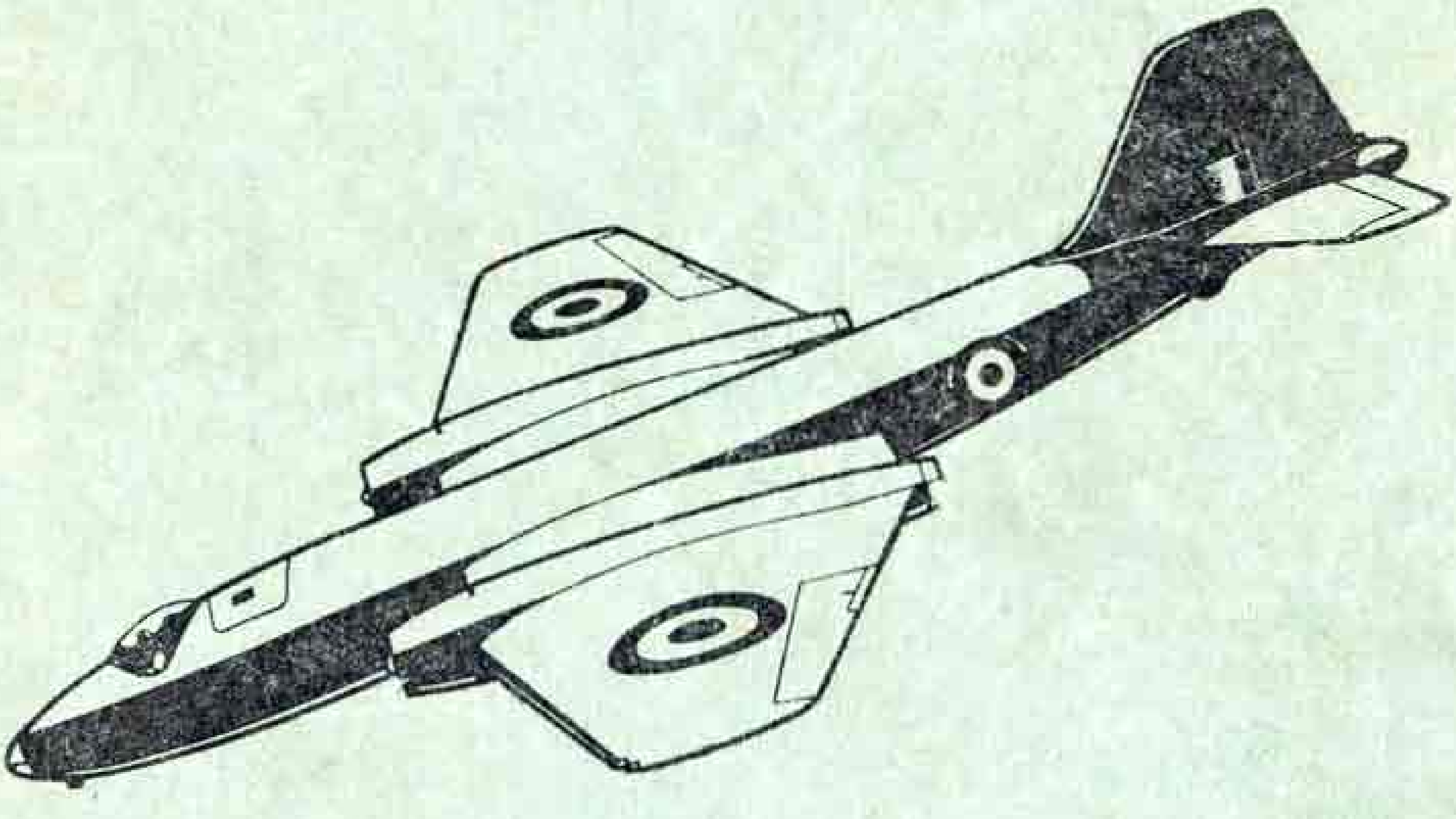
RESTRICTED

2nd Edition

A.P. 4326B—P.N.

# PILOT'S NOTES

# CANBERRA B.2



Prepared by Direction of the Minister of Supply

Promulgated by Order of the Air Council

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# NOTES TO USERS

These Notes are complementary to A.P.2095 Pilot's Notes General, and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (see A.M.O. A.178/53).

Additional copies may be obtained by the Station Publications Officer by application on R.A.F. form 294A, in **duplicate**, to Command Headquarters for onward transmission to A.P.F.S. (see A.P.113) The number of this publication must be quoted in full A.P.4326B—P.N.

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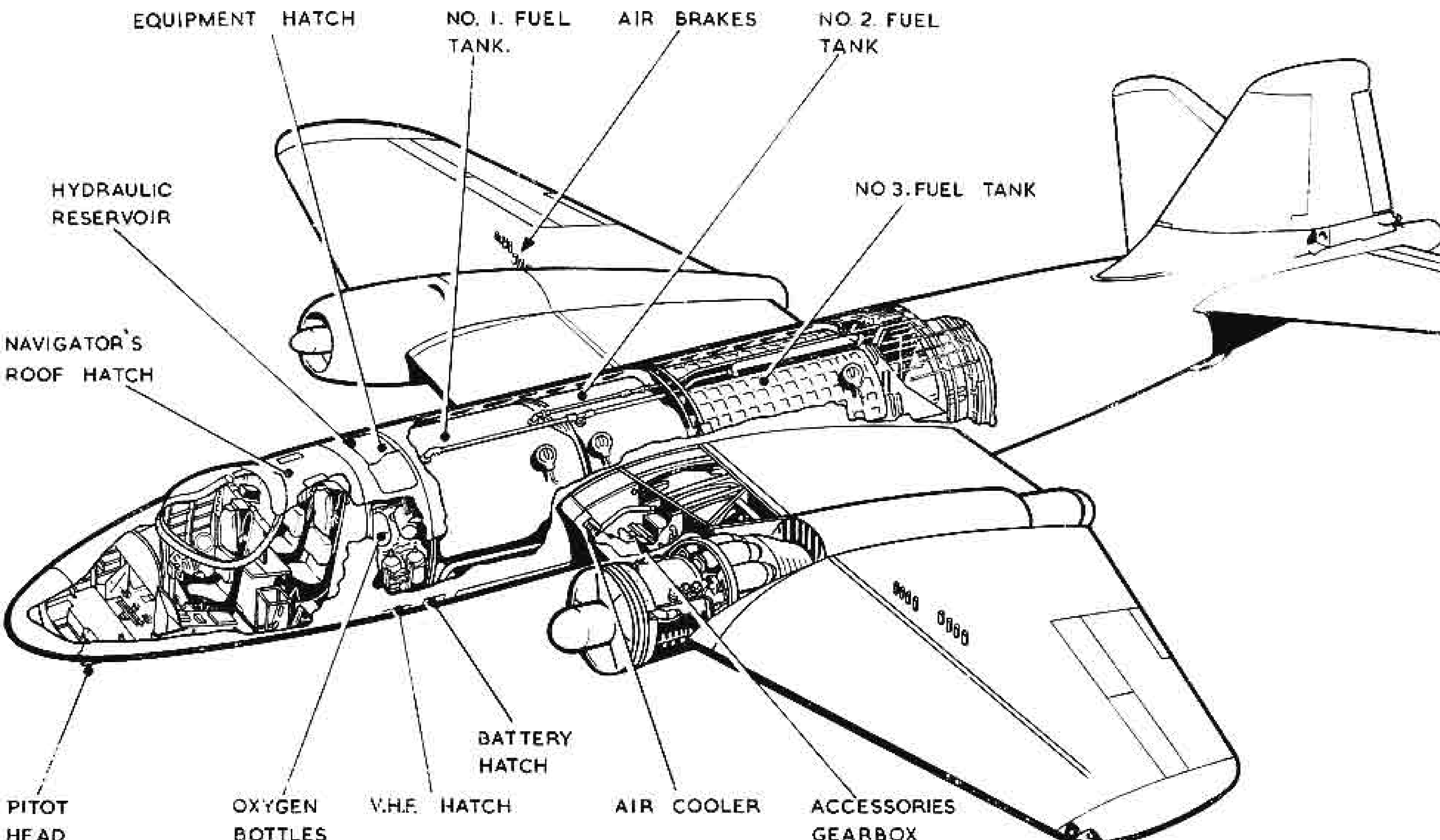
EQUIPMENT HATCH
NO. 1. FUEL TANK.
AIR BRAKES
NO. 2. FUEL TANK
HYDRAULIC RESERVOIR
NO 3. FUEL TANK
NAVIGATOR'S ROOF HATCH
BATTERY HATCH
PITOT HEAD
OXYGEN BOTTLES
V.H.F. HATCH
AIR COOLER
ACCESSORIES GEARBOX

CANBERRA B2

## LIST OF ASSOCIATED AIR PUBLICATIONS

| TITLE | A.P. No. |
|---|---|
| Canberra B Mk. 2 Aircraft ... ... | 4326B |
| Avon Mk. 1 Aero-engine ... ... ... | 4321A |
| | |
| Electrical equipment ... ... ... | 1095A |
| Engine starting systems ... ... ... | 1881 |
| Ejection equipment ... ... ... | 4288A |
| Gee-H ... ... ... ... ... | 2557G |
| Hydraulic equipment ... ... ... | 1803 Series |
| I.F.F. ... ... ... ... ... | 2887D |
| Instrument manual ... ... ... | 1275A, B |
| Intercomm. equipment ... ... ... | 2876B |
| R.A.F. engineering ... ... ... | 1464 Series |
| Rebecca ... ... ... ... ... | 2914Y |
| Signal manual ... ... ... ... | 1186D |
| V.H.F. equipment ... ... ... ... | 2538H |

# PILOT'S EXTERNAL CHECK LIST

*The items starred are peculiar to this aircraft, the others are all common airmanship checks.

