes around the plastic nose and a diffuser directed onto the sighting panel are automatically supplied with conditioned air whenever the air-conditioning system is in operation.

7 Use of demisting system

(*a*) Check the nose and canopy drying cartridges on entering the aircraft, and during the pre-start checks, the operation of both demister motors.

(*b*) In flight, the windscreen quarter panels may be demisted as required, but it is advisable to always turn on the supply before commencing a descent from high altitude so that any misting which occurs during the descent is cleared as rapidly as possible.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 9—AIRCREW EQUIPMENT ASSEMBLY AND ASSOCIATED SYSTEMS

Contents

SAFE FOR PARKING

◀ CANOPY/SNATCH MASTER switch OFF ▶
Safety pin in face screen firing handle
Safety pin in seat pan firing handle

Ejection Seat (Type 2CB)

1 General

Post-Mod. 2687 the pilot is seated in a Type 2CB Mk. 1 ejection seat. The seat is equipped with an 80 f.p.s. ejection gun, Type ZM safety harness incorporating a negative-G strap, leg restraint, Mk. 16 seat type parachute assembly, Type M Mk. 3 personal survival pack and a Mk. 4 emergency oxygen set (see para. 9 following). The system is fully automatic. When either firing handle on the seat is pulled, the control column snatch unit and canopy jettisoning are automatically initiated. After the seat ejects, automatic facilities release the safety harness, separate the occupant from the seat and open the parachute at a safe height and speed.

2 Controls

(*a*) *Firing handles*

Two firing handles are provided, one protruding from the front of the drogue container (face screen firing handle), and one on the front of the seat pan. A safety pin, with a red disc attached, is provided for each firing handle; stowages for these pins are on the starboard side of the seat pan. When either firing handle is pulled, the control column snatch unit is operated, the canopy is jettisoned and, one second later, the ejection gun is fired.

(*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

Fig. 1. Ejection seat Type 2 CB

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 controls*

The parachute is normally deployed by a withdrawal line attached to the seat via an apron in the seat pan. If the ejection seat fails to fire or if the automatic harness release fails to function after ejection, separation of the parachute from the seat and deployment of the parachute must be achieved manually; two controls on the parachute waist belt are provided for this purpose. The outer D-ring (override D-ring), when pulled, disconnects the parachute from the withdrawal line; the inner D-ring (parachute rip cord) must then be pulled to deploy the parachute when clear of the aircraft or seat.

(*e*) *Leg restraint*

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 safety harness. The length of the restraining cords may be adjusted by pressing the knob under each snubber 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

When either firing handle on the seat is pulled, the canopy is jettisoned; the elevator control rod is severed and the control column snatch unit operated; approximately one second after the firing handle is pulled the ejection gun is fired. The sequence of events thereafter is as follows:—

(*a*) As the seat ascends the guide rail, the drogue gun time delay mechanism is operated, and the leg restraint cords tighten, pulling the legs together; the barostatic time release for the seat harness is armed; the emergency oxygen supply is turned on automatically; and the main oxygen hose, AVS hose and mic-tel leads are pulled away from the aircraft connections.

(*b*) Half a second after the seat ejects the drogue gun is fired to deploy the drogues which stabilise and decelerate the seat.

◀(*c*) If the ejection has taken place above 10,000 feet, a stabilised fall occurs until this height is reached. At this point the barostatic time release operates and, after 1¼ seconds, the safety harness is released and the scissors shackle opens, leaving the drogue line connected to the apron behind the occupant and thence via the parachute withdrawal line to the apex of the parachute. The pull of the drogues streams the parachute, which on deploying sharply checks the descent of the seat occupant, causing the seat to fall clear. ▶

(*d*) If the ejection occurs below 10,000 ft. the same sequence ensues except that the barostatic time release unit operates 1·25 seconds after ejection, subject to the overriding influence of the 'G' controller which delays operation of the barostatic time release unit if the speed is too high for safe parachute deployment.

Navigator's Seats and Safety Equipment

4 (*a*) When at his normal station the navigator occupies a bucket-type swivel seat mounted on a mechanical structure which is hinged and locked to catch plates in the floor. When not required, the seat can be unlocked from the floor catch plates and, by the hinge action of the mechanical seat structure, be stowed and locked beneath the navigator's table. A spade-shaped handle, protruding from the rear of the structure, controls the locking action of the mechanism. To release the seat from its stowed position, the handle is pulled down: to release the seat from its operative position, the handle is pulled up. The action of locking the seat in either position is automatic upon the engagement of the catches. The swivel seatpan itself can be locked to one of four positions, i.e. facing forward, aft or either side, by the operation of a knob below the starboard side of the seatpan. The seat must face the navigation table and the hinge backrest must be lowered before the seat can be moved to its stowed position.

