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R.A.A.F. Publication No. 185
(September, 1941)

PILOT'S NOTES

The Australian Beaufort Aeroplane

Pratt & Whitney Twin Wasp S.3.C.4-G Engines

AIRCRAFT PRODUCTION COMMISSION

AUS. 420857
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NO 1 O.T.U. R.A.A.F.
E. SALE
VICTORIA

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ROYAL AUSTRALIAN AIR FORCE

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Pratt & Whitney Twin Wasp S.3.C.4-G Engines

The following handling notes are issued for the guidance of pilots.

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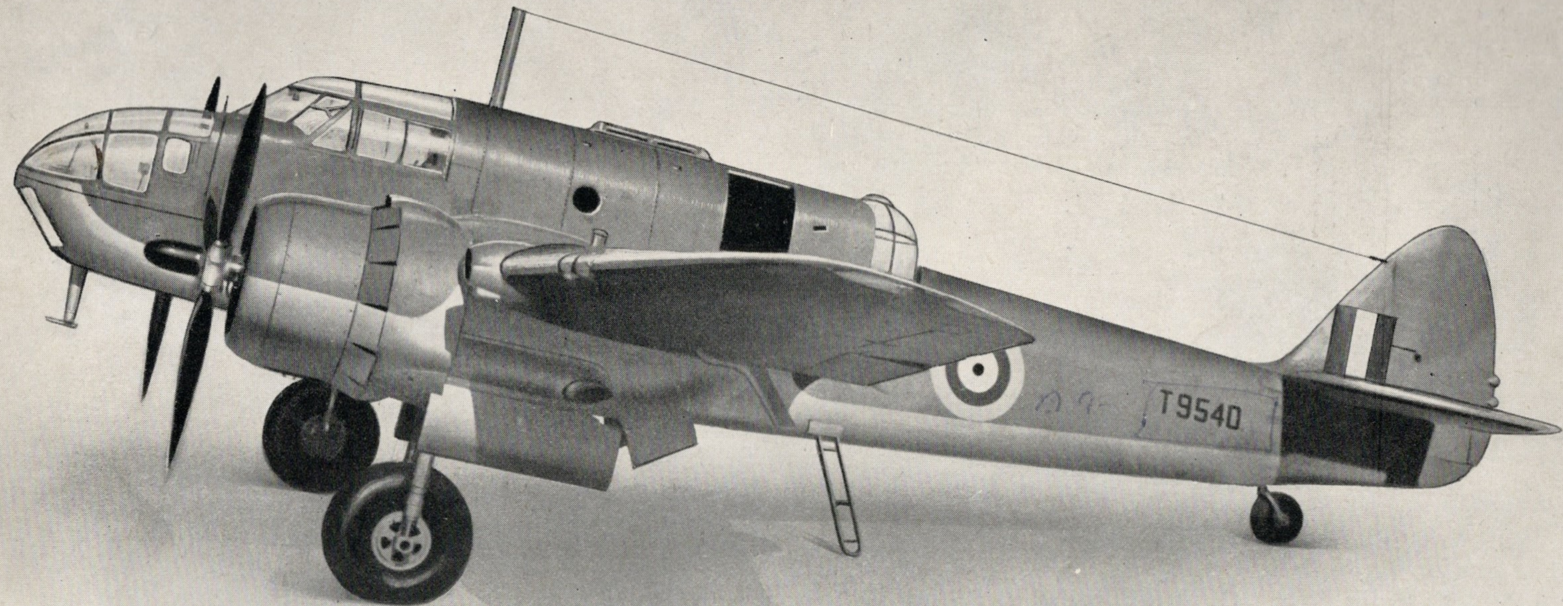
By Command of the Air Board.

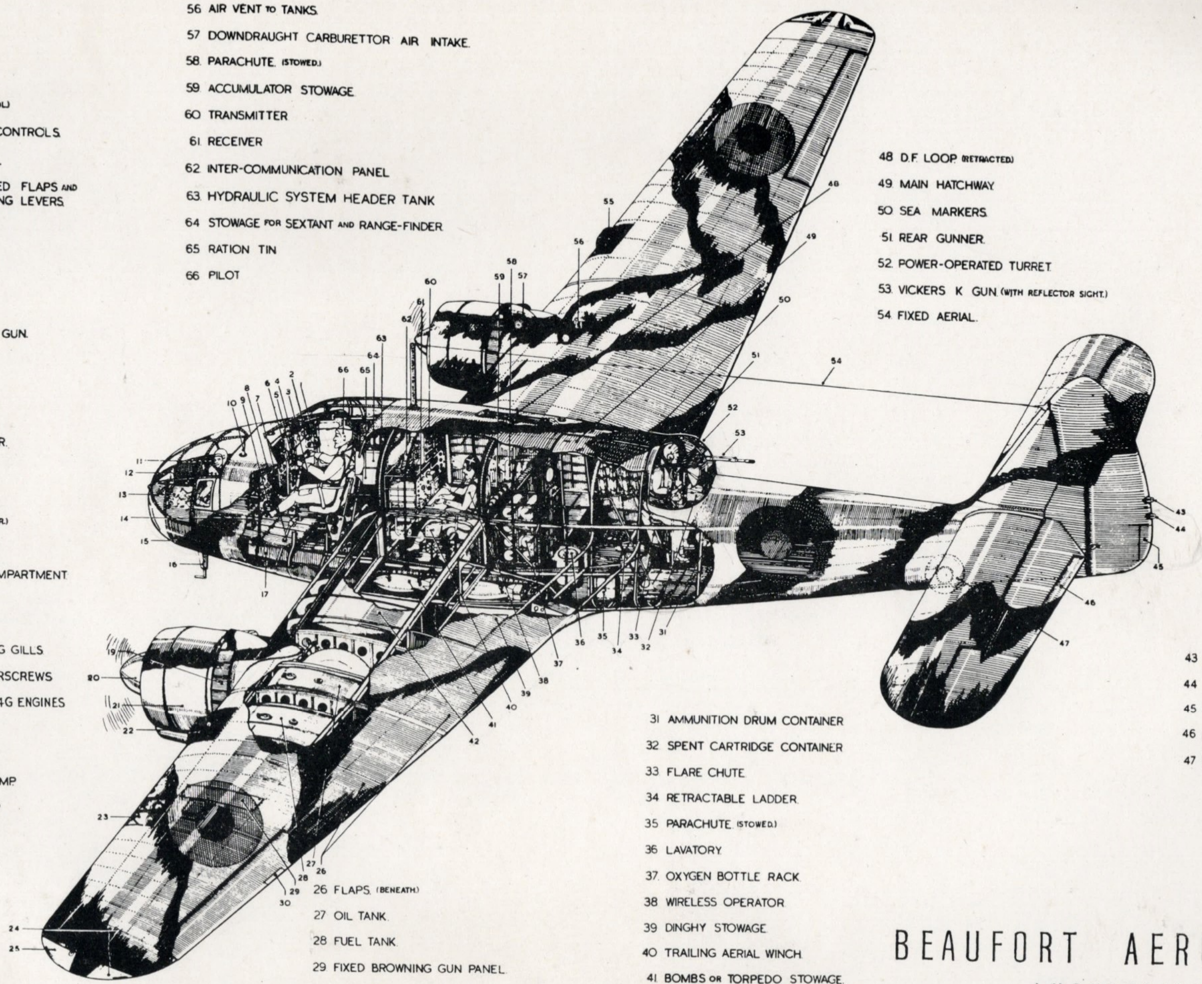
F. J. Mulrooney.

List of Illustrations



BEAUFORT AEROPLANE
(AUSTRALIAN)

1. COMPASS. (DUAL CONTROL)
2. DASHBOARD. (DUAL CONTROL)
3. THROTTLE AND MIXTURE CONTROLS.
4. ELEVATOR TAB CONTROL.
5. HYDRAULICALLY OPERATED FLAPS AND UNDERCARRIAGE ACTUATING LEVERS.
6. RUDDER TAB CONTROL.
7. BLIND FLYING PANEL.
8. SIGNAL PISTOL.
9. COMPASS.
10. FORWARD SIGHT FOR WING GUN.
11. BOMB-AIMERS PANEL.
12. NAVIGATOR OR BOMB-AIMER.
13. CHART TABLE.
14. AUTO-PILOT STOWAGE.
15. EMERGENCY EXIT. (IN FLOOR)
16. PRESSURE HEAD.
17. FORE END. TORPEDO COMPARTMENT.
19. CONTROLLABLE COOLING GILLS.
20. CURTISS ELECTRIC AIRSCREWS.
21. PRATT & WHITNEY S3 C4G ENGINES.
22. OIL COOLER AIR CHUTE.
23. TWIN LANDING LAMPS.
24. FORMATION KEEPING LAMP.
25. PORT NAVIGATION LAMP.
26. FLAPS. (BENEATH)
27. OIL TANK.
28. FUEL TANK.
29. FIXED BROWNING GUN PANEL.
30. AILERON ADJUSTABLE TAB.
31. AMMUNITION DRUM CONTAINER.
32. SPENT CARTRIDGE CONTAINER.
33. FLARE CHUTE.
34. RETRACTABLE LADDER.
35. PARACHUTE. (STOWED)
36. LAVATORY.
37. OXYGEN BOTTLE RACK.
38. WIRELESS OPERATOR.
39. DINGHY STOWAGE.
40. TRAILING AERIAL WINCH.
41. BOMBS OR TORPEDO STOWAGE.
42. FUEL TANK.
43. FORMATION KEEPING LAMP.
44. TAIL NAVIGATION LAMP.
45. RUDDER, CONTROLLED TAB.
46. ELEVATOR, CONTROLLED TAB.
47. RETRACTABLE TAIL WHEEL.
48. D.F. LOOP. (RETRACTED)
49. MAIN HATCHWAY.
50. SEA MARKERS.
51. REAR GUNNER.
52. POWER-OPERATED TURRET.
53. VICKERS K GUN. (WITH REFLECTOR SIGHT)
54. FIXED AERIAL.
55. OIL COOLER AIR CHUTE.
56. AIR VENT TO TANKS.
57. DOWNDRAUGHT CARBURETTOR AIR INTAKE.
58. PARACHUTE. (STOWED)
59. ACCUMULATOR STOWAGE.
60. TRANSMITTER.
61. RECEIVER.
62. INTER-COMMUNICATION PANEL.
63. HYDRAULIC SYSTEM HEADER TANK.
64. STOWAGE FOR SEXTANT AND RANGE-FINDER.
65. RATION TIN.
66. PILOT.



BEAUFORT AEROPLANE

AUSTRALIAN

Amendment Certificate

Incorporation of an amendment list in this publication should be certified by inserting the amendment list number, initialling in the appropriate column and inserting the date of incorporation.

Holders of the Pilot's Notes will receive only those amendment lists applicable to the preliminary matter, introduction and sections 1 and 2.

Amendt. List No. .										
Preliminary Matter										
Leading Partics. ..										
Introduction ..										
Section 1										
Section 2										
Section 3										
Section 4										
Section 5										
Section 6										
Section 7										
Section 8										
Section 9										
Section 10										
Section 11										
Section 12										
Date of Incorporation										

List of Sections

(A detailed Contents List appears at the beginning of each Section.)

REVISED AND AMENDED FOR TWIN ROW WASP

Introduction

1. The Beaufort is an all-metal mid-wing monoplane fitted with two Twin Wasp S.3.C.4.G engines. It is equipped for torpedo-bombing, general reconnaissance and general purpose duties, and accommodation is provided for a crew of four, consisting of the pilot, the navigator or bomb aimer, the wireless operator and the gunner.

2. The fuselage, main plane, tail plane and fin are covered with alclad sheet. Monocoque construction is employed in the fuselage, with alclad lipped channel and Z-section formers and lipped extruded hiduminium angle-section stringers. The main plane is a two-spar stressed-skin cantilever structure tapered in chord and thickness ; it is constructed in three portions, the port and starboard outer planes and the centre plane. The centre plane spars are continuous through the fuselage and are bolted to it. The fin and tail plane are cantilever structures constructed mainly of alclad, and the rudder, elevators and ailerons have a duralumin tubular spar, alclad ribs and fabric covering.

3. A retractable ladder and a hatch on the port side just forward of the gun turret provide the means of entry to the aeroplane and inside the fuselage a walkway on the starboard side leads through a curtained partition and over the centre plane spars to the extreme nose of the aeroplane. A table, and a seat that can be stowed out of the way under the table, are provided in the nose for the navigator or bomb aimer. The pilot with his equipment and controls is accommodated on the port side at a higher level than the walkway and there is an additional seat for the navigator or bomb aimer on the starboard side just aft of the pilot's seat. Emergency exits are provided in the floor and roof of the nose portion. Aft of the pilot, the wireless equipment and the wireless operator's seat are located between the centre plane spars. A seat for the gunner is incorporated in the gun turret

4. The alighting gear consists of two independent undercarriage units, fitted under the engine nacelles at the outer ends of the centre plane, and a tail wheel unit. The three units are retractable and are operated hydraulically. A separate hydraulic system operated by a hand pump is at present employed for emergency lowering of both the undercarriage and tail wheel but, at a

later date, a cartridge-fired system for emergency lowering of the undercarriage is fitted. The undercarriage units swing backwards and upwards into the engine nacelles and the tail wheel unit retracts forwards and upwards into a recess in the fuselage tail. Electrical indicators and a buzzer in the pilot's cockpit indicate the position of the three units. Each undercarriage unit has two Vickers oleo-pneumatic shock-absorber legs and the tail wheel unit has a single Lockheed oleo-pneumatic shock-absorber leg. Dunlop pneumatically-operated brakes are fitted to the undercarriage.

5. The flying controls are orthodox in operation ; the pendulum-type rudder pedals are connected to the rudder, and the spectacle-type control column to the ailerons and elevators by chains and cables. For directional and longitudinal trimming, tabs controllable by the pilot are inset in the trailing edges of the rudder and elevators. For lateral trimming, a pilot-operated tab is fitted on the starboard aileron and another tab, adjustable on the ground only, is fitted to the port aileron. Dual controls may be installed side-by-side with the main controls. Hydraulically-operated split-trailing-edge flaps extend from the fuselage sides to the ailerons.

6. The two Twin Wasp S.3.C.4.G. engines, which are of the air-cooled radial type, are installed in nacelles near the outboard ends of the centre plane and are fitted with Curtiss Electric constant speed Full Feathering Airscrew. Long-chord cowlings are fitted over the engines, and controllable gills that govern the flow of cooling air are fitted round the trailing edge. Fuel is carried in four main tanks, two in the centre plane and one in the outer plane on each side, and an auxiliary fuel tank may be installed in the bomb cell under the fuselage. Each engine has a separate oil tank mounted in the centre plane and, mounted in the outer plane, a separate oil cooler, for which the cooling air is collected by a duct on the leading edge. The engines are fitted with electrical starters and hand-turning gear is provided for maintenance work.

† 7. The protective armament consists of a fixed Browning gun mounted in both main planes and fired pneumatically by means of a push-button valve on the pilot's control column, and two Browning guns in a hydraulically-operated turret amidships, and one each side—one firing aft. The main bomb load is carried beneath the fuselage in a cell fitted with hydraulically-operated doors but provision is also made for carrying a bomb externally under each main plane. When a torpedo or a 2,000-lb. bomb is carried, the bomb cell doors are folded inwards and the bottom of the cell is left open.

† 8. The electrical installation for which power is derived from a 24-volt 1,000-watt dual purpose generator driven by the starboard engine and a 500-watt generator driven by the port engine, provides for the usual lighting services, landing lamps in the leading edge of the port outer plane, engine starting, A.S.I. pressure head and gun heating, camera motor, Graviner

† Subject to alteration.

fire extinguishers, wireless motor generator, undercarriage position indicators and warning buzzer, bomb release and fuzing, etc. The wireless installation is mounted between the centre plane spars and comprises a transmitter and a receiver ; both a fixed and a trailing aerial are provided. Intercommunication between the members of the crew is provided by an independent amplifier.

9. Other equipment provided includes a dinghy in the port centre plane, a signal pistol, flares, sea-markers, an Elsan sanitary closet, a F.24 camera, oxygen apparatus, etc. Lorenz beam approach equipment, desert equipment, a camera gun and a target towing hook may also be fitted.

SECTION I.

Controls and Equipment in Pilot's Cockpit

SECTION I.

List of Contents

List of Illustrations

SECTION I.

Controls and Equipment in Pilot's Cockpit

INTRODUCTORY

1. This Section gives the location and, where necessary, explains the function and operation of the controls and equipment in the pilot's cockpit, and also of equipment that is located elsewhere but with which the pilot should be acquainted. The layout of the various items is illustrated and referenced in figs. 1–4 ; each item is given an individual reference number and a key to the items referenced faces each illustration.