Start at the entrance door and work clockwise round the aircraft.

| ITEM | CHECK |
|---|---|
| Nose wheels | Locking pin removed<br>Tyres for cuts and creep<br>Extension of oleo<br>Condition of nose wheel doors |
| *Electrical panel access hatch | GROUND/FLIGHT switch (if fitted) as required (Para. 19(iii)) |
| Starboard undercarriage | Lock removed<br>Tyre for cuts and creep<br>Extension of oleo<br>Condition of doors<br>Brake lead secure |
| *Starboard wheel well | Hydraulic accumulator pressure 1,350 lb./sq. in. min. (Para 18(iii)) |
| Starboard engine | Intake guard removed |
| Starboard mainplane | Condition of undersurface and leading edge |
| Starboard navigation light(s) | Condition |
| Starboard tip tank | Condition |
| Starboard aileron | External control lock removed<br>Condition of spring tab |
| Starboard flap | Condition and position |
| Starboard mainplane | Condition of upper surface |
| Starboard engine jet pipe | Cover removed |
| *Bomb doors | Condition and position |

| ITEM | CHECK |
|---|---|
| Starboard fuselage | Condition<br>*Camera hatch secure<br>Condition of tail skid |
| Fin | Condition |
| Starboard tailplane | Condition and position |
| Starboard elevator | Condition<br>External control lock removed<br>Condition of geared tab |
| Navigation lights | Condition |
| Rudder | External control lock fitted (Para. 54).<br>Position and condition of spring tab |
| Port elevator | External control lock removed<br>Condition of spring tab |
| Port fuselage | Condition |
| Port mainplane | Condition of upper surface |
| Port flap | Condition and position |
| Port engine jet pipe | Cover removed |
| Port aileron | External control lock removed<br>Condition and position of spring tab |
| Port navigation light(s) | Condition |
| Port tip tank | Condition |
| Port mainplane | Condition of undersurface and leading edge |
| Landing lamp | Condition. Retracted |
| Port engine | Intake guard removed |
| Port undercarriage | Lock removed<br>Tyre for cuts and creep<br>Extension of oleo<br>Brake lead secure<br>Condition of doors |
| Port fuselage | *Battery and radio hatches secure<br>*Condition of navigator's window |

| ITEM | CHECK |
| --- | --- |
| Nose port side | Static vent plugs removed |
| Nose | Condition |
| Pressure head | Cover removed |
| Nose starboard side | Static vent plugs removed |

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# CANBERRA B.2

This edition supersedes the previous edition issued in November, 1951.

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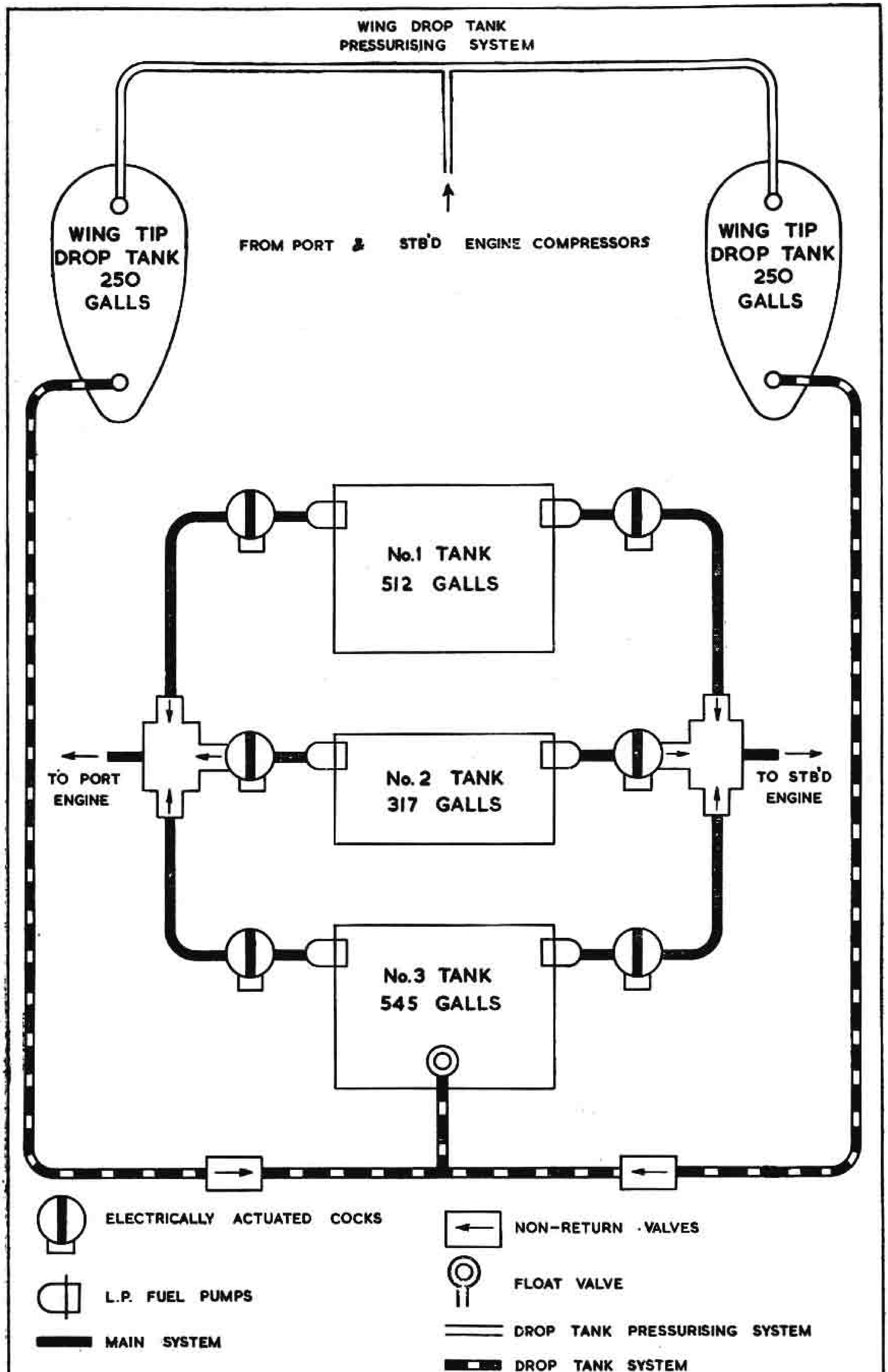


SIMPLIFIED FUEL SYSTEM

**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-clockwise. 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.

# PART II
# *LIMITATIONS*

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## 50. Engine limitations—Avon Mk. 1

| | R.P.M. | J.P.T. |
|---|---|---|
| **Max. take-off and operational necessity** *30 mins. limit* | 7,800 ±50 | 600 |
| **Max. continuous** | 7,600 | 565 |
| **Idling on the ground** | 2,750 ±100 | 500 |

**Oil pressures**

| | |
|---|---|
| Minimum idling ... ... ... ... | 3 lb./sq. in. |
| Minimum at 7,400 r.p.m. and above ... | 15 lb./sq. in. |

## 51. Flying limitations

(i) The aircraft is designed as a light bomber. Intentional spinning and aerobatics are not permitted. When carrying wing tip tanks, gentle manoeuvres only are permitted.

(ii) *Speed and Mach number limitations*

| | |
|---|---|
| Clean aircraft ... ... ... | 450 knots |
| Below 15,000 ft. ... ... | .75M |
| 15,000 to 25,000 ft. ... | .79M |
| Above 25,000 ft. ... ... | No limitation But see para. 64 (iv) |
| With wing tip tanks ... ... | 365 knots or .8M |
| Flaps down ... ... ... | 160 knots |
| Undercarriage down ... ... | 190 knots |

| | |
|---|---|
| Bomb doors open ... | 350 knots or .75M up to 40,000 ft. .8M above 40,000 ft. |
| Air brakes out ... ... | No limitation |
| Jettisoning wing tip tanks ... | 300 knots or .75M |

(iii) *Maximum weights*

| | |
|---|---|
| For take-off and all permitted forms of flying... ... | 46,000 lb. |
| For landing ... ... | 31,500 lb. |

52. **Pilot limitation**

Pilots having a thigh length in flying clothing of more than 26.5 inches must not fly the aircraft. This restriction is imposed because personnel with a greater thigh length are liable to injury due to the knees fouling the coaming if the ejector seat is used. All pilots should press the legs back as far as possible if the ejector seat is to be used.

53. **Use of AVTAG**

AVTAG may be used under the following conditions:—

(i) It should be realised that a.n.m.p.g. is related to the specific gravity of the fuel used and in consequence where the S.G. of the fuel uplifted is less than 0.8 (the average S.G. of 100 AVTUR) more will be required to fly a given distance than would be the case with 100 AVTUR. This is shown on the Flight Planning Charts.

(ii) The current jet pipe temperature and engine r.p.m. limitations must not be exceeded. It is to be noted that the change of fuel grade may introduce a tendency to overspeed

(iii) The fuel temperature at the commencement of the flight must not exceed 30°C.

(iv) The specific gravity of the fuel must be within the range of 0.75 to 0.79 and the engines adjusted accordingly.

# PART III
# *HANDLING*

54. **Cockpit checks**

| **Item** | **Check** |
|---|---|
| Oxygen selection cocks (16) | At P.B. with type "J" masks or At ECON. with type "H" masks |
| Fire-extinguisher and crash axe | Stowed |
| *Electrical control panel* | |
| Battery isolating switch (8) | On |
| Generator switches | ON |
| Voltmeter | Reading |
| Generator failure warning lights (6, 9) | On |
| Pilot's services and generator field circuit-breakers (5) | Set |
| Radar master switches (20, 21, 22) | All off |
| Circuit-breakers at rear base of pedestal | All set |
| Circuit-breakers for L.P. cocks and pumps (front face of pedestal) (11, 18, 19) | All set |
| Ejection seats safety pins | Remove and stow |

When seated and strapped in, start on left-hand side and work clockwise round the cockpit.

| | |
|---|---|
| Rudder lock | Removed |

| Item | Check |
|---|---|
| Bomb door emergency control lever (30) | Wired SHUT |
| Windscreen D.V. panel heater, pressure head heater and vent valve switches (24, 25 and 23) | Off |
| Canopy "sandwich" de-mister (50) | Off |
| Oxygen (31) | On<br>Check contents and flow |
| Bomb door switch (27) | SHUT |
| Aileron and rudder trimmers (46, 47) | Function<br>Operation of indicators |
| External lighting switches (at 44) | All off or as required |
| Canopy jettison master switch (at 36) | ON |
| H.P. pump isolating switches (43) | NORMAL (down) |
| H.P. cocks (32) | Off |
| Throttles (34) | Closed |
| Intercomm. amplifier (33) | On |
| I.F.F. switches (35) | Off |
| D.V. panel | Closed |
| Flap indicator (40) | Indication |
| Undercarriage indicator (52) | Three green lights<br>Check changeover and day/night screen |
| Undercarriage selector (54) | DOWN. Check position of UP button override. |
| Flaps selector (38) | Locking pin out |
| Undercarriage emergency handle (37) | In |
| Canopy internal de-mister | OFF |
| Ventilator (39) | As required |
| Ignition switches (93, 97) | On |

| Item | Check |
|---|---|
| Mk. 4B compass selector (91) | COMP. |
| Fuel pressure warning lights (82, 90) | On |
| L.P. fuel cock and booster pump switches (67, 71, 83, 85, 87, 88) | All OFF |
| Cabin pressure and heat control (80) | Function, leave indicator at COLD |
| Cabin pressure warning horn override switch (73) | On (up) |
| Brake pressure (79) | 2,500 lb./sq. in. or pump to this figure |
| Internal lighting switches | As required |
| Magnetic stand-by compass (65) | Heading |
| Entrance hatch | Locked (emergency handle strapped in position) |
| Hydraulic handpump handle (15) | Fitted in its operating position |
| Brakes | On |
| Tailplane actuator (64) | Full up, full down, then neutral *Then 1 div. nose up, 1 div. nose down, finally return to neutral.* |

## 55. Management of the fuel system

(i) Start the engines with all booster pumps on, then use the fuel as follows:—

*Take-off.* Take-off with all pumps on. At 30,000 feet, or after 10 minutes, switch off No. 1 and 2. and fly on No. 3.