(*b*) *Navigator's crash seat*

For take-off and landing the navigator occupies a seat to the right of and below the pilot. This seat has a Z-type harness and a mic/tel socket is on the starboard wall above the G. Mk. 4B compass amplifier box. No oxygen regulator is provided at this station.

(*c*) *Navigator's safety equipment*

(i) The navigator wears a flying suit incorporating a parachute safety harness and emergency oxygen bottle. His parachute may be placed in a stowage on the cabin starboard wall.

(ii) Post-Mod. 3832, a chest-type Mk. 8 parachute is supplied for the navigator. Incorporated in the parachute is a barometric release to open the parachute automatically at 13,000 ft. when the navigator abandons the aircraft. If abandoning takes place below 13,000 ft. the parachute opens automatically 2 seconds after the navigator leaves the aircraft. The barometric release is armed by a static line from the parachute to a U-bolt below the parachute stowage. A rip cord D-ring is also provided on the parachute to open it manually if the barometric release fails, or if abandoning occurs at low level.

(*d*) Detailed abandoning drill is given in the Flight Reference Cards.

Doors and Emergency Exits

5 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 pulling the guarded DOOR EMERGENCY RELEASE lever, above the door, forward, to release the hinge pins, and striking the top of the door. When the lever is operated, provided that the windbreak air cylinder locking pin is removed, a windbreak at the forward edge of the door aperture is forced out under air pressure into the slip-stream, thus forming a shield to aid escape through the door aperture. The windbreak air cylinder, locking pin and pressure gauge are above and aft of the entrance door on the cabin starboard wall. The locking pin has a red warning label ◀attached. Windbreak air cylinder pressures are given in the leading Particulars. ▶

6 Canopy

(*a*) (i) The canopy is secured to the aircraft by explosive bolts which are fired electrically to jettison the canopy. The detonators are operative irrespective of the position of the battery master switch; if the aircraft battery fails they are automatically supplied by the emergency battery. All electrical supplies to the canopy detonators are initially ◀controlled by the CANOPY/SNATCH MASTER switch on the cockpit starboard wall.

(ii) Separation of the canopy from the aircraft is assisted, during jettisoning, by a canopy jettison ram on the upper fuselage behind the pilot's seat. This forces the canopy up into the slipstream after the explosive bolts have been fired. To prevent inadvertent operation on the ground, a safety pin is inserted in the canopy jettison ram; this must be removed before flight.

(iii) The canopy may be jettisoned independently of, or in conjunction with, the ejection system.

(*b*) *Independent jettison*

(i) To jettison the canopy independently of the ejection system, ensure that the CANOPY/SNATCH MASTER switch is on, and then operate the CANOPY JETTISON handle on the port console. The canopy should be jettisoned at speeds above 120 knots, if practicable, as below this speed it may strike the tail unit.

(ii) When the CANOPY JETTISON handle is operated, a double pole switch is closed to permit current to flow to the canopy detonators; simultaneously, the release for the canopy jettison ram is mechanically operated, the canopy is forced up into the slipstream, and is jettisoned.

(*c*) *Canopy jettison in conjunction with the ejection system*

(i) Provided that the CANOPY/SNATCH MASTER▶ switch is ON, the canopy is jettisoned automatically when ejection takes place.

(ii) When either firing handle on the ejection seat is pulled, the cartridge in the time-release and breech unit is fired. From the breech unit gas is forced under pressure to operate a piston which releases the canopy jettison ram; simultaneously, the control column snatch unit is operated and the electrical circuits to the canopy detonators and snatch unit detonator are completed.

Oxygen System

Description

7 Oxygen supplies and contents gauges

Oxygen is carried in two 2,250 litre and two 750 litre bottles stowed in the upper equipment bay. In some aircraft an additional 2,250 litre bottle is installed. 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 pairs, each pair having a separate supply line; these lines, after passing through stop valves (normally wire-locked on) on the front face of the pressure bulkhead, are interconnected through non-return valves so that, while each pair can supply all the regulators independently, fracture of one supply line will not cause a total loss of oxygen. Two gauges on the cockpit starboard wall indicate the contents of each pair of bottles.

8 Oxygen regulators and supply points

(*a*) The supply of oxygen to the crew supply points is ◀controlled by Mk. 17E or 17F regulators. The pilot's▶ regulator is on the cockpit starboard wall, while the navigator has one each at his normal and nose stations.

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.

▶◀

(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*) The pilot has a remote flow indicator on the flight instrument panel and the navigator has one on the bomb sight mounting bracket at his nose station. When oxygen flow ceases the relevant indicator remains black.

