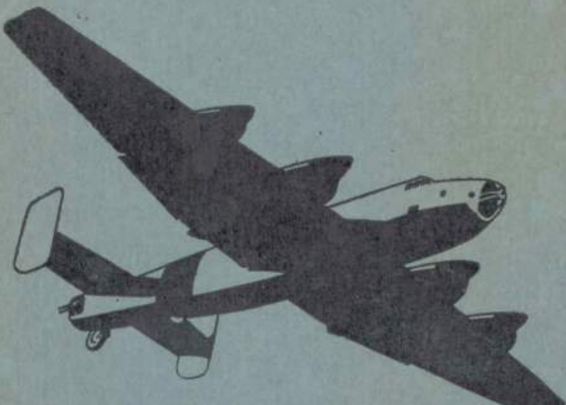
2nd EDITION

A.P. 1719B & E—P.N.

PILOT'S AND FLIGHT ENGINEER'S NOTES



HALIFAX II & V

FOUR MERLIN XX or 22 ENGINES

PROMULGATED BY ORDER OF THE AIR COUNCIL

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AMENDMENTS

Amendment lists will be issued as necessary and will be gummed for affixing to the inside back cover of these notes.

Each amendment list will include all current amendments and will, where applicable, be accompanied by gummed slips for sticking in the appropriate places in the text.

Incorporation of an amendment list must be certified by inserting date of incorporation and initials below.

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2			8		
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5			11		
6			12		

NOTES TO USERS

This publication is divided into six parts: Descriptive, Handling Instructions, Operating Data, Emergencies, Additional Data for Flight Engineer, and Location of Controls and Illustrations. Part I gives only a brief description of the controls with which the pilot and flight engineer should be acquainted.

These Notes are complementary to A.P. 2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (see A.M.O. A93/43). Flight Engineers should also have a copy of A.P. 2764 to be issued shortly in provisional form.

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

Additional copies may be obtained from A.P.F.S., Fulham Road, S.W.3, by application on R.A.F. Form 294A, in duplicate, quoting the number of this publication in full—A.P. 1719B and E—P.N.

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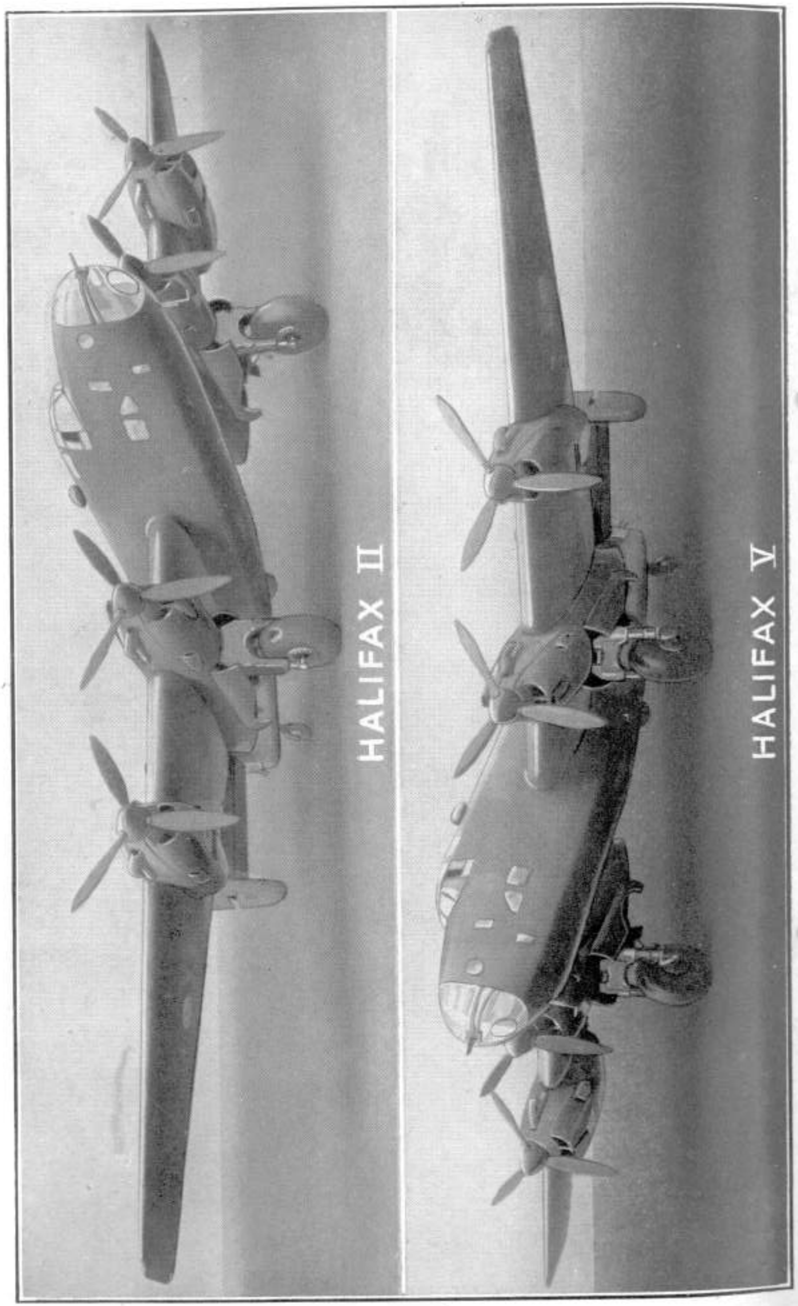

AIR MINISTRY
January 1944

AIR PUBLICATION 1719B & E—P.N.
Pilot's and Flight Engineer's Notes

PILOT'S & FLIGHT ENGINEER'S NOTES HALIFAX II and V

2nd Edition. *Supersedes all previous issues.*

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PART I

DESCRIPTIVE

NOTE.—The numbers quoted in brackets after items in the text refer to the illustrations in Part VI.