*Cruise.* Fly with No. 3 tank on until 300 gallons remain in it, then turn on No. 1 and fly on 1 and 3 until 200 gallons remain in No. 1.

Then (a) If, due to uneven feeding, No. 3 tank contains more than 100 gallons when No. 1 is down to 200 gallons, No. 1 should be switched off until the level in No. 3 falls to 100 gallons.

(b) If it is essential to obtain maximum range, as much fuel as possible should be used from No. 3 tank at this stage.

When No. 1 is down to 200 gallons and No. 3 to 100 gallons (or less), switch on all pumps and leave them on for the rest of the flight.

*Land* Land with all booster pumps on.

NOTE.—When any tank is empty the booster pumps should normally be switched off, though there is no harm in leaving them running for a short time.

(ii) *General*

(a) 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 will normally read full, but under certain conditions of flight the level may fall to 450 gallons before transfer has been completed. When the level in No. 3 tank falls steadily below 450 gallons, it indicates that the transfer of fuel from the wing tip tanks has ceased. Normally the rate of transfer from each wing tip tank will vary, giving rise to emporary lateral trim changes. If one tank will not feed at all, and the other one is empty, a safe landing is possible provided that the speed is kept about 5 knots above the minimum for adequate lateral control and that weather and runway conditions are suitable. Otherwise, both tanks should be jettisoned before landing.

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

(c) In an emergency it may be necessary to vary the fuel drill. For instance, if a bomb hangs up on the forward beam the C.G. will be well forward of the limit. This necessitates a higher approach speed, there will be reduced elevator control and very careful judgment of the landing will be required. The pilot may counteract this to a large extent by having as much fuel as possible in No. 3 tank. Similarly, if a bomb hangs up on the aft beam, No. 1 tank should be kept as full as possible.

(d) In a steep climb, or when rapid accelerations or manoeuvres are being made, there is a risk of fuel surge uncovering the pumps in No. 1 and 3 tanks if they contain less than 60 and 80 gallons respectively. Normally this surge will not be dangerous, as with the levels in 1 and 3 so low, No. 2 will be on as well, but the fact should be remembered if it is necessary to vary the fuel drill.

(iii) *Reserve fuel*

The last 150 gallons in No. 2 tank is the minimum safe allowance for a circuit, an overshoot and a landing. The surge in No. 2 does not become dangerous until the level has fallen to 50 gallons, but even below this level all fuel can be used provided all manoeuvres or attitudes which might lead to fuel surge are avoided.

(iv) *Fuel booster pump failure*

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

(b) The effect of booster pump failure depends on altitude and engine r.p.m. and may also vary between aircraft. It may also be influenced by the head of fuel in the tanks.

(c) The engine-driven H.P. pump is designed to operate with a positive inlet pressure and as booster pump failure causes the pump to have to suck fuel from the tank, the delivery to the engine will be affected. At medium altitudes a drop of 50 to 100 r.p.m. may be expected; above 35,000 feet a drop of 400 r.p.m. may occur at full power, but this drop becomes progressively less at lower powers and is about 50 to 80 r.p.m. at 6,500 r.p.m. Power can be restored by opening the throttle. If the distribution of fuel permits, another booster pump should be switched on. Fuel from the tank with the failed pump may be used for the other engine.

56. **Engine handling**

(i) *Fuel pump isolating switches*

(a) When taking off at weights above 37,000 lb. it is recommended that both fuel pump isolating switches are set to ISOL. With the switches set to NORMAL the failure of an H.P. pump or part of the servo mechanism will be shown by a rapid and unaccountable loss in r.p.m. Should this occur the throttle must be fully closed immediately, and the appropriate fuel pump isolating switch set to ISOL. (up). If the engine then idles normally an attempt may be made to accelerate it. If it fails to idle normally, the H.P. cock should be closed and the engine re-lit as recommended in para. 77 leaving the isolating switch set to ISOL. Having re-lit, it may not be possible, at low altitudes, to obtain maximum r.p.m.

(b) With a fuel pump isolating switch set to ISOL., considerable care must be exercised when the engine is opened up from idling r.p.m. If the throttle is handled coarsely at engine speeds below 5,000 r.p.m., the engine is prone to over-fuelling, excessively high jet pipe temperatures and a possibility of fire. While opening the throttle a check should be kept on the r.p.m. and j.p.t. If the j.p.t. rises rapidly and reaches the maximum, the r.p.m. meanwhile remaining constant, the throttle should be closed immediately and a slower acceleration attempted.

(c) At all times during flight, engine speeds lower than 4,500 r.p.m. should be avoided. If the r.p.m. fall below this figure, care must be used when opening up again otherwise it is possible to stall the compressor. This applies especially when the speed is low and the aircraft is sinking.

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(ii) *General*

(a) Above about 3,000 feet the effect of the A.C.U. is reduced and rapid acceleration of the engine up to 5,000 r.p.m. will cause over-fuelling and surging. Engine acceleration deteriorates progressively with altitude and care is required when increasing power at the higher altitudes.

(b) At altitudes above 35,000 feet, the engine should not be throttled to below 6,500 r.p.m. otherwise the bleed valves will open. If the bleed valves open the throttle must be fully closed and not opened up again above 28,000 feet. During a descent with the throttles closed there may be an audible rumbling from the engines accompanied by a slight increase in j.p.t. This is not harmful but the j.p.t. will become excessive if an attempt is made to open the throttle above 28,000 feet.

NOTE.—On engines fitted with Mod. 175 (progressively variable swirl vanes) the throttles may be opened up at any altitude. Great care is still necessary, particularly at high altitudes.

(iii) *High altitude surge*

When flying at 7,800 r.p.m., with low forward speed, in an indicated air temperature of −55°C. or less, there is a risk of engine surge resulting in flame extinction. This risk may be avoided by throttling back by 100 r.p.m. per 5°C. drop in temperature below −55°C.

**57. Starting the engines**

NOTE 1: Whenever the external battery is plugged in or removed, the battery switch and the aircraft battery isolating switch must both be off. On aircraft pre-Mod. 258, where the GROUND/

FLIGHT switch is still fitted, the switch is to be at FLIGHT while the external battery is plugged in or out. When there is no GROUND/ FLIGHT switch the battery is always to be plugged in or removed by moving the 3-pin adaptor and lead complete.

NOTE 2: If no external battery is used, from the time that the battery isolating switch is switched ON until the generators cut in at about 3,800 r.p.m. all electrical power is taken from the aircraft battery. Provided that checks are carried out without undue delay and the period spent on the ground before take-off is normal the aircraft battery can cope with these demands. An external battery is only required when it is anticipated that the time spent doing checks will be longer than normal. If an external battery is used it is recommended that it should be removed before starting the engines.

NOTE 3: During the starting procedure numbers 2 and 3 inverters should be checked as follows:—

(a) While starting the port engine, when the master starting switch is put on, the stand-by inverter for the flight instruments (No. 3) will be heard to cut in and the emergency instrument supply indicator will show white. Check that the G4B compass starts up.

(b) While starting the starboard engine, when the master starting switch is put on, the normal inverter for the flight instruments (No. 2) will cut in; the indicator will then show normal (black).

(i) *Checks before starting*

Immediately before starting, have the external battery, if used, unplugged and the access door closed.

| | |
|---|---|
| H.P. fuel pump isolating switches | NORMAL (down) |
| Throttles | Closed |
| H.P. cocks | Closed |

| | |
|---|---|
| Ignition switches | On |
| L.P. cocks and booster pump switches | All ON (one at a time) aural check<br>Fuel pressure warning lights out |
| Canopy "sandwich" de-mister | ON |

(ii) For each engine in turn switch ON the master starting switch, open the H.P. cock and press the starter button for about 2 seconds.

(iii) When the cartridge fires, the engine speed builds up rapidly to 1,500 to 1,800 r.p.m. and may then drop back slightly. When the engine lights up the r.p.m. increase steadily to the idling figure of 2,750 $\pm$ 100 r.p.m.

(iv) Check that the oil pressure builds up to not less than 3 lb./sq. in.

(v) *Failure of an engine to start*

(a) If an engine fails to accelerate to idling r.p.m. the H.P. cock should be closed immediately and the master starting switch set to off. When the engine has come to rest, the starter may be re-loaded. The master starting switch should be set to ON and the H.P. cock opened immediately before the new cartridge is fired.

(b) If a cartridge fails to fire, the H.P. cock should be closed immediately. Wait for one minute before removing the breech cap. If a second cartridge fails to fire the electrical circuit should be checked.

(c) Two cartridges may be fired in succession but a period of 10 minutes must elapse between each subsequent re-loading, otherwise the starter will overheat.

(d) After a failure to start, if the H.P. cock is closed without delay there should be no necessity to "blow through" the engine. If in doubt, excess fuel may be removed by firing another cartridge as follows:—

| | |
|---|---|
| Master starting switch | ON |
| Ignition switch | OFF |
| H.P. cock | Closed |

If an engine fire is suspected the L.P. cocks and pumps for the engine must also be put OFF.

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**58. Checks after starting**

| | |
|---|---|
| Instruments | Set Mk. 4B compass<br>Check heading by E2A compass |
| Hydraulic system | Test by partially lowering and raising flaps |
| Wheelbrakes | Pressure 2,500 lb./sq. in. |
| Airbrakes | Check operation |

NOTE.—If it is desired to test the isolating valves, increase r.p.m. to 6,000 and move the isolating switch to ISOL. Immediately an increase in r.p.m. occurs, return the switch to NORMAL.

**59. Taxying**

(i) *Checks before taxying*

| | |
|---|---|
| Instruments | Serviceability |
| D.V. panel de-mister | ON |
| Pressure head heater | As required |
| Wheel brakes | Operation as soon as possible |

(ii) The hydraulic brakes are powerful. Rudder and control column loads can be high when taxying in strong winds.

(iii) Fuel consumption while taxying is of the order of 2 galls. per minute for each engine.

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## 60. Take-off

(i) *Checks before take-off*

| | |
|---|---|
| Trimmers | All neutral |
| Airbrakes | IN |
| Fuel | Contents |
| | All L.P. cock and pump switches ON and circuit-breakers made |
| | Fuel pressure warning lights out |
| | H.P. cocks full on and tightened |
| | Fuel pump isolating switches NORMAL |
| Flaps | UP |
| Instruments | Jet pipe temperatures and oil pressures within limits |
| | Check Mk. 4B compass |
| | Flight instruments supply indicator—black |
| Oxygen | On (check with crew) |
| | Cabin pressurisation and heating as required |
| Hatches and canopy | Entrance door closed, handle locked |
| | D.V. panel closed |
| | Canopy jettison master switch ON |
| Bomb doors | Closed |

(ii) Align the aircraft on the runway and apply the brakes. Under crosswind conditions it may be necessary to head the aircraft into wind to prevent surging and ensure satisfactory engine acceleration. In this case the aircraft should not be re-aligned with the runway until just after the bleed valves close at about 6,600 r.p.m.