(*c*) The supply tube from the pilot's regulator terminates at a quick release socket on the right-hand side of his ejection seat. The supply to each of the navigator's stations connects with a flexible tube terminating at a quick release socket. The flexible tubes enable the navigator to move about at his stations and to readily interchange supply points when moving from station to station. Automatic shut-off valves, one on each supply point, prevent oxygen waste when a supply point is not in use.

9 Oxygen emergency supplies

The pilot's emergency oxygen bottle is fixed to the rear starboard side of his ejection seat. The navigator's emergency bottle is in his flying suit. The bottles have a safety pin fitted in the head and this must be removed before flight. The pilot's supply is operated by pulling the yellow/black striped knob to starboard of his seat. The navigator's is operated by a toggle on his flying suit. The duration of the emergency oxygen bottle is approximately 10 minutes.

10 Associated equipment

Pressure demand masks must be worn.

Oxygen system—Normal operation

◀**11 Checks before flight**

(*a*) Ensure that the contents gauges show sufficient oxygen for the flight. Connect the mask tube to the main and emergency oxygen supply pipes.

(*b*) On each regulator check:—

ON/OFF switch ON and wired

Air inlet switch at NORMAL

Pressure 200-400 PSI

Magnetic indicators (MI's) functioning correctly.

(Check remote indicators also.) ▶

◀(*c*) To test the regulator and check the face mask for leaks:—

(i) Put the toggle on the mask harness to the down position and press in the EMERGENCY PRESS TO TEST MASK button on the regulator. 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.

(ii) 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.

(iii) All three 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.

Oxygen system—Emergency Use

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

◀Set 100% OXYGEN on the regulator air inlet switch; move the selector control to EMERGENCY and tighten oxygen mask by pulling down the toggle on the mask harness.

15 Flow indicator failure

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

1. Check contents and select 100% OXYGEN on the regulator. ▶
2. Check pressure 200–400 PSI (needle oscillating).

3. Depress the regulator EMERGENCY switch. Increased flow indicates that the regulator is serviceable; flight may be continued on 100% OXYGEN.

4. If no increase in flow is felt, operate the emergency oxygen bottle, disconnect the main supply and descend to 10,000 ft.

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

1. Check connections.

2. If all connections are properly made, operate the emergency bottle, disconnect the main supply and descend to 10,000 ft.

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

1. Check mask for tight fit.

2. If the blinker remains white and excessive pressure is felt, operate the emergency bottle, disconnect main supply and descend to 10,000 ft.

3. Turn the regulator OFF.

16 Partial system failure

Partial system failure or a leak on 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 annoxia are felt indicating lack of oxygen or if oxygen failure occurs at altitude, operate the emergency oxygen bottle supply and descend to a safe altitude. With the emergency bottle supply in use the oxygen main connection will have to be disconnected to allow free breathing. The pilot's emergency supply can be made available by pulling up the yellow-and-black striped handle on the right-hand side of his seat pan; the navigator's supply can be made available by operating the control attached to his flying suit. When abandoning the aircraft the pilot's emergency bottle is operated automatically when the ejection seat is fired but the navigator's bottle can only be operated manually as above.

Normal Use of the Pilot's Equipment Assembly

18 Strapping-in procedure

(*a*) Ensure that the seat is "safe for parking" and carry out the Ejection Seat checks given on the Flight Reference Cards.

(*b*) Sit in the seat and adjust seat height to the flight 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.

(*c*) Connect survival pack lanyard to the life jacket quick-release connection on the right so that the lanyard lies outside the right thigh.

(*d*) Connect the quick-release fittings on the sides of the survival pack to the two corresponding fittings on the life jacket.

(*e*) Connect the parachute harness shoulder straps to the quick-release fitting. The shoulder straps should lie under ◀the life jacket stole. When an inertia proof quick-release fitting is incorporated in the parachute assembly, it is necessary to turn the disc knob until the yellow line passes the dots on the body of the fitting, hold it in this position, and insert the first lug. Repeat this procedure when inserting the remaining lugs. ▶

(*f*) Pass the parachute leg straps through the leg-loop and attach them to the quick-release box. Adjust the box so that is lies centrally with the waist-belt close to the body.

(*g*) Tighten the shoulder straps so that the parachute quick-release box will lie clear of and above the safety harness quick-release when this is assembled. Tighten the parachute harness leg straps.

(*h*) Connect the air supply hose to the air ventilated suit, if worn.

◀(*j*) (i) *Pre-mod. ES*3112. Fasten the lap straps of the safety harness but do not tighten. ▶

◀(ii) *Post-Mod. ES*3112. Draw the negative G restraint strap up between the legs ensuring that it lies to the rear of, and *not* through, the seat pan firing handle.

(*k*) (i) *Pre-Mod. ES*3112. Draw the negative G restraint strap up between the legs and tuck the V-shaped end under the safety harness. Ensure that the strap is clear of the seat pan firing handle.

