# CANBERRA B.2

# PART I

# *DESCRIPTIVE*

NOTE.—Throughout this publication the following conventions apply:—

(a) Words in capital letters indicate the actual markings on the controls concerned.

(b) The numbers quoted in brackets after items in the text refer to the illustrations in Part V.

(c) Unless otherwise stated all airspeeds and Mach numbers quoted are "Indicated".

## INTRODUCTION

The Canberra B.2 is a light bomber powered by two Avon Mk. 1 engines, each of 6,500 lb. static thrust.

The cabin is pressurised and provides accommodation for a crew of three seated in ejection seats. There is an alternative position in the nose for the air bomber, but no provision is made for his ejection from this station. Bombs are carried in a bay in the belly of the fuselage, and provision is made for carrying a camera in the rear fuselage. A variable incidence tailplane is fitted. There is no auto-pilot.

## FUEL AND OIL SYSTEMS

### 1. **Fuel system description**

(i) Three fuel tanks are fitted in the fuselage above the bomb bay; they are numbered 1, 2 and 3 from front to rear. Jettisonable wing tip tanks may be carried.

(ii) Fuel from the wing tip tanks feeds automatically under air pressure into No. 3 fuselage tank. Fuel from the fuselage tanks is fed to the engines by immersed, electrically-driven pumps, two in each tank, through low-pressure cocks and filters.

(iii) From the L.P. cocks the fuel flows to the twin engine-driven H.P. pumps, through the throttle valves and H.P. fuel cocks to the Duple type burners.

(iv) A barometric pressure control (B.P.C.) helps to control the delivery pressure of the H.P. pumps and to maintain the correct flow of fuel for a given throttle setting under changes of altitude and airspeed.

(v) An acceleration control unit (A.C.U.) ensures satisfactory acceleration of the fuel flow for rapid throttle openings and reduces the possibility of engine surge and high jet pipe temperatures.

2. **Fuel tanks**

(i) The three fuselage tanks are of flexible construction; No. 1 and 2 are internally braced and are self-sealing; No. 3 is of the flexible bag type. These tanks are vented to atmosphere and there is provision for nitrogen protection. Filler caps, one for each tank, are located in the roof of the fuselage.

(ii) The wing tip tanks are not self-sealing. They are pressurised from the engine compressors and both feed together and automatically through float-valves into No. 3 fuselage tank. No cocks or other controls, except the jettison switch—see para. 3—are required for these tanks and there is no provision for nitrogen protection.

(iii) The effective fuel capacities of the tanks are approximately:—

| | |
|---|---|
| No. 1 tank ... ... ... | 512 gallons |
| No. 2 tank ... ... ... | 317 gallons |
| No. 3 tank ... ... ... | 545 gallons* |
| *Total main tanks* ... ... | 1,374 gallons |
| Wing tip tanks 2 × 250 ... ... | 500 gallons |
| *Total all tanks* ... ... ... | 1,874 gallons |

*The capacity of this tank may be found to be somewhat less than normal until the bag stretches with use.

3. **Wing tip tanks jettisoning**

Both wing tip tanks are jettisoned electrically by pressing the FUEL JETTISON pushbutton (49) on the port side of the cockpit.

4. **L.P. fuel cocks and pumps**

(i) Two electrically-driven pumps are fitted in each fuselage tank, one on each side. Each pump feeds through an electrically actuated L.P. cock with which it is electrically interconnected. The pumps on the port side of the tanks feed the port engine through a common collector box; those on the starboard side similarly supply the starboard engine. Thus either one, two or three tanks can be used to feed either or both engines together or independently.

(ii) Each pump and its associated low-pressure cock is controlled from one of six switches (67, 71, 83, 85, 87, 88) fitted in two rows, one each side of the fuel tank contents gauges, on the engine instrument panel. The left-hand row of switches controls the port pumps and cocks, and the right-hand row controls the starboard pumps and cocks. The upper switch of each row controls the No. 1 tank pump and cock; the middle switch, the No. 2; and the bottom switch, the No. 3 pump and cock. The switches are set up for ON. The engines should not be stopped by turning off these switches as this causes the engine-driven pumps to run dry and air to be drawn into the pipe lines. For this reason it is also necessary to leave at least one switch on for each engine whenever it is rotating.

5. **H.P. fuel cocks**

Two H.P. cocks, one for each engine, are controlled by levers (32) outboard of the throttles. The levers incorporate relighting pushbuttons and may be clamped in either the ON (forward) or OFF position by the smaller of the two knurled knobs (42) labelled UNLOCK, LOCK.

6. **H.P. fuel pumps**

(i) The twin engine-driven H.P. fuel pumps are connected by a common servo system to the B.P.C. and A.C.U. which control the output of the pumps. Either pump is capable of supplying sufficient fuel at full stroke to permit 70% of take-off thrust to be obtained at low altitudes.

(ii) A solenoid-operated isolating valve is incorporated in the upper pump.