(iii) At weights above 37,000 lb. open up the engines against the brakes to 7,000 r.p.m. and set the fuel pump isolating switches to ISOL.

(iv) Increase to 7,000 r.p.m. On engines not fitted with Mod. 175 check that the swirl vanes and bleed valves operate correctly.

(v) Release the brakes and open the throttles fully.

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(vi) There is a tendency for the nosewheel to rise early in the take-off run. It should be held just clear of the ground by a slight push force on the control column. At high weights the take-off run is increased if the nosewheel is held too high.

(vii) Ease the aircraft off the ground at 95 to 110 knots, depending upon the weight.

(viii) The safety speed is 140 knots.

(ix) When comfortably airborne apply the wheel brakes and retract the undercarriage. There is little change of trim but care should be taken not to exceed 190 knots before the wheels are locked up.

(x) If the take-off has been made with the H.P. pump isolating switches set to ISOL., return them to NORMAL.

(xi) The aircraft accelerates rapidly and above 120 knots an increasing nose up change of trim should be trimmed out.

(xii) If a climb to altitude is intended the engines should be throttled to give 7,600 r.p.m. and the speed held at 330 knots. For circuit practice it is recommended that the speed be kept below 200 knots. For the climb to circuit height 7,000 r.p.m. is sufficient.

### 61. **Climbing**

(i) The aircraft is easy to trim on the climb and holds the trimmed speed well.

(ii) The recommended climbing speed is 330 knots until .72M is reached at about 20,000 feet. Thereafter maintain .72M until the desired altitude is reached.

(iii) R.p.m. tend to increase with altitude and must be restrained by careful throttling. At high altitudes the precise setting of a desired r.p.m. is not easy. Jet pipe temperatures remain roughly constant up to about 30,000 feet, after which they may increase slightly at constant r.p.m.

(iv) If the cabin pressurisation control has not been set before take-off, pressurise at 10,000 feet by holding the control switch to HOT until the indicator needle is vertical.

62. **General flying**

(i) The aircraft is easy to trim and pleasant to fly at all altitudes. Lateral trim is sensitive to asymmetric thrust and rudder trim; a deliberate yawing of the aircraft produces a pronounced rolling motion in the direction of the yaw.

(ii) *Controls*

These are well harmonised and smooth in operation at all altitudes. The rudder is light and sensitive for small deflections but becomes quickly heavier with increase of movement. It should be used with care at high I.A.S. The ailerons are light at low speeds but become heavy at high speeds. They are effective at all speeds down to the stall but their effectiveness decreases suddenly at the highest mach numbers. The elevator is light and powerful, but becomes heavier at high speeds and loses effectiveness at the highest mach numbers. Because of the increased heaviness of the controls at high I.A.S. the aircraft is tiring to manoeuvre for any length of time.

(iii) *Trimmers*

The tailplane incidence control is powerful at all speeds and becomes very sensitive at high I.A.S. when it is best used in a series of short "blips". The rudder trimmer is powerful and quick in operation; it requires care in its use. The aileron trimmer is the least powerful of the trimmers and slowest in operation.

(iv) *Air brakes*

At high I.A.S. these are effective but below about 300 knots their effectiveness decreases until at approach speeds their effect is negligible. At high mach numbers their use causes increased buffeting with little deceleration and, at .81M, a slight nose down change of trim. Their use above .82M is not recommended normally (but see para. 65 (iv)(f)).

(v) *Changes of trim*

| | |
|---|---|
| Undercarriage down | Slight nose up |
| Undercarriage up | Little change |
| Flaps down | Strong nose up |
| Flaps up | Strong nose down |
| Air brakes out | Little change except for slight nose down at high mach numbers |
| Air brakes in | Little change |
| Bomb doors open or closed | No change |

(vi) (a) When lowering flaps, slight buffeting occurs which decreases as the speed is reduced.

(b) Buffeting and vibration is most marked when the bomb doors are opened at high airspeeds and mach numbers. At lower combinations of mach number and airspeed, buffeting is less marked.

(vii) *Flying at reduced airspeed*

Reduce speed to approximately 150 knots and keep the flaps up.

(viii) *Flying in conditions of severe turbulence*

The recommended speed is 240 knots up to 35,000 feet.

63. **Stalling**

The approximate stalling speeds in knots are :—

| *Power off* | 32,000 lb. *No wing tip tanks* | 42,000 lb. *Wing tip tanks* |
|---|---|---|
| Undercarriage and flaps up | 85 to 90 | 105 to 110 |
| Undercarriage and flaps down | 75 | |
| *Power on* | | |
| Typical approach conditions | | |
| Undercarriage and flaps down | 75 | |

NOTE.—The power off stalling speeds quoted above apply with the engines throttled back. When practising stalling, an engine speed of not less than 4,500 r.p.m. should be maintained to avoid the possibility of stalling the compressor.

(ii) Warning of the approach of the stall is given by a slight buffeting some 10 knots above the stall which increases as the stall is approached; at the stall the buffeting may be severe enough to make accurate reading of the A.S.I. difficult. At about the speeds quoted above the nose and either wing may drop gently. Aileron control is effective in raising the dropped wing and the recovery from the stall is straightforward on release of the backward pressure on the control column. The height lost in recovery is small. The stalling speed is not noticeably affected by opening the air brakes or bomb doors, but a slight increase in buffeting may be noticed.

(iii) At any time when "g" is applied ample warning of the approach of the stall is given by buffeting which increases steadily down to the stall proper at which there is a tendency for either wing to drop. Recovery is immediate upon releasing the pull force on the control column.

(iv) With wing tip tanks the pre-stall buffet is more marked and at the stall slight aileron snatch occurs together with a mild wing drop. If ailerons are used to hold up the dropped wing the snatching becomes more marked and the wing drops sharply. The speeds at which these characteristics occur are 5 to 10 knots higher than the stalling speeds without using tip tanks.

64. **High speed flying—Limitations**

(i) The aircraft is easily capable of exceeding its airspeed and mach number limitations even in level flight. Care is therefore needed to avoid exceeding the limiting I.A.S.

(ii) Up to 15,000 feet the limitation of .75M must not be exceeded. Above this speed severe buffeting and longitudinal oscillation commence suddenly and may overstress the airframe.

(iii) Between 15,000 and 25,000 feet a limitation of .79M is imposed for the same reasons as given in (ii) above. In this height band, however, exceeding the limit inadvertently is less likely to result in overstressing of the airframe unless buffeting is severe.

(iv) Above 25,000 feet no mach number limitation is imposed for a clean aircraft, but it is recommended that .82M, or any lower mach number at which compressibility effects become marked, should not be exceeded. (See para. 65 (iv)).

NOTE.—When wing tip tanks are carried, a limitation of .80M is imposed which must not be exceeded, as the behaviour of the aircraft at higher speeds becomes unpredictable.

65. **High speed flying—Characteristics**

(i) *Sea level to 15,000 feet*

As speed increases there may be a slight change of longitudinal trim, and, at the maximum speed or mach number, slight intermittent buffeting may occur. If a rapid longitudinal oscillation develops at or near the I.A.S. or mach number limitation, speed should be reduced as quickly as possible until the oscillation ceases.

(ii) The air brakes are effective at high I.A.S. but their use is accompanied by noticeable buffeting.

(iii) *15,000 to 25,000 feet*

As speed is increased buffeting commences at about .77M and increases in strength as the speed rises. If the limitation of .79M is exceeded there is a tendency for lateral unsteadiness to develop.

(iv) *Above 25,000 feet*

(a) Up to about 35,000 feet warning of the approach of severe compressibility effects is given by a nose-up change of trim which occurs at about .84M to .85M. Below this speed the first symptoms are given by slight buffeting which commences at about .78M to .8M. At about .81M, the buffeting increases in intensity and at .83M, a slight nose-down change of trim occurs, followed by a nose-up change at about .85M. The lateral trim becomes sensitive at these speeds and lateral unsteadiness may be encountered.

(b) Above 35,000 feet warning of the approach of severe compressibility effects is given by a tendency for one wing, generally the starboard, to become heavy at about .84M. At about 45,000 feet the wing starts to get heavy at slightly lower speeds, between .82M and .83M. Below these speeds the symptoms are much the same as in (a) above.

(c) Above 35,000 feet if the aircraft is accelerated past the speed at which a wing becomes heavy, any wing drop that occurs is usually accompanied by aileron snatching, and complete loss of aileron effectiveness may occur. At the same time the elevator loses most of its effectiveness and very severe buffeting sets in. Should control be lost, great care must be taken to avoid overstressing the aircraft during the subsequent recovery at the lower altitudes when the I.A.S. may be high. Use of the tail trimmer during recovery should be avoided but extreme oare must be taken if it has to be used.

(d) The behaviour under compressibility will vary between aircraft and is also likely to vary on individual aircraft depending on the C.G. position and the external condition of the aircraft. Although the wing heaviness case is given as being the most critical from the point of view of possible temporary loss of control, other effects such as strong nose-up or nose-down changes of trim, lateral rocking and directional instability may be noticed. As soon as compressibility effects become marked, irrespective of the altitude but particularly at the highest altitudes, speed must be reduced as the consequences of still further increasing the speed are unpredictable and may be serious. The remarks in this paragraph apply both to the clean aircraft and when wing tip tanks are fitted.

(e) Recovery from mild compressibility conditions best made by throttling back to not less than 6,500 r.p.m. and reducing speed, care being taken to avoid high "g" which will aggravate matters. After throttling back to 6,500 r.p.m. a constant check should be kept on the r.p.m. indicator to prevent the engine speed falling to the bleed valve/swirl vane changeover point, as the airspeed decreases.

(f) If control is lost the engines must be throttled right back, the air brakes extended and the control column held hard back. About 10,000 feet may be lost before the mach number has fallen to a figure at which control can be regained. During the recovery "g" loads must be kept low. Use of the tail trimmer during recovery should be avoided, but extreme care must be taken if it has to be used.

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NOTE.—With tip tanks fitted the compressibility effects described above will occur at slightly lower mach numbers, and will occur even lower if they are badly fitted. If complete loss of control occurs recovery may be more difficult.

66. **Maximum range and endurance**

(i) *Flying for range*

(a) Climb as recommended in para. 61 or, if it is necessary to reach cruising altitude in the shortest practical distance, climb at any speed down to 280 knots and .7M above the coincident height. The charts in the centre of the book are based on a climb at this speed but the overall range is unlikely to vary to any significant extent if climbing speeds between the two extremes (280/.7M to 330/.72M) are used. Climb to an altitude at which the rate of climb has fallen to about 300 feet per minute. Speed should then be increased to .72M and r.p.m. reduced to 7,400. If height is not maintained at this speed or r.p.m. the aircraft should be allowed to find its own cruising ceiling by permitting it to gain or lose height without changing speed or r.p.m.