FUEL AND OIL

2. The fuel and oil to be used with the Twin Wasp S.3.C.4.G engines are :—

Fuel	.. ..	Specification 95 octane
Oil	.. .. ..	Specification D.T.D. 109

AEROPLANE CONTROLS

3. *Control Column.*—Aileron control is obtained by rotation of the spectacle-type handwheel at the top of the control column (7) ; elevator control is obtained in the normal manner. The handwheel incorporates a gun firing pushbutton (89) and a brake-operating lever (90). The firing button controls the air supply to the pneumatically-fired fixed guns in the main planes ; before use, the outer ring should be rotated from the SAFE position by a quarter of a turn. A spring-loaded catch (93) for retaining the brake lever in the on position for parking is fitted near the pivot point and is engaged by operating the break lever, pressing down the catch and releasing the lever ; the catch is then held in position but will spring out of the way when the brake lever is pressed down. In connection with parking, it should be noted that, when parking the aeroplane in the open during windy weather, either the rudder control should be locked or the wheels chocked against movement to the rear (*see* A.M.O. A114/38).

4. *Rudder Control.*—The rudder is controlled by pendulum pedals (4) pivoted at the top. For leg reach, the pedals are adjustable by a handle (99) under the instrument panel.

5. *Locking of Primary Flying Controls.*—Locking gear for the primary flying controls is stowed on the starboard side of the fuselage on the port side below the entrance hatch. The method of locking the controls is as follows :—

(i) Hold the control column in the central position.

(ii) Insert the eyebolt on the gear through the hollow bolt at the bottom of the column and secure with the pin.

(iii) Insert the aft end of the gear through the hole in the back of the pilot's seat and attach it by the quick-release pin to the structure behind the seat.

(iv) Fix the clip on the aileron handwheel.

(v) Fix the clips on the rudder pedals.

6. *Aileron Trimming Tab Control.*—The trimming tab on the starboard aileron is controlled from a handwheel (62) mounted forward of and below the engine throttles. To counteract any tendency of the aeroplane to fly with the port wing high the wheel should be rotated to port in the direction marked PORT WING DOWN, and *vice versa.* To depress the port wing, the tab is raised and the air load on the tab then forces the starboard aileron down slightly. An indicator (58) showing the position of the tab is fitted on the hydraulic control panel beside the rudder trimming handle. The tab on the port aileron can be adjusted only on the ground.

7. *Elevator Trimming Tabs Control.*—The trimming tabs on the elevators are controlled from a handwheel (50) at the top of the hydraulic control panel. The spindle of the handwheel is mounted transversely with a portion of the wheel protruding beyond the panel and, when the handwheel is rotated upwards towards the position marked NOSE DOWN, the action of the tabs tends to depress the nose of the aeroplane and relieve the pilot from the prolonged effort of countering any slight "tail heavy" tendency. This operation causes the tabs to be raised and the load on the tabs then forces the elevators down slightly. When the handwheel is rotated downwards towards the position marked NOSE UP, the effect is reversed. An indicator showing the position of the tabs is incorporated on the handwheel.

8. *Rudder Trimming Tab Control.*—The trimming tab on the rudder is controlled from a handle (56) mounted on the hydraulic control panel below the undercarriage and flap controls. When the handle is turned clockwise in the direction marked TURN RIGHT, the action of the tab tends to turn the aeroplane to starboard and relieve the pilot from the prolonged effort of countering any slight tendency of the aeroplane to turn to port. This operation causes the tab to be moved to port and the air load on the tab then forces the rudder slightly to starboard. When the handle is turned counter-clockwise in the direction marked TURN LEFT, the effect is reversed. An indicator showing the position of the tab is incorporated on the handle.

Hydraulic Controls

9. *General.*—The hydraulic system operates the undercarriage and tail wheel retracting gear, the flaps, the bomb doors and the gun turret. On earlier aeroplanes, fluid under pressure is supplied to the actuating jacks by two pumps, one on each engine, but two hand pumps, one on the starboard side of the pilot's seat, mainly for servicing, and another on the hydraulic control panel for emergency operation of the alighting gear, are also provided in the pilot's cockpit. As the hydraulic pump on the starboard engine is fitted temporarily in place of the air compressor for the auto-controls, the auto-controls cannot be used. On later aeroplanes, a cartridge-fired system for emergency lowering of the undercarriage and tail wheel is fitted. With this system, the hand pump on the starboard side of the seat and the additional engine-driven pump on the starboard engine are not fitted and the pump on the control panel is used, on the ground, for servicing and, in flight, for lowering the flaps.

10. *Selector Control.*—The selector control (51) operates a valve that directs the fluid either for the operation of the undercarriage, flaps and bomb doors or to the gun turret and fluid by-pass. For undercarriage, flaps and bomb doors operation, the control should be pulled out, but, unless these services are being used, it should be pushed in. The indicator (47) at the side of the control shows which of the alternatives is in use.

11. *Undercarriage Control.*—The undercarriage lever (55) which has a black round knob, controls the raising and lowering of the two undercarriage units and of the tail wheel unit. The movement of the lever is in the same sense as the movement of the units, *i.e.*, up to raise the units and down to lower them.

12. *Undercarriage Control Safety Lock.*—In order to prevent inadvertent retraction of the alighting gear when the aeroplane is on the ground, the control lever is automatically locked in the DOWN position by the safety lock (53). The lock consists of a spring-loaded pin connected by cable to the ram of the inboard oleo leg of the starboard undercarriage unit. When the weight of the aeroplane is on the undercarriage and the oleo frame is compresesd, the cable is slack and the pin is forced by the spring into a position where it obstructs the movement of the control lever to the UP position ; when the aeroplane is in flight and the weight is removed from the undercarriage, the oleo frame moves downward and the pin is withdrawn. If necessary, the lock can be moved out of the way by hand by pulling out the knurled knob at the centre of the pin and moving the pin to the left.

13. *Undercarriage Radius Rod Locking Pins.*—In addition to the undercarriage control safety lock, a further positive means of preventing inadvertent retraction of the undercarriage when the aeroplane is on the ground is provided by locking pins that are fitted, directly by hand from the ground, into the knuckle joints of the inboard radius rod of each undercarriage unit. A red flag is attached to each pin and the pins must be removed before

flight. If the pins have been accidentally left in position the red flags can be seen by the pilot; the starboard pin being visible more easily through a small window below the emergency exit window. These locks are stowed in a bag on the diaphragm forward of the gun turret.

14. *Undercarriage Position Indicators and Warning Buzzer.*—Three electrical position indicators (48), one on each side for the corresponding undercarriage unit and one in the middle for the tail wheel unit, are mounted at the top of the hydraulic control panel. When the three units are locked in the retracted position, the indicators show the word UP on a red background and, when the units are locked in the lowered position, they show the word DOWN on a green background. When the units are not locked in either the up or down position, or the indicators are switched off, black and white dazzle lines are shown at the centres of the indicators. There is also, in the nose of the fuselage, an electrical warning buzzer that sounds if the engine throttle levers are closed beyond about the one-third open position with the undercarriage units not locked in the down position and remains in operation with the throttle levers in this position until the undercarriage units are locked down.

15. The switch (30) for the undercarriage and tail wheel position indicators is fitted beside the main magneto switches. The indicator switch knob is fitted with an extension bar which, in the off position of the switch, obstructs the movement of the magneto switches from the off to the on position. When the indicators are switched on by moving the switch knob sideways to the left, the bar is withdrawn from the magneto switches. Conversely the indicators cannot be switched off until the magneto switches are also off.

16. *Flaps Control and Position Indicator.*—The flaps control lever (54) which has a white square knob, controls the lowering and raising of the split-trailing-edge flaps. Its movement is in the same sense as the movement of the flaps, *i.e.*, down to lower the flaps and up to raise them. To lower the flaps to a lesser degree than fully down, the lever should be placed in the DOWN position until the indicator (52) at the right-hand side of the control shows that the flaps are lowered to the desired position and the lever should then be returned to the gate in the middle of the quadrant, thus shutting off the control valve.

17. *Bomb Doors Control.*—The bomb doors lever (46) which has a red knob, controls the opening and closing of the hydraulically-operated doors of the bomb cell under the fuselage. In the up position of the lever, the doors are closed and in the down position, the doors are open. Safety switches fitted on the door-operating mechanism cut off the electrical supply to the bomb release gear until the doors are fully open.

18. *HYDRAULIC EMERGENCY SYSTEM AND HAND PUMP.*—A hydraulic hand pump for emergency lowering of the undercarriage, tail wheel and flaps is fitted behind the hydraulic control panel with an attach-

ment (59) for the pump handle protruding through the panel. The pump handle (18) has a red hand grip and is stowed in clips at the bottom of the hydraulic control panel. When this pump is used, the fluid is delivered to the jacks through pipe-lines separate from the engine-driven pumps system ; automatic valves isolate the two systems from each other.

19. On the first stroke of the emergency hand pump, a red-painted knob (57) below the rudder trimming handle moves out and indicates that the normal pipe-lines are isolated and that the emergency pipe-lines are in circuit. The knob must be depressed before the normal system can be used again.

19A. *CARTRIDGE-FIRED EMERGENCY SYSTEM.*—When the cartridge-fired system for emergency lowering of the undercarriage and tail wheel is fitted, the cartridges are fired electrically by pressing a shielded push-button below the bomb jettison switch. Before the button is pressed, the undercarriage control lever (55) must be in the down position and, in addition, an emergency by-pass control lever below the push-button must be pulled back from the vertical position to the horizontal position marked EMERGENCY.

19B. The gas must be released from the system as soon as possible (*see* Sect. 4, Chap. 2.)

19C. When the cartridge-fired system is fitted, the hand pump behind the hydraulic control panel is used for emergency lowering of the flaps. Before the pump is used, the flap control lever (54) must be in the down position and the knob (57) above the pump handle attachment must be pulled out.

Engine Controls

20. *Throttle and Mixture Controls.*—Two throttle control levers (3) and two mixture control levers (2) are mounted on a quadrant at the forward end of the engine control panel, on the right hand side of the pilot's seat. The throttle lever slots are fitted with a gate to prevent the engines being over-boosted during take-off, the gate being adjusted so that the maximum boost obtained is 48" Hg. They are also marked "shut" and "open."

The mixture control lever has four positions :

(1) Right back—Full Rich.
(2) *First position forward—Automatic Rich.* This position is used for all normal operations and take-off.
(3) Second position forward—Automatic Lean.
(4) Right Forward—Idle Cut-off position.

An adjuster for the stiffness of the controls is provided at the side of the quadrant. A shielded bomb-firing switch (60) is fitted on the starboard throttle lever.

21. *Fuel Cock Controls.*—The five fuel cock control levers (65) for the normal fuel system are mounted at the rear end of the horizontal part of the engine control panel. The pair of cock control levers for the port tanks have

red knobs, the starboard have green knobs and the balance cock lever, which is between the two pairs, has a black knob. The tank cock control levers are in the corresponding positions of their respective tanks and all levers should be moved forward to open the cocks.

22. Fuel is carried in four main tanks, two in the centre plane and one each side of the outer plane, and the supply to the engine carburettors is maintained by engine-driven pumps. A suction-balance pipe connects the port and starboard fuel systems and enables fuel to be drawn from any tank to either engine if the balance cock is open. For short range flights the two outer tanks should not be filled and should be turned off. For intermediate range flights all four fuel tanks should be filled and the outer tanks should be used first, the inner main tanks being turned off; when the outer tanks are emptied they should be turned off and the inner main tanks turned on. The outer and inner pairs of tanks should not be used together. When the auxiliary fuel tank for long range flights is fitted in the bomb cell, the supply from the tank is governed by a handle (108) on the starboard side of the fuselage. The control is connected to a cock on the auxiliary system pipe-lines and has alternative positions for providing a supply to both engines or to one or the other engine. Fuel flows as required from the main tanks into the auxiliary tank and the engine pumps draw fuel from that tank only.

23. *Airscrew Controls.*—The speed control levers (64) for the constant-speed-operated airscrews are fitted on the engine control panel aft of the throttle levers. In the extreme aft position of each lever, the airscrew blades are held at their maximum coarse pitch angles. For all other positions of each lever, the airscrew is under constant-speed operation, provided that the airscrew and the constant-speed governor unit are within their limiting conditions, and movement of the control forward will increase the engine r.p.m. and movement rearward will decrease the engine r.p.m.

24. *Cowling Gills Control.*—The cowling gills control switch on the port fuselage side controls the opening and closing of the cowling gills that govern the flow of cooling air for the engines.

25. *Carburettor Air-intake Controls.*—The air-intake shutter levers (66) are situated above the fuel cock levers and control the supply of either hot or cold air to the carburettors. The lever for the port engine air intake has a red knob and that for the starboard is green. In the down position of the levers, cold air is supplied, and in the up position, hot air is supplied.

26. *Carburettor Cut-out Controls.*—The carburettor cut-out controls (69) are fitted at the top of the vertical part of the engine control panel and have a red knob for the port engine and a green knob for the starboard.

Doors, Windows and Seat, etc.

27. *Method of Entry to Aeroplane.*—Entrance to the fuselage is through a hatch on the port side just forward of the gun turret. A retractable ladder

in the lower radius of the fuselage just aft of and below the port wing trailing edge provides means for climbing on to the wing root walkway from which entry through the hatch can be effected. Hand grips are provided on the fuselage sides. The ladder is accessible through a spring-loaded hinged door and it can be withdrawn by lifting it up and swinging it outwards to clear the stowage hook at the top and then pulling it down until the foot reaches the ground. The top half of the entrance hatch can be opened by means of the flush handle and then secured in a clip at the top of the fuselage ; the bottom half should be pushed open and down. Entry is made by stepping on to the tread plate on the top of the Elsan sanitary closet. After the crew have entered the aeroplane, it is important that the ladder should be retracted by pulling it through the door and replacing it in its stowed position.

28. *Pilot's Seat.*—The pilot's seat (6) is constructed to take a seat-type parachute and is fitted with hinged armrests. The seat is adjustable for height by means of a lever on the left-hand side ; the lock for securing the seat at the desired height can be released by turning the twist grip at the end of the lever. Sutton harness is fitted and the release lever for the harness is on the starboard side of the seat.

29. *EMERGENCY EXITS.*—At each side of the cockpit a special window (73) with a fixed pane and a sliding pane is provided. Each window can be jettisoned by operating a lever at the bottom (shown in the illustration) and used as an emergency exit. The lever is operated by releasing the safety catch at the end, raising the lever clear of the fulcrum point near its middle and removing the lever from the support bracket at the forward end. The window can then be jettisoned by pushing it outwards.

30. There is also an exit hatch in the roof on the starboard side, consisting of two hinged doors opening inwards. The doors are held shut by two draw bolts in stops at the forward and after ends and may be opened by pulling down the handle at the centre. The inboard door, when open, is held against the roof by an elastic cord at the rear end ; the head should be kept clear of the inboard door when opening the hatch, as the elastic cord causes it to open violently. This hatch may also be used for navigational observations and is fitted with a retractable deflector screen at the forward end.

31. Another emergency exit is provided on the floor in the nose of the aeroplane. It is released by raising the handle in the recess on the outboard side, lifting it inwards and then jettisoning it through the hole.

32. The entrance door forward of the gun firing aft turret also provides an emergency exit.

33. *DIRECT-VISION WINDOWS AND KNOCK-OUT PANELS.*—In the rear corner of the pilot's windscreen on each side is a direct-vision window (9), for use if the windscreen is obscured. The windows open inwards on hinges at the inboard sides and are retained in the open position by trip

catches at the bottom of the windscreen. When the windows are opened, a small wind deflector plate at the hinges is rotated outwards. A small bar for opening the windows if they become frozen to the draught-excluder round their edges is stowed along the sill tube behind the starboard direct-vision window ; to force the window open, the bar should be used as a lever in the fork below the securing catch.

34. Immediately aft of each direct-vision window is a triangular panel (8) that is secured on the outside only by the draught-excluder round the edges and therefore may be easily knocked out if necessary in extreme conditions of bad visibility.

35. *Optically-true panel.*—A portion of the windscreen panel in front of the pilot is ground optically true to enable sextant readings to be taken. The sextant is stowed behind the pilot's head.

Operational Equipment

36. *EMERGENCY CONTROL—Suction Pump Change-over Control.*—Each engine drives a suction pump, and the artificial horizon, the direction indicator and the turn indicator on the instrument-flying panel are operated by one or other of these pumps. In the event of failure of the pump, the other can be selected by means of the change-over cock control (43) at the top of the instrument panel. The suction available is shown on the gauge (44) beside the change-over control.

37. *EMERGENCY CONTROL—Fuel Jettison Control.*—By pulling forward the red-painted lever (74) on the port side of the fuselage in line with the back of the pilot's seat, the fuel in each outer plane tank can be jettisoned. The lever controls a pneumatically-operated jettison valve on each tank.

38. *Fuel Contents Gauges.*—The contents of the main plane tanks are indicated by four gauges (22 and 23) at the middle of the lower portion of the instrument panel and the contents of the auxiliary tank, when fitted, are indicated by a gauge (107) on the starboard side of the fuselage. The master switch (106) above the auxiliary tank gauge operates all the gauges ; it is important that this switch is switched off at the end of each flight. Location of petrol gauges is altered in Australian Beauforts.

39. *Pilot's Gun Sight.*—The sight for the fixed Browning gun consists of a ring (11) suspended close to the inside of the pilot's windscreen and a bead on a faired post forward of the windscreen. Vertical adjustment is provided for the ring and lateral adjustment for the bead.