(ii) *Post-Mod. ES*3112. Insert the lug of the left-hand lap strap through the loop of the negative G restraint strap. Ensure that the negative G restraint strap end fitting is located behind the larger diameter of the quick-release fitting before fastening the harness. If correctly fitted, the negative G restraint strap end fitting should be a loose fit over the end of the lap strap. Give each lap strap a jerk to

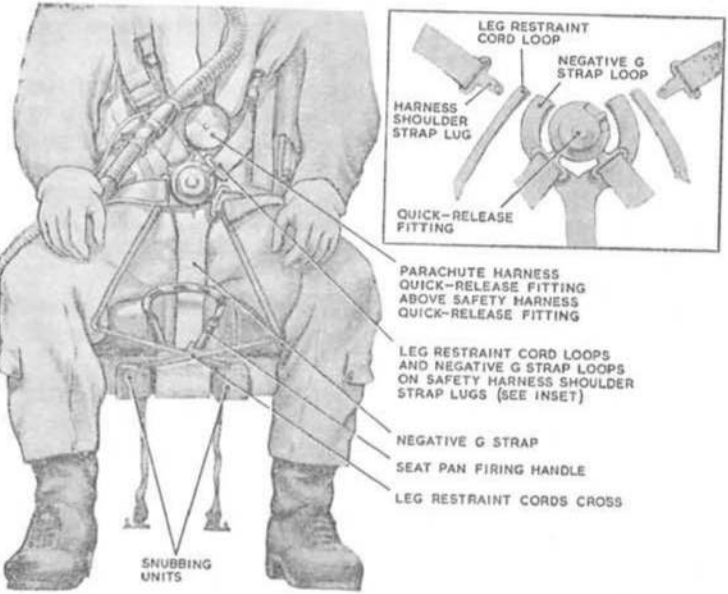


Fig. 2. Ejection seat Type 2CB—arrangement of leg restraint and negative G strap (Pre-Mod. ES3112 ▶

◀ensure that they are correctly engaged in the quick-release fitting. Do not tighten the lap straps at this stage.

(*l*) Ensure that the loop of the right restraining cord is placed through the D-ring on the left garter and threaded under the left-hand side of the safety harness lap-strap. Pass the lug of the left shoulder strap of the safety harness through the loop in the end of the leg restraint cord (and, Pre-Mod. ES3112 only, through the left loop of the negative G restraint strap) and insert the lug into the safety harness quick-release box.

(*m*) Proceed similarly for the left restraint cord and, pre-Mod. 3112 only, the right loop of the negative-G restraint strap. 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.

(*n*) (i) *Pre-Mod. ES*3112. 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. Tension the negative-G strap.

(ii) *Post-Mod. ES*3112. Tighten the lap straps of the safety harness. Tighten the negative-G restraint strap by pulling downwards on the free end of the blue strap. Move the body about inside the harness and then re-tighten the lap straps and negative-G strap. Repeat until the straps are as tight as possible. The negative-G strap can be loosened by pulling down on the yellow tab attached to the snubber lever.

(*o*) Tighten the safety harness shoulder straps. Do not over-tighten as this may arch the back, resulting in possible injury on ejection.

(*p*) Put on the helmet and protective helmet, connect the mic-tel lead and fasten the chin straps of both helmets.

(*q*) 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.

(*r*) Pass the emergency oxygen supply pipe under the lap-strap of the safety harness, over the parachute harness, and connect it to the oxygen mask tube.

(*s*) Connect the oxygen mask tube locating chain to the D-ring on the life jacket. ▶

(*t*) Check that the face screen handle can be reached with both hands together.

(*u*) Have the safety pin(s) removed and stowed.

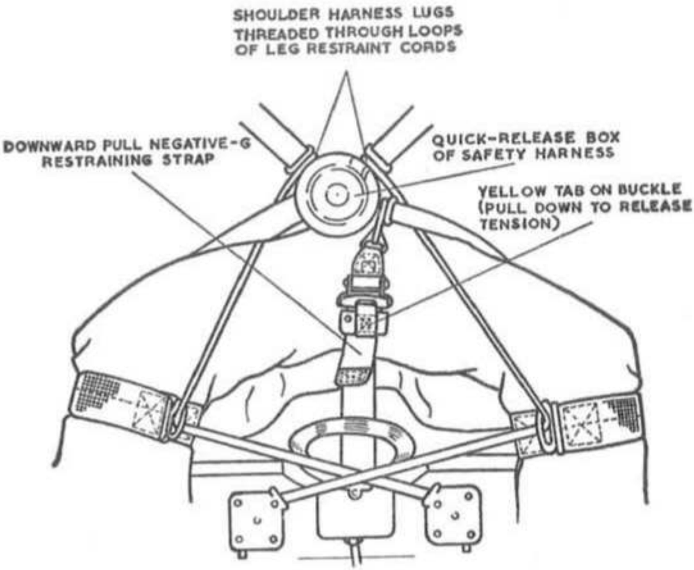


Fig. 3. Ejection seat type 2CB—Arrangement of leg restraint and negative G strap (Post-Mod. ES3112)

19 Normal exit from the seat

(*a*) Make the seat safe for parking.