7. **H.P. fuel pump isolating valve**

(i) The isolating valve is primarily intended as a means of restoring power in flight in the event of a sudden drop in engine r.p.m. caused by failure of the fuel pumps servo system; it may also be used as a safeguard against failure of the system during take-off.

(ii) In the take-off case the valve should be operated only at r.p.m. above 6,000, since in the isolated state the upper pump cannot be controlled by either the B.P.C. or the A.C.U. and surge can easily occur.

(iii) When the switch (43) on the port console panel is set to ISOL., the upper pump is isolated from the B.P.C. and A.C.U. servo system which then controls only the output of the lower pump. The upper pump moves to full stroke and is controlled only by its overspeed governor.

8. **Fuel pressure warning lights**

Two fuel pressure warning lights (82 and 90), one for each engine, are fitted on the engine instrument panel. They come on if the fuel pressure at the suction side of

the engine-driven pumps falls appreciably below normal due to failure of a low-pressure pump or shortage of fuel in the tank(s) in use. For the effect of fuel booster pump failure, see para. 55 (iv).

### 9. Fuel contents gauges

Three capacitor type gauges are mounted on the engine instrument panel. The upper gauge (70) indicates the contents of No. 1 tank; the centre gauge (84) indicates the contents of No. 2 tank, and the lower gauge (86) indicates the contents of No. 3 tank. No contents gauges are fitted for the wing tip tanks.

### 10. Oil system

(i) The sump of each engine contains about 19 pints of oil for lubricating the main engine bearings and engine-driven accessories. There are no oil tanks.

(ii) Oil pressure gauges (72 and 89), one for each engine, are fitted on the engine instrument panel; these register whenever electrical supply to the instruments is available.

## ENGINE CONTROLS

### 11. Throttle controls

The two throttle levers (34), marked SHUT, OPEN, are on the engine controls quadrant on the port side of the cockpit. The friction is adjusted by the larger of the two knurled knobs (41) on the side of the throttle box; the knob must be turned clockwise to increase the friction.

### 12. Swirl vanes and bleed valves

Surging in the lower r.p.m. range is minimised by the incorporation in the engine compressors of automatic bleed valves and variable angle swirl vanes. As the engine accelerates, the closing of the bleed valves and

change in angle of the swirl vanes cause, at about 6,500 r.p.m., a sudden decrease of approximately 300 r.p.m. with an increase in thrust. The r.p.m. then increase steadily as the throttle is further opened. As power is reduced. when r.p.m. fall to about 6,200, there is a sudden increase of about 300 r.p.m. with a decrease in thrust as the bleed valves open and the swirl vane angle changes. With the bleed valves open the engine operates less efficiently, with a consequent increase in specific fuel consumption.

NOTE.—When engine Mod. 175 is fitted, the change in the swirl vane angle is progressive and cannot be detected.

13. **Engine starting and stopping controls**

(i) A single-breech cartridge starter is fitted for each engine. They are operated by the starter pushbuttons (92 and 98) fitted below the instrument flying panel. Two MASTER STARTING switches (99) and two IGNITION switches (93 and 97) are fitted below the instrument panel.

(ii) The cartridge starter firing pushbuttons and ignition switches are operative only when the master starting switch is ON. When these pushbuttons are pressed the starter time sequence switches come into operation to energise the torch igniters and fire the cartridges. To turn the engines without starting them, the ignition switches are turned off to ensure that the torch igniters do not operate when the starter pushbuttons are pressed.

(iii) To stop the engines the H.P. cocks should be closed by pulling the levers back.

14. **Starter loading**

(i) After checking that the MASTER STARTING switch (99) is off, the breech cap is 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, while holding the central spring-loaded stud depressed. If screwed too tight it may be difficult to unscrew subsequently and the starter may be damaged.

(ii) When the starter is cold two shots may be fired in rapid sequence. A pause of ten minutes must be made before reloading and firing each subsequent shot.

(iii) On no account should any work be carried out on the starter while the engine is turning.

15. **Engine relighting system**

The torch igniters may be used to relight an engine in flight, by pressing the relighting pushbutton on the top of the appropriate H.P. cock lever. The ignition switch and the master starting switch must be on.

16. **Engine instruments**

The fuel gauges, fuel pressure warning lights, r.p.m. indicators, oil pressure gauges, and a dual jet pipe temperature gauge (69), are fitted on the engine instrument panel.

17. **Engine and fuel tank fire-extinguishers and warning lights**

(i) Three fire-extinguisher bottles are fitted, one for the fuel tank bay and one for each engine. The engine bottles have twin heads and can be discharged into the fuel tank bay.

(ii) Fire warning lights (74) on the instrument panel come on when an engine fire trips one or more of the flame switches in the engine bays. The fire-extinguisher should then be operated by pressing the pushbutton (75) on the instrument panel. When the fire is extinguished the warning light will go out.

(iii) If fire occurs in the fuel tank bay the warning light (76) on the instrument panel will come on, and all three

bottles are automatically fired into the bay. When the fire is extinguished the light will remain on.