40. *Bomb and Torpedo Releasing.*—On earlier aeroplanes, the pilot has control over the selection, fuzing, releasing and jettisoning of the bombs or torpedo ; a firing switch is also provided in the nose of the aeroplane to enable the bomb aimer to release the bombs. On later aeroplanes, an automatic bomb distributor is fitted at the bomb aimer's station and the pilot has control over only releasing and jettisoning.

41. Before the bombs can be released or jettisoned, the master switch in the bomb jettison switch (92) must be on and also the doors on the bomb cell must be opened (*see* para. 17), as switches linked to the door operating mechanism cut off the electrical supply to the release gear until the doors are fully open. When releasing bombs carried externally on the wings, the cell doors must be open also, as the electrical supply for the external carriers also passes through the door switches. When a torpedo or a 2,000-lb. bomb is carried, the cell doors are folded in wards, leaving the bottom of the cell open, and the door switches are cut out by means of a shorting plug in the cell. The torpedo or 2,000-lb. bomb is selected for release by switch No. 7, which is coloured red to distinguish it from the others. Switch No. 8 is not wired. The torpedo depth-setting control must be set by hand by a member of the crew. A type B torpedo sight can be fitted.

42. *Landing Flare Release Control.*—The release of the two forced-landing flares carried aft of the turret is controlled by means of a red-painted lever working in a gated quadrant mounted on the port side of the fuselage in line with the back of the pilot's seat and below the fuel jettisoning lever. When the lever is pulled forward as far as the gate, the first flare is released and when pulled through the gate the second flare is released. After use, the lever should be returned to the normal position.

43. *Navigation and Identification Lamps and Signalling Switch-boxes.*—The navigation lamps are controlled by the switch (27) at the bottom of the instrument panel on the port side.

44. The signalling switchbox (84) on the port side of the cockpit provides for independent or simultaneous use of the upward and downward identification lamps through the morsing key or, alternatively, a steady illumination from the lamps. The desired downward lamps (red, green or clear) should be selected on the 3-unit switchbox (81). The head-lamp can be brought under the control of the DOWNWARD switch of the identification signalling switchbox by placing the knob of the switch (79) in the upward position, which is marked SIGNALLING. In the central position of the switch knob, the headlamp is off and in the downward position marked INDEPENDENT, steady illumination is provided from the headlamp independently of the downward identification lamps.

45. The signalling switchbox (109) on the starboard side of the cockpit provides the morsing or steady illumination from the formation-keeping lamps; only the DOWNWARD switch is wired.

46. The spring pressure on the morsing key of the signalling switch-boxes can be adjusted by disengaging the lock at the upper left-hand corner and turning the ring until the required pressure is obtained, when the lock should be released to engage in one of the slots. The range of movement of the key can be altered to suit the operator by opening the cover and adjusting the screw and locknut at the centre of the cover.

47. *Signal Pistol.*—The signal pistol can be fired either downwards through the tube (98) on the left-hand side of the seat or upwards through a tube above and behind the pilot's head. The inner ends of both tubes are constructed to provide stowage for the pistol. Stowage (72) for six smoke puff cartridges is provided on the port side of the fuselage aft of the pilot's seat and for signal or illuminating cartridges under the navigator's seat.

48. *Landing Lamp Controls.*—The landing lamp lever (61) on the side of the engine control panel controls the dipping of both landing lamps in the leading edge of the port plane. To depress the lamp beam, the lever should be pushed forward. The control is spring-loaded towards the dipped position and a gate is provided on the lever quadrant for holding the lever in the aft position.

49. Each lamp has a completely independent electrical circuit and is controlled by a switch (63) behind the throttle controls. In the central position of the switch, both lamps are off and when the switch knob is moved to starboard or to port the inner or the outer lamp is illuminated, respectively.

50. *Oxygen Equipment.*—A standard oxygen regulator (31) is fitted on the port side of the instrument panel and a Mk. IIIA bayonet union is fitted on the port side of the fuselage in line with the back of the pilot's seat. The oxygen supply is obtained from eight interconnected cylinders in a crate situated on the port side forward of the bulkhead at the rear of the wireless compartment.

51. *Intercommunication.*—A combined microphone and telephone socket is fitted on the front edge of the pilot's seat.

52. *Camera Gun Control.*—The camera gun control is fitted on the side of the engine control panel aft of the airscrew controls, and changes the film and sets the shutter of the G.22 camera gun, which can be mounted, for firing practice, at the starboard side of the nose fuselage. An indicator for the number of exposures made is fitted at the side of the handle. At a later date, the G.22 camera gun may be replaced by a G.42B cine-camera gun for which a loading handle is not necessary. The exposures of the camera gun are controlled from the gun-firing pushbutton (89) on the control column.

53. *Height and Airspeed Computor Stowage and Map Case.*—A map case and stowage for a height and airspeed computor are fitted on the side of the horizontal part of the engine control panel, forward of the engine throttle levers.

54. *Cabin Heating Control.*—The cabin heating control (100) is fitted on the starboard side of the fuselage and is connected to the heater unit in the starboard engine nacelle. In the forward position of the lever, the heating is on.

55. *Camera Indicator.*—The remote control unit for the F.24 camera is fitted in the nose of the aeroplane on the starboard side and the warning

lamps contained in it are visible to the pilot. The red warning lamp is illuminated four seconds before the exposure and remains alight until the exposure begins; the green warning lamp is then brought into circuit and remains alight during the time that the camera motor is energized.

Miscellaneous Equipment

56. *FIRE EXTINGUISHERS.*—The two shielded pushbuttons (42) at the top of the instrument panel, when pressed, release the contents of two fire extinguishers, one in each engine nacelle. Two flame switches in each engine nacelle provide automatic operation of this fire-extinguishing system. The flame switch operates if fire breaks out in the engine nacelles. A hand fire-extinguisher is stowed on the port side of the fuselage aft of the wireless operator's seat.

57. *FIRST-AID OUTFITS.*—Two first-aid outfits are stowed on the port side of the fuselage just aft of the main entrance door.

57A. *ABANDON AIRCRAFT SIGNALLING SYSTEM.*—On later aeroplanes, the pilot's panel for the abandon aircraft signalling system is fitted below the bomb jettison switches. Other panels are fitted at each crew station.

58. *DINGHY RELEASE.*—A type H dinghy is fitted in the trailing edge of the port centre plane and is released by pulling the manual release at the aft inboard corner of the stowage cover. Marine distress signals are stowed with the dinghy.

59. *AXE.*—An axe, for cutting a way out of the fuselage in an emergency, is stowed at the side of the vertical part of the engine control panel.

60. *SUNBLIND.*—A sunblind is provided above the pilot's head; it is fitted with a tab and hook to enable it to be pulled forward and secured in an eye at the forward end of the wire rails on which it slides.

61. *Flying Rations.*—Flying rations are stowed below and aft of the writing pad container (70) behind the pilot's head.

Key to Fig. 1

4. Rudder Pedals
6. Pilot's Seat
7. Control Column
8. Knock Out Window
9. Direct Vision Window
11. Gun Sight
18. Handle Hydraulic Pump
27. Navigation Light Switch
30. U/c. Position Indicator Switch
48. Undercarriage Position Indicator
57. Emergency Hand Pump Indicator
61. Landing Lamp Lever
62. Aileron Trim Tab Control
64. Airscrew Pitch Control
65. Fuel Cock Controls
89. Gun Firing Switch
90. Brake Operating Lever
92. Jettison Switches
93. Spring Loaded Brake Lock
99. Rudder Pedal Adjustment
114. Pressure Head Heater Switch
115. Gun Heater Switch
119. Supercharger Control

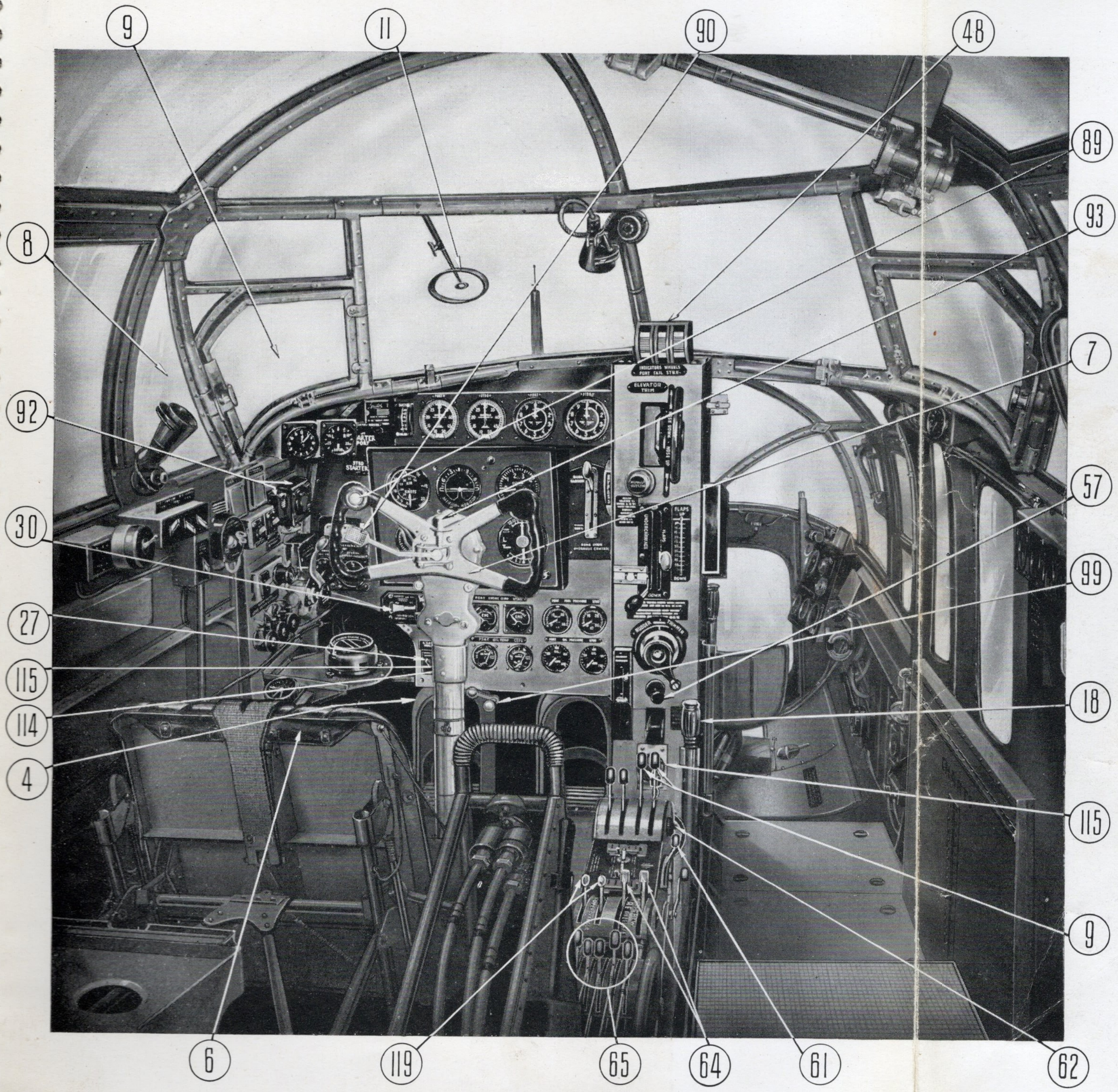
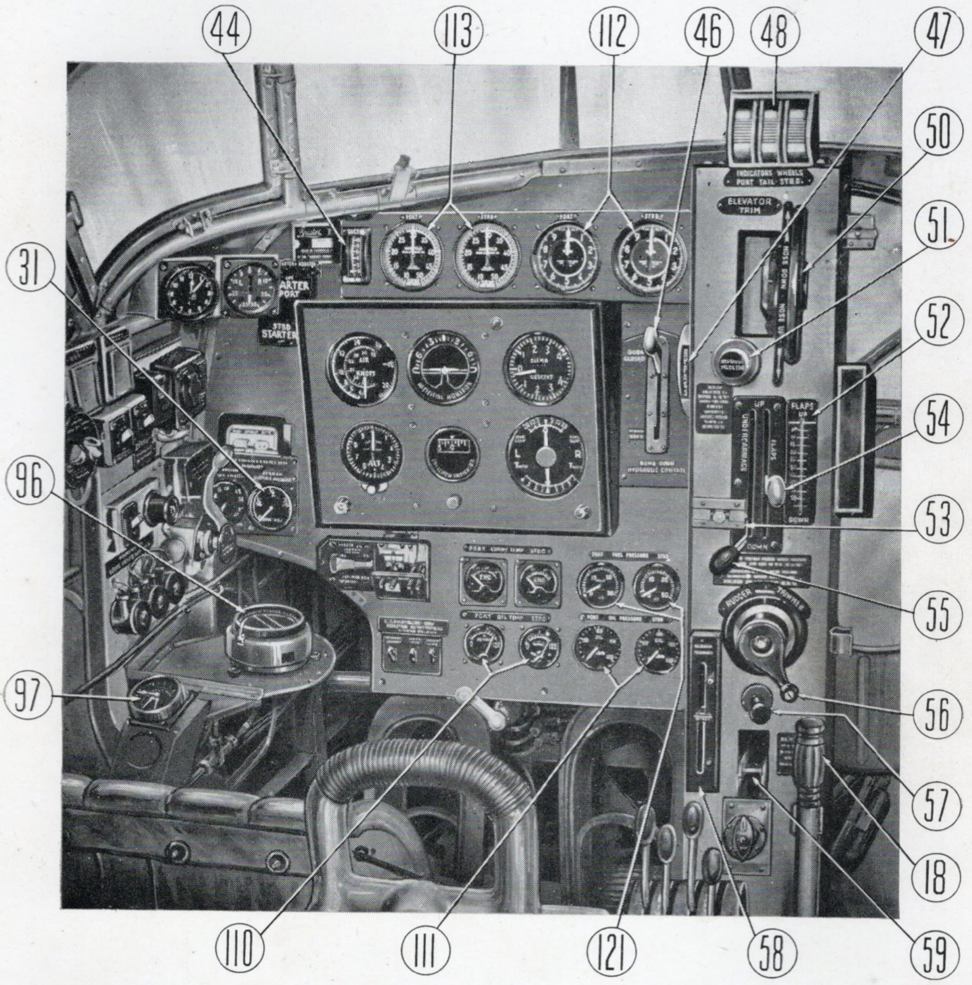


FIG.1 COCKPIT

Key to Fig. 2

18. Handle Hydraulic Hand Pump
30. Undercarriage Indicator Switch
31. Oxygen Regulator
44. Vacuum Gauge
46. Bomb Door Control
47. Indicator (By Pass Turret)
48. Undercarriage Position Indicators
50. Elevator Trim Tab Control
51. Hydraulic Selector
52. Flap Indicator
53. Undercarriage Safety Lock
54. Flap Control
55. Undercarriage Control
56. Rudder Trim Tab Control
57. Emergency Hand Pump Indicator
58. Aileron Trim Tab Indicator
59. Hand Pump
96. Compass
97. Triple Pressure Gauge
110. Oil Temperature
111. Oil pressure
112. Tachometer
113. Boost Gauge
121. Fuel pressure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97
96
31
ELEVATOR TRIM
FLAPS
UNDERCARRIAGE
STBD STARTER

FIG. 2

Key to Fig. 3

74. Fuel Jettison
81. 3-Unit Switchbox
84. Signalling Switch Box
92. Bomb Jettison Switch
96. Compass
97. Triple Pressure Gauge
116. Abandon Aircraft Switch
117. Head Light Switch

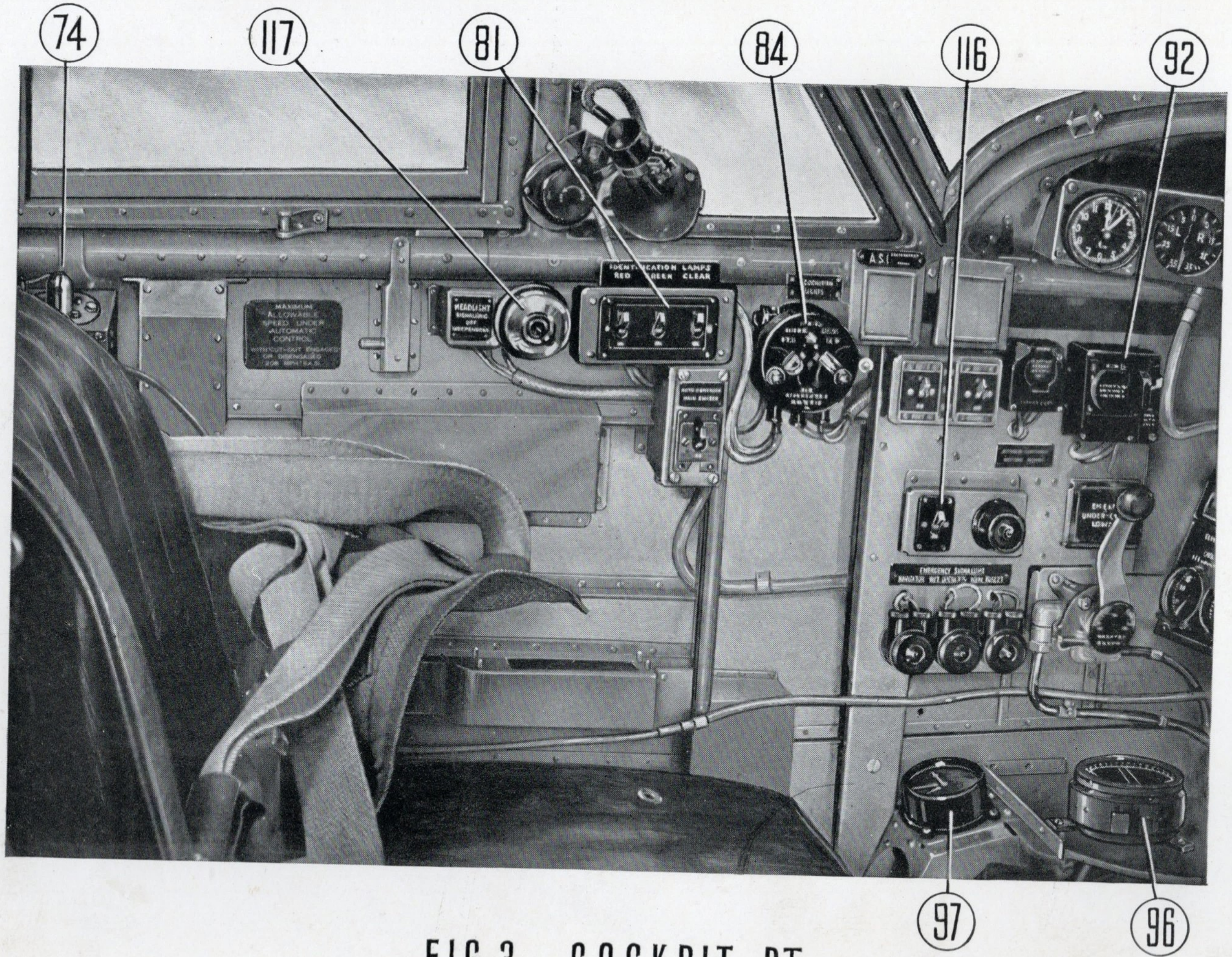

FIG. 3 COCKPIT PT.