INTRODUCTION

The Halifax Mark II aircraft is a heavy bomber with four Merlin XX or 22 engines and Rotol fully-feathering propellers.

The Halifax Mark V aircraft is similar to the Halifax Mark II later aircraft except that it is fitted with a Dowty instead of a Messier hydraulic system. The Pilot's Notes will therefore be common to both Marks of aircraft except where the hydraulic system and controls are involved.

FUEL, OIL AND COOLANT SYSTEMS

1. **Fuel tanks.**—There are twelve self-sealing wing tanks, the layout of which, together with the control cocks, is given in Fig. 5. The capacity of these tanks is as follows:

Two No. 1 inboard tanks	..	247 galls each
Two No. 2 nose tanks ..	..	100 ,, ,,
Two No. 3 centre tanks	..	188 ,, ,,
Two No. 4 outboard tanks	..	161 ,, ,,
Two No. 5 outer engine tanks ..		122 ,, ,,
Two No. 6 outer engine tanks ..		123 ,, ,,

The No. 6 tanks are not fitted on early aircraft, but when they are fitted, they are connected with their respective No. 5 tanks, so that Nos. 5 and 6 tanks may be considered as one tank containing 245 gallons of fuel.

Provision is also made for carrying three 230-gallon self-sealing long-range fuel tanks in the fuselage bomb compartments on all aircraft, as well as two 80-gallon tanks for exceptional long-range operations at the rest positions in the centre fuselage. Two different methods of fitting the rest position tanks are described in A.P. 1719E Vol. II, Part I.

A nitrogen fire-protection system for all tanks is being installed: nitrogen is fed into the tanks automatically as fuel is used, so that no inflammable petrol-air mixture is present in the tanks. The control valve is on the port side of the fuselage at the rest station, and must always be fully opened before any fuel is used. No further attention is necessary.

2. **Fuel cocks**

(i) The supply to each engine can be shut off by the master engine cocks, which are mounted on the bulkhead aft of the first pilot and accessible to his right hand. In each case, the cock is moved to the ON position by pushing the lever up. These fuel cocks also operate the slow-running cut-outs for stopping the engines when moved to the OFF position.

(ii) Each tank has its own ON-OFF cock (tanks Nos. 5 and 6 being considered as one tank), the cocks being under the control of the flight engineer. On early aircraft the cock levers are under the rest seats in the centre fuselage, but on later aircraft they are above the rest seats at the forward end.

(iii) The fuel systems in each wing for port and starboard engines are identical and entirely independent, but are interconnected by a cross-feed pipe and cock. This cock, which is normally kept shut, is on the aft face of the rear spar, under the control of the flight engineer. Port and starboard cross-feed cocks are provided in each fuel system to segregate the sets of tanks supplying individual engines: when these cocks are closed, tanks Nos. 1 and 2 supply inboard engines and tanks Nos. 3, 4, 5 and 6 supply outboard engines. It will be noted that the total capacity of tanks Nos. 1 and 2 is less than that of tanks Nos. 3, 4, 5 and 6, and thus if all fuel is to be consumed, a time arrives when the inboard engine must draw fuel from the outboard group of tanks (*see* Para. 40). The port and starboard cross-feed cocks should be kept closed at take-off and when the aircraft is over the target and only opened when it is necessary to feed two engines

from one tank. On early aircraft the cocks are behind the rear spar above the rudder and elevator control tubes, but on later aircraft they are mounted at the forward end of the rest seats.

(iv) If the 230-gallon fuselage bomb bay tanks are fitted, the contents may be transferred to the No. 1 or No. 3 tanks by means of distributing cocks fitted under the step aft of the front spar.

3. **Immersed pumps.**—An immersed pump is fitted in each of the three fuselage bomb bay tanks, and the contents of the tanks are transferred to the No. 1 or No. 3 tanks by switching on the pumps.

4. **Fuel contents gauges.**—The fuel contents gauges (57) for tanks Nos. 1, 2, 3 and 4 are at top of flight engineer's panel and the contents gauges (60) for tanks Nos. 5 and 6 are at the bottom of the panel. All the gauges are direct reading and a circuit switch (38) is mounted in the pilot's roof panel. The long-range tanks are fitted with direct reading contents gauges visible through the bomb hatches in the fuselage floor.

5. **Fuel pressure warning lamps**

(i) Four fuel pressure indicator lamps (58) are mounted at the top of the flight engineer's panel and on later aircraft are duplicated on the cock control mounting bracket at the rest station. These lamps light up when the fuel pressure at the carburettors drops below 6 lb./sq.in.

(ii) On early aircraft there is a fuel pressure warning lamp and a switch for the long-range bomb-cell tanks, on the engineer's lower instrument panel. On later aircraft the single switch is superseded by a duplicate set of switches mounted below, and interlocked with the fuel pump switches. The lamp warns when a long-range tank is empty, and its pump should be switched off immediately.

6. **Fuel priming pumps.**—An induction priming pump, together with a selector cock, is mounted on the panel at the rear of each undercarriage fairing and serves both engines on the one side.

7. **Oil system**

(i) Four self-sealing oil tanks, one for each engine, are fitted; those for the outboard engines being situated in the engine nacelles, and those for the inboard engines being mounted in the nose portion of the centre plane just inboard of the engine. Each tank has an oil capacity of 28 gallons, the outboard tanks having $6\frac{1}{2}$ gallons air space, and the inboard tanks $7\frac{1}{2}$ gallons air space.