(iv) In the event of a crash all three bottles are fired by the crash switch, the engine fire-extinguishers discharging into the engine bays and the fuel tank fire-extinguisher discharging into the fuel tank bay.

## MAIN SERVICES

### 18. **Hydraulic system**

(i) A hydraulic pump on each engine draws fluid from a reservoir which contains 16 pints of fluid and is fitted on the starboard side above the equipment bay. A stack-pipe in the reservoir ensures a reserve of fluid for use with the handpump. From the engine-driven pumps fluid is delivered to the system for operating the :—

Undercarriage
Flaps
Wheel brakes
Air brakes
Bomb doors

(ii) A handpump (15), fitted to the right of the pilot's seat, works in conjunction with a hydraulic GROUND/FLIGHT cock situated in the front of the bomb bay on the starboard side. When the cock is at FLIGHT the handpump can be used to operate only the undercarriage and bomb doors and to charge the brake accumulator. With the cock at GROUND, the handpump can be used to test all services. The cock is normally wire-locked in the flight position. When not in use the handpump handle is stowed in clips above and aft of the entrance door. The handle must be fitted, ready for use, before taxying and left in position.

NOTE.—Until Mod. 710 is fitted, there is no ground/flight cock and the handpump will operate all services in flight as well as on the ground.

(iii) There are two hydraulic accumulators in the system; the one for the wheel brakes is fitted in the equipment bay,

and that for the undercarriage, flaps, air brakes and bomb doors is in the starboard wing. Each accumulator has an air pressure gauge, the one for the brake accumulator is in the bomb bay on the front bulkhead and the one for the wing-mounted accumulator is in the starboard wheel well. The air pressure in each accumulator should be 1,350 lb./sq. in. when there is no pressure in the hydraulic system. A brake hydraulic pressure gauge (79) is on the starboard edge of the instrument panel. On aircraft incorporating Mod. 887 a gauge (77) is fitted in the cockpit, adjacent to the brake pressure gauge, to show the pressure in the wing-mounted accumulator; if this gauge does not read more than 1,500 lb./sq. in. during flight, a hydraulic failure must be assumed and it is probable that the handpump will have to be used to lower the undercarriage prior to landing.

(iv) A cut-out in the hydraulic pump delivery circuit maintains the working pressure in the accumulators and system at 2,000 to 2,550 lb./sq. in.

(v) The selector valves for all services except the wheel brakes, are electrically actuated from switches in the cockpit. The wheel brake control valve is mechanically operated and there is provision for mechanical actuation of the selector valves for lowering the undercarriage and opening the bomb doors in the event of electric failure.

19. **Electrical system—24-volt**

(i) *D.C. supply*

A 6kW generator on each engine charges a battery and supplies power for the operation of the electrical services.

(ii) *Generator control*

(a) Each generator has an ON/OFF switch (7 and 10), a field circuit-breaker (at 5) and a generator failure warning light (6 and 9) situated on the electrical control panel. On some aircraft additional warning lights are at the top of the engine instruments panel. Should a generator fail in flight as indicated by its warning light, its control switch should be set to

OFF and after a short pause ON again; this will reset the main generator circuit-breaker if this has tripped. If the warning light does not go out, check and if necessary reset the field circuit-breaker. If the warning light still remains on, the generator should be switched OFF. A voltmeter on the electrical panel indicates the voltage of the D.C. electrical system. When the generators are charging, the normal reading is 28 volts; when they are not charging the normal reading is 24 volts.

(b) Should a generator failure warning light remain on, or when flying on one engine, all non-essential electrical load, and in any case No. 5 inverter, should be switched off.

(c) The generator cut-in speed is between 3,500 and 3,800 r.p.m. and the cut-out speed is between 3,100 and 2,900 r.p.m. Full output is maintained at r.p.m. in excess of 5,000. Should at any time the voltmeter reading fall below 22 volts when low r.p.m. are being used, r.p.m. should be increased and maintained above 5,000 for as long as practicable and all non-essential electrical load switched off.

(iii) *Battery control*

(a) Until Mod. 258 is incorporated, a GROUND/FLIGHT switch and external battery socket are fitted behind an access door on the starboard side of the fuselage aft of the entrance door. When the switch is set to GROUND the aircraft battery is isolated from the system, but all services can be operated from a ground battery or by current supplied by the generators provided the engines are running above 4,500 r.p.m. On later aircraft a different type of battery plug, necessitating a special adaptor, is used. On these aircraft, when an external battery is plugged in, the aircraft batteries are isolated. No GROUND/FLIGHT switch is fitted.

(b) A battery isolating switch (8) on the electrical control panel, when set to OFF, isolates the battery from the electrical system with the exception of the crash switch, the canopy escape hatches, and bomb

emergency jettison. circuits. A similar isolation of the electrical services is effected automatically by the crash switch which also operates the engine fire-extinguishers.