Key to Fig. 4

2. Mixture Control
3. Throttle Control
8. Knock-out Window
9. Direct Vision Window
22. Fuel Contents Gauges
23. ,, ,, ,,
43. Vacuum Pump Selector
60. Bomb Firing Switch
61. Landing Lamp Lever
66. Carburettor Air Controls
73. Emergency Exit Window
106. Master Fuel Gauge Switch
107. Auxiliary Fuel Contents Gauge
108. ,, ,, Cock
109. Signalling Switchbox
120. Airscrew Switch

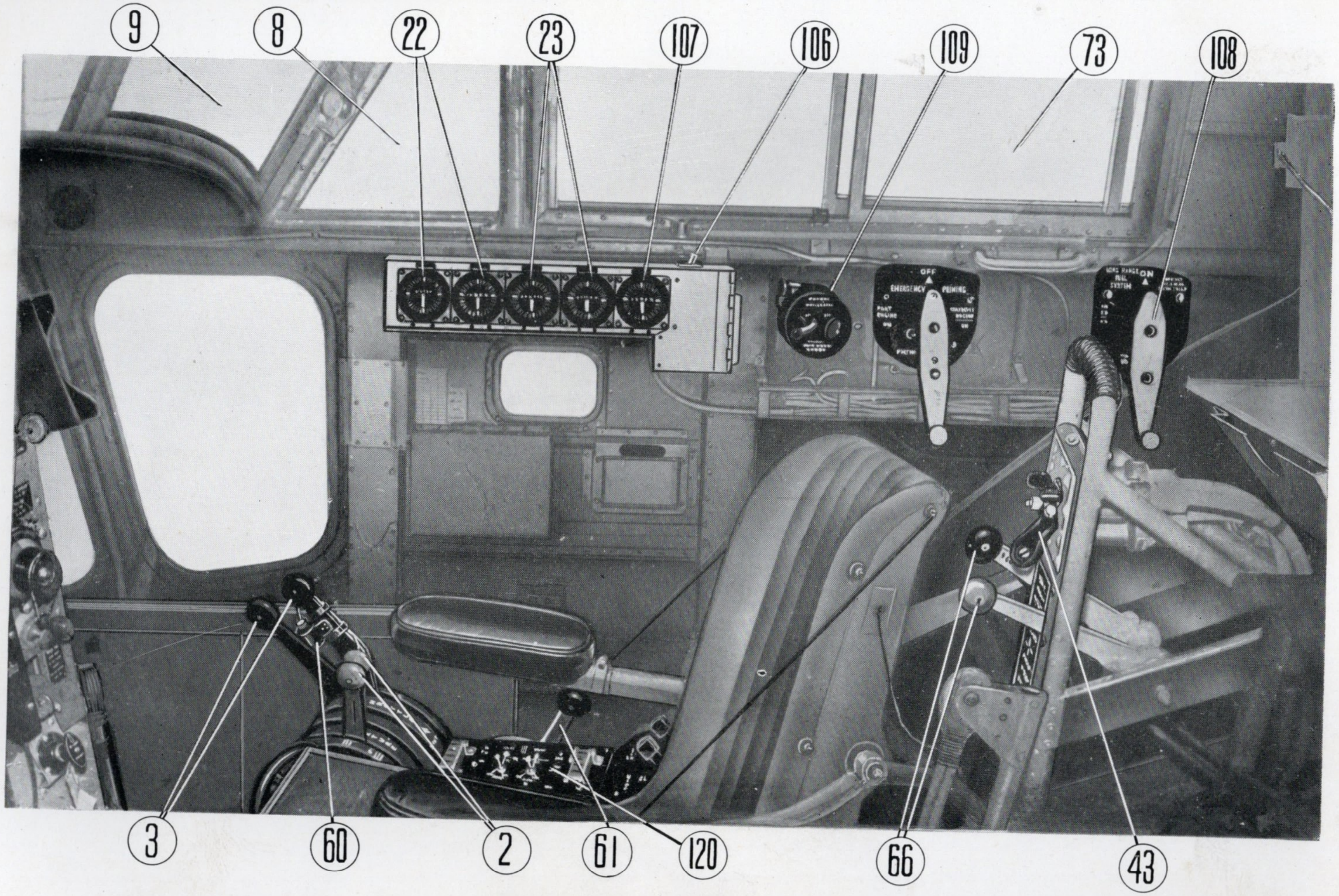

FIG. 4 COCKPIT STB.

SECTION II.

Handling and Flying Notes for Pilot

SECTION II.

HANDLING AND FLYING NOTES FOR PILOT

List of Contents

List of Illustrations

SECTION II.

Handling and Flying Notes for Pilot

INTRODUCTORY NOTES

1. The information given in this paragraph is complementary to the description of the equipment included in Section 1 :—

(i) *Hydraulic System.*—The hydraulic system operates the retractable undercarriage, the flaps, the retractable tail wheel, the bomb doors and gun turret. The engine-driven hydraulic pump is mounted on the port engine. A hand-operated pump is provided for use in case the engine pump fails or for operating when the engine is stationary.

The hydraulic controls are described in Section 1.

(ii) *Flaps.*—These are of the split trailing edge type and can be set at any position over their range of movement. The effect with the flaps fully down, is (*a*) to increase drag and so steepen the gliding angle for the approach and (*b*) to increase the lift coefficient and so reduce the stalling speed. With this aeroplane the use of flaps (30°) for take-off is necessary and they should be fully down for landing. They must not be lowered at speeds above 140 m.p.h. (115 knots) I.A.S.

(iii) *Trimming Tabs.*—Trimming tabs are provided on the elevators, rudder and on one aileron (starboard). The tabs are very powerful in operation but a very fine adjustment can be obtained by means of the controls. The tab controls should be used to keep the aeroplane in trim during flight. The elevator tab control may be used to assist manœuvring and recovery from the dive, but must be used very slowly and carefully because large stresses can be set up without being apparent on the controls (*see* para. 20 (iii).

(iv) *Airscrew Controls.*—The airscrews are of the variable-pitch type governed by constant-speed units. Curtiss Electric full feathering propellers are fitted on Serial No. A1 to A90 Beaufort. See Para. 12 for details of operation.

(v) *Mixture Control.*—These engines are equipped with the (PD-12F2) Stromberg Injection Carburettor incorporating the Bendix one-position automatic mixture control unit as described in the carburettor manual. This floatless carburettor meters the fuel through fixed orifices according to air venturi suction, and is provided with a manual mixture control which may be set in one of the following positions :

(*1*) Full Rich.—Without automatic compensation for altitude or temperature conditions by making the automatic mixture control unit inoperative. (Recommended for use only when the automatic unit is believed to be inoperative.)

(*2*) Automatic Rich.—Usual operating position, automatically maintaining the desired fuel/air ratios at all engine speeds and loads, independent of changes in altitude, temperature, propeller pitch, supercharger speed or throttle position.

(*3*) Automatic Lean.—A leaner setting than "Automatic Rich" and suitable for cruising operation under favourable conditions. This setting may be too lean for good acceleration. Therefore, WHEN MANŒUVERS ARE NECESSARY USE "AUTOMATIC RICH."

(*4*) Intermediate Positions.—Each position has a tolerance of about 5° plus or minus at the carburettor with a total throw of the mixture control of 90° with proportionate amounts in the cockpit depending upon the quadrant and control design. Between positions there is a fairly uniform transition in its effect on the mixture delivered by the carburettor. Between "Full Rich" and "Automatic Rich" the transition varies in its rate and amount depending upon the density of the air entering the carburettor as affected by temperature and altitude. Automatic Lean is 5% to 10% leaner than Automatic Rich depending upon the particular carburettor setting. Between Automatic Lean and Idle Cut-Off further reduction in mixture strength is attainable by manual control primarily for use when the automatic unit may not function properly due to damage. This practice is definitely not recommended and must not be used except in case of extreme circumstances. *Manual leaning of the carburettor beyond the Automatic Lean position must be done with extreme caution* having due regard to the engine operating conditions and fuel characteristics, particularly the tendencies to detonation with leaner mixtures than found advisable by the engine and carburettor manufacturers.

(*b*) The accelerating pump is operated by and in proportion to the momentary changes in the air pressure in the entrance to the main supercharger. The accelerating pump is not connected with the throttle or throttle controls. Hence, when the engine is not running, no fuel is pumped from the carburettor when the throttle is moved, no matter how rapidly. The carburettor is normally non-icing and regulation of the carburettor air temperature is not necessary as a rule. However it is still important that there be a good source of hot air for the induction system in the event that certain climatic conditions (such as saturated air at 35° F. to 60° F.) cause ice to form somewhere in the system.

(*c*) Ratings of the engines with various fuels are predicated upon extensive laboratory tests. High power ratings, even with the best of fuels, are accomplished by using mixtures richer than maximum power in order to suppress tendencies of the fuels to detonate. It is necessary to use increasingly richer settings of the carburettor as octane numbers of the fuels are lowered, particularly is this true with take-off and military ratings, and to lesser extent with normal power. Manifold pressures are modified with resulting differences in critical altitudes. Pilots are especially cautioned against leaning out in order to increase the available power when operating under such conditions. An engine with carburettor setting for high octane fuel should not be used with fuels having lower octane numbers. A low octane engine can use safely fuels of higher octane numbers and the corresponding power ratings but may not have the fuel economy that a suitable carburettor setting would provide.

(vi) *Cowling Gills.*—Fully closed, the gills allow enough air to pass the cylinders to give adequate cooling during normal flight. For ground running they should be fully open. With this aeroplane the gills must be opened 10°–25°, dependent on local temperatures, during a full power climb. For other conditions of flight gills should be closed provided that engine temperatures are within the required limits.

(vii) *Undercarriage.*—The undercarriage when down causes drag, thereby steepening the gliding angle. It should not be lowered at speeds exceeding 160 m.p.h. (138 knots) I.A.S.

(viii) *Carburettor Air-intake Heat Controls.*—These controls have two positions only, *i.e.*, HOT or COLD. They should be used in the appropriate position for the following conditions :—

Cold Position.

The carburettor is normally non-icing and regulation of the carburettor air temperature is not necessary as a rule, but may be necessary to use heat in the event of saturated air condition at 35° F. to 60° F. Normal position Cold. Also Cold for take-off—see take-off notes.

Hot Position.

(*a*) When warming up the engines during cold weather this condition seldom occurs. Machine can be flown in icing conditions with carburettor air intake control in normal position, *i.e.*, cold.

(*b*) During all conditions of flight when there is a possibility of ice formation and when the engines show signs of being unduly cold.

Important.—When conditions of excessive humidity are known to exist, *i.e.*, flying through or under heavy cloud or in snow, it may be necessary to apply heat if temperature is in range stated above.

2. Note the following :—

(i) *Weight Sheet Summary.*—Ensure that the total weight and the disposition of the load are in accordance with the Weight Sheet Summary.

(ii) *Danger of Carrying Non-standard Loads.*—The danger of carrying non-standard loads is emphasized in the following sub-paragraphs. This information should be carefully read and understood :—

(*a*) When any load is carried other than the normal crew and military load, it is of the greatest importance to ensure that it is disposed in such a way that the balance of the aircraft is not disturbed. Serious accidents have occurred on a number of types of aircraft due to tail heaviness from additional load carried in the after portion of aircraft.

(*b*) As a rough rule, no additional load should be carried aft of a point approximately one-third of the wing chord behind the leading edge at the wing root, unless it is balanced by an approximately equal load the same distance forward of this point.

(*c*) Wherever possible, however, the C.G. position should be determined by the data provided and the loading should be adjusted to bring the C.G. within the range notified in the Weight Sheet Summary as the safe range for the particular aircraft.

(*d*) Attention is drawn to A.M.O.A. 254/1936.

PRELIMINARIES

3. Note the following—On entering the cockpit proceed as follows :—

(i) See that the undercarriage operating lever is in the DOWN position, that the selector cock control knob is pulled out, and the hydraulic system indicator shows UNDERCARRIAGE and BOMB DOORS. After checking flaps, push Control Knob in and leave same in until the Drill of Vital Actions for Takeoff is carried out.

(ii) Make sure that the red knob controlling the undercarriage EMERGENCY system is flush with the panel.

(iii) Set the air-intake heat control to COLD AIR.

(iv) Set the cowling gills fully open. This is done to keep the engines cool during the run-up and taxying.

(v) Put the airscrew control levers fully forward to give fine pitch.

(vi) Vacuum Selector on Right or Left.

(vii) Check the movement of all flying controls.

(viii) Set Altimeter. Set and wind clock.

(ix) Check the contents of all fuel tanks.

Excessive priming also has a tendency to wash the oil off the cylinder walls and may result in barrel scoring or piston seizure. Rusting of piston rings and cylinder walls will occur if the engine is allowed to stand for a day or more after unsuccessful attempts to start, unless the surfaces are protected by a fresh application of oil. Underpriming is usually indicated by backfiring of the engine through the intake system with attendant hazards and fire.

(*b*) Always make certain that the primer valve, or pump, is closed and locked before the engine is started if the source of priming fuel supply is from the pressure side of the fuel system. Do not wobble more than 2 to 4 pounds of pressure while the hand primer is open, as the primer may become hydraulically locked.

(*c*) WITH PRIMER VALVE : Follow special instructions of airplane manufacture for type of valve installed.

10. Turn the ignition switch to the "Both On" position.

11. With direct Cranking Electric Starters.

(*a*) *Warm Engines :*

Where engines are warm from previous running or where outside air temperatures are 60° F. (15° C.) or above, priming by means of hand primer pump or other external priming device may not be necessary.

(*1*) Raise the maintain fuel pressure to about 10 lbs./sq. in. In warm weather (80° F. (27° C.) and above) 6 lbs. is more desirable.

(*2*) Maintaining fuel pressure, close booster switch (if manually controlled) and engine starter simultaneously.

(*3*) While engine is being turned by starter move mixture control out of "Idle Cut-Off" whether engine has fired or not. If engine does not start almost immediately (3 seconds) while maintaining fuel pressure with the wobble pump, return mixture control to "Idle Cut-Off." If engine does not start in about the next 5 seconds while mixture control is in "Idle Cut-Off," again move the mixture control out of "Idle Cut-Off" still keeping the engine turning with the starter and maintaining fuel pressure at 8–10 lbs. /sq.in. and repeat procedure. In general, one to three repetitions of this procedure will result in starting the engine. However if a start is not effected in a reasonable length of time, investigation should be made to ascertain the cause. Overloading with warm engines will be indicated by a discharge of fuel from the drain located in the lower part of the engine blower. In this case, KEEP THE MIXTURE CONTROL IN "IDLE CUT-OFF," discontinue wobbling, open the throttle and turn the engine over with the starter in order to clear it out. If the engine has been loaded and

Note.—For full details of the Wasp engine, reference should be made to Operators Handbook, Twin Wasp C4 Engines.

4. *A. STARTING.*

Magneto Switches Off.

1. Turn the engine over four or five revolutions by pulling the propeller through by hand. This will remove any oil or gasoline which might have collected in the lower cylinders while the engine has been idle. (It is advisable to remove the lower spark plugs before turning the engine over if there is any reason to believe the cylinders are loaded. This is especially important where a relatively high position of the exhaust tail pipe will prevent drainage out of the exhaust valves.)