(*b*) Disconnect the main and emergency oxygen supply and the mic/tel lead.

(*c*) Release the safety harness and the parachute harness.

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

(*e*) Leave the seat.

20 Changes to Type 2CB series ejection seats

(*a*) In order to minimise the possibility of back injuries during ejection, Ejection Seat Modifications ES3241, ESA9, ESA10 and ESA11 have been authorised. When embodied these modifications have the following effect:—

(i) *Mod. ESA*9 introduces a modified ejection gun assembly with a slightly reduced charge. Because of an associated parachute modification which allows faster deployment of the parachute, the limitations for Type 2CB seats, given in Pt. II, Ch. 2, Para. 9 are not changed.

(ii) *Mod. ESA*3241 introduces a modified drogue assembly with an anti-squid line and lengthens the exposed drogue lines.

(iii) *Mod. ESA*11 increases the drogue gun time delay (see para. 3(*b*)) from ½ second to one second.

(iv) *Mod. ESA*10 increases the barostatic time release delay (see para. 3(*c*) and (*d*)) from 1¼ to 1½ seconds.

(*b*) When Mod. ESA10 has been embodied the nomenclature of Type 2CB series seats is changed as follows:—

Type 2CB Mk. 1 becomes Type 2CB Mk. 2.

◀**21 Ejection seat safety pin stowages**

Post-Mod. 4446 a new stowage is provided on the pressure bulkhead for three safety pins. Each safety pin has an integral tally; they are marked "Face screen or main gun sear", "seat pan handle", and "canopy jettison sear". The latter pin is not associated with the canopy jettison system; it is used in the control column snatch unit sear during servicing operations. ▶

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 10—RADIO AND RADAR EQUIPMENT

Contents

1 Intercomm and crew-call system

(*a*) Intercomm is provided by a Type A.1961 amplifier. Provision is made to use the amplifier of the radio sets for intercomm if the A.1961 amplifier fails.

(*b*) Five mic/tel sockets are provided. The pilot's is on his ejection seat; three for the navigator are situated one near his take-off seat, one beneath his chart table and one at the prone position; an external intercomm socket is installed on the outer surface of the fuselage in the starboard wheel well.

(*c*) Intercomm is controlled by an I/C ON/OFF switch and an I/C NORM/EMY changeover switch on the radio control panel to starboard of the pilot's seat. If the A.1961 amplifier fails, the changeover switch should be placed to EMY to obtain intercomm from the VHF or UHF set (pre-Mod. 4320). Post-Mod. 4320, when EMY is selected on the changeover switch, intercomm will be available on V-UHF or standby UHF, whichever is in use.

(*d*) A crew-call light and pushbutton are on the starboard side of the forward coaming and at the navigator's normal and nose station. This is a visual call system; each button, when depressed, illuminates all three call-lights.

2 Radio installation (Pre-Mod. 4320)

Radio communication is provided by two VHF sets and, post-Mod. 3404, one UHF set. A VHF/UHF changeover switch on the starboard side of the cockpit coaming is provided to change from the VHF to the UHF system. A radio control panel to starboard of the pilot's seat carries the VHF volume control, ILS volume control, the intercomm ON-OFF and NORMAL-EMERGENCY switches and the UHF TONE and PRESS-TO-MUTE switches. Press-to transmit switches are provided for the pilot on the starboard throttle lever, and for the navigator next to his ASI. These operate the transmitters on VHF or UHF, whichever system is in use. Further details of the individual systems are as follows:—

(*a*) VHF *installation*

The VHF installation consists of two 10-channel transmitter receivers, TR 1985 and TR 1986. The VHF control box is mounted on the starboard side of the cockpit coaming and incorporates a No. 1/No. 2 changeover switch for selection of the appropriate set, and channel selectors for each set. Illumination of the channel selectors is controlled by a knob labelled DIM.

(*b*) UHF *installation*

The UHF installation consists of one transmitter/receiver type TR5/ARC52, which can be selected to operate on any one of eighteen pre-set frequencies, 1,750 manually selected frequencies, and one guard channel. Power supplies are DC. The UHF control unit is mounted to starboard of the pilot's seat forward of the radio control panel, and carries all the UHF controls except the TONE and PRESS-TO-MUTE switches which are on the radio control panel. 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 equipment is switched on for operational purposes; at the T/R+G position the guard receiver is on in addition to the transmitter/receiver; the ADF position is inoperative.