(iv) *Circuit breakers*

Twelve circuit-breakers, (11, 18 and 19) one for each L.P. cock and each L.P. pump, are situated on the forward face of the electrical control panel. Any circuit-breaker which has tripped due to temporary overload may be re-set by pressing its ON pushbutton. A circuit-breaker marked PILOT'S SERVICES (at 5), mounted on the electrical control panel, protects the supply to:—

External lights and landing lamp
D/V panel de-misting heater
Pressure head heater

On early aircraft the circuit-breakers are covered by a perspex plate and any one may be reset by pressing the plate.

(v) *Inverters*

A.C. is supplied by four inverters. Note that No. 1 inverter is not fitted.

**Distribution of power from inverters**

| Inverter No. | Supply to:— | Emergency change-over to:— |
|---|---|---|
| 2.<br>115V—400 c/s | Artificial horizon<br>Mk. 4B compass<br>Oil pressure indicators | No. 3 inverter |
| 3.<br>115V—400 c/s | Bomb sight<br>Computor<br>Radar cooling motors<br>Stand-by for No. 2 inverter<br>No. 5 inverter regulator cooling motor | No stand-by |
| 4.<br>115V—1600 c/s | Emergency stand-by for No. 5 inverter (operates at reduced output) | No stand-by |
| 5.<br>115V—1600 c/s | Radar equipment (Rebecca—Gee H—tail warning device) | No. 4 inverter |

The D.C. supply to No. 2, 3 and 4 inverters is protected by three circuit-breakers below the electrical control panel, and to No. 5 inverter by a circuit-breaker in the equipment bay. The supply to the inverter relays is protected by two circuit-breakers below the electrical control panel.

(vi) *Flight instruments power supply*

(a) The power supply for the A.C. operated flight instruments is provided by No. 2 and 3 inverters.

(b) In the event of failure of No. 2 inverter the supply to the flight instruments is automatically transferred to No. 3 inverter. At the same time, an indicator (58) on the instrument flying panel shows white by day and fluorescent by night.

(vii) *Flight instruments control*

(a) Under normal operation No. 2 inverter starts running when the starboard MASTER STARTING switch is set to ON. No. 3 inverter starts running when the port MASTER STARTING switch is ON, but only supplies power to the flight instruments when No. 2 inverter fails.

(b) The turn and slip indicator is operated from duplicated 24-volt D.C. supplies having automatic changeover. Both supplies are primarily controlled by the MASTER STARTING switches.

(c) Failure of both No. 2 and 3 inverters will be indicated by the failure of the flight instruments except the turn and slip indicator. If the trouble is due to temporary overload it may be possible to regain the supply by operating the No. 2 and 3 inverter circuit-breakers. If the failure is complete, No. 5 inverter should be closed down, as without No. 3 inverter running there is no supply to the radar cooling motors.

(d) During prolonged taxying, the battery voltage may fall, resulting in a fall in No. 2 inverter output and a consequent automatic transfer to No. 3 inverter. It is undesirable to take off with No. 3 inverter

supplying the flight instruments. If the indicator is showing white before take-off, the engines should be opened up to generator charge r.p.m., the starboard engine master switch put OFF and after an eight second delay put ON again. This should restart No. 2 inverter and the magnetic indicator should show black.

(viii) *Radar power supply*

A.C. at 115-volts, 1,600 c/s is provided by No. 5 inverter with No. 4 inverter as an emergency stand-by. A switch (3) marked No. 4-No. 5 CHANGEOVER is fitted on the electrical control panel. It is normally set to No. 5.

(ix) *Control of radar power supply*

(a) Control of No. 5 inverter is effected through two push switches (1 and 2) on the electrical distribution panel, marked START—No. 5 INVERTER: STOP —No. 5 INVERTER, provided that the changeover switch is set to No. 5. No. 3 inverter automatically starts when No. 5 is switched on.

(b) Three ON-OFF switches (20, 21 and 22), labelled for their respective services distribute the output of No. 5 inverter in addition to the D.C. supply to the individual equipment.

(x) *Radar power supply emergency control*

In the event of failure of No. 5 inverter the A.C. supply can be maintained by switching the changeover switch to No. 4, and switching on No. 4 inverter switch (4). No. 4 inverter operates at a reduced output and automatic isolation of the tail warning device and the transmitter of the Gee H equipment is provided. Both Rebecca and the Gee receiver, however, remain operative but only one of these aids should be used at a time to prevent over-loading No. 4 inverter.

NOTE.—It is important when starting No. 4 or No. 5 inverter that the individual services supply switches should be in the OFF position.

## AIRCRAFT CONTROLS

### 20. **Flying controls**

The control column handwheel carries the wheel brake lever (62), brake parking catch, tailplane incidence control switch (64), a V.H.F. press-to-transmit pushbutton

(95) the air brake control switch (57) and a bomb release pushbutton (56). A snatch device is incorporated to ensure that the control column does not impede the pilot's exit during ejection. This works in conjunction with the canopy emergency jettison system which, when operated, severs, by means of an explosive charge, the connection between the control column and the elevator control system, and at the same time pulls the control column fully forward.