2. In cold weather the oil should be preheated before starting. In extremely cold weather it may also be necessary to preheat the engine before starting.

3. Place the mixture control in the "Idle Cut-Off" position.

4. Be sure that cowl flaps are open.

5. The blower ratio selector valve should be set in the "Low" position for all ground operations, except when it is expressly desired to check the operation of the blower ratio selector valve.

6. Propeller control in "Low Pitch" or "High R.P.M." Safety switches on and Control Switch in "Auto."

7. Throttle about 1/10″ open (after the spring of the control system has been taken up).

8. Fuel supply "ON."

9. Priming (see starting instructions for Warm and Cold engines).

(*a*) *WITH PRIMER PUMP:*

With hand wobble pump, bring the fuel pressure up to 2 to 3 lbs./sq. in. (140 to 120 g./cm^2) which is usually sufficient to furnish fuel to the primer pump. If the fuel pressure exceeds 4 to 5 lbs./sq. in. (280 to 350 g./cm^2) and the mixture control at the carburettor is not in the extreme idle cut-off position, the carburettor will pass raw gasoline into the induction system. Care should be taken to see that the carburettor and fuel system are filled with gasoline, but that the induction system is not flooded. Prime sufficiently but not excessively having due regard to engine temperature. This will vary from no prime with a hot engine to four or six or more strokes with very cold engines, having in mind that one stroke of a small size primer pump will fill about 5 ft. of primer line. Excessive priming will load the cylinders with raw gasoline making it difficult to start the engine.

the ignition is left on, it is frequently possible to effect a start while clearing the engine out with the starter. In this case, it is necessary to be ready to immediately retard the throttle to prevent overreving. If the ignition switch is not left on during the clearing-out procedure, a reasonable number of turns, such as 6 or 8 revolutions of the propeller, should be sufficient to clear. Then repeat the starting procedure outlined above, starting with the mixture control in "Idle Cut-Off" and being more careful this time about moving the mixture control out of "Idle Cut-Off." If no drainage of fuel is evident from the engine blower, the difficulty is probably not from overloading. In this case it is possible that the engine has not yet obtained sufficient fuel due either to the fuel pressure not having been kept up during the starting procedure or to the mixture control not having been moved out of "Idle Cut-Off" a sufficient number of times or for long enough periods. In this case, repeat the starting procedure, operating wobble pump and the mixture control with caution so as to feed a little more fuel into the engine.

If it is still not possible to start the engine, in all probability some part of the ignition system is not functioning, such as the booster, and investigation should be made. Protracted operation of the booster can sometimes overheat the coils so as to render the booster inoperative.

(*4*) As soon as the engine starts, move the mixture control to "Automatic Rich." With the Beaufort fuel system the pressure builds up quickly and it is seldom necessary to operate wobble pump after priming procedure has been carried out. If pressure does not build up, continue to operate wobble pump until the desired pressure, *i.e.*, 16 lbs./sq. in. has been obtained.

(*5*) Adjust throttle control to hold the engine to as low speed as possible for the first 30 seconds after starting and watch for an indication of oil pressure on the gauge. CAUTION: IF OIL PRESSURE DOES NOT REGISTER ON THE GAUGE ALMOST IMMEDIATELY, STOP AND INVESTIGATE.
(See "Oil Pressure," Operators Handbook, Twin Wasp C4 Engine.

(*6*) After the first half minute, adjust the throttle to about 1,000 R.P.M.

(*b*) *Cold Engines:*

Where engines are cold and have been exposed to outside air temperatures below 60° F. (15° C.) priming is necessary. The lower the temperature, the greater the amount of priming which will be required. Under the various temperature conditions which may be encountered, experience will dictate how much priming is necessary to obtain good starting. With priming accomplished, follow starting instructions as outlined for warm engines.

Note : On cold engines, overloading is not necessarily indicated by a discharge of fuel from the engine blower, but rather by the presence of raw gasoline in the exhaust collector, particularly in the stacks leading from the primed cylinders. In this case follow the procedure outlined for clearing out a warm engine when loaded.

If there is no evidence of raw gasoline in the exhaust collector, in all probability the engine has not been given sufficient prime, EVEN THOUGH FUEL MAY BE DRAINING FROM THE BLOWER. In cold weather considerable quantities of fuel may be discharged into the blower and pass out through the drain and still leave the engine underprimed. The reason for this is that fuel at low temperature discharged into the blower is NOT sufficiently atomized to be carried into the cylinders in mixture strengths necessary for combustion when engine is turned over. For this reason, direct atomized priming to the cylinders with a pump or special priming valve is required in cold weather, rather than flooding the blower and causing a possible fire hazard from the drainage. On the other hand, in warm weather, both the fuel and the engine are at higher temperatures so that fuel discharged into the blower is atomized sufficiently to be carried into the cylinders in mixture strengths necessary for combustion when the engine is turned over. When under-priming is suspected, additional priming should be made cautiously and the starting procedure repeated as outlined for warm engines.

12. With Inertia or Shot-Gun Starters.

(*a*) The instructions outlined for Direct Cranking Electric Starters are generally applicable for Inertia or Shot Gun-Starters with the following important exceptions.

1. Before engaging starter, turn ignition switch to "BOTH ON."

2. LEAVE MIXTURE CONTROL IN "IDLE CUT-OFF" UNTIL ENGINE FIRES. The reason for this precaution is that the higher speeds obtained with these starters can cause the engine fuel pumps to develop pressures in excess of 5 lbs./sq. in., irrespective of whether the wobble pump is operated or not. Should the mixture control be placed prematurely out of "Idle Cut-Off" and the engine fail to start for one reason or another, considerable quantities of fuel may be discharged into the engine and drain from the blower section, creating a possible fire hazard. Further, with these types of starters, there is seldom time to use the procedure of moving the mixture control in and out of "Idle Cut-Off" while the engine is turning over.

Inasmuch as it is impractical, therefore, to use the mixture control to obtain partial priming as is done with the direct cranking starters, it is advisable to use *only the hand primer* under any conditions where it is felt that the engine is not getting sufficient fuel to start.

3. As soon as the engine fires and before the prime is used up, move the mixture control without hesitation to the "Automatic Rich" position.

As with the direct cranking starter, it is still important to operate the wobble pump sufficiently to insure an unbroken flow of fuel to the fuel pump, particularly at the moment the engine fires.

B. *WARM-UP.*

Note: It is suggested that the Pilot's Check Chart be used in conjunction with the remaining instructions in this section. See next page.

1. After the first half minute, the warm-up should be made with the propeller, regardless of type, in the "Low Pitch" or "High R.P.M." position and at engine speeds of about 1,000 R.P.M.
2. Be sure the cowl flaps are open. Do not attempt to warm the engine up more quickly by closing the cowl flaps in extremely cold weather. This may cause burning of the ignition system at the spark plug elbows.
3. When starts are made with cold oil, oil pressures may remain at 300 lbs./sq. in. (21 kg/cm^2) for a minute or more while the delayed action of the compensating relief valve is controlled by the temperature of the income oil. The relief valve is designed to produce initial high oil pressure for positive lubrication of an engine which has been standing idle for an extended period. The high pressure is reduced when the oil inlet temperature reaches 40° C. (104° F.).
4. The blower ratio selector valve should remain in the "Low" position throughout the warm-up period.
5. Continued idling below 800 r.p.m. may result in fouled spark plugs.

C. *GROUND TEST.*

1. When the oil-in temperature has risen above 40° C. (104° F.) the throttle may be opened to approximately 30″ Hg. (760 mm) absolute manifold pressure with the propeller in "Low Pitch" or "High R.P.M." Do not attempt to operate above 1,000 R.P.M. until the oil-in temperature has exceeded 40° C. (104° F.).

Do not run motors up until head temperature has reached 150° C. Note the loss of revolutions when switching to one magneto at a time. In switching from both magnetos to one, the normal drop-off is 50 to 75 R.P.M. (if over 75 do not takeoff but have plugs checked, otherwise buring of pistons may occur in defective cylinder) and does not usually exceed 100 R.P.M. When switching from one magneto to the other, the change in R.P.M. should not be more than 30 or 40. It should be noted that the loss in R.P.M. when operating with one or two magnetos varies with different engine speeds. *This check should be*

From P & WA Curve T-596.

PILOT'S CHECK CHART.

Pratt & Whitney Twin Wasp R–1830–S3C4–G, Single Stage, Twp Speed, PD–12F2, 95 Octane.

Operating Condition	Alt. (ft.)	Engine R.P.M.	Man. Press. Max. Hg.	Blower Ratio	Mixture Control	Oil in Temp. °C.	Oil Press. lbs./in.f	Fuel Press. lbs./in.f	Cyl. Heads Max. °C.	Cyl. Barrels Max. °C.	Cowl Flaps	Approx. Fuel Cons. in U.S. gal./hr.
Start	—	500–600 $\frac{1}{2}$ min.	1/10 Throt.	Low	Cut-off and Auto. Rich	—	(300)	2–3 14–16	—	—	Open	—
Warm-up	—	1000	—	,,	Auto. Rich	—	—	14–16	205	168	,,	—
Ground Test	—	*(Low Pitch)	30.0	,,	,,	40–85	80–100	,,	232	,,	,,	—
Take-off	—	2700	48.0	,,	,,	,,	80–105	,,	260	,,	,,	150
Military Rating (5 min.)	0–9500	,,	45.0	,,	,,	100	80–100	,,	,,	,,	,,	150
Military Rating (5 min.)	9500–	,,	41.0	High	,,	100	,,	,,	,,	,,	,,	138
Rated Power	0–10000	2550	41.0	Low	,,	40–85	,,	,,	,,	,,	As req'd.	131
Rated Power	10000–	2700	39.0	High	,,	,,	,,	,,	,,	,,	,,	130
75% Power	0–14000	2325	32.5	Low	,,	,,	,,	,,	232	,,	Closed	80
75% Power	14000–	2325	31.0	High	,,	,,	,,	,,	,,	,,	,,	76
Cruising (Max.)	0–14500	2250	28.0	Low	Auto. Lean	60–75	65–100	,,	,,	,,	,,	55
Cruising (Max.)	14500–	2250	29.5	High	Auto. Rich	,,	,,	,,	,,	,,	,,	63
Cruising, Recommended	0–10600	2000	29.0	Low	Auto. Lean	,,	,,	,,	,,	,,	,,	50
Cruising, Recommended	0–7300	1600	29.0	,,	,,	,,	,,	,,	,,	,,	,,	37
Dive or Glide	—	3060 *(1400)	—	,,	Auto. Rich	,,	,,	,,	,,	,,	,,	—
Approach for Landing	—	*(2600)	48.0	,,	,,	,,	,,	,,	,,	,,	$\frac{1}{2}$	—
Stop	—	800 *(2700)	—	,,	Cut-off	—	(15)	,,	205	—	Open	—

*Propeller governor setting.

made in as short a time as practicable. Continued running on one magneto with manifold pressures as high as 25″ to 30″ Hg. (635 to 760 mm) absolute, may cause serious detonation.

2. In rare circumstances, even after the engine has been run a sufficient length of time to give reasonable assurance that the spark plugs are cleared out, excessive R.P.M. drop or uneven engine operation may be experienced during the regular magneto check. In this case it is permissible to make a quick check of magnetos at 33″ Hg. (840 mm) in low pitch in order to determine if the trouble lies in the magnetos themselves.

   CAUTION : Operation on one magneto at this power output must be held to the shortest possible length of time because of the possibility of serious damage from detonation.

3. Check oil pressure, oil temperature, fuel pressure and other items at 2,000 R.P.M.

4. Oil pressure should be 75 10 lbs./sq. in. (5.3 0.7 kg./cm²) at 2,000 R.P.M. with 60° C. (140° F.) oil inlet temperature.

5. Oil pressure will vary with R.P.M. and temperature and need cause no alarm by falling to as low as 25 lbs./sq. in. (1.7 kg./cm²) with the engine idling. On initial running after overhaul, if the oil pressure is not within the specified range, the oil pressure relief valve in the rear section should be adjusted to give the desired pressure and the low pressure system of the rear section should be checked and adjusted if necessary. On subsequent running of the engine, any appreciable change in oil pressure under the same conditions of R.P.M. and oil temperature may indicate troubles within the engine or oil system which should be investigated.

6. *IMPORTANT.*—To aid in the prevention of sludge accumulation and to check the operation of the two-speed blower mechanism, shift the blower ratio selector valve in accordance with the following procedure prior to each flight :

   After the oil inlet temperature has reached at least 40° C. (104° F.), increase the engine speed to 1,200–1,400 R.P.M., with the propeller control in low pitch (high R.P.M.) position, and shift the blower ratio selector valve to the "High "position. A momentary drop in oil pressure should accompany the shift. Open the throttle to obtain not more than the limit of manifold pressure prescribed for cruising in high blower ratio (approximately 27.5″ Hg.) and/or not more than 2,000 R.P.M., lock the throttle and immediately shift back to "Low" blower ratio. *Blower shifts should be made without hesitation or dwelling between the control stops* to avoid dragging or slipping the clutches. A drop in manifold pressure will usually accompany the shift from "High" to "Low" blower and the manifold pressure gauge should be watched for this indication when the shift is made. The drop in pressure is a positive indication that the control system is functioning properly, and this check is important to prevent inadvertent take-off in "High" blower ratio.

As soon as the check for change in manifold pressure has been made, reduce the engine speed to 1,000 R.P.M. or less. If the shift did not appear to be satisfactory, operate the engine at 1,000 R.P.M. or less for two minutes to permit heat generated during the shift to become dissipated from the clutches, then repeat the shifting procedure. Prolonged fluctuation or loss of manifold pressure when shifting from "Low" blower ratio to "High" blower ratio would indicate improper "High" clutch engagement, in which case the blower ratio selector control should be returned to the "Low" position and the shift repeated as just described.

MAKE SURE THAT THE BLOWER RATIO SELECTOR VALVE CONTROL IS IN THE "LOW" POSITION WHEN GROUND TESTS HAVE BEEN COMPLETED.

7. Cooling of the cylinder heads and barrels, and ignition harness is usually insufficient while on the ground for continued running above 1,400 R.P.M. to 1,500 R.P.M. Avoid prolonged running at power above this. It is recommended not to exceed 232° C. (450° F.) head temperature during ground operations.

C. *COWL FLAPS.*

The adjustable cowl flaps should be fully opened during all ground operations, and at least partially opened (10°–15°) for take-off and climb. The cowl flaps should be adjusted to keep the cylinder temperatures under the limits specified in Section 11.

6. *TAXYING OUT.*

Before opening up the engines for taxying, see that the parking brake is released. Taxying is normal, and change of direction should be made by means of rudder and engines, to obviate use of brakes as much as possible.

Note : Clearing Engines After Slow Running.—The engines should be cleared in turn on reaching take-off position (facing across wind) by running up against the brakes to about 2,000 R.P.M. (25 in.h.g.) boost. Engines should not tick over for more than two or three minutes without being cleared. Test the switches at 1,500 Revs. when finally clearing the engines for take-off.

7. *FINAL PREPARATION FOR TAKE-OFF—DRILL OF VITAL ACTIONS.*

1. Stop across wind facing the circuit so that approaching aeroplanes can be seen, and then check the following Drill of Vital Actions.

Some of these may be made before or during, taxying out, but must be checked in correct sequence *before every take-off*.

A convenient catchphrase is
"High Tension Member British Parliament for Gosport Town."

H—Hydraulics. Pull hydraulic selector knob out, so that hydraulic selector indicator shows : U/C flaps and bomb doors.

T—Trim. Rudder and aileron neutral. Elevator slightly nose-heavy.

M—Mixture. Mixture control for automatic rich.

B—Blower in low ratio.

P—Propeller. Safety switch on, Selector switch to Automatic. Constant speed operated airscrew control levers fully forward to give positive fine pitch. Check petrol pressures.

F—Flaps max. 30° down for heavy load, and 15° for normal load.

G—Gills. Should be 10–15° in very hot weather on take-off.

T—Throttle Tightness. Tightness on Throttle and Pitch control levers.

8. E. *TAKE-OFF*.

1. Before starting take-off, make sure oil temperature is at least 140° F. (40° C.).

2. Check oil and fuel pressures.

3. Note loss of R.P.M. when switching to one magneto at a time, as instructed under "Ground Test."

4. Cylinder head temperatures should be at a minimum of 250° F. (120° C.) before starting take-off.

5. Cowl flaps open as required.

6. Propeller governor controls set for take-off R.P.M.

7. Fuel selector valve on suitable tank for take-off.

8. Mixture control set for take-off (Automatic Rich).

9. Blower ratio in "Low."

10. Carburettor air cold.

11. Cylinder head temperatures before the start of take-off must be low enough to insure that the maximum limits are not exceeded during the use of take-off or emergency power.

12. Throttle friction sufficient to prevent throttle creeping if hand is removed.

13. Open throttle gradually, being careful not to exceed limiting manifold pressure. (48″ h.g. in emergency.)

14. As soon as clear of the ground and obstructions, adjust the power to the normal climb conditions.

15. It is suggested that the following procedure be followed in adjusting power :

First, bring the manifold pressure down to about 2 in.h.g. under that for normal rated power, then bring the R.P.M. down to that for normal rated power. If further reduction in power is desired, reduce the manifold pressure 2 in.h.g. (50 mm.) then the R.P.M. 200, in successive alternate steps till the desired power is attained for climb or cruising conditions.