(ii) Oil dilution is provided. Four push switches (52) are fitted on the engineer's panel immediately below the starter magneto switches.

8. **Coolant system.**—The coolant system is thermostatically controlled, the radiator being by-passed until the coolant reaches a certain temperature. The radiator shutters are hydraulically controlled from the flight engineer's station.

MAIN SERVICES

9. **Messier hydraulic system—Mark II aircraft**

(i) Most aircraft are fitted with a single hydraulic pump on the port inboard engine, and this pump feeds the following services:

Undercarriage
Flaps
Bomb doors
Radiator shutters
Landing lamps

A feature of the undercarriage, flaps and bomb doors circuits is the use of the pump to operate the jacks in one direction only (that is, to raise the undercarriage and flaps and to close the bomb doors); the fluid above the piston is thereby forced into an accumulator, increasing the air pressure in the accumulator and thus storing energy which is used to operate the jack in the reverse direction when required. The radiator shutters and landing lamps circuits differ from the main circuits in that the pump operates the jacks in both directions.

IMPORTANT NOTE— The undercarriage, flaps or bomb doors levers should be returned to the "neutral" position after use, thereby closing the distributor. Should a lever be left in its operating position and the pipe lines from the distributor to the jacks be damaged, fluid would be automatically discharged through the damaged pipe, thus leaving no fluid for the operation of the remaining undamaged circuits. The undercarriage lever should, however, be left in the DOWN position when the undercarriage is lowered, and the bomb door lever should be operated on a decent as described in para. 31.

(ii) Two hydraulic handpumps are fitted, one on each side of the fuselage. The one on the starboard side feeds from an emergency reservoir which has no return pipe to it and should, therefore, only be used if the port handpump fails to complete the operation. In the event of the engine-driven pump failing, or for ground operations, the port handpump may be used to operate the radiator shutters and landing lamps, to raise the undercarriage and flaps, and to close the bomb doors, through the normal pipe lines.

(iii) In the event of damage to the accumulators or their pipe lines, the undercarriage may be lowered and the bomb doors may be opened through separate emergency pipelines by turning on special cocks, which admit fluid under pressure from the engine pump to the down side of the jack, normally served by the accumulator only. If the engine pump has also failed, these operations can be carried out through the emergency pipelines (after turning on the special cocks), by using the port handpump, and, if this fails to complete the operation, the starboard handpump.

(iv) Some early aircraft have a slightly different hydraulic system, a pump being fitted on each of the inboard engines; the pump on the port engine feeds the port undercarriage, flaps, radiator shutters and landing lamp, while the pump on the starboard engine feeds the starboard undercarriage and the bomb doors. Two handpumps are fitted, the port one feeding the same services as the port engine pump, and the starboard one the same services as the starboard engine pump. Special cocks are also fitted to allow the engine pumps or handpumps to lower the undercarriage and bomb doors through emergency hydraulic pipelines, in the event of accumulator damage.

(v) Each gun turret in all aircraft has a self-contained hydraulic pump which is electrically operated through the aircraft batteries.

(vi) When Messier engine-driven pumps are fitted, it is necessary to raise the pressure in the hydraulic system to 2,400 lb./sq.in. by means of the handpumps in order to de-clutch the pumps before starting engines, owing to lubrication difficulties at low r.p.m.

10. **Dowty hydraulic system—Mark V aircraft**

(i) Two Lockheed pumps mounted on the inner engines draw fluid from a tank on the front spar to operate the same services as on the Halifax II, namely:

Undercarriage
Flaps
Bomb doors
Radiator shutters
Landing lamps

The pumps are in parallel and either can operate the system, though at a reduced speed. The delivery from the pumps operates the jacks both ways. An automatic cut-out valve is fitted in the pump delivery line, which by-passes the fluid back to the reservoir when the system is at full pressure and no service is being operated. The only accumulator in the system is under the port rest seat just aft of the front spar and serves to reduce fluctuations in pressure and consequent "machine-gunning" of the cut-out valve.

(ii) One handpump mounted on the front spar just forward of the starboard rest station, works the complete system through the normal controls if the engine pumps are not working.

(iii) The undercarriage, flaps and bomb doors are raised and lowered by the operation of rotary control valves, whereas the radiator shutters and landing lamps are controlled by spring-loaded distributors which must be held in the appropriate setting until the operation is completed.

(iv) In the event of complete failure of the hydraulic system, an emergency air system may be used for opening the bomb doors and lowering the flaps. Compressed air is released into the appropriate side of the jacks by opening the air release valves on the aft face of the front spar. The air bottle is mounted under the port rest seat. The system will not close the doors or raise the flaps and will necessitate bleeding and refilling the hydraulic system after use.

11. **Pneumatic system.**—Mounted on the port inner engine is a Heywood compressor for operating the wheel brakes and the air-intake heat control. An R.A.E. compressor is also mounted on this engine for operating the automatic pilot. A Pesco vacuum pump is fitted on each inboard engine for supplying the instrument flying panel, and a changeover cock (16) and suction gauge (10), when fitted, is mounted on the instrument panel behind the engine controls pedestal. On later aircraft one pump is arranged to work at a higher suction and operates the Mk. XIV bombsight. If the other pump fails, this pump can be used to operate the instrument flying panel, but this should only be done in an emergency, as the use of the higher suction for long periods is detrimental to the instruments. In this case the changeover cock is marked NORMAL and EMERGENCY.