## 21. Flying controls locking gear and picketing points

(i) All control surfaces are locked by means of external clamps with red flags attached. When not in use the clamps are stowed in a valise in the rear fuselage reached through the camera hatch. Operation of the flap selector switch when the external clamps are fitted can damage the flaps; this is prevented by locking the switch in the up position with a pin attached to a large metal disc. In flight the pin is stowed with the locking clamps in the valise.

(ii) Ring bolts are provided for picketing; they are stowed with the control locking clamps and screw into sockets covered by flaps labelled PICKETING POINT located as follows:—

On each main undercarriage fairing.

Below the fuselage aft of the rear skid.

A fourth picketing attachment is provided by the radius rod lugs on the nosewheel strut.

## 22. Variable incidence tailplane and trimming controls

(i) The tailplane incidence is electrically controlled by a tail trim switch (64) labelled NOSE DOWN, NOSE UP, on the control column.

(ii) The rudder trimming tab and aileron spring tab bias are also electrically operated by switches (46 and 47) on the port console panel.

(iii) Position indicators for all three trimmers (51, 53 and 55) are on the left-hand side of the instrument flying panel. When Mod. 504 is fitted, the NOSE UP trim is limited to two divisions.

## 23. Undercarriage controls and indicator

(i) Two pushbuttons (54) to the left of the instrument flying panel control the electrical actuator for the undercarriage selector valve. The top button is pressed for UP and the bottom button for DOWN. An electrically operated lock prevents normal operation of the UP button when the weight of the aircraft is on the wheels. This lock can be overridden by turning the ring encircling the UP button until the knobs on the ring are above and below the button. Undercarriage UP can then be selected normally.

(ii) A standard undercarriage position indicator (52) is fitted below the pushbuttons. The red nosewheel light comes on at any time if either throttle is less than one-third open when any wheel is not locked down.

(iii) In the event of an electrical defect the undercarriage can be selected down mechanically by pulling the red toggle handle (37) fitted above the pushbuttons.

## 24. Undercarriage emergency operation

(i) If the undercarriage fails to lower normally the hydraulic selector valve can be operated mechanically by pulling the red toggle handle (37) fitted above the selector push-buttons. If the defect is an electrical one the under-carriage should then lower; if it does not, a hydraulic defect is the probable cause and an attempt may be made by using the handpump but this takes a considerable time. (See para. 81).

(ii) After the emergency toggle handle has been pulled it is not possible to retract or unlock the undercarriage.

## 25. Flap control

(i) The flap selector is controlled electrically by a switch lever (38). The flaps have only two positions, fully up

or fully down. In the event of hydraulic failure the flaps cannot be operated by the handpump, and in the event of electrical failure it is not possible to operate the selector.

(ii) The flap position indicator (40) is on the panel below the undercarriage position indicator.

### 26. **Air brakes control**

The switch (57) controlling the electrical actuator for the air brakes is on the control column. It has two positions, IN and OUT.

### 27. **Wheel brakes control**

(i) The hydraulic wheel brakes are operated by the lever (62) on the control column. A parking catch is provided. Differential braking is obtained by movement of the rudder bar.

(ii) The gauge (79) on the extreme right of the instrument panel shows the available brake pressure stored in the brake accumulator. Normally 2,550 lb./sq. in., this pressure allows several full applications of the brakes if the main system has failed, and in this event the pressure will fall to 1,350 lb./sq. in. as the brakes are used. At this point the accumulator is discharged and pressure will drop rapidly to zero. Thus, as the pressure falls towards 1,350 lb./sq. in., reliance should not be placed on the continued availability of the brakes. Pressure may, however, be restored by means of the handpump.

## COCKPIT EQUIPMENT

### 28. **Access**

Entrance to the pressure cabin is through the door on the starboard side of the fuselage below the canopy. It is opened from outside by pressing the button to release the handle which is then pulled out and turned anti-clock-

wise. From inside, the door is locked by rotating the toggle handle near the lower edge anti-clockwise and then pulling the handle inboard. To open the door the button forward of the handle is pressed, the handle pushed outboard and rotated clockwise.

29. **Emergency operation of the entrance door**

The entrance door can be jettisoned by turning the crank fitted centrally above it. This releases the hinge pins allowing the door to fall outwards. The crank may be stiff to operate and four and a half full turns are required. The normal handle should not be used to open the door in flight.

30. **Seats and harness releases**

(i) The pilot's and navigators' seats are of the ejection type. (See (iv) below.)

(ii) Adjustment for height is effected by means of a lever (14), incorporating a thumb operated spring-loaded catch, fitted on the starboard side of the seat.