(b) For extreme range the speed and r.p.m. quoted above should be maintained and, as the weight of the aircraft decreases with the use of fuel, it should be allowed to climb. Under these conditions the aircraft should gain height at approximately 1,500 feet per hour.

(c) If extreme range is not essential, the loss of range resulting from restricting the height to 48,000 feet, for pressure-breathing considerations, is not large. When the aircraft reaches this altitude any further tendency to gain height should be countered by reducing r.p.m., level flight being maintained at .72M.

(d) The loss in range due to cruising at altitudes below 40,000 feet is considerable as can be seen from the range charts. If, however, operational considerations necessitate flying at lower altitudes, maximum range will be achieved by flying at the highest practicable altitude at the air speeds shown on the charts. At any height the aim should be to maintain the optimum speed, but if this involves the use of r.p.m. less than 6,700, care is necessary to ensure that the swirl vanes and bleed valves have not moved to their low power position, as this seriously increases the specific fuel consumption. Should this occur, the r.p.m. must be increased until the vanes and valves take up the high power position and then carefully decreased to 6,700 r.p.m. or as much below as practicable, the resulting speed being accepted. Below 30,000 feet this speed will generally be in excess of the optimum, as are the speeds given on the range charts for these conditions.

NOTE.—If engine Mod. 175 is fitted, it is not possible to detect the swirl vane change, so r.p.m. below 6,700 should be avoided.

(e) In an emergency, at 20,000 feet or below, some increase in range can be obtained by flying on one engine. An indicated airspeed of 240 knots should be maintained and all non-essential electrical load must be switched off. Above 20,000 feet no worthwhile advantage is gained by flying on one engine. Below this height the advantage increases progressively provided the r.p.m. are maintained above the bleed valve and swirl vane changeover figure. At 10,000 feet the gain in range with a full fuel load is of the order of 50 miles.

(f) The descent should be made with the throttles fully closed, at .75M down to 20,000 feet and at 350 knots below this height. The r.p.m. will gradually decrease but should be prevented from falling below 4,500 by adjusting the throttles as necessary.

(g) The distance covered on the descent is appreciable due to the relatively low rate of descent in the initial stages.

(ii) *Maximum endurance*

(a) The speed for maximum endurance varies between 165 knots at sea level and 180 knots at 45,000 feet. At any required altitude the endurance speed may be found by flying at the speed which requires minimum r.p.m. to maintain level flight.

(b) Endurance increases progressively with increase of altitude up to 45,000 feet. Above this height little or no increase results.

(c) The climb to altitude should be carried out at the normal climbing speeds.

(d) At medium and low altitudes an increase in endurance will result from flying on one engine at the speeds recommended above. The saving in fuel varies with altitude, but at 3,000 feet is about 80 gallons per hour.

67. **Flight Planning Charts**

(i) The flight planning charts in the centre of the book show the fuel used for any range at any altitude when flying at either the best range speed or the maximum cruising speed. Conversely they can be used to find the maximum range at any altitude for a given fuel load. One chart shows the clean aircraft, the other shows the aircraft with wing tip tanks. The following paragraphs describe the use of the charts.

(ii) On the left of the chart is the altitude scale, the time to height, based on a climb as recommended in para. 61, being marked against it.

(iii) To the right of the altitude scale is the main part of the chart. This shows, on the left, the distance (in A.N.M.) covered on the climb. Altitude lines are drawn horizontally at 10,000 foot intervals, and above 40,000 feet the upward sloping line represents the climbing cruise to be used when extreme range is required (see para. 66). The body of the chart consists of curved distance lines, the distances being marked in air nautical miles. The unbroken curves represent the distance when flying at the best range speed, and the broken curves give the distance at the maximum cruising speed.

(iv) At the foot of the chart is the fuel scale, the specific gravity being shown at the side and the gallons used along the top. The last 150 gallons is the landing reserve. The top line, .80 S.G., represents 100 AVTUR which is normally used in the aircraft; the rest of the scale allows adjustment to be made to the range if a fuel of lower S.G. is used.

(v) At the right of the chart are the speed scales; the one marked HIGH WEIGHT is to be used at the beginning of the flight, and the other, marked LOW WEIGHT, at the end of the flight. Speeds should be interpolated for intermediate weights. It will be seen that at the lower altitudes the best range speed cannot always be used because it would be below the swirl vane change point (see para. 66 (i) (d)), and the maximum cruising speed can also not be used as it is above the I.A.S. or mach number limitation.

(vi) The descent data is tabulated at the bottom right hand corner of each chart.

(vii) *Example 1.*

To find the fuel required for a flight, with wing tip tanks, of 1,400 miles at best range speed, cruising at 40,000 feet, first subtract the distance covered in descent, 115 miles, leaving 1,285 miles. Interpolate between the points where the 1,200 and 1,400 mile unbroken curves cross the 40,000 foot line and then read downwards on to the fuel scale to find 1,310 gall. Add the fuel used on descent, 48 gall., and the landing reserve of 150 gall.; the total fuel required is 1,510 gall. approximately. To find the speed, read across from the 40,000 foot line on to the speed scales and then vertically down to read off a speed of 206 knots at the beginning of the cruise, and 180 knots at the end.

(viii) *Example 2.*

To find the distance that can be covered on a given quantity of fuel, say 1,200 gall., at say 40,000 feet, first subtract the landing allowance of 150 gall. and the descent allowance of 48 gall., leaving 1,002 gall. Then read upwards on to the distance/altitude graph to find, at 40,000 feet, 925 miles (approx.) at the best range speed, or 850 miles at the max. cruising speed. Add the descent distance of 115 miles and find the relevant speeds as before from the speed scales.

68. **Pressure error corrections**

| From<br>To | | 150<br>200 | 200<br>350 | 350 knots<br>450 I.A.S. |
|---|---|---|---|---|
| At 26,000 lb. | Add | 3 | 2 | 1 |
| At 40,000 lb. | Add | 5 | 4 | 3 |

Large errors in both airspeeds and altitude are induced on the instruments if the aircraft is yawed, the instruments tending to read low. Mod 262 moves the pressure head to the centre of the nose, but P.E.C.'s are not affected.

69. **Approach and landing**

(i) *Checks before landing*

Fuel — Contents
All L.P. cock and pump switches ON in tanks containing fuel
Circuit-breakers made
Fuel pump isolating switches NORMAL

Reduce speed to 170 knots and check

| | |
|---|---|
| Undercarriage | Down<br>Three green lights |
| Brakes | Pressure 2,500 lb./sq. in.<br>Check operation |
| Flaps | Down on final |
| Air brakes | In |

(ii) The flaps may be lowered on the cross wind leg and the turn on to the final approach made at 120 knots. Until the decision to land has been made, the r.p.m. must be kept above 4,500.

(iii) When lined up on the final approach the speed should be reduced to 105-110 knots early in the approach as the aircraft loses speed very slowly. At higher speeds the approach becomes unnecessarily flat. Speed should be reduced progressively until the airfield boundary is crossed at 90 to 95 knots. On throttling back, the thrust falls off slowly and the engines should be throttled fully back before reaching the airfield boundary so that the touchdown is made with the least amount of residual thrust. If landing at a forward C.G., and/or with tip tanks fitted, the final approach speed should be 100 to 105 knots.

(iv) After lowering the nosewheel on to the runway, the brakes may be applied continuously but should be used with care while the speed is high, to avoid locking the wheels. The pressure can be increased as the speed falls off but care will still be necessary to avoid locking the wheels, especially on a wet runway.

70. **Instrument approach**

The following speeds, flap and approximate power settings, are recommended for use during instrument approaches with the undercarriage down. The figures apply, specifically, to an aircraft without wing tip tanks. The effect of empty wing tip tanks on the r.p.m. required will be very small.

| | R.P.M.* | Flaps | Airspeed knots |
|---|---|---|---|
| Pattern | 6,300 | UP | 140 |
| Final | 6,100 | UP | 125 |
| Glide Path | 6,100 | DOWN | 105 |

*Bleed valves at low power setting.

NOTE.—When the glide path is intercepted and flap is lowered, the aircraft tends to maintain height unless the airspeed is kept at 125 knots until the flaps are fully down.

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## 71. Going round again

(i) A minimum of 150 gallons of fuel, which allows about 5 minutes of flying should be available for this possibility.

(ii) Open the throttle smoothly as required and raise the undercarriage. At 500 feet raise the flaps and trim as required. There is a strong nose-down change of trim during the last half of the flap travel

(iii) Throttle back as necessary to avoid exceeding the limiting speed of 160 knots for the flaps, while they are coming up.

NOTE.—If it is necessary to go round again after touching down, care is necessary when opening the throttles (see para. 56 (i) (c)).

## 72. Checks after landing

After landing carry out the following checks:—

| | |
|---|---|
| Flaps | UP |
| Brakes | Pressure sufficient for taxying |
| L.P. cocks and pumps | One for each engine ON, all others OFF |
| Pressure head heater | Off |
| D.V. panel de-mister | Off |
| Canopy "sandwich" de-mister | OFF |
| Oxygen | OFF |
| Cabin pressurising | COLD (off) |
| Radar | Off |
| No. 4 and 5 inverters | Off |
| Master starting switches | Off |

73. **Stopping the engines**

(i) Stop the engines by closing the H.P. cocks while the engines are at idling r.p.m Leave on one L.P. cock for each engine until the engines come to rest.

(ii) Carry out the following checks:—

| | |
|---|---|
| Canopy and hatch master jettison switches | OFF |
| Chocks | In position |
| Brakes | Off |
| All electrical services | Off |
| L.P. cock and pump switches | OFF |
| Battery isolating switch | Off |
| Flap lever locking pin | In position |
| Ejection seat safety pins | In position |

# PART IV
# *EMERGENCY HANDLING*

## 74. Engine failure on take-off

(i) The safety speed is 140 knots.

(ii) At weights below about 33,000 lb., if corrective action is taken quickly, control may be maintained at speeds as low as 125 knots and the aircraft will accelerate and climb away comfortably from this speed.

(iii) Raise the undercarriage, trim as necessary and build up speed to 150 knots.

(iv) Close the H.P. cock and throttle of the failed engine.

(v) Switch off the L.P. cocks and pumps of the failed engine.

## 75. Engine failure in flight

In the event of failure due to an obvious mechanical defect the immediate action should be:—

| | |
|---|---|
| H.P. cock and throttle | Closed |
| L.P. cocks and pumps | OFF |

Shed all non-essential electrical load and land as soon as possible.