12. **Electrical system**

(i) On early aircraft three 24 v. 1,000 w. generators are fitted, one on each of the port outer, port inner and starboard inner engines. The generator on the port inboard engine, in conjunction with a 24 v. 25 amp. hr. accumulator provides for the following services:

Usual general lighting
Landing lamps
Camera motor

Navigation lights
Fire-extinguishers
Pressure-head heater
Bomb release and fusing
Mid-upper and Mid-under turrets (if fitted)
Radio and Beam Approach equipment

The generator on the starboard inboard engine, in conjunction with a 24 v. 40 amp. hr. accumulator, provides for:

Engine starting
Azimuth steering indicator
Dinghy installation
Call-up lights and glove heating

The generator on the port outboard engine, in conjunction with a 24 v. 40 amp. hr. accumulator, provides for rear turret only. On some aircraft an A.C. generator on the starboard outer engine supplies the A.R.I. 5033, and on certain aircraft an A.R.I. 5119 also.

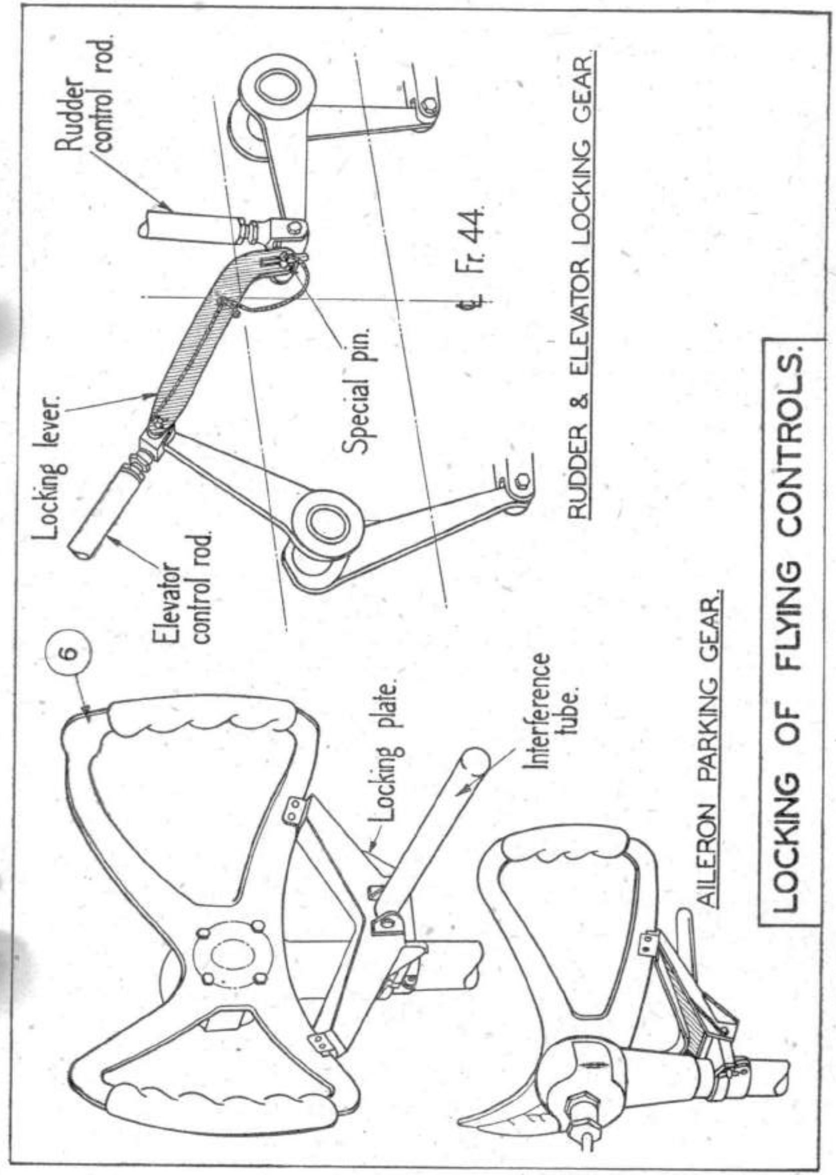
(ii) On later aircraft the three 1,000 w. generators are superseded by three 24 v. 1,500 w. type KX generators connected in parallel and feeding two sets of two 24 v. 40 amp. hr. accumulators and this constitutes the power supply for all services. When these paralleled generators are fitted, a GROUND/FLIGHT switch is also fitted on the starboard side of the fuselage at the flight engineer's station, and allows the aircraft accumulators to be isolated when the aircraft is parked and when a ground battery is being used.

AIRCRAFT CONTROLS

13. **Flying controls**

(i) Dual controls can be fitted if required.

(ii) The rudder pedals can be adjusted on the ground by removing a nut and bolt from the shank of the pedal, sliding the pedal backwards or forwards as required, and refitting the bolt, which should then be locked by a split pin. Finer adjustments can be made by a foot operated centrally placed starwheel.



14. **Locking of flying controls** (*see* page 15).—Before attaching the locking gear, the rudder control should be moved to the central position and the control column to the aft position. The aileron control should be locked by applying the special locking plate to the handwheel in the manner shown, and securing it to the block on the column with the bolt provided. The plate carries a tube which crosses the pilot's seat when the plate is in position, and prevents the seat from being occupied before the controls are unlocked. The rudder and elevator controls should be locked with the locking lever connected to the elevator and rudder control rods at the tail. The locking lever is fixed at its top end on a spigot on the elevator control and held in position by a fastener spring attached by lanyard to the locking lever. At its lower end the locking lever is secured to the rudder control and the adjacent fuselage member by means of a special screwed pin also attached by lanyard to the locking lever.