(iii) The Z type harness lock may be released by means of a spring-loaded lever (12) on the starboard thigh guard, to allow the wearer to lean forward. When the lever is released the harness is locked by a ratchet mechanism from going further forward; as the wearer leans back, however, the harness is locked in any position, and to lean forward again he must operate the spring-loaded lever. If in the first instance the wearer leans forward more than six inches before releasing the lever, the harness locks will be beyond the ratchet mechanism and the wearer can lean forward or back as desired until he leans back to the six inch position, where the ratchet mechanism again comes into play.

(iv) The ejection seat incorporates a headrest, footrest, and two thigh guards. The right thigh guard can be folded down by releasing the clamp (13) at the forward edge. At the rear of each seat is the ejection gun and on the port side the drogue gun. The ejection gun of each seat

is fired independently by means of a handle immediately above the headrest, to which is attached a flexible blind to protect the face. When the handle is pulled down to the full extent of its travel it fires the seat.

(v) The drogue gun, which releases a drogue parachute stowed in the container behind the headrest, is fired by means of a static line attached to the aircraft and does not operate until the seat is well clear. The drogue parachute slows down and stabilizes the seat, enabling the pilot to release his harness, fall forward out of the seat and make a normal parachute descent.

WARNING.—The firing handle must always be locked against the possibility of accidental withdrawal whenever the aircraft is on the ground. A fabric safety strap is attached to the front edge of the drogue container and it should be passed through the blind handle and secured by means of the safety pin which is attached to a metal disc. It is the occupant's responsibility to do this after landing, and to remove and stow the pin in the stowage provided on the starboard side of the drogue container prior to take-off. Immediately on entering the cockpit personnel must ensure that the firing handles are locked.

## 31. **Cabin heating and ventilating**

(i) The cabin is heated with a controllable mixture of hot air from the engine compressors and cold air from an inlet in the wing leading edge. The mixing valve is controlled by adjusting the switch (80) on the right of the instrument panel, which is marked COLD-HOT and is spring loaded in the mid (off) position. The setting of the mixing valve is shown on an indicator (81) on the right of the instrument panel. The upper half of the indicator is divided in two; the left-hand sector is coloured blue and is marked COLD, and the right-hand sector is red and is marked HOT.

(ii) When the indicator needle is right over to the left in the blue sector, the mixing valve is in the fully cold position and only cold air from the duct in the wing leading edge is

admitted to the cabin. When the switch is moved to HOT the mixing valve progressively reduces the amount of cold air and increases the amount of hot air, the indicator needle turning clockwise across the blue sector. The valve is stopped in any desired position by releasing the switch. When the needle reaches the vertical position the cold air inlet is shut off and only hot air from the engine compressors reaches the cabin, though at this setting most of the hot air is being passed through coolers in the wing roots. As the needle moves further into the red segment, progressively less air is passed through the coolers until, when the needle reaches the bottom of the red segment, hot air is coming in at its maximum temperature. The mixing valve should be returned to the fully cold position after landing.

(iii) At low altitudes, cold air can be admitted to the cabin through a vent (39) to the left of the instrument flying panel. This shuts off automatically when pressurising commences but should always be closed when cold air is not required.

## 32. **Cabin pressurising**

(i) At about 10,000 feet a pressure control valve comes into operation to control the outlet of air from the cabin, thus allowing the heating and ventilating system to build up pressure until the full differential of 3.5 lb./sq. in. is reached at about 25,000 feet. Above this height the differential pressure is constant, and the cabin altitude is shown on an altimeter (78) on the right of the instrument panel.

| Aircraft altitude (ft.) | Cabin altitude (ft.) |
|---|---|
| 10,000 | 10,000 |
| 25,000 | 13,000 |
| 40,000 | 22,000 |
| 50,000 | 26,000 |

(ii) As the cold air for ventilation is only at ram pressure, full pressurising will not be obtained while the mixing

valve is admitting cold air. When pressurising is required, therefore, the valve must be adjusted until the indicator needle is vertical or in the red sector. (See para. 31 (ii)).

(iii) A warning horn sounds if the cabin pressure falls excessively. A horn override switch (73) is at the top right of the instrument panel.

## 33. Canopy, D.V. panel and de-misting

(i) The jettisonable canopy cannot be opened on the ground or in flight. A direct vision window is fitted. The window is electrically heated, the switch (24) being on the port console panel. At low altitudes, at which the cabin is not pressurised, the window can be opened by unscrewing the knurled clamping knob and hinging the frame downwards ensuring that it engages in the retaining clip. The window must always be closed and tightly secured before the aircraft is taken to altitudes at which pressurising becomes effective.

(ii) The entire canopy, the navigator's window, and the plastic nose are of the "dry air" sandwich type. Cartridges containing the drying agent for the canopy and the navigator's window are fitted, one on the coaming behind the pilot's right shoulder and one on the shelf behind his seat. Another cartridge is mounted just aft of the plastic nose. Small indicator windows in the casings enable the crystals to be seen; they will appear pink when the cartridges are unserviceable. Dry air is circulated through the canopy by a small electrically-driven fan controlled by a switch (50) marked CANOPY DE-MISTER on the port console panel.