(ii) CHANNEL selector switch. This has 20 positions. Those numbered 1-18 are for selecting the required preset 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. ▶◀

(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.

3 Radio installation (Post-Mod. 4320)

(*a*) *General*

When Mod. 4320 is embodied the VHF and UHF sets are replaced by a combined V/UHF set (ARI.23143/1-PTR.175) and a standby UHF set (ARI.23057). PTR.175 provides transmission/reception facilities on 3,500 UHF and 370 VHF frequencies. Nineteen frequencies, including the guard channel, may be pre-set for immediate selection, the remainder being selected manually. An emergency battery is provided for operation of the standby UHF if the main aircraft electrical supply fails.

(*b*) *Selection of services*

Controls for selecting PTR.175 or standby UHF are on the starboard instrument panel and on a sub-panel below, and consist of:—

(i) A POWER NORMAL/STBY switch. When placed at STBY, power is fed from the emergency battery to the standby UHF.

(ii) A V-UHF/UHF STBY switch for selection of PTR.175 or standby UHF.

(*c*) *PTR.*175 *controller*

The PTR.175 controller is on the starboard instrument panel and consists of the following:—

(i) A seven-position function switch labelled OFF/TR/TR + G/ADF/DL/DL-T/TR-ON-DL-OFF. The last four positions of the switch are inoperative. At the TR position the equipment is switched on for operational purposes; at the TR + G position the guard receiver is available in addition to the transmitter/receiver.

(ii) A 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) Three rotary manual switches which are to select any channel as required. The frequency selected is displayed above the switches.

(iv) A volume control.

WARNING: Interference may occur to ILS, the radio altimeter and the radio compass, causing incorrect indications, when transmitting on UHF.

(*d*) *Standby UHF*

Standby UHF (ARI.23057) is installed to provide intercomm., and transmission/reception on the guard frequency, if failure of PTR.175, or main power failure, occurs. Power supplies are controlled by the NORMAL/STBY switch (see paragraph (*b*)(i)), and selection by the V-UHF/UHF STBY switch (see paragraph (*b*)(ii)). A CHANNEL A/GUARD frequency switch on the sub-panel, is normally kept in the gated position at GUARD, the CHANNEL A position being provided for testing purposes on a frequency adjacent to the GUARD frequency.

(*e*) *Miscellaneous controls*

The TONE control and the press-to-mute switch are on the sub-panel below the starboard instrument panel; press-to-transmit switches are one on the starboard throttle lever and one adjacent to the navigator's airspeed indicator.

(*f*) *Malfunction*

(i) *Failure of PTR*.175

If PTR.175 fails:

Put the V-UHF/UHF STBY switch to UHF STBY.

(ii) *Failure of aircraft normal electrical supply*

1. Put the POWER NORMAL/STBY switch to STBY.

2. Put the V-UHF/UHF STBY switch to UHF STBY.

3. If an emergency call is to be made ensure that the CHANNEL A/GUARD switch is at GUARD.

NOTE: The standby set will operate from the emergency battery for about 30 minutes. Care must be taken to conserve the battery: it should not be used for ground testing.

(iii) *Failure of the A.1961 intercomm amplifier*

1. Select EMY on the I/C NORMAL/EMY switch (paragraph 1).
2. Put the V-UHF/UHF STBY switch to V/UHF.

4 Blue Silk and GPI Mk. 4A

(*a*) The Blue Silk control panel and GPI Mk. 4A are to the left of the navigator's table. One switch on the ECP, controls the No. 9, type 103A, inverter and one the Blue Silk equipment. The latter cannot be switched on until No. 9 inverter is running. An impulse counter is above the Blue Silk control panel. A remote controller for Blue Silk is at the nose station. During pre-taxying checks switch ON No. 9 inverter and, after 30 seconds, the Blue Silk equipment.

(*b*) A roller map is installed at the navigator's station. An alternative position is provided at the nose station where it may be installed in lieu of the bomb-sight. Power supplies are through No. 2 inverter.

5 IFF 10

Power supplies for IFF 10 are through No. 5 inverter. A master switch for the equipment is on the ECP. The transmitter-receiver control and coder control are on the fuselage port wall over the navigator's table and an I/P switch is adjacently positioned. If SIF is fitted the equipment is to be switched off during low level high speed sorties below 3,000 feet and above 250 knots.

6 Decca

Power supplies for Decca are DC. The controller, decometers and lane identification meter are adjacent to the ECP at the navigator's station. Post-Mod. 4279 an external electrical supply may be plugged in to pre-heat the Decca crystal ovens (See Part I, Chapter 1, paragraph 4).