During the take-off run any tendency to swing should be corrected by use of rudder. The tail should be raised almost to flying position, the nose held at a constant attitude and the aeroplane allowed to fly itself off. (See Para. 5. SUBSEQUENT ACTION.)

9. *IMMEDIATE ACTION AFTER TAKE-OFF.*

1. Raise undercarriage as soon as the aircraft is fully airborne. This is done to reduce the drag as soon as possible to facilitate the attaining of a safe air-speed in a minimum period of time.
2. Make no attempt to Climb the aircraft until at least 120 m.p.h. has been reached. This is done as the one engine performance at speeds below 120 m.p.h. is such that the good engine must be shut off to regain control if one engine should fail.
3. As soon as 120 m.p.h. has been reached, and not before, pull back the throttles to 45 in.h.g., revs. to 2,700 (if 48″ Hg. has been used for takeoff). This relieves excessive strain on the engines as soon as it is safe to do so.
4. By this time the aircraft will have climbed to approximately 600′ at which altitude it is safe to raise the flaps. Speed about 150 m.p.h. Continue climb at 155 m.p.h. (Best climbing speed.)
5. When flaps are fully up, return control lever to neutral position and push hydraulic selector control knob in. The indicator should then read "BYPASS & TURRET." This releases the load on the engine pump and enables the turret to be operated if necessary.
6. Provided absolute speed is not essential for the climb, the engine should now be throttled back to 41 in.h.g. and revs. reduced to 2,550. This further releases the strain on the engines.
7. When the required height has been attained throttle back to 28 in.h.g. boost and reduce revs. to 2,250 and adjust gills as necessary. This is maximum cruising 0–14,500 ft. Low Plower ; oil pressure 65–100 ; Temp. 60°–75° C. Recommend lower powers for general use (as per Pratt & Whitney Manual).

10. *SUBSEQUENT ACTION.*

1. Adjust the cowl flaps to maintain cylinder temperatures somewhat less than the maximum permissible, preferably about the maximum permissible for cruising, *i.e.*, 232° C. (450° F.)

2. A material reduction in cylinder and/or oil temperatures can be obtained by climbing at an indicated air speed ten or twenty miles per hour higher than the speed for best climb.

3. A tendency for the oil to overheat can be checked the quickest by reducing the engine speed with the propeller control, rather than by throttling alone.

4. See comments on blower ratio selection and operation, Section 11 for detailed operation.

5. Note :—It is important to keep the HAND ON THE THROTTLE CONTROLS during and after taking off, because, if one engine fails, the aeroplane swings and rolls so quickly that, unless both throttles are pulled back instantly, a crash will result. It is good practice in the initial opening up of the motors and the start of the takeoff run until about 40 m.p.h. is reached, to correct the swing with the steady opening up of the throttles, also not to attempt to raise the tail until this speed is reached. If this is done the tendency to swing in the takeoff will be minimised. Cross-wind takeoffs in this aeroplane can be done with ease. The following procedure should be adopted :—

Open throttles steadily using anything from 3 to 8″ more boost on the engine on the windward side. The amount of boost dependent on the velocity of the wind. This will overcome any tendency of the machine to swing into the wind. Throttles operated in this way will minimise any undue strain upon the undercarriage caused by the machine tending to drift on the ground. As soon as machine is clear of ground and under flying control, boost should be equalized on both motors.

After raising the undercarriage lever the hand must be returned to the throttle controls immediately. The best climbing speed is about 135 knots (155 m.p.h.) A.S.I. reading up to 12,000 ft. then reduce by 2 knots or m.p.h. per 1,000 ft.

11. *ENGINE FAILURE DURING TAKE-OFF.*

Note.—NEVER ATTEMPT TO FLY ON ONE ENGINE AT FULL R.P.M. (2,700) OR WITH FLAPS DOWN.

If an engine fails during taking off with r.p.m. at about 2,700, or with flaps partly down, a rapid swing and roll will develop (vertical bank in two or three seconds) which cannot be stopped by rudder or aileron, UNLESS throttles are pulled back instantly. NO ATTEMPT to adjust rudder tab or airscrew pitch control must be made.

Immediate Action.

1. Instantly pull back the throttle levers.
2. Maintain flying speed by putting the nose down.

3. Ensure that the undercarriage is coming UP, if there is not a suitable landing field straight ahead.

4. Land straight ahead.

Note I.—If there is time enough, lower flaps and switch OFF the ignition.

Note II.—If the engine has not failed completely and there is only partial loss of power, the pilot will naturally use his discretion about the correct action. For example, if the loss of power is only slight and any tendency to swing can easily be corrected, then it would obviously be wrong to close throttles and land outside the aerodrome; the climb should be continued and the aeroplane then brought back to the aerodrome and landed without delay.

12. *FAILURE OF ENGINE DURING CRUISING FLIGHT.*

This aeroplane will maintain height on one engine provided cowling gills are closed and the flaps are up. The drag of the gills and flaps cause loss of height. Note the following :—

1. At cruising and high speeds, the result of sudden failure of one engine is quite mild, provided flaps are up and r.p.m. are not more than 2,550 and the resulting yaw can easily be corrected.

2. If height is maintained speed will eventually drop to 120–130 knots (138–150 m.p.h.) A.S.I.

Action.

3. Put the airscrew control of failed engine into FEATHERED position. For further details see overleaf.

4. Fully close cowling gills on dead engine. Do not open the gills of the live engine unless cylinder temperature exceeds 260° C. Keep right amount of gill opening to ensure this temperature is not exceeded.

5. Nurse the live engine by keeping its power as low as possible.

6. Keep r.p.m. at 2,550 and airspeed at about 125 knots (145 m.p.h.) A.S.I.

7. ~~The suction balance cock should be opened so that both tanks will supply the live engine.~~

8. Turns should preferably be made towards the good engine. If a turn is made towards the dead engine and adequate pressure is not maintained on the rudder to counteract the pull of the good one, the aeroplane will tend to skid outwards, and considerable opposite aileron will be needed to prevent over-banking, while if speed is reduced, the spinning point may be reached.

9. Fly to the nearest aerodrome or landing ground.

FEATHERING OPERATION.

In case of emergency set feathering switch to feather position indicated on Switch Guard and place Mixture Control in Idle Cut-off position immediately.

For testing feathering operations the following procedure should be adopted :—

Set feathering switch to feather position.
Decrease power on engine being feathered.
Shut off gas to dead engine, *i.e.*, place in Idle Cut-off position.
Adjust aeroplane controls for single engine operation.
Adjust operating engine to R.P.M. 2,550 Climbing Power 41″ H.G. max.
Climbing Air Speed 125–140 m.p.h. Set Cowl Flaps 15° open . . . more if required.

In case of failure . . . turn ignition off. If only testing propeller operation, leave ignition on. Use as little power as required to maintain comfortable level flight. R.P.M. and H.G. to be regulated to suit conditions and power to be used.

UNFEATHERING OPERATION.

Set feather switch to normal position indicated on switch guard, gas on, throttle partly open.

Hold manual switch in increase R.P.M. position until 300 R.P.M. is obtained before switching to automatic. The reason for this is to enable pressure to build up and close the circuit for automatic control. *Note.*—It is recommended that the engine should not be stopped longer than necessary while testing otherwise it gets too cold and takes a considerable time to warm up.

Warm up engine at 1,000 R.P.M. before applying full power to engine that has been stopped.

This aircraft operates very well with one engine. It climbs at indicated air speed of 125–140 m.p.h. and turns may be made in either direction. Care must be exercised to maintain higher airspeed in turns. When turning towards the dead engine be careful not to do so at too fast a rate.

Remember—do not go below 125 m.p.h. indicated air speed when using one engine.

Approach and Landing.

As a general rule it is not advisable to attempt to land this aeroplane with the assistance of one live engine, but it is possible with care and concentration. A very experienced pilot can use his discretion as to whether he will shut off the live engine and use full forced landing procedure, or make use of the engine. The reason for special care is as follows :—

1. With flaps and undercarriage down it is difficult to prevent roll and swing, if more than about quarter throttle of the live engine is used and if speed is allowed to drop below about 110 knots (120 m.p.h.) A.S.I.

2. The rudder trimming tab is very effective and can be applied fully to counteract the yawing effect of the live engine even at high power, provided speed is maintained at over 110 knots (120 m.p.h.) A.S.I. ; but if the live engine, in the course of an approach with its assistance, is throttled down the rudder trimming tab causes a severe yaw the other way (towards the live engine which has been throttled down). Therefore variations of engine power during the approach cause yaw one way or the other. This should not be corrected by varying the rudder tab position, but the tab should be reduced to about 1 or 1*2* (a satisfactory mean position) not too little for almost half power and not too much for engine off.

3. The variation of "gliding" angle obtainable by the use of the live engine is small, because of the limited power which can safely be used.

Method of Approach and Landing without Use of Engine :—

1. On reaching a suitable landing ground, ensure that height is at least 3,000 ft., if possible. If not climb on one engine at about 120 knots (140 m.p.h.) A.S.I. 41″ Hg. 2,550 maximum.

2. Put the airscrew pitch control of the failed engine to the feathered position, if it has not already been done.

3. When in a good position for the glide approach, LOWER THE UNDERCARRIAGE.

Note.—The undercarriage can, if the pilot finds he has misjudged the approach and may undershoot or overshoot, be unlocked and partly raised at the last moment. This will be enough to enable a landing on the fuselage to be made.

4. Throttle down the live engine a little at a time, reducing the rudder trimming tab correspondingly, preventing yaw by rudder control.

5. Carry out a forced landing approach and landing as described in para. 3.

Method of Approach and Landing with Assistance of One Engine.

This is only advisable for a very experienced pilot who has practised it at least once :—

1. Ensure that height is at least 2,000 ft., if possible, before starting the approach and get into a good position on the leeward side of the landing ground.

2. Carry out the Drill of Vital Actions before landing, but leave the flaps up until later.
Catchphrase H.U.P. :—
H—Hydraulic Selector—ON (Pull out knob).
U—Undercarriage—DOWN.
P—Airscrew pitch—In position to give 2,550 r.p.m.

3. Approach the landing ground, losing as little height as possible, until almost within gliding distance, then LOWER FLAPS fully—Maintain speed at about 110 knots (120 m.p.h.) A.S.I.

Note.—

It is vitally important that this should be done at the right distance at the right moment, to ensure that the subsequent approach "glide" can be done with as little assistance from the live engine as possible.

4. Throttle down the live engine to half power or less, if possible, and at the same time reduce the rudder trimming tab to about 1 or 12 on indicator (from about 3).

5. Glide straight towards the landing ground *concentrating the attention* on maintaining the correct path of approach (neither overshooting nor undershooting) using enough engine power to do so and stopping any tendency to yaw, when varying engine power, by rudder control.

6. Speed should not be reduced below 100 knots (115 m.p.h.) A.S.I. until flattening out is begun.

7. Flatten out—then throttle right back, keep straight and land.

Note.—

(*a*) It is vitally important neither to overshoot nor to undershoot. ON NO ACCOUNT ATTEMPT TO FLY IN FLAT HAVING UNDERSHOT. In other words, never use more than about half power of the live engine, or less than 110 knots (120 m.p.h.) A.S.I. gliding speed.

(*b*) If the approach is misjudged, throttles should be closed, undercarriage lever raised (in order to at least unlock and start the undercarriage up) and the aeroplane landed wherever the straight glide will take it. This is better than the loss of control which is found to result from an attempt to "stretch the glide" by opening up one engine.

13. *THE ENGINES IN CRUISING FLIGHT.*

For detailed instruction see the following :—

1. *Normal Rated Power Climb and High Speed Level Flight :*

0 to 10,000 ft. 3,050 m (critical 6,200 ft., 1,890 m).

Maximum Engine R.P.M.	2,550
Maximum Manifold Pressure, 6,200 ft.	41.0″ hg. 1,040 mm Hg.
Mixture Control	Auto. Rich
Blower Ratio	Low
Fuel Consumption (approx.) ..	131 gal/hr. 495 liters/hr.

10,000 ft., 3,050 m and up (critical 14,500 ft., 4,420 m).

Maximum Engine R.P.M.	2,700
Maximum Manifold Pressure ..	39.0″ Hg. 990 mm Hg.
Mixture Control	Auto. Rich
Blower Ratio	High
Fuel Consumption (approx.) ..	130 gal/hr. 490 liters/hr.

2. *75% Power Operation :*

0 to 14,000 ft., 4,210 m (critical 10,700 ft., 3,260 m).

Maximum Engine R.P.M.	2,325
Maximum Manifold Pressure ..	32.5″ Hg. 825 mm Hg.
Mixture Control	Auto. Rich
Blower Ratio	Low
Fuel Consumption (approx.) ..	80 gal/hr. 305 liters/hr.

14,000 ft., 4,270 m and up (critical 16,700 ft., 5,100 m).

Maximum Engine Speed	2,325
Maximum Manifold Pressure ..	31.0″ Hg. 186 mm Hg.
Mixture Control	Auto. Rich
Blower Ratio	High
Fuel Consumption (approx.) ..	76 gal/hr. 290 liters/hr.

3. *Cruising—Maximum :*

0 to 14,500 ft., 4,420 m (critical 14,000 ft., 4,260 m).

Maximum Engine R.P.M.	2,250
Maximum Manifold Pressure ..	28.0″ Hg. 710 mm Hg.
Mixture Control	Auto. Lean
Blower Ratio	Low
Fuel Consumption (approx.) ..	55 gal/hr. 210 liters/hr.

14,500 ft., 4,420 m and up (critical 17,000 ft., 5,180 m).

Maximum Engine R.P.M.	2,250
Maximum Manifold Pressure ..	29.5″ Hg. 750 mm Hg.
Blower Ratio	High
Mixture Control	Auto. Rich
Fuel Consumption (approx.) ..	63 gal/hr. 240 liters/hr.

4. *Cruising—Examples of Recommended Method for Low Power :*

0 to 10,600 ft., 3,230 m (critical 10,600 ft., 3,230 m)

Engine R.P.M.	2,000
Manifold Pressure	29.0″ Hg. 738 mm Hg.
Mixture Control	Auto. Lean
Blower Ratio	Low
Fuel Consumption (approx.) ..	50 gal/hr. 192 liters/hr.

0 to 7,300 ft., 2,220 m (critical 7,300 ft., 2,220 m).

Engine R.P.M.	1,600
Manifold Pressure	29.0″ Hg. 738 mm Hg.
Mixture Control	Auto. Lean
Blower Ratio	Low
Fuel Consumption (approx.) ..	37 gal/hr. 142 liters/hr.

5. *Cylinder Temperatures Maximum :*

	Heads		*Barrels*	
	Fahr. °	*Cent.* °	*Fahr.* °	*Cent.* °
Take-off, Military, Normal Rated Power Climb, High Speed (5 min.)	500	260	335	168
All level flight continuous ..	450	232	335	168
Desired Continuous	210–400	100–200	200–275	95–135

6. *Oil Pressure :*

	Lbs./sq. in.	kg./cm²
Desired, at 2,000 R.P.M. at 60° C.	80–100	5.6–7.0
Maximum	105	7.4
Minimum at rated R.P.M.	80	5.6
Minimum at cruising	65	4.6
Minimum at idling	15	1.0

7. *Oil Inlet Temperatures :*

	Fahr. °	*Cent.* °
Minimum for Take-off and flight	104	40
Desired	140–167	60–75
Maximum, Level Flight	185	85
Maximum, Climb	212	100

8. *Fuel Pressure :*

	Lbs./sq. in.	*kg./cm²*
Desired	15	1.06
Allowable range	14–16	0.98–1.13

RECOMMENDED GUIDE FOR POWER CONTROL :

(Twin Wasp S3C4-G 95 Octane).

1. *Maximum Take-off :*

2,700 R.P.M.—48.0″ Man. press.—Low Blower.
If less power is sufficient, reduce manifold pressure with thrott without reducing R.P.M.

2. *Maximum Military Rating (5 minutes) :*

Low Blower :
2,700 R.P.M.—45.0″ Hg. or full throttle—to 9,500′.
High Blower :
2,700 R.P.M.—41.0″ Hg. or full throttle—above 9,500′.

3. *Normal Rated Power :*

Low Blower :
2,550 R.P.M.—41.0″ Hg. or full throttle—to 10,000′.
High Blower :
2,700 R.P.M.—39″ Hg. or full throttle—above 10,000′.

4. *75% Power :*

Low Blower :
2,325 R.P.M.—32.5″ Hg. or full throttle—to 14,000′.
High Blower :
2,325 R.P.M.—31.0″ Hg. or full throttle—above 14,000′.

5. *Cruise—Minimum Fuel Consumption—"Auto. Lean" :*

Low Blower :
0 to 14,500′. Maintain 29.0″ Hg. manifold pressure up to full throttle. Do not exceed 2,200 R.P.M.
High Blower : (above 14,500′)
Maintain 30.0″ Hg. manifold pressure up to full throttle. Do not exceed 2,200 R.P.M.