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(iii) On aircraft incorporating Mod. 739 a perforated tube along the coaming in front of the pilots, is fed with hot air from the cabin heating system and directs this hot air on to the front of the canopy. A control valve on the tube below the coaming on the left side enables the pilot to regulate the flow of hot air. The de-mister must not be on during a climb. It should be turned on when starting a descent from altitude and turned off again immediately after landing.

34. **Canopy and roof hatch jettisoning and control column snatch unit**

(i) A panel (36) marked DANGER DETONATORS on the port side of the fuselage carries:—

(a) A MASTER SAFETY SWITCH which must be set to ON before the canopy jettisoning and control column snatch unit can be operated. It should be set to ON before take-off and switched OFF after landing.

(b) A CANOPY JETTISON SWITCH, when set to ON, fires the detonators to explode the canopy bolts thus allowing the canopy to blow off. It does not operate the control column snatch unit. This switch is protected by a spring guard.

(ii) With the master safety switch on, raising the shielded lever (48), fitted on the port console panel operates the canopy jettisoning and control column snatch unit circuits. It is for use before abandoning the aircraft by means of the ejection seat. It should only be operated immediately before abandoning as control of the aircraft is lost as soon as the control column snatch unit operates. This lever is shielded by a hinged flap marked DANGER, CONTROL COLUMN RELEASE AND CANOPY JETTISON.

(iii) The navigator's roof hatch is jettisoned independently of the canopy by setting the SAFETY switch to ON and then operating the associated guarded switch marked JETTISON. These switches are on the cabin port wall at the navigator's station and are duplicated on the starboard side.

35. **Oxygen system and pressure-breathing**

(i) The oxygen cylinders are stowed on the port side, aft of the pressure bulkhead.

(ii) A Mk. 11C regulator (31) is fitted on the port wall of the cockpit for the pilot. A Mk. 11D regulator on the port wall at the navigator's station supplies oxygen to the

navigator as well as to two Mk. 11E regulators fitted one on the starboard side of the cabin at the air bomber's station, and the other at the air bomber's forward station. Three economisers are fitted, one for the pilot, one for the navigator and one for the air bomber. At the forward station only pressure-breathing is provided.

(iii) The supply from the regulators is taken to selector valves marked P.B. and ECON. The valve for the pilot is to the right of his seat (16), that for the navigator is on the port wall at his station and that for the air bomber is on the starboard wall. The selector valve enables oxygen to be used with or without pressure-breathing equipment and should be set as follows:—

(a) *With pressure-breathing equipment*

Turn on the oxygen and set the selector to P.B. The oxygen then by-passes the economiser and flows to the pressure-breathing waistcoat and the type "J" oxygen mask. The flow selector lever on the regulator is used in the normal way to vary the flow according to the cockpit altitude.

(b) *Without pressure-breathing equipment*

After turning the oxygen on and setting the selector to ECON., the oxygen flows through the economiser and thence to the mask.

NOTE.—Damage will result to the economiser if pressure-breathing equipment is used with the selector at ECON.

## 36. **Oxygen emergency supply**

Each crew member has an emergency supply of oxygen for use when abandoning the aircraft. The bottles are carried in the parachute packs and are connected to the main oxygen supply tubes at the quick release socket. This reserve supply can be made available in the event of failure of the main system by pulling up the ball (17) on the operating cable at the right hand side of the seat pan. The supply is operated automatically when the ejection seat is fired. A further reserve bottle is mounted

in the nose for the use of the air bomber when at his forward station.

## 37. **Cabin lighting**

(i) The cabin is illuminated by two dome lamps, one on each side of the roof in the navigator's compartment. The lamp-holders incorporate switches. Small floodlamps are fitted near the dome lamps. They are controlled by dimmer switches adjacent to them.

(ii) The cockpit instrument panels are illuminated by 4 U.V. and 4 red floodlamps. Four dimmer switches, (59, 61, 66 and 68), each controlling two lamps, are fitted centrally on the coaming.

(iii) Emergency panel lamps are on either side below the coaming. The ON-OFF switch (63) for these is on the coaming; it has a luminous spot for identification in the dark. These emergency lamps are operated from a separate 2.4-volt battery.

(iv) In addition to the main lamps and floodlamps in the navigator's compartment there is a portable chartboard lamp with an integral dimmer switch, which can be plugged into either of two sockets, one embodied in each of the main dome lamps.

(v) A dome lamp with an integral switch is fitted at the air bomber's nose station.

## 38. **External lighting**

(i) An EXTERNAL LIGHTS MASTER switch (at 44) is on the port console panel; it must be set ON before any of the external lights will function.

(ii) The navigation lights are controlled by a switch (at 44) near the master switch.

(iii) An identification lights selector switch (at 44), a colour switch (at 44) and a MORSING pushbutton (45) are also fitted on the same panel.

(iv) The landing lamp is controlled by a three-position switch (at 44) marked OFF, LOW, HIGH, on the same panel.