## 76. Single-engine flying

(i) An engine should be stopped by closing the throttle and then shutting the H.P. cock; at least one L.P. cock and pump should be left on. The generator should be switched off and all non-essential electrical load shed.

(ii) The aircraft has a very good single-engine performance and the rudder trimmer is powerful enough to trim out all foot loads at normal cruising speeds. At 7,400 r.p.m. a single engine will maintain a speed of about 330 knots in level flight below 5,000 feet.

77. **Relighting an engine in flight**

(i) Engine relighting is practicable at heights up to 20,000 feet and at speeds up to 200 knots. Relighting becomes progressively more certain with reduction of altitude and airspeed; therefore relighting above 15,000 feet is not recommended. Successful relighting is more certain if high energy ignition (engine Mod. 174) is fitted.

(ii) Ensure that the H.P. cock is closed, then:—

(a) Reduce speed to 200 knots or less until the windmilling r.p.m. are 1,000-1,200.

(b) Ensure that at least one L.P. cock and pump switch is on and that the fuel pressure warning light is out.

(c) Check that the master starting and ignition switches are on.

(d) Close the throttle fully.

(e) Keeping the H.P. cock closed, press the relight pushbutton.

(f) After 3 seconds move the H.P. cock to the fully open position.

NOTE.—If high energy ignition is fitted, the H.P. cock may be opened immediately before pressing the relight pushbutton.

(g) When the r.p.m. start rising, release the relight button.

(h) When the r.p.m. have stabilised at the correct idling r.p.m. for the particular altitude, the engine may be opened up slowly to the desired figure.

(i) If the engine r.p.m. fail to build up within 30 seconds of opening the H.P. cock, the relight button should be released and the H.P. cock closed immediately. NOTE.—60 seconds, if high energy ignition is fitted.

A.L.1 Para. 77 (ii) (j) Page 67

(j) A further attempt may be made after descending to a lower altitude; an interval of about two minutes should be allowed, to let the engine dry out.

78. **Action in the event of fire**

When an engine fire warning light comes on, or a fire is suspected, the L.P. and H.P. cocks must be closed immediately. Speed should be reduced as much as possible and the fire-extinguisher pushbutton pressed. The warning lights will go out when the fire is extinguished.

79. **Single engine landing**

(i) Maintain a speed of 140 knots while positioning the aircraft with the flaps up.

(ii) Lower the undercarriage in the normal position on the circuit; after turning on to the final approach reduce speed to 125 knots and lower the flaps. Maintain this speed until the final decision to land has been made.

(iii) After lowering the flaps reduce speed and cross the airfield boundary at the speed recommended for a normal landing.

80. **Going round again on one engine**

(i) This can be done comfortably provided that the speed is at least 125 knots.

(ii) Raise the undercarriage and carefully increase the power on the live engine to 7,600 r.p.m. At a safe height raise the flaps; up to 200 feet of height may be lost while the flaps are retracting but, with care, little or no height need be lost.

(iii) Allow the speed to build up to 150 knots before commencing to climb away.

(iv) In an emergency, and at light weights, going round again is possible from speeds down to 110 knots. If this has to be done, the engine must be opened up very slowly and carefully as the aircraft accelerates, until the speed reaches 125 knots. Mishandling of the throttle will quickly produce large amounts of yaw and consequent errors in the airspeed reading. The rolling motion due to yaw is pronounced. About 200 feet of height will be lost during the period while the aircraft is accelerating to 125 knots.

### 81. Emergency operation of the undercarriage

Failure of the undercarriage to lower normally may be caused through either a hydraulic, mechanical or electrical fault. Action to be taken is as follows:—

(a) Check changeover lights on u/c position indicator (52).

(b) Check fuses No. 67 and 68 in main electrical control panel.

(c) Operate hydraulic hand pump and check pressure build-up on wheel brake gauge. Continue pumping until hand pump becomes solid.

(d) If hydraulic pressure does not build up, an hydraulic fault is probable and an attempt should be made to lower the undercarriage by further hand pumping. This may take a considerable time.

(e) If hydraulic pressure does build up and pressure is felt on the handpump, reselection of the undercarriage may overcome any slight sticking sequence valves, doors or latches.

(f) If there is no evidence of selection, an electrical fault may be assumed and the hydraulic selector valve can be operated by pulling the red toggle handle (37) fitted above the selector pushbuttons.

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

82. **Flapless landing**

(i) A slight increase in drag and thus a slightly steeper angle of approach may be obtained by carrying out the final approach and landing with the bomb doors open. The weight should be reduced as much as possible before landing by using excess fuel.

(ii) (a) Turn on to the final approach at 130 knots thereafter reducing speed to 115 knots. The approach, which should be longer than that for a normal landing, will be very flat.

(b) Open the bomb doors.

(c) Throttle back early aiming to cross the airfield boundary at a speed of 100-105 knots.

(d) Lower the nosewheel immediately after touchdown and use as much brake as possible without actually locking the wheels.

(e) On a 2,000 yard runway a flapless landing may be carried out comfortably following a correctly executed approach.

83. **Landing with a defective hydraulic system or wheel brakes**

(i) If the handpump has had to be used to lower the undercarriage for landing, it may be found that the wheel brake hydraulic pressure is low and shows no signs of building up. Should this occur, or at any other time that the brake pressure remains low, an attempt may be made to raise the brake pressure by means of the handpump. If this is unsuccessful, the landing should be made as follows:—

(a) Reduce the weight as much as possible by using excess fuel.

(b) Cross the airfield boundary at as low a speed as practicable and, after touchdown, close the H.P. cocks.

(c) If some brake pressure is available lower the nosewheel on to the ground early in the landing run and use the brakes up to a maximum without actually locking the wheels. After applying the brakes do not release them until the aircraft has come to rest, otherwise pressure will be lost from the system. If possible, the crew member should operate the hand-pump while the brakes are in use.

(ii) If no brake pressure is available, the touchdown should be made as slowly as possible and the H.P. cocks closed immediately afterwards. Hold the nosewheel well off for as long as possible to obtain the greatest aerodynamic braking.

84. **Cabin pressurisation failure at altitude**

In the event of cabin pressurisation failure occurring at heights above 44,000 feet the following emergency drill should be used:—

(a) Captain warns crew "Immediate descent" and orders "Masks HIGH, Emergency Oxygen". Crew acknowledge.

(b) Throttle right back.

(c) Air brakes OUT.

(d) Bomb doors open.

(e) Descend at .81 Mach.

(f) Level out at 40,000 feet, and if power can be applied and air temperature permits, continue flight at this altitude. The rate of descent using the above drill is approximately 11,000 feet per minute.

85. **Abandoning the aircraft in flight**

(i) The navigator's roof hatch should, where possible, be jettisoned before the canopy. This should be done at a speed above 150 knots.

(ii) After speed has been reduced as much as possible the navigator and air bomber should eject themselves independently. The navigator must double-fold his chart table forward before ejection. The canopy jettison and control column snatch unit lever should then be pulled and the pilot's seat ejected.

(iii) To avoid difficulty in grasping the ejection seat firing handle at high speeds or high "g" after the canopy has been jettisoned, the right hand should be placed on the firing handle before the canopy is jettisoned.

86. **Jettisoning wing tip tanks**

(i) Reduce speed to a maximum of 300 knots or .75M.

(ii) Jettison both tanks by pressing the FUEL JETTISON pushbutton (49) on the cockpit port side.

87. **Forced landing**

(i) If a forced landing has to be made, the navigator's roof hatch should be jettisoned at a speed above 150 knots and while electrical power is still available.

(ii) With engine power available.

(a) Make a normal approach and landing but keep the undercarriage retracted.

(b) Close the H.P. cocks before touchdown.

(iii) With no engine power available.

(a) Glide at 165 knots.

(b) While positioning for the landing reduce the speed to 130 knots and maintain this speed until the final approach is commenced.

(c) Keep the undercarriage retracted but use the flaps if possible and reduce speed to 95-105 knots.

(iv) Before touchdown switch off the battery isolating switch.

(v) After landing, if necessary, the canopy should be jettisoned by operating the canopy jettison switch.

88. **Ditching**

Pending further investigation of the ditching characteristics it is advisable to abandon the aircraft in flight.

# PART V

# *ILLUSTRATIONS*

## KEY TO FIG 1

1. No. 5 inverter STOP pushbutton.
2. No. 5 inverter START pushbutton.
3. No. 4/No. 5 inverter changeover switch.
4. No. 4 inverter switch.
5. Circuit-breakers—from left to right:—
   Pilot's services
   No. 1 generator field
   No. 2 generator field
6. No. 1 generator failure warning light.
7. No. 1 generator switch—port.
8. Battery isolating switch.
9. No. 2 generator failure warning light.
10. No. 2 generator switch—starboard.
11. Circuit-breakers—from left to right:—
    No. 1 tank starboard pump
    ,, ,, ,, cock
    No. 1 tank port pump
    ,, ,, ,, cock
12. Harness release lever.
13. Thigh guard clamp.
14. Seat adjusting lever.
15. Hydraulic handpump.
16. Oxygen selector valve.
17. Oxygen emergency supply control.
18. Circuit-breakers—from left to right:—
    No. 3 tank starboard pump
    ,, ,, ,, cock
    No. 3 tank port pump
    ,, ,, ,, cock
19. Circuit-breakers—from left to right:—
    No. 2 tank starboard pump.
    ,, 2 ,, ,, cock.
    No. 2 tank port pump.
    ,, 2 ,, ,, cock.
20. Gee H supply switch.
21. Tail warning device supply switch.
22. Rebecca supply switch.