Reduce power by reducing engine speed with propeller governor control. Engine speeds below 1,500 R.P.M. may be found satisfactory depending on vibration characteristics of engine mounts. This will give nearly the maximum cruising over-all engine efficiency and economy.

14. *GENERAL FLYING.*

Note the following :—

1. *Stability.*—The aeroplane is stable and can be flown "hands off" and "feet off" with trimming tabs adjusted. Weathercock stability is good. For normal flight, including turns, rudder need not be used, except if aileron control is applied coarsely, when it causes considerably adverse yaw. Therefore, although accurate turns can be done with feet off, rudder may be used to counteract the adverse yaw (unless the turn can be started slowly) and to steady the aeroplane if bumpy air necessitates coarse use of the ailerons.

2. *Turning.*—Turns should be made by aileron and elevator control ; rudder need not be used unless quick entry is desired, when it may be used to prevent adverse yaw as described in (*1.*) above. The slight

amount of yaw required is obtained automatically owing to the fact that any tendency to sideslip is converted into steady yaw by the effective fin area.

(*a*) The correct incidence corresponding to the angle of bank will be exactly obtained if the nose is kept on the horizon by elevator control while the bank is kept constant by the ailerons. Rudder control is not required. This eliminates the need for careful co-ordination of hand and foot, and is particularly valuable in flying by instruments.

(*b*) If the maximum angle of bank for a sustained turn at a particular speed is exceeded for more than a few seconds, stalling incidence will be reached. This would require great force on the elevator control unless the aeroplane is trimmed tail heavy. The tab trimmer must not be used in this way, therefore steep turns at low speed must not be done.

3. *Change of Trim.*—The change of trim on operation of the undercarriage, cowling gills, throttle levers, etc., is slight and well within the range of control of the elevator.

4. *Rudder Trimming Tab.*—The rudder trimming tab is a fine adjustment, though it is also required in case of one engine failing.

5. *Aileron Trimmer.*—This is provided for adjustment of lateral trim.

6. *Elevator Trimming Tabs.*—The elevator trimming tab control should be used to keep the aeroplane in trim for all conditions of flight. It may be used to assist manœuvring and recovery from a dive, but must be used very slowly and carefully otherwise great stresses can be put on to the aeroplane structure which are not apparent on the controls.

7. *Slow Flying.*—Flying at slow speeds down to the stall should be practised at a safe height, in order that the pilot may become familiar with the feel of the controls. Feet should be put on the rudder control at low speed, as it might have to be used if the aeroplane stalled.

8. *Practice Flying on One Engine.*—Normally this should not be practised below 5,000 ft.; but it is recommended that practice approach and landing on one engine should be carried out at lcest once by very experienced pilots only, by Commanding Officer's authority. Other essential precautions are :—

(*a*) Speed must not drop below 110–120 knots (120–130 m.p.h.) A.S.I.

(*b*) Rudder trimming tab control must be kept "trimmed" according to whether one or both engines are in use, *i.e.*, always prevent yaw by means of rudder control, assisted by the tab whenever necessary.

(c) NEVER OPEN UP TO FULL POWER ON ONE ENGINE (except when flying steadily with adequate rudder trimming tab applied and not more than 2,550 r.p.m.) PARTICULARLY WHEN FLAPS ARE DOWN.

15. *FLYING BY INSTRUMENTS.*

The method of flying by instruments fully explained in A.P.129 Flying Training Manual, Part 1, Chapter 3, should be applied to this aeroplane.

Note.—See para. 1. GENERAL FLYING regarding flying with feet off the rudder controls.

16. *STALLING.*

Though the stall usually occurs at low speed, it may occur at any speed if the control column can be brought far enough back to put the aeroplane at stalling incidence. Note the following :—

(1) The stalling speed with undercarriage retracted, flaps up, and gills closed, is 73 knots (84 m.p.h.) A.S.I. reading.

With undercarriage and flaps down and gills closed, it is 64 knots (74 m.p.h.) A.S.I. reading. The aeroplane is not easy to stall completely, but when this does occur one wing drops sharply.

(2) No warning of a stall should ever be relied upon. Sta'ling should be practised at a safe height, so that the pilot may be better able to avoid stalling unintentionally. Feet must be placed on the rudder pedals for this practice.

(3) The immediate action to prevent spin and regain control from a stall is, "control column forward and rudder as necessary."

(4) Use of aileron control near the stall should be avoided, as it often has reverse effect and induces a spin. Use the rudder to keep level. Note the A.S.I. reading at stalling point.

17. *SPINNING.*

Deliberate spinning is prohibited. Note the following :—

(1) If a spin starts owing to misuse of controls, the standard method of recovery must be used, *i.e.*, apply full opposite rudder, followed by pushing the control column steadily forward, until the rotation stops. In addition, a burst of power may be given by the inner engine.

(2) If a spin occurs in cloud, use the standard method of recovery with the aid of the Reid and Sigrist turn indicator. Endeavour to centralize the turn pointer by means of the rudder.

18. *GLIDING.*

Gliding may be carried out at any speed up to that at which it becomes a dive, and down to the necessary margin of about 25% above stall. Lowering either the flaps or the undercarriage, or both, steepens the gliding angle, the nose being lower at a given speed. Also, the rate of descent is much increased. During a glide the cowling gills should be closed and the cylinder temperature gauges carefully watched. If the temperature falls below 100° C., the engines should be opened up for a short period. The carburettor air-intake heat controls must be in the HOT positions if the engines show signs of becoming unduly cold or if there is the least possibility of "icing-up."

(1) *Long Distance Gliding.*—With flaps and undercarriage up the glide is very flat, and long distances can be covered when gliding at the optimum gliding speed (about 110 knots, 125 m.p.h.) A.S.I. reading.

(2) *Approach Glide.*—Before lowering flaps, the minimum gliding speed should be 110 knots (125 m.p.h.) A.S.I., or more if turns are done. With flaps down, the correct gliding speed for the final glide if, for any reason, engines are not being used, is about 95–100 knots (110–120 m.p.h.) A.S.I. This will allow gradual, smooth flattening-out with a little float.

(3) *Gliding Turns.*—Speed should be increased if turns have to be done, especially at low altitude or with flaps down, when the controls are a little sluggish unless the airspeed is above 120 knots (140 m.p.h.) A.S.I. Gliding turns with steep bank or near the ground should not be made.

(4) *Engine-assisted Glide.*—Opening up the engines to a fast tick-over will flatten the glide-path and reduce the rate of descent. This method of gliding enables the pilot to regulate the glide-path by the amount of engine power used. Airspeed should be about 90–95 knots (105–110 m.p.h.) A.S.I., according to the load, or rather less than that suitable for the glide without engines.

19. *DIVING.*

1. The maximum speed permitted is 300 knots (350 m.p.h.) I.A.S. Note the following :—

(*a*) The centrifugal or inertia loads on the master rod bearing increase as the square of the R.P.M. These loads, however, are in the opposite direction from the power impulse loads from the pistons. Therefore, high engine speeds with low manifold pressures impose the severest loads on the master rod bearings and should be avoided if possible. Where overspeeding of the engine is unavoidable in dives, it is recommended that the throttle be partially opened to give 15″ to 20″ Hg. (380 to 500 mm) if practicable. However, this may increase the speed of the engine somewhat ; the maximum safe overspeed R.P.M. has been defined at 3,060 R.P.M. The propeller control should be set for cruising R.P.M. or lower. Controls right back to full coarse pitch, *i.e.*, 1,500 R.P.M. is best when diving. See Para. 2.

(*b*) Since dives are usually accompanied by other manœuvres that may require full power of the engine, the mixture control must be in the "Automatic Rich" position.

(*c*) The blower ratio selector valve should be "Low."

2. When diving, flaps must be fully up and airscrews in positive coarse pitch.

3. The elevator control becomes very heavy in recovering from a dive, owing to longitudinal stability, if the aeroplane is trimmed for flight at maximum level speed. The aeroplane should, therefore, be trimmed slightly tail heavy before entering the dive. If necessary the trimming tabs may be used to assist the pilot in recovery, *but extreme care must be taken to move them slowly so that excessive acceleration in change of attitude is avoided.*

4. The rate of descent is very great, so ample height for recovery must be allowed.

20. *APPROACH AND LANDING.*

General Remarks.—The landing should always be made with flaps fully down, because these reduce the stalling speed and the float, and help to stop the run on the ground, especially if there is much wind. There are several different ways of carrying out the approach and landing of this aeroplane. The four standard methods are :—

(*1*) The engine-assisted approach and landing (normal method, and for landing with one engine).

(*2*) Approach and landing without use of engines (for forced landing without engines).

(*3*) Final glide and landing without engine after approach with engine (a convenient method of practising landings without engine).

(*4*) Creeper (for accurate landing in short space).

Note.—The approach and landing at night are similar to (*1*) the engine-assisted approach, but on a slightly flatter path.

21. *Preliminary Approach.*—High speed may be maintained until the aeroplane nears the aerodrome. A convenient method is to throttle down

"to the hooter," (Be sure that revs. are under 2,000, otherwise if high revs. and low boost are used wind milling will occur and this may cause considerable damage to engine owing to high centrifugal loads on the big end piston and connecting rods. Always remember—high revs. and low boost is a bad combination and dangerous at high indicated air speed.) *i.e.*, throttle back as far as possible without sounding the undercarriage hooter. Any non-vital preparations for landing should now be made, such as closing the cowling gills, caging the directional gyro, and so on. Then throttle right back, raise the nose and climb to reduce speed, and, as the speed drops below about 140 knots (160 m.p.h.) A.S.I., carry out the Drill of Vital Actions for landing.

22. *Drill of Vital Actions for Landing.*—A convenient catchphrase is applied to this drill—*H.U.P. and Flaps.* That is :—

H—Hydraulic selector—OUT.

U—Undercarriage DOWN (watch the indicator).

P—Pitch to give 2,550 r.p.m.

and Flaps—Lower flaps (this should actually be delayed until the end of the circuit).

Note.—2,550 r.p.m. are ample for use in case of a mislanding ; 2,700 r.p.m. may be dangerous in case of failure of one engine to pick up immediately the throttles are opened up, either after throttling back during an engine-assisted approach, or after mislanding. Therefore, leave pitch control levers in the cruising position (2,550 r.p.m.).

23. *Engine-assisted Approach and Landing.*—This is the normal method. Proceed as follows :—

(*1*) Complete the circuit, slightly beyond gliding distance on the leeward side, then turn towards the aerodrome at about 1,000 ft. and lower the flaps fully at 120 knots (140 m.p.h.) A.S.I. (watch the flap indicator) approach in level flight slightly across wind.

(*2*) When almost within gliding distance, throttle back enough to keep the aeroplane heading straight towards the edge of the aerodrome, just beyond gliding distance all the way down, and turn into wind for the final straight approach. Regulate the glide path by use of throttles and maintain a constant speed of 90–95 knots (105–110 m.p.h.) A.S.I.

(*3*) Trim slightly tail-heavy with elevator tabs (this is not essential, but assists landing).

(*4*) For the last 200 feet or so, when the aeroplane is heading comfortably into the aerodrome, the throttle should be set to give about double idling r.p.m. (to a very fast tick-over), and not altered again until closed for landing. Always keep hand on throttles in takeoff and landing. One hand on control is sufficient.

(5) Flatten out smoothly with engines running at this speed, and then close the throttles fully and hold the aeroplane just clear of the ground, easing the control column steadily back until it is fully and firmly back, when the aeroplane will make smooth contact with the ground, all three wheels together.

24. *General Remarks about Landing which Apply to All Methods.*—

(1) Hold the control column firmly back to prevent the elevators flapping, and, if wheel brakes are used, to help keep the tail on the ground. Keep straight with rudder, and do not use the brakes unnecessarily. Apply them smoothly and if the tail lifts, release them and try again.

(2) Do not swing until nearly all speed is lost, as it is bad for the tyres. It may be useful in emergency, however, and a sharp swing can be done without any tendency to capsize.

(3) After coming to rest, look at the flaps control and raise the flaps (watch the indicator).

25. *Three-point Landing.*—It is important to land tail-down (that is, three-point) with control column fully back. If held off reasonably close to the ground, the aeroplane will not land appreciably tail-first and even if the tail wheel does make smooth contact with the ground before the main wheels, there is little strain on it. In fact less strain is induced than if the aeroplane comes down wheels first and then drops its tail, which results in severe bouncing of the tail. After a three-point landing and with full use of the brakes, the pilot can be certain of stopping the aeroplane within about 400 yds., but if a wheel-landing is made the run will be of indefinite length, and use of the brakes is dangerous until the tail is on the ground.

26. *Landing-point.*—Always make a mental note of the point on the aerodrome short of which the landing (tail down) must be made. If the landing is not made before this point (a touch of the wheels is not a landing) the throttles must be open fully and another circuit made. IF IN DOUBT GO ROUND AGAIN.

27. *Mislanding.*—In case of an unsuccessful attempt to land, the aeroplane will climb satisfactorily with flaps and undercarriage down. Note the following :—

(1) Raise the undercarriage immediately.

(2) Do not raise the flaps until a safe height (about 500 ft.) is reached. Put the nose down slightly and increase speed to about 110 knots (120 m.p.h.) A.S.I. ; then raise the flaps. Flaps will come up slowly owing to the restrictor valve in the hydraulic system.

(3) Mislanding should be avoided, as failure of one engine during the take-off with flaps down would necessitate immediate closing of throttles and landing, whatever the state of the ground ahead.

28. *Approach and Landing without Use of Engines.*—This is necessary in case of forced landing without engines.

Note.—Forced Landing.—For further details concerning the method of preliminary approach to a field, *see* para. "Forced Landing."

(1) Having carried out the Drill of Vital Actions for landing (with the exception of lowering flaps, which is left till later) fly to such a position that a half circuit of the aerodrome is required to bring the aeroplane into position to land.

(2) Shut off the engines and glide at about 110 knots (120 m.p.h.) A.S.I. turning-in at the same time and keeping the landing point in view, if possible, just in front of the inner engine. Concentrate on judging the angle of approach and watch for landing point. Turn into wind for the final glide with a little surplus height, but the turn-in should be completed not lower than about 500 ft.; then, when quite sure of gliding into the aerodrome lower the flaps fully.

(3) Depress the nose to maintain a gliding speed of not less than 90–95 knots (105–110 m.p.h.) A.S.I.

(4) Start to flatten-out in good time, almost imperceptibly at first, and continue to make a smooth curve until the aeroplane is floating just above the ground. Make a three-point landing with control column fully back, as already described. The surplus speed used in this method enables a wide easy curve to be made when flattening-out, with a little float before landing.

29. *Final Glide and Landing without Engine after Approach with Engine.*—This is a convenient method of practising landings without engine. It must not be regarded as the normal method, but may be used by pilots thoroughly accustomed to the aeroplane, in favourable conditions.

(1) The preliminary approach is the same as that for the engine-assisted approach, *i.e.*, Drill of Vital Actions, turn in and lower flaps. Continue to approach with engines, losing height gradually so that gliding distance is reached at about 600 ft. If necessary, fly level at 600 ft. until in a position for the final glide.

(2) Then close throttles, put the nose down to glide at 90–95 knots (105–110 m.p.h.) A.S.I. Complete the flattening out and landing exactly as in the method already described.

(3) A height of 600 ft. is chosen to start gliding because it is more difficult to judge the point at which to close the throttles if higher up, and there is not enough time to settle down to a steady glide if much lower.

(4) If engine power is needed at any time during the final glide, owing to under-shooting or other reasons, revert to the engine-assisted approach and use engines until after the flattening out is completed. The reason for this is that, if engines were shut off, for example, at 100 ft., and the nose put down to maintain speed, the increase in rate of descent and steep angle would make it difficult to flatten out smoothly.

30. *The Creeper.*—This must NOT be practised. It is only for use if a landing in a space about equal to the landing run of the aeroplane becomes necessary (only over low obstacles such as a hedge).

(1) The preliminary approach is the same as for the engine-assisted approach, *i.e.*, Drill of Vital Actions, turn in and lower the flaps. Then approach, undershooting by several hundred yards, almost closing the throttles if necessary. When 200–300 yds. short of the landing ground the aeroplane should be low down, clearing obstacles by a comfortable margin, with the engines opened up to fly in almost flat, and speed reduced to about 70 knots (80 m.p.h.) A.S.I. Speed should not be more than 80 knots (90 m.p.h.) A.S.I. or float will be too long, and NEVER LESS THAN 70 knots (80 m.p.h.) A.S.I. Concentrate attention on the airspeed reading and the ground, using the throttles to regulate the glide.

Important Note.—These low speeds apply only to landing grounds with no obstacles to impede low approach.

(2) After crossing the boundary, come down close to the ground, then fully close the throttles, and land. It is very important not to close throttles until the aeroplane is close to the ground, as the margin over stalling speed is only about 20% and there will be practically no float.

31. *General Remarks about the Approach.*—Note the following :—

(1) *Varying the Angle of Glide.*—It is not possible to vary the angle of glide, without use of the engines, once the flaps are down, because a very effective sideslip cannot be done, and raising the flaps, once they are down, does not give a flatter glide owing to the initial loss of lift.

(2) *Side-slipping.*—An attempt to sideslip slightly increases the gliding angle, but only very little bank can be maintained, and its usefulness is almost negligible.