(v) A switch (at 44) on the port console panel controls the taxying lamps.

39. **A.S.I. system**

(i) The pressure head is at the bottom left of the nose and the heater is controlled by a switch (25) on the port console panel. On later aircraft the pressure head is in the centre of the nose.

(ii) Two static vents are fitted, one each side of the nose of the aircraft.

40. **Emergency equipment**

(i) *Signal pistol*

There is a pressure-tight mounting for a signal pistol in the escape hatch in the roof of the navigator's compartment. The pistol can be removed from its mounting when the cabin is not pressurised.

(ii) *Hand fire-extinguisher*

A hand fire-extinguisher is stowed on the starboard wall of the fuselage aft of the entrance hatch.

(iii) *Crash axe*

A crash axe is stowed on the cockpit starboard wall.

(iv) *Asbestos gloves*

A pair of asbestos gloves is stowed on the cockpit starboard wall.

(v) *First-aid kit*

A first-aid kit is stowed on the starboard side of the cockpit.

## NAVIGATIONAL AND RADIO EQUIPMENT

### 41. **Mk. 4B compass**

A Mk. 4B gyro compass is installed. The master indicator and control panel are at the navigator's station. The pilot's repeater (96) which can also be used as a directional gyro is fitted centrally on the instrument flying panel. The repeater embodies caging and setting knobs and an annunciator. A changeover switch (91) marked COMP.-D. GYRO is on the sloping panel below the instrument flying panel.

### 42. **Magnetic stand-by compass**

An E2A stand-by compass (65) is fitted centrally below the coaming. A few early aircraft have a P.12 compass instead, fitted below the coaming on the starboard side.

### 43. **V.H.F. installation**

The V.H.F. incorporates two transmitter-receivers, T.R. 1934-T.R.1935. The channel selectors, volume control and changeover switch (94) are at the bottom of the intrument flying panel. On a few early aircraft they are on the cockpit port wall. A press-to-transmit push-button (95) is on the control column handwheel.

### 44. **Intercomm.**

(i) Intercommunication is by amplifier A.1134A with the V.H.F. T.R. 1934/35 as an emergency stand-by. The ON-OFF switch (33) and NORMAL-EMERGENCY changeover switch are on a panel on the cockpit port wall. The pilot's Mic/Tel. socket is on the left of his seat back.

(ii) Later aircraft have an external intercomm. socket fitted on the starboard side of the fuselage, just below the wing

## 45. **Radar equipment**

(i) *Gee-H—A.R.I.5829*

This equipment is under the control of the navigator. The pilot's indicator (60) which consists of three small lamps is on the top left of the instrument panel.

(ii) *Rebecca—A.R.I.5610*

This equipment is under the control of the navigator.

(iii) *I.F.F.—A.R.I.5131*

The control is at the navigator's station. The receiver control switch and G/D switch (35) are on a panel above the pilot's port console.

(iv) *Rear warning—A.R.I.5800*

The control unit is on the port console panel and the equipment gives audible warning in the crew's headphones. The visual indicator is fitted on the pilot's instrument panel.

# OPERATIONAL CONTROLS

## 46. **Bomb doors**

The bomb doors are operated by the pilot by means of a switch (27) marked OPEN, CLOSE, mounted on the port console panel; a red light (28) alongside the switch comes on when the doors are fully open. On later aircraft two indicators are fitted alongside the switch and indicate white when the doors have reached the selected position.

## 47. **Bomb control installation**

(i) The main bomb controller and distributor are mounted on the starboard side of the fuselage at the air bomber's station.

(ii) The bomb release pushbutton is on the starboard side in the nose compartment, and is duplicated on the control column (56).

## 48. Emergency operation of bomb doors and jettisoning bombs

(i) In emergency the bomb doors can be opened and all bombs jettisoned by the pilot by means of the shielded EMERGENCY BOMB JETTISON switch (29) on the port console panel.

(ii) Should the doors fail to open when the emergency jettison switch is operated, the doors selector valve can be operated mechanically by means of the lever (30) on the port side of the cockpit. The lever should be pulled down after releasing the gate. If the defect is electrical the doors should then open and the bombs automatically jettison as soon as the doors reach the fully open position. If the indicator light does not come on, however, indicating that the doors have not opened, an hydraulic fault is the probable cause and an attempt may be made to open them by means of the handpump.

(iii) If the emergency lever is operated it is impossible to close the doors subsequently in flight. The doors should, therefore, not be opened by this means if it is of vital importance to reclose them after jettisoning the bombs. If time permits an attempt should be made by selecting air brakes or flaps to ascertain whether the defect is electrical or hydraulic. If these fail to operate, a hydraulic failure may be assumed and the handpump used to open the doors, and, after resetting the bomb door selector switch to CLOSED, to close them. Subsequent lowering of the undercarriage by the handpump may not prove possible.

## 49. Camera controls

The camera is controlled by the air bomber, the control unit and switch box being mounted on the cabin starboard wall at his station.