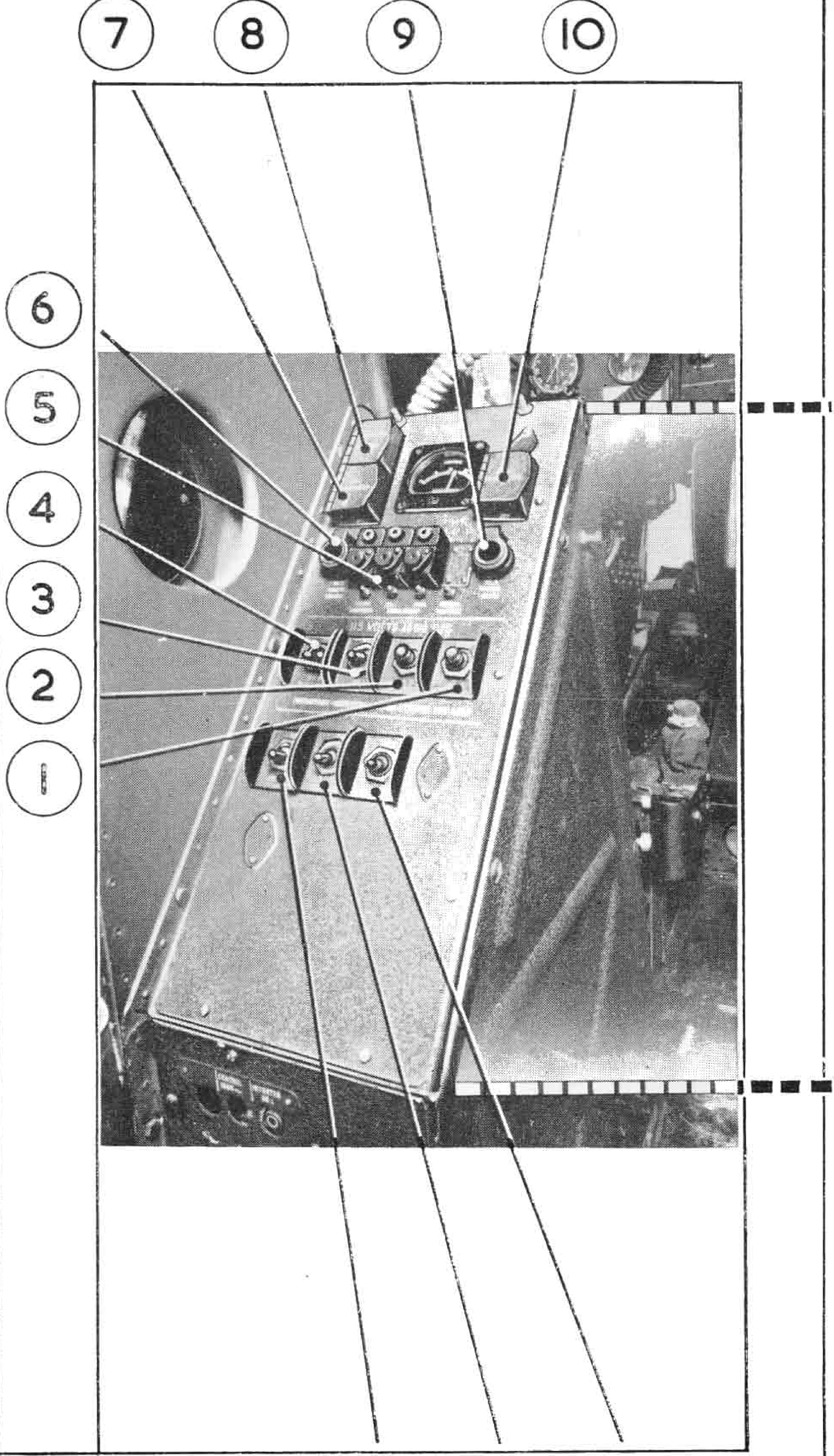
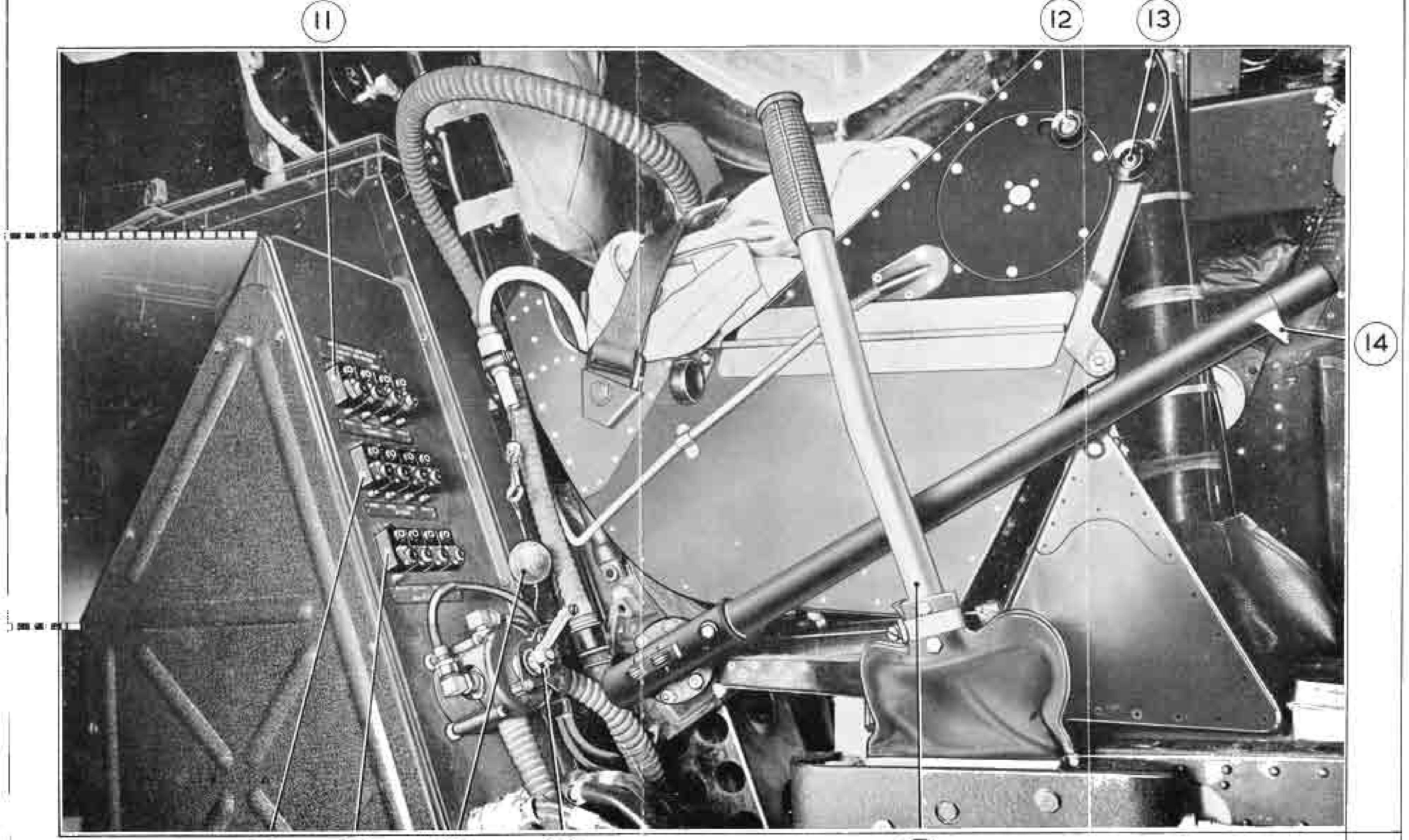



FIG 1

ELECTRICAL CONTROL PANEL




COCKPIT – VIEW FROM ENTRANCE DOOR

FIG 1

## KEY TO FIG. 2

23. Fuel vent valve heater switch (inoperative).
24. D.V. panel heater switch.
25. Pressure head heater switch.
26. Fuses in Gee circuit.
27. Bomb door control switch
28. Bomb door warning lamp.
29. Emergency bomb jettison switch.
30. Emergency bomb door selector lever.
31. Oxygen regulator.
32. H.P. fuel cock levers.
33. Intercomm. switches.
34. Throttle levers.
35. IFF receiver and G/D switches
36. Canopy jettison and snatch unit master safety switch and canopy jettison switch (Hidden by throttle levers)
37. Undercarriage emergency selector handle.
38. Flap selector switch lever.
39. Adjustable cold air vent.
40. Flap position indicator.
41. Throttle lever friction control.
42. H.P. fuel cock lever friction control.
43. H.P. fuel pump isolating valve switches.
44. External lights switches—from top to bottom:—
    Navigation lights switch
    Taxy lights switch
    Landing lamp switch
    Identification lights switch
    Identification lights colour switch
    External lights master switch
45. Identification lights morsing push-button.
46. Rudder trimming switch.
47. Aileron trimming switch.
48. Canopy jettison and snatch unit operating lever.
49. Wing tip tanks jettison button.
50. Canopy "sandwich" de-mister switch.

## KEY TO FIG. 3

51. Aileron trim indicator.
52. Undercarriage position indicator.
53. Rudder trim indicator.
54. Undercarriage selector pushbuttons.
55. Tailplane incidence indicator.
56. Bomb release pushbutton.
57. Air brake control switch.
58. Flight instruments emergency supply indicator.
59. Port u/v lamps dimmer switch.
60. Gee-H indicator.
61. Port flood lamps dimmer switch.
62. Brake lever.
63. Emergency lamp switch.
64. Tailplane incidence control switch.
65. Magnetic stand-by compass.
66. Starboard floodlamps dimmer switch.
67. L.P. cock and booster pump switch—No. 1 tank, port.
68. Starboard u/v lamps dimmer switch.
69. Dual jet pipe temperature gauge.
70. Fuel contents gauge—No. 1 tank.
71. L.P. cock and booster pump switch—No. 1. tank, starboard.
72. Oil pressure gauge—starboard.
73. Cabin pressure warning horn override switch.
74. Engine fire warning lights.
75. Engine fire-extinguisher pushbuttons
76. Fuel bay fire warning light.
77. Hydraulic warning gauge.
    NOTE.—On early aircraft not incorporating Mod. 887, a nitrogen gauge is fitted here.
78. Cabin altimeter.
79. Brake pressure gauge.
80. Cabin heating and pressurising switch.
81. Cabin heating and pressurising indicator.
82. Fuel pressure warning light—starboard.
83. L.P. cock and booster pump switch—No. 2. starboard.
84. Fuel contents gauge—No. 2 tank.
85. L.P. cock and booster pump switch—No. 3. starboard.
86. Fuel contents gauge—No. 3 tank.
87. L.P. cock and booster pump switch—No. 2. port.
88. L.P. cock and booster pump switch—No. 3. port
89. Oil pressure gauge—port.
90. Fuel pressure warning light—port.
91. Mk. 4B compass changeover switch.
92. Starter pushbutton—starboard.
93. Ignition switch—starboard.
94. VHF channel selector and volume control.
95. VHF press-to-transmit pushbutton.
96. Mk. 4B compass repeater.
97. Ignition switch—port
98. Starter pushbutton—port.
99. Master starting switches.