(3) *Gliding.*—Judge the gliding speed not only by the A.S.I. reading, but also by the position of the windscreen panels in relation to the horizon. On a gusty day, or when there is a large wind-gradiant, glide even faster (add about 5–10 knots, m.p.h.) A.S.I., if necessary to land without use of engines.

(*4*) The pilot should always know the flaps-down stalling speed of the aeroplane he is flying, because if it is abnormal for any reason, such as instrument error, the difference must be allowed for in the approach speed.

32. *Landing Across Wind.*—If a landing has to be made in a long and narrow aerodrome or field, with a wind across it, and there is the slightest doubt about the amount of room to land into wind, a cross-wind landing using the full length of the ground should be made. Note the following :—

(*1*) Owing to the high landing speed and wide-track undercarriage, the aeroplane may safely be landed across wind, as drift is less than in the case of slow aeroplanes.

(*2*) Drift cannot be fully counteracted, as landing with one wing down is not easy or advisable. Therefore cross-wind landing in a high wind should not be made.

(*3*) Drift may be partly counteracted in two ways :—

(*a*) By keeping one wing slightly down (into wind) before flattening out.

(*b*) By making a slight and very careful yaw by rudder *towards the direction the aeroplane is drifting* just before landing. This will point the aeroplane along its flight path and eliminate drift.

33. *Landing.*—This aeroplane can be stopped in less than 400 yds. with any load in a light wind on level ground, provided a fully tail-down (three-point) landing is made, with the flaps down and the wheel-brakes used. Lightly loaded, in more favourable conditions it can, of course, be stopped in a much shorter distance.

(*1*) The following factors which add to this basic distance must be allowed for :—

(*a*) Downward slope of ground (if any).
(*b*) Tree-height obstacles.
(*c*) Inaccurate approach.
(*d*) Fast or wheel-landing.
(*e*) Defective brakes.

(*2*) With great care it is possible to land in a space about 600 yds. long, provided brakes are effective, and there are no obstacles to a low and absolutely accurate power approach.

(*3*) For a pilot with little experience of this aeroplane, the available landing space should be not less than 800 yds. with clear approaches, or 1,000 yds. if the approach must be over trees on the boundary. Even a gentle slope down adds greatly to the length of landing run.

Note.—Flaps should not be raised until the aeroplane has come to rest at the end of the landing run.

34. *PROCEDURE AFTER LANDING.*

After raising flaps taxy in towards the apron, in accordance with aerodrome traffic rules in force.

(*1*) Open the cowling gills while taxying.

(*2*) Close the throttles for about a minute to allow oil to settle in the sump, whence it can be removed by the scavenge pump.

(*3*) Stop engines at 800 R.P.M. by placing machine control in Idle Cut-off. Then switch off ignition switches and turn off the fuel.

(*4*) Switch OFF all electrical switches.

(*5*) See that undercarriage safety links are replaced.

35. UNDERCARRIAGE *EMERGENCY* OPERATION.

Full particulars of the emergency system fitted to any one of these aeroplanes are given in Sect. 1, paras. 18 to 20 (c).

Note.—If it is found that only one side of the undercarriage can be locked down, a landing should not be attempted until it is *unlocked* again, as the aeroplane should only be landed with the undercarriage as follows:—

(*1*) Fully down and locked.

(*2*) Fully up, or unlocked on *both* sides.

36. *FLYING IN RAIN AND BAD VISIBILITY.*

When flying in conditions of bad visibility open the port side window panel. Attention is drawn to the following :—

(*1*) If landmarks are being followed it is better to keep these on the port side, so that they can be seen through the open window ; and, for the same reason, flying in formation is best in echelon right.

(*2*) It is advisable, in order to make navigation easier, and to obviate the risk of collision with suddenly rising ground, greatly to reduce speed.

(*3*) There is nothing to be gained by lowering the undercarriage, unless a precautionary landing is decided upon. If a landing becomes necessary, the undercarriage should only be lowered if the pilot is able to select a suitable landing ground to ensure a safe landing.

37. *FORCED LANDING OWING TO ENGINE FAILURE.*

The principles of forced-landing this aeroplane are the same as those which apply to most modern types, the first actions being to maintain ample gliding speed, select a landing ground, glide towards it and then try to rectify the trouble. If a landing is inevitable, switch off ignition and turn off the fuel. Certain features of this aeroplane, however, call for particular care in the subsequent procedure :—

(1) As an effective side-slip cannot be done, other methods of regulating the glide-path must be used.

(2) "S" turns may be used down to about 2,000–3,000 ft. Below this height the approach may be regulated to some extent by gliding acros wind and gradually turning in to land, early or late, according to whether the glide-path tends to undershoot or overshoot.

(3) Flaps should be up at this stage. Glide at about 110 knots (120 m.p.h.) A.S.I.

(4) A further adjustment of the gliding angle is provided by the flaps, lowering of which may be delayed until the last 500 ft. It must be remembered that once lowered no advantage is gained by raising them. Maintain speed at least 90–95 knots (105–110 m.p.h.) A.S.I. as flaps are lowered.

(5) *Undercarriage.*—The question of whether or not to lower the undercarriage is decided by the size and surface of the landing ground, bearing in mind that a skid landing does less damage than turning over. IF IN DOUBT, LAND WITH THE UNDERCARRIAGE UP. As the undercarriage is an effective airbrake when down, it should be left up to extend the initial glide towards suitable country, whether it is to be lowered finally or not, but it must be lowered in good time. It can easily be raised again, if the pilot decides on a skid landing, as it will collapse on touching the ground, provided both sides are unlocked.

(6) *Flaps.*—If possible, flaps should be fully lowered for landing, to reduce landing speed and float, which would be excessive, especially if the undercarriage were up.

(7) *Landing.*—A normal tail-down landing should be made exactly as described in para. "*Landing-point.*"

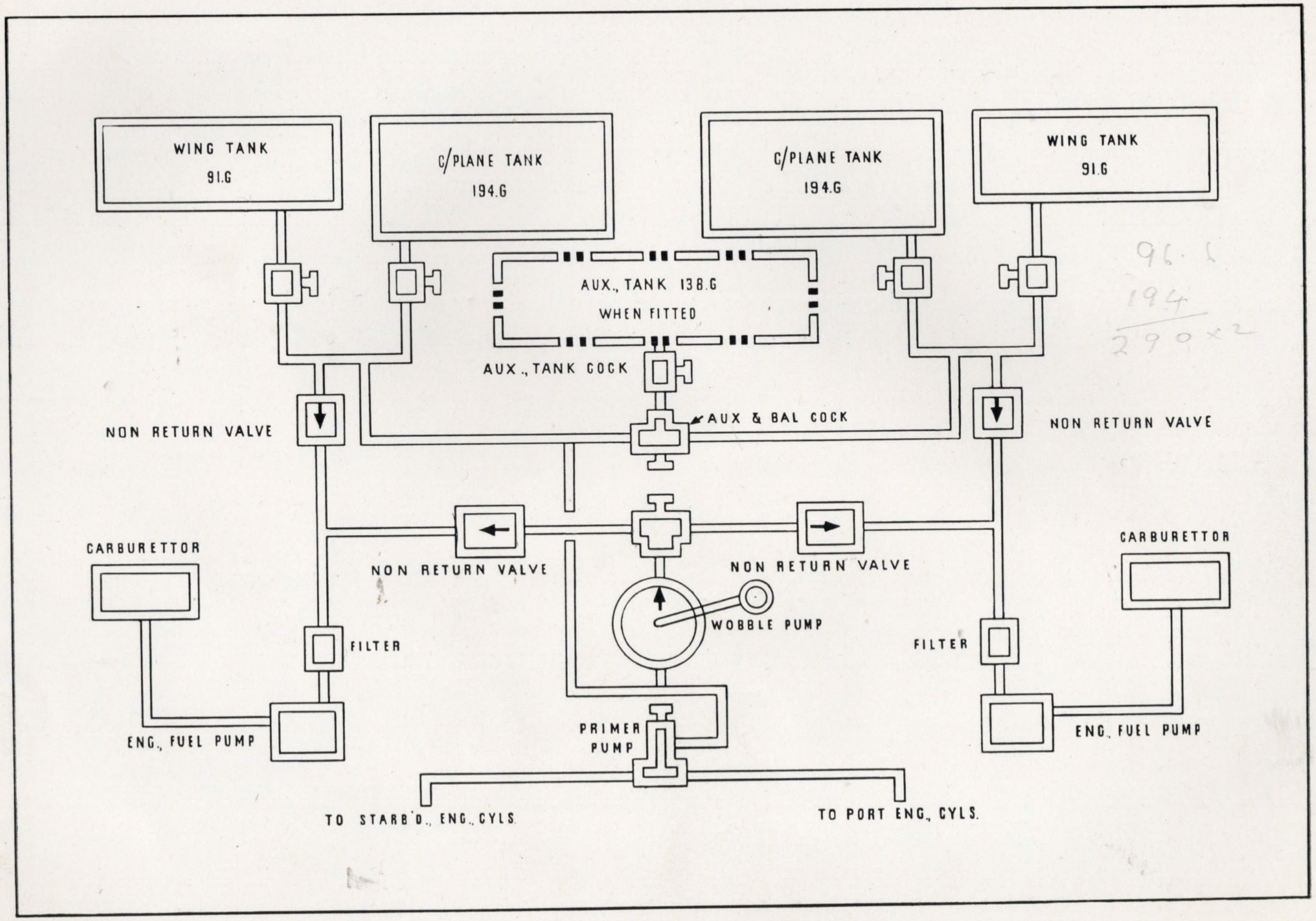

FIG. I. FUEL SYSTEM.

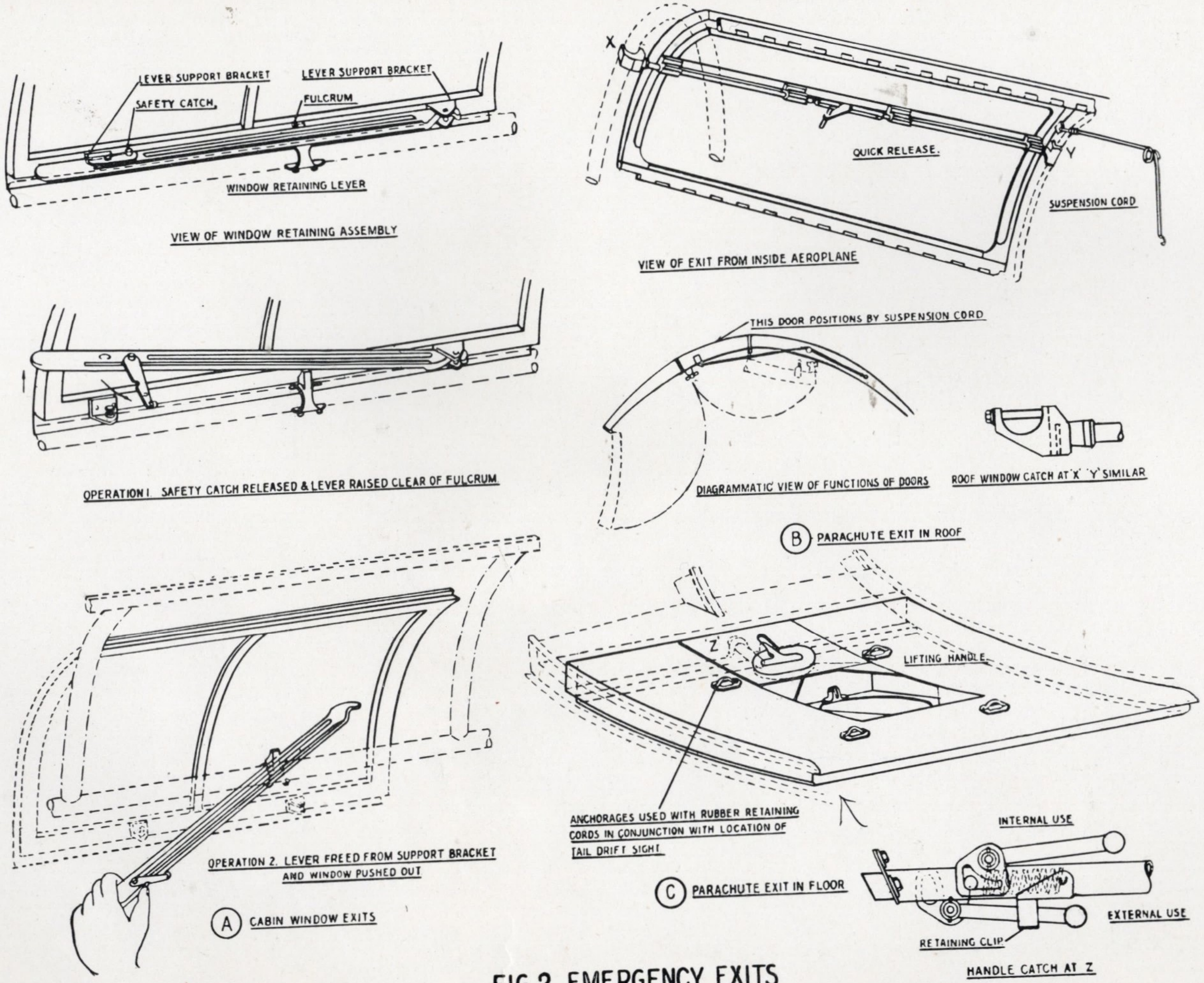

FIG.2 EMERGENCY EXITS

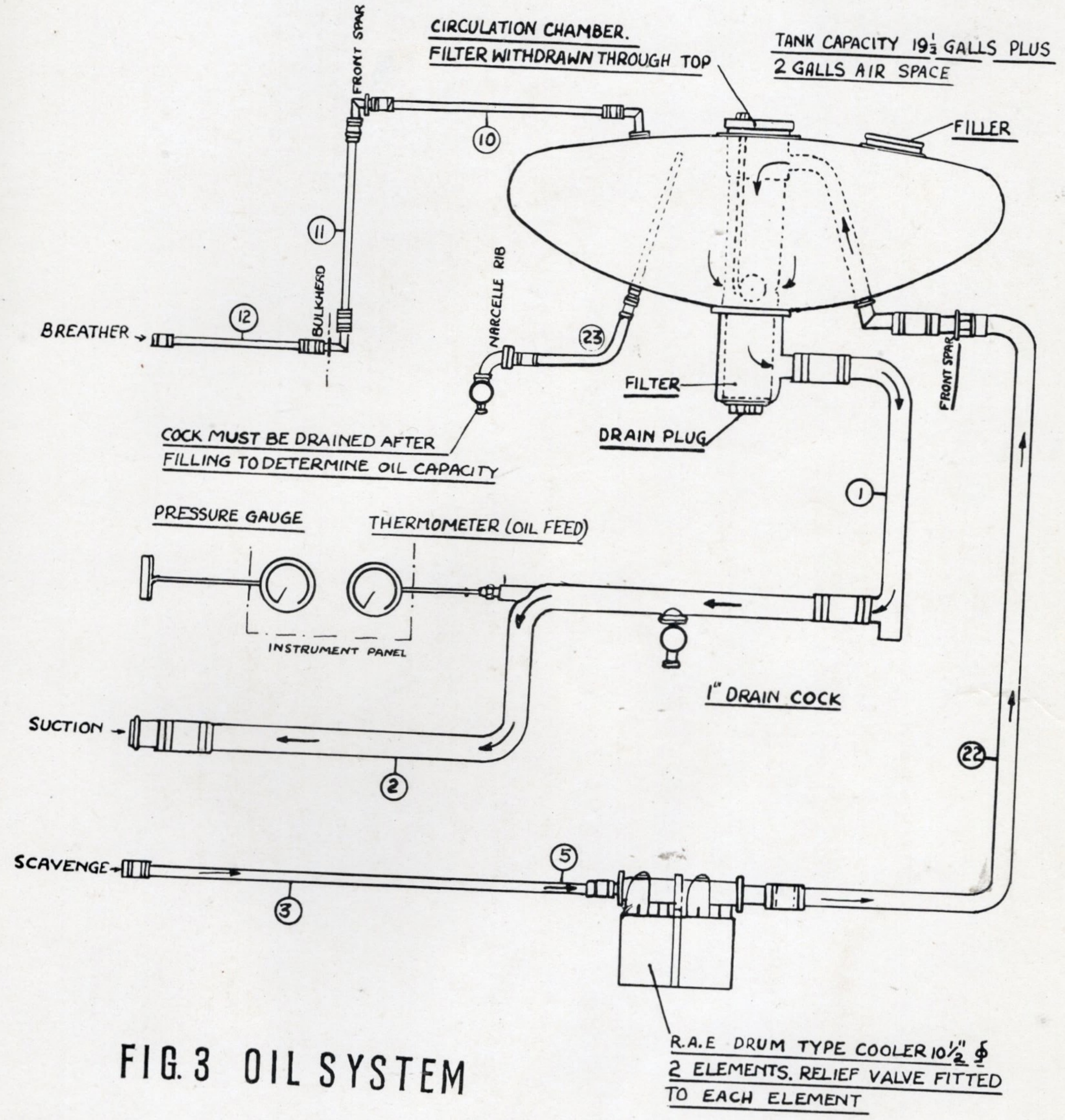

FIG. 3 OIL SYSTEM