15. **Trimming tabs**

(i) The trimming tab controls and indicators for the starboard aileron and rudder are fitted on the port side of the cockpit. All work in the natural sense.

(ii) The elevator trimming tab handwheel (32) is mounted on the centre line of the aircraft accessible to both pilots. An indicator scale (51) along which a pointer travels is mounted aft of the wheel. The movement of the wheel is also in the natural sense.

16. **Automatic Pilot.**—The controls include main switch (67), clutch lever (78), control cock (76), attitude control (75), and steering control (68) mounted on the port side of the cockpit.

A combined pressure and trim gauge (28) is on the lower port side of the instrument panel (for operating instructions *see* A.P. 2095 Pilot's Notes General).

17. **Undercarriage control.**—The hydraulic operation of the undercarriage is controlled by the longest lever (29) mounted immediately below the flaps and bomb doors control levers on the right side of the pilot's seat. For

raising the undercarriage the lever is pulled up. A " neutral " position is provided and after raising the undercarriage, the control lever should be returned to this position. The flight engineer has mechanical up-locks under his control (one on each side of the fuselage above the rest seats), and must pull them out before the undercarriage can be lowered. The control lever should be left in the " down " position after lowering the undercarriage. An electrical interlocking mechanism is provided to prevent the undercarriage being retracted until the weight of the aircraft is off the wheels. This mechanism consists of a solenoid which becomes energised when the weight of the aircraft is off the wheels, and withdraws a bolt which then allows the undercarriage lever to be moved from the " down " position. Should it ever become necessary to override this safety device, hold back a small lever located through a hole in the right-hand side of the control box (Messier System) or through a hole in the left-hand side (Dowty System).

18. **Undercarriage indicator.**—On early aircraft the switch on the pilot's sloping panel which controls the lamp circuit is interlocked by a lever with the adjacent ignition switch, so that the indicator switch is ON when the ignition switch is ON. A guard (25) is hinged over the indicator switch to prevent accidental operation. On later aircraft no switch is fitted and the indicator comes on when the GROUND/FLIGHT switch is turned to FLIGHT or when an outside battery is plugged in, with the switch at GROUND.

On early aircraft three separate indicator lamps are provided and may be dimmed for night flying by shutting the shade covers fitted over them. On later aircraft these separate lamps are superseded by a single instrument (23) on which are upper and lower sets of three lamps each. A control knob in the centre of the instrument enables the lamps to be dimmed for night flying and may also be used to bring into operation a duplicate set of lamps in the event of breakage. The lower lamp on early aircraft and the centre lights of each set on later aircraft are rendered inoperative when the tail wheel is fixed.

The operation of the lamps is as follows:

(i) *Early aircraft :*

Upper lamp shows red ..	.. Locked up position
Middle lamp shows green	.. Locked down position
No lights	.. Unlocked positions

(ii) *Later aircraft :*

Upper lamps show red ..	.. Unlocked positions
Lower lights show green	.. Locked down position
No lights	.. Locked up position

19. **Undercarriage warning horn.**—A horn on the port side of the cockpit sounds when the throttle lever is closed two-thirds or more, and warns the pilot if the undercarriage is not locked down. On later aircraft a white warning light (26) also comes on when the horn sounds and goes out when the horn stops.

20. **Flaps control.**—The control (31) for operating the flaps is the longer of the two small levers on the hydraulic control box mounted on the right of the pilot's seat. The movement of the lever is in the same sense as the flaps, i.e. the upward movement of the lever raises the flaps.

NOTE.—The flaps lever should be returned to " neutral " after each operation.

On Mark II aircraft, isolating cocks are fitted between the flaps hydraulic accumulators and the jacks and are closed by the flight engineer when the flaps are not in use. If these isolating cocks are not closed and one of the hydraulic pipelines is damaged, the flaps will immediately lower under the accumulator power which is thereby released.

21. **Flaps position indicator.**—An electrical indicator (4) is mounted on the lower portion of the pilot's instrument panel immediately forward of the first pilot's control column. It shows the settings of the flaps by means of a pointer which moves over a scale graduated in degrees and marked UP and DOWN at the extremities. This indicator and the undercarriage indicator are controlled on early aircraft by a common switch mounted on the pilot's instrument panel, but this switch is deleted on later aircraft.

22. **Brakes control.**—The brake levers (35) are mounted on the first pilot's handwheel, on all aircraft, and are duplicated on the second pilot's handwheel on certain aircraft when dual control sets are fitted. There is a parking catch on the underside of the control. The brakes are also operated differentially by the rudder bar. A triple pressure gauge (19) is mounted on the starboard side of the instrument panel.

ENGINE CONTROLS

23. **Throttle controls.**—The four throttle levers (43) are mounted in the top tier of the engine control box. Three scales are provided between the four throttle levers, the two outer giving settings calibrated from 0 to 10, and the centre marked SLOW RUNNING, MINIMUM CRUISING SPEED, and RATED BOOST. To prevent the throttle levers moving under engine vibration, a friction lever (18) is fitted on the starboard side of the control box. This lever locks the throttle levers in any desired position when pulled aft.

(*a*) On Merlin XX engines a gate is provided at the top of the throttle quadrant for use during take-off. +9 lb./sq.in. boost is obtainable at the gate, and +12 lb./sq.in. boost through the gate. The automatic boost control cut-out must not be operated

(*b*) On Merlin 22 engines, +9 lb./sq.in. boost is obtainable at the gate, but when +14 lb./sq.in. boost is required, the automatic boost control cut-out should be operated and the throttles opened only to the gate.