7 Radio compass

Mod. 4129 introduces a radio compass (AD.722). A control unit, indicator and isolation switch are at the navigator's station. A second indicator is on the pilot's main instrument panel and a volume control is on his radio panel. Audio output is fed into the intercomm system. The pilot can override the navigator's radio compass audio reception by pressing the "call nav" pushbutton on the pilot's starboard panel. Power supplies are DC and AC, the latter being supplied by No. 2 inverter.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 11—ARMAMENT AND CAMERA CONTROLS

Contents

Introduction

1 Operational roles

The aircraft may be used in the following roles depending upon the modification state:—

Bombing

Interdictor

Air sampling (Post Mod. 3525) ▶

◀2 **Armament—general**

For the bombing role the stores are carried in the bomb bay. In the interdictor role, rocket launchers or wing bombs are carried on underwing pylons; alternatively the underwing pylons may carry air sampling ducts. Provision is also made for the carriage of cameras Type F24, F95 and G45.

3 **Armament safety break and supplies circuit breaker**

(*a*) Power supplies to all armament stores relase and jettison circuits, except flares, are inoperative until the armament safety break is connected. The safety break consists of a plug and socket in the cabin above the entrance door. It must be disconnected and the warning pennant attached to the cable at all times when the aircraft is on the ground. When not in use the pennant is stowed in a container on the lower part of the entrance door.

(*b*) The normal bomb release and RP firing circuits are protected by a circuit breaker beside the armament panel at the navigator's station.

Bombing Role

4 **Bombing controls**

The bomb control equipment is located on panels forward of the navigator's normal position. The bombs may be released, after the appropriate selections have been made by the navigator, by a pendant switch at the starboard side of the nose station or by the bomb/RP button on the control column right hand grip.

5 **Bomb release safety lock**

(*a*) A bomb release safety lock panel is on the port console. The lock provides a positive safety mechanism to prevent inadvertent release of the 1,650 lb. bomb, and consists of a catch which when locked, engages in the bomb release unit. The lock is controlled by a double pole two-way switch, marked LOCKED and UNLOCKED, having two adjacent indicator lamps; in the LOCKED position the green indicator lamp will show and in the UNLOCKED position the amber lamp will come on. The switch is normally wired in the LOCKED position.

(*b*) The operating circuits of the bomb release safety lock are duplicated. If a false light indication is suspected it▶

◀may be checked by pressing in simultaneously both indicator lamps, the indication for the alternative circuit will then be given.

6 Bombsight

The bombsight is mounted on a spigot over the clear view panel in the plastic nose; it is an alternative fitting to the roller map. The bombsight computor and the air control cock are on the port side of the nose station.

7 Bomb/flare doors control and indicators

(*a*) The electrically actuated bomb/flare doors selector valve is controlled by a three-position OPEN/SHUT/AUTO switch on the port console. If, after the doors have been opened, the switch is put to AUTO, the doors will close automatically after release of the stores in the bomb bay. A magnetic indicator inboard of the control switch, normally black, shows white when the doors are fully open. This indicator is duplicated on the armament panel at the navigator's station.

(*b*) To prevent inadvertent closing of the doors on the ground a locking pin, stowed in a bag on the wall of the port console when not in use, is inserted in the control switch guard with the switch at the OPEN position.

8 Bomb/flare doors emergency control

(*a*) Should the bomb/flare 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 CONTROL lever on the cockpit port wall. However, as the 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.

(*b*) If the failure is hydraulic and, provided that fluid is available, the doors may be opened and closed by means of the hand pump 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. ▶

◀**9 Bomb/flare emergency jettison**

(*a*) The pilot may jettison the bombs or flares in the bomb bay by means of a guarded switch labelled BOMB/FLARE JETTISON, 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 or flares jettisoned, safe. Switching OFF the jettison switch will remake the normal circuit and the bomb/flare doors will close. *There is no jettison facility for the* 1,650 *lb. bomb.* If, in aircraft embodying mods. 4330 and 4331 or 4347 and 4348, it is not possible or practicable to release the 1,650 lb. bomb by pressing the bomb release push-button on the control column, it may be released by the secondary release switch on the weapon control panel provided that the appropriate selections have been made, the bomb release safety lock is UNLOCKED and the bomb doors are open.

(*b*) Should the bomb/flare 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 paragraph 7 or 8 the bombs will be jettisoned when the bomb doors are fully open.

(*c*) If the aircraft is equipped for the bomber, as distinct from the night interdictor role, use of the BOMB/FLARE JETTISON switch will also jettison any underwing armament stores, SAFE or LIVE, as selected on the fuzing selector switch.