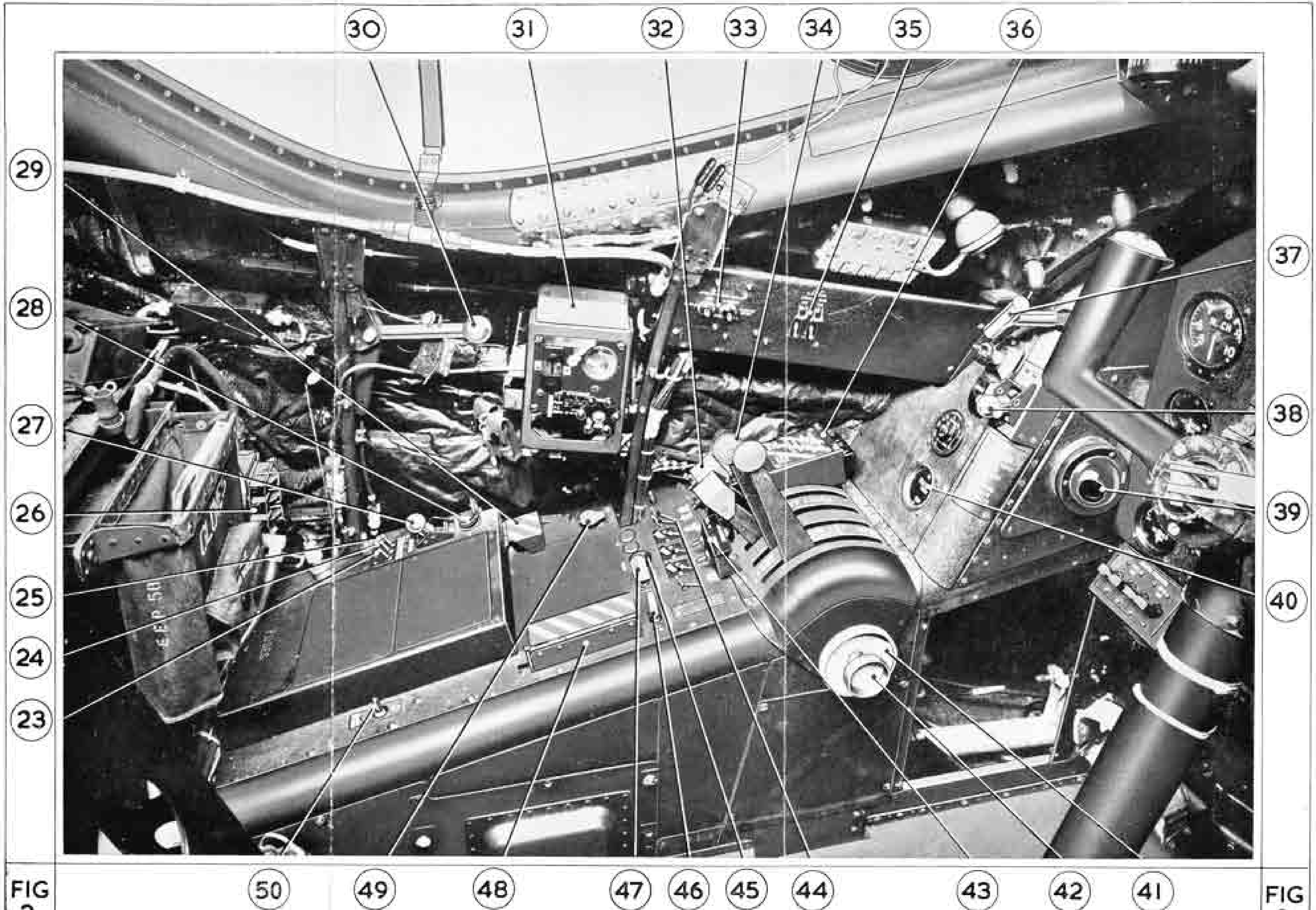



FIG 2

COCKPIT—PORT SIDE

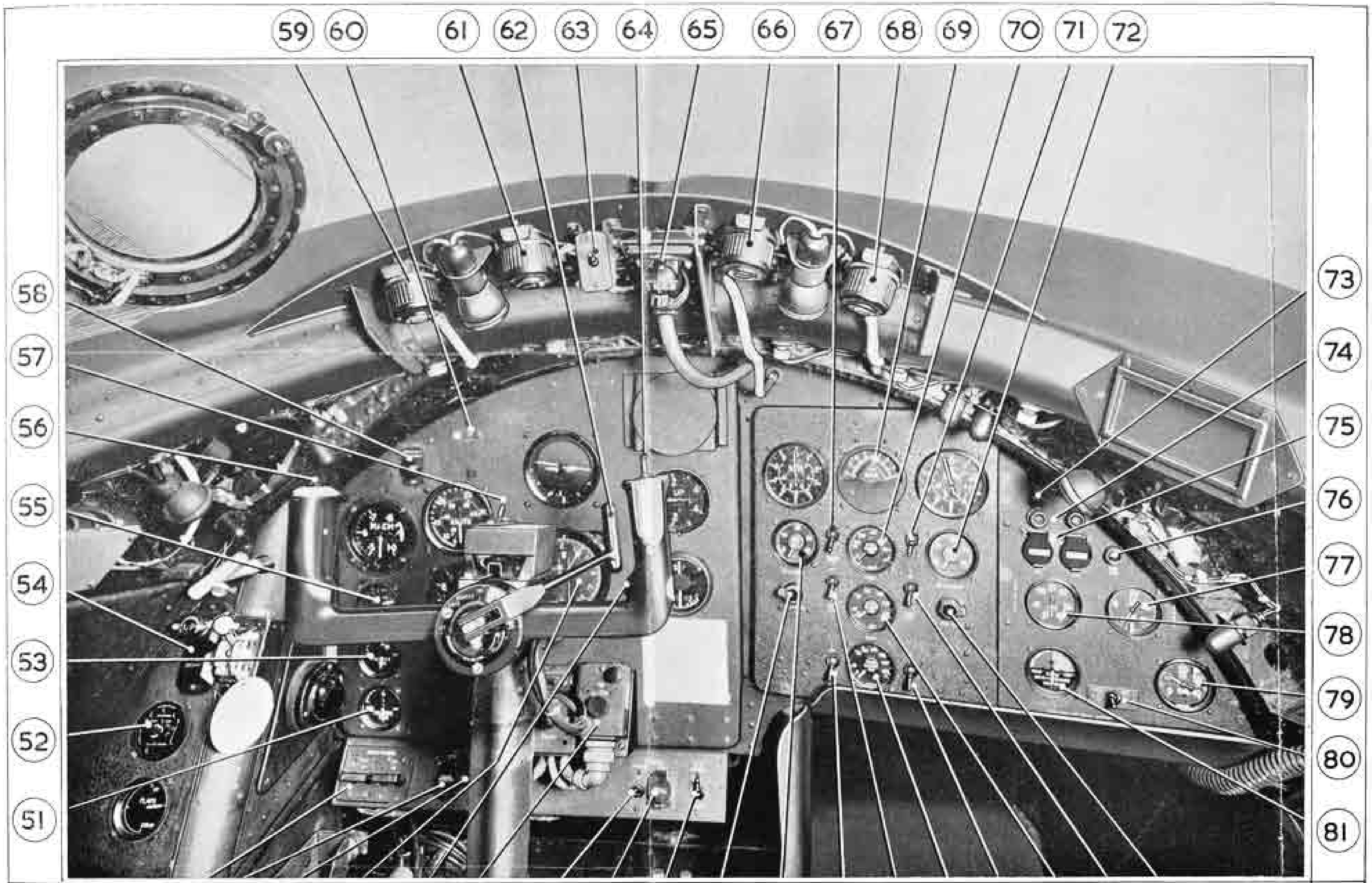



FIG 3

INSTRUMENT PANEL

FIG 3

AIR MINISTRY
*March, 1954*

Amendment List No. 1
to A.P.4326B—P.N.
*Pilot's Notes*
**2nd Edition**

## CANBERRA B.2

NOTE.—Incorporation of this Amendment List must be certified by inserting the date of incorporation and initials in the spaces provided on the inside front cover of the Notes.

When a manuscript amendment is made, the adjacent margin should be endorsed with the A.L. number viz. "A.L.1".

| PAGE | PARA. | AMENDMENT |
|---|---|---|
| ✓ 1 | Notes to Users | Second paragraph. In line 3 *amend* duplicate to quadruplicate, and in line 5 *amend* A.P.113 to A.P.113A |
| ✓ 11 | Intro-duction | *Delete* "or two Avon Mk. 101 . . . . . . static thrust." |
| ✓ 30 | 33 (iii) | *Amend* by gummed slip herewith |
| ✓ 38 | 50, 51 (i) | *Amend* by gummed slip herewith |
| ✓ 38 | 51 (ii) | In the last line on page 38 *amend* 170 knots to 190 knots |
| ✓ 43 | 54, 55 | *Amend* page 43 by gummed slip herewith |
| ✓ 44 | 55 (ii) (iii) | *Amend* page 44 by gummed slip herewith |
| ✓ 46 | 56 (ii), 57 | *Amend* the lower half of page 46 by gummed slip herewith. |
| ✓ 49 | 58 | *Amend* by gummed slip herewith |
| ✓ 50 | 60 (i) | *Amend* by gummed slip herewith |
| ✓ 50 | 60 (iii) | In the second line *amend* 6,000 to 7,000 |
| ✓ 51 | 60 (vi) | *Amend* by gummed slip herewith |
| ✓ 51 | 60 (ix) | In line 3 *amend* 170 to 190 |
| ✓ 52 | 62 (iv) | In the last line *amend* 66 to 65 |
| ✓ 57 | 65 (iv) (f) | *Amend* the NOTE by gummed slip herewith |
| ✓ 63 | 71 | *Amend* by gummed slip herewith |
| ✓ 67 | 77 (ii) (j) | *Amend* by gummed slip herewith |
| ✓ 72 | Key to Fig. 1 | Item 19. In lines 3 and 5 *amend* 3 to 2 |
| ✓ 38-39 | Flight Planning Charts | *Remove* the existing Flight Planning Charts between pages 38 and 39 by opening the staples of the book, and *insert* the new Charts supplied herewith, so that the staples pierce the insert along its fold and its pages register correctly with pages 38 and 39. Firmly close down the staples, taking care not to damage the insert. |

When the Amendment List is fully incorporated, *affix* this sheet to the inside back cover of the Notes.

## FINAL CHECKS FOR TAKE-OFF

| | |
|---|---|
| TRIMMERS ...... ...... | All neutral |
| AIR BRAKES ...... ...... | IN |
| FUEL ...... ...... ...... | Contents<br>All L.P. cock and pump switches ON and circuit-breakers made<br>Fuel pressure warning lights out<br>H.P. cocks full on and tightened<br>Fuel pump isolating switches NORMAL |
| FLAPS ...... ...... ...... | UP |
| INSTRUMENTS ...... | Jet pipe temperatures and oil pressures within limits<br>Check Mk. 4B compass |
| OXYGEN ...... ...... | On (check with crew)<br>Cabin pressurisation and heating as required |
| HATCHES AND CANOPY ...... ...... | Entrance door closed, handle locked<br>D.V. panel closed<br>Canopy jettison master switch ON |
| BOMB DOORS ...... ...... | Closed |

## FINAL CHECKS FOR LANDING

| | |
|---|---|
| FUEL ...... ...... ...... | Contents<br>All L.P. cock and pump switches ON in tanks containing fuel<br>Circuit-breakers made<br>Fuel pump isolating switches NORMAL |

Reduce speed to 170 knots and check

| | |
|---|---|
| UNDERCARRIAGE ...... | Down<br>Three green lights |
| BRAKES ...... ...... ...... | Pressure 2,500 lb./sq. in.<br>Check operation |
| FLAPS ...... ...... ...... | Down on final |
| AIR BRAKES ...... ...... | In |