(*c*) When climbing at a boost setting of less than +9 lb./sq.in., the automatic boost control cannot open the throttle valve fully and the boost will begin to fall off before full throttle height is reached. The throttle lever should be progressively advanced to the gate to maintain the desired boost.

24. **Mixture control.**—The mixture control is entirely automatic, and the pilot has no control. On early aircraft which were originally fitted with a mixture control lever, this lever is now wired and is inoperative; on later aircraft the lever is used to operate the outboard engines superchargers.

25. **Propeller speed controls.**—The four propeller speed control levers (46) are mounted in the centre of the control box. The control levers are moved upwards to increase the engine revolutions. At the lower end of the range of movement of each control lever, a gate is provided through which the lever may be passed to reach the feathering position. To do this, the knob on the lever must be raised in order to pass through the gate. As the engine speed decreases, the oil pressure falls but, by pressing a switch (36) on the instrument panel in the pilot's roof, an electrically-driven auxiliary pump augments the oil pressure until the propeller is fully feathered and ceases to rotate, which takes approximately 10 seconds. A friction lever similar to the one described in para. 23 is fitted on the starboard side of the control box.

26. **Two-speed supercharger controls.**—On early aircraft a single lever (49) for the 4 superchargers is situated on the starboard side of the mixture control lever in the bottom tier of the control box. On later aircraft the lever (49) is used for the inner engine superchargers only and the lever formerly used for the mixture control (*see* para. 24) is used for the outer engine superchargers. The upper position of the levers are for HIGH gear and the lower position for LOW gear. Automatic locking stops are provided for each position, disengagement being obtained by pressing the knob at the top of each control lever.

27. **Carburettor air intake heat control.**—This is under the control of the flight engineer and is fitted on the port side of the fuselage. It has two positions marked WARM AIR and COLD AIR. The COLD AIR position should always be used unless the intake becomes iced up. As gapped ice guards are fitted, this will rarely happen.

28. **Radiator shutter controls.**—The radiator shutters are hydraulically operated by the flight engineer from controls (54) mounted below and to the left of the temperature gauges (55).

COCKPIT ACCOMMODATION AND EQUIPMENT

29. **Cabin heating.**—Hot air is drawn from heaters mounted on the inboard engines and is led to all crew stations with

the exception of the tail gunner. A heat diffuser, controlling the supply of hot air to the cockpit, is fitted on the starboard fuselage beside the second pilot. When not required, the heat can be turned off by operating two controls which are fitted on the ducts aft of the front spar, one on each side of the fuselage.

30. **Oxygen equipment.**—On early aircraft, oxygen bayonet sockets are provided at 13 points in the aircraft, all except the second pilot's position being accompanied by a flowmeter calibrated in thousands of feet of altitude. On later aircraft these bayonet sockets are superseded by flexible pipes with a similar type of socket at the free end, and connected at the other end to an economiser which in turn is connected to a cut-off valve. Flexible pipes, cut-off valves, economisers and flowmeters are provided at all crew stations. The first pilot's flexible pipe (66) is stowed just aft of the auto-pilot control panel on the port side. An oxygen regulator unit (45) is mounted on the starboard side of the main instrument panel, and regulates the supply of oxygen to all points in the aircraft. The first pilot's flowmeter (2) is at the extreme port side of the sloping instrument panel. The main valve in the supply line should be turned on before flight by the flight engineer.

OPERATIONAL CONTROLS AND EQUIPMENT

31. **Bomb doors control.**—The control (30) for operating the bomb doors is a lever on the hydraulic control box to the right of the pilot's seat. It is beside the lever operating the flaps, but works in the opposite sense in order to provide adequate clearance. When the lever is moved to the "up" position the bomb doors open. After opening or closing the doors, the lever must be returned to the "neutral" position.

A selective closing cock is provided in the pipeline to the fuselage bomb door jacks. It is located aft of the pilot's bulkhead and under the control of the flight engineer, and is closed only when large bombs are carried which necessitate the fuselage bomb doors remaining partially open. In this case, the bomb doors are partially closed by using the handpump before the engines are started; and then the selective closing cock is closed.

When large bombs are carried and the cock is closed, it *must not* be re-opened until the bombs have been released.

On Mark II aircraft an isolating cock is fitted between the bomb doors accumulators and the jacks. If this isolating cock is not closed and the hydraulic pipelines are damaged, the bomb doors will immediately open under the accumulator power which is thereby released. However, the isolating cock should be left open on the outward journey of an operational flight, and should only be closed after the bombs have been dropped and the bomb doors closed; otherwise, the need to open the isolating cock may cause delay when jettisoning bombs in an emergency.

On Mark II aircraft, in order to relieve pressure due to expansion of hydraulic fluid on descending to warmer air after opening the bomb doors over the target, the selector lever should be operated momentarily as follows for every 15° rise in temperature.

(*a*) Select bomb doors CLOSED.

(*b*) Select bomb doors OPEN.

(*c*) Select bomb doors CLOSED.

(*d*) Return selector lever to neutral.

32. **Bomb release controls.**—The bomb jettison control (14) and bomb door warning lights (15) are mounted on the starboard side of the main instrument panel, and the pilot's bomb firing switch (21) on the sloping instrument panel below it. The bomb release is inoperative until the bomb doors are open, and the bomb door warning lights are duplicated at the bomb aimer's station.

The pilot is not provided with a selector switchbox, but he may fire any bombs selected by the bomb aimer, by pressing the bomb firing switch button (21) on the sloping

instrument panel. Before the bomb doors are opened, the trailing aerial must be wound in by the W/T operator. (For details of bomb jettisoning *see* para. 68.)