(*d*) 25lb. practice bombs carried on light series carriers in the bomb-bay cannot be jettisoned by means of the BOMB/FLARE JETTISON switch.

Interdictor role

10 Underwing bomb and RP controls

(*a*) The underwing bombs or rockets are released by a push-button covered by a safety flap on the right-hand grip of the control column. Bombs may also be released by a push-button, on a flexible lead, stowed in a clip on the starboard side at the nose station. Selection and fuzing of underwing stores is carried out by means of five switches on the armament panel. These comprise:—

(i) A bomb/RP selector switch

(ii) A pair of wing bomb/ON/OFF selector switches ▶

◀(iii) A wing bomb fuzing switch

(iv) An RP selector switch, which enables quarter, half or full load to be selected.

(*b*) A practice bomb facility from the wing pylons, for use with or without simulator Type 105, is introduced by Mods. 4341 and 4342. A modified control panel is in the upper armament panel position, forward of the navigator's station.

11 Underwing stores jettison

In the interdictor role underwing stores may be jettisoned by means of the guarded EMERGENCY WING STORES JETTISON switch on the pilot's port console. This switch must not be depressed for longer than 10 seconds.

12 Flare release

The flare release circuits are controlled by a flares master switch and either the flare release push-button on the armament panel or the flare release push-button on the cockpit coaming. A "flares-left" indicator is on the armament panel. Operation of the flare doors and jettisoning of flares is as at paragraphs 7, 8 and 9 preceding.

13 Gunsight

A Mk. 3N or an SFOM (Mod. 0139/RAFG) reflector gunsight is mounted on the coaming above the flight instrument panel. The master switch is on the port console. A dimmer switch is on the left side of the sight.

14 Gun firing controls

(*a*) The four 20 mm. guns in the rear of the bomb-bay are fired by a folding gun-trigger on the right-hand grip of the control column. The trigger is released into the firing position by raising a safety catch covering the trigger. Safety cut-outs in the wiring system ensure that the guns cannot be fired with the nosewheel down, the bomb doors open or when the armament safety break is disconnected.

(*b*) Mod. 0150/RAFG introduces a GUN SELECTOR switch panel, adjacent to the armament safety break, to permit selective firing of inboard or outboard guns. INNER▶

◀and OUTER ON/OFF switches on the selector must be put to ON before the gun firing circuits are operative for the inboard and outboard guns respectively.

(*c*) Mods. 0216 and 0217/RAFG introduce gun port and empty case-chute transit covers respectively to reduce drag and prevent ingress of dirt to the gun pack during non-firing sorties. These covers must be removed before air firing sorties.

Air Sampling Role

15 Air sampling ducts

If Mod. 3525 is incorporated, air sampling ducts may be fitted to a pylon under each mainplane. The ducts are controlled by two AIR SAMPLING OPEN/SHUT switches on the armament panel; magnetic indicators above the switches show whether each duct is open or shut.

Camera Controls and Operation

16 G.45 camera

(*a*) A G.45 camera is installed in the mainplane inboard of the starboard engine. The camera MASTER switch and SUNNY/CLOUDY switch are on the navigator's armament panel. The camera operates automatically when the guns are fired and may be operated independently by a push-button on the right-hand grip of the control column.

(*b*) Provided that the camera MASTER switch is ON operation of the pilot's push-button starts the camera. When the push-button is released the camera will continue to run for 1½ seconds. When the BOMBS/RP selector switch is set to RP the camera will run after pressing and releasing the camera push-button and continues to run for 1½ seconds after the BOMBS/RP push switch is pressed. If rocket firing does not take place and the BOMBS/RP push switch is not pressed then the BOMBS/RP selector switch must be set to BOMBS to stop the camera.

17 F.24 camera

An F.24 camera may be installed in a bay in the rear fuselage, aft of the bomb bay. A control unit and switch box for the camera is on the roof at the navigator's normal station. A master ON/OFF switch controlling the power▶

◀supplies is on the armament panel. On some aircraft a pushbutton control is provided at the navigator's nose position to give single exposure control.

18 F.95 camera

(*a*) An F.95 camera may be fitted in the nose of the fuselage adjacent to the bomb-sight spigot and aligned to operate through the clear view panel. The camera is an alternative fit to the bomb-sight. The camera controller is on the fuselage port wall at the navigator's normal station.

(*b*) A switch on the control column provides independent control of the camera for the pilot providing the camera selector switch is set to ON.

(*c*) With RAFG Mod. 0132 embodied the following controls are introduced:—

At navigator's normal station
An F95/G45 selector switch
A normal test switch

At navigator's front position
A camera heater switch
A camera auto/manual switch
A camera controller▶


847
DANGER
CANOPY
DANGER
EJECTION SEAT
ENTRANCE OTHER SIDE
2