33. **Camera control.**—A camera control switch is mounted in the pilot's cockpit just forward of the rudder tab control handwheel, and is operable only when the bomb aimer's camera control is fully connected.

34. **Reconnaissance flares.**—A chute for launching reconnaissance flares is mounted on the starboard side of the step up to the floor over the bomb compartment whilst stowage is provided for eight 4½-in. flares on the port side of the fuselage just aft of the rear spar. On some later aircraft a multi-flare chute is fitted instead, and in this case launching of the flares is controlled through a switch panel in the bomb aimer's position.

The switches are numbered 1 to 3 from the forward end and they all have FIRE and OFF positions, the No. 1 switch also having a third position—CAMERA. The flares are released by setting the switches to the FIRE position. In the case of No. 1 switch, when set to the CAMERA position, the corresponding flare is selected for release by the bomb-firing push switch, which at the same time releases any selected bombs, and also operates the camera. As this flare is released, a warning light (1) on the pilot's instrument panel comes on and stays on until the camera operation is complete.

35. **Sea-marking equipment.**—Stowage is provided on the port side of the fuselage gangway just forward of the entrance door for six flame floats or six sea markers These may be launched through the chutes at the flare launching station.

36. **Paratroop signalling switch.**—A switch and two indicator lamps (17) for paratroop release are mounted on the starboard side of the pilot's instrument panel. A similar switch and lights are duplicated at the bomb aimer's station and also at the paratroop station in the rear fuselage.

NAVIGATIONAL, SIGNALLING AND LIGHTING EQUIPMENT

37. **Wireless controls.**—A remote control unit for the T.R.9F wireless installation is mounted on the port side of the pilot's cockpit forward of the windscreen main arch tube. The complete control comprises a remote controller (69) and a switchbox (70). When the switch is in the OFF position, the circuit may be used for normal intercommunication and when switched to the position marked SPECIAL it may be used for short-wave reception or transmission. The upper handle of the controller (69) has three positions: the central position is OFF, the forward position SEND and the aft position RECEIVE; the remaining controls are for tuning and volume.

On some later aircraft the upper handle of the controller has only two positions: OFF in the centre and RECEIVE in the aft position, the forward position being rendered inoperative by a stop fitted halfway along the quadrant. A press button fitted on the pilot's control column is used for SEND, and this prevents pilots inadvertently leaving their T.R.9F. on SEND.

38. **Intercommunication.**—The circuit is brought into operation by the wireless operator when requested by a call-up light (73) operated by the pilot.

39. **Landing lamp controls.**—The landing lamp housings can be lowered from the leading edge of the wing to the desired angle by means of an hydraulic circuit, the control lever (20) for which is mounted on the port side of the pilot's control box. The switch (11) for the lamp is mounted at the top centre of the instrument panel. Only one lamp can be illuminated at a time.

PART II

HANDLING INSTRUCTIONS

All handling speeds are quoted for aircraft with the static side of the A.S.I. connected to the pressure head. Speeds given in brackets are for aircraft with the static vent on the port side of the rear fuselage connected; in which case the letters SV will be painted on the instrument panel adjacent to the A.S.I. Refer to Table given in para. 62 for A.S.I. calibrated in knots.

40. **Management of fuel system**

(i) In using the fuel system, there are several methods which may be adopted, but all methods should conform to the following requirements and limitations:

(*a*) The fuel tanks should be used in such an order as to require a minimum of cock changes, so arranged that even when full fuel is not carried, the sequence of cock changes remains as far as possible the same.

(*b*) The supply of fuel should be arranged so that at no time will two engines on the one side of the aircraft cut together through lack of fuel. If a tank is allowed to run dry, and the wing cross-feed cock be open, the other engine will also cut.

(*c*) All three cross-feed cocks should be off for take-off and also when the aircraft is over the target or over enemy territory where interception is likely. This is necessary in case part of the system should be damaged; if the cocks were open all the engines might cut.

(*d*) No engine should be run at any time on two tanks simultaneously, and when a tank empties, its cock should be turned off before another tank is turned on.

(*e*) When long-range tanks are carried in the bomb bays, their contents should be used as early in the flight as possible, in order that the flight duration can be re-assessed in the event of any of the fuel transfer pumps failing.

(*f*) It is necessary for strength considerations of the aircraft structure, that if the aircraft is to take-off with reduced fuel load at weights exceeding 55,000 lb., tanks Nos. 5 and 6 should be filled rather than the tanks further inboard.

(ii) *Specimen schedule of tank changes :*

Six wing tanks only—1,882 gallons:

	Tank contents				
	1	2	3	4	5 & 6
Take-off on 1 and 3. Use 80 galls.	247	100	188	161	245
Change to 1 and 4	167	100	108	161	245
Drain 1 and 4. Change to 2 and 3	0	100	108	0	245
Drain 2 and 3. Change to 5 and 6 with cross-feed open	0	0	0	0	245

Six wing tanks and one bomb bay tank—2,112 gallons:

	Tank contents					
	1	2	3	4	5&6	B.B.
Take-off on 1 and 3. Use 70 galls.	247	100	188	161	245	230
Change to 2 and 4	177	100	118	161	245	230
Pump 55 galls. from B.B. into No. 3, and 60 galls. from B.B. into No. 1 while running on 2 and 4	237	70	173	131	245	0
Change to 1 and 3. Use 100 galls.	137	70	73	131	245	0
Change to 1 and 4—Drain ..	0	70	73	0	245	0
Change to 2 and 3—Drain. Change to 5 and 6, open crossfeed	0	0	0	0	245	0

Six wing tanks and three bomb bay tanks—2,572 gallons:

	Approx. time after take-off*	Tank contents					
		1	2	3	4	5&6	B.B.
Take-off on 1 & 3	—	247	100	188	161	245	690
Use 100 galls. ..	2 hr. 10 min.	147	100	88	161	245	690
Pump from forward B.B. into No. 3 tanks ..	2 hr. 50 min.	117	100	173	161	245	460
Pump from rear B.B. into No. 1 tanks	3 hr. 30 min.	202	100	143	161	245	230
Wait 1 hour ..	4 hr. 30 min.	157	100	98	161	245	230
Pump from Centre B.B. into No. 1 tanks ..	5 hr. 10 min.	242	100	68	161	245	0
Drain 3 change to 4	6 hr. 35 min.	174	100	0	161	245	0
Drain 1 and 4. Change to 2, and 5 and 6 ..	10 hr. 20 min.	0	100	0	0	245	0
Drain 2, open cross-feed ..	12 hr. 30 min.	0	0	0	0	145	0

* Times for economical cruising to be reduced according to length of initial climb.

41. Preliminaries

(i) Before entering the aircraft, check:

Engine, cockpit and pitot-head covers off.

Visual check for oil, fuel and coolant leaks.

Cowlings secure.

Tyres for cuts and creep: oleo legs for even compression.

Undercarriage accumulator pressure (150 lb./sq.in. minimum) (Mk. II).

Undercarriage door accumulator pressure (350 lb./sq.in. minimum) (Mk. II).

(ii) On entering the aircraft, check:

All loose equipment stowed.

Turrets central and engaged.

All controls unlocked: locking gear stowed.

GROUND/FLIGHT switch to GROUND if ground battery connected.

Indicator lights.

Up-locks disengaged and clips secured.

Hydraulic system—Mk. II:

P & S. flaps accumulator pressure (500 lb./sq.in. flaps up).

P & S. flaps accumulator pressure (350 lb./sq.in. flaps down).

P & S flaps isolating cocks unscrewed.

Bomb doors accumulator pressure (500 lb./sq.in. doors closed).

Bomb doors accumulator pressure (350 lb./sq.in. doors open).

Declutch Messier pump (if fitted).

Hydraulic system—Mk. V:

Reservoir level.

Emergency air bottle pressure (1,200 lb./sq.in. minimum).

Power accumulator pressure (1,850 lb./sq.in. minimum).

Nitrogen valve (if fitted) ON.

All cross-feed cocks OFF.

Fuel contents.

(iii) Before starting engines, check:

Flaps up and landing lamp retracted.

Undercarriage lever down, flaps and bomb doors levers neutral.

Brake pressure: brakes ON.

Flying controls.

Oxygen capacity and flow.

Test visual call light system.

42. **Starting the engines and warming up**

(i) The starting magneto switches, the radiator shutters, temperature gauges, pressure gauges and warning lights, and the air-intake heat control are under the charge of the flight engineer, but the pilot should be in his seat to see that the following sequence of actions is carried out. The engines should be started in turn; an engine should not be primed until its turn for starting comes.

(ii) Have ground battery (24v) plugged in and GROUND/FLIGHT switch (if fitted) turned to GROUND.

(iii) Turn ON the master engine cocks and instruct the flight engineer to turn ON tanks 1 and 3 (*see* para. 40).

(iv) Set the engine controls as follows:

Throttle	½ inch open.
Supercharger	M ratio.
Propeller control	INCREASE REVS.
Carb-air intake heat control	COLD.
Radiator shutters	SHUT.

(v) Instruct the ground crew to turn on the priming cock to the appropriate engine and operate the priming pump until the suction and delivery pipes are primed. This may be judged by a sudden increase in resistance.

(vi) Switch ON the ignition, instruct the engineer to switch on the starter magneto and press the starter button for each engine in turn while the ground crew prime the induction system as each engine is being turned. Turning periods must not exceed 20 seconds with 30 seconds intervals. If the engine is hot it should start after 2 or 3 strokes of the pump. If cold, the engine should start without greatly exceeding the following number of strokes.

Air temperatures .. °C.	+30	+20	+10	0	−10
No. of strokes ..	3	4	7	12	18

(vii) It will probably be necessary for the ground crew to continue priming after the engine fires until it picks up on the carburettor.

(viii) When the engine is firing steadily, the engineer should switch off the starter magneto. The ground crew will turn off the priming cock and screw down the priming pump. Have the GROUND/FLIGHT switch (if fitted) turned to FLIGHT and the ground starter removed when all engines have been started.

(ix) Open each engine up gradually to 1,200 r.p.m. and warm up at this speed.

(x) D.R. compass switches to ON and SETTING.

43. Testing engines and installations

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising the flaps.

(ii) Check brake pressure. Pesco pumps, intercom.

After warming up, and for each engine in turn:

NOTE.—The following comprehensive checks should be carried out after repair, inspection (other than daily), or at the pilot's discretion. Normally, they may be reduced in accordance with local instructions.

(iii) At 1,500 r.p.m. test each magneto as a precautionary check.

(iv) Open up to +4 lb./sq.in. boost and check operation of two-speed supercharger. R.p.m. should fall, and boost rise momentarily, when S ratio is engaged. Return to M ratio.

(v) At the same boost check operation of constant-speed propeller. R.p.m. should fall to 1,800 with the control fully down. Return control fully up.

(vi) Open throttle fully momentarily and check take-off boost and r.p.m. (To obtain take-off boost of + 14 lb./sq.in. on Merlin 22 engines it is necessary to operate the boost control cut-out and then open throttles only to the gate.)

(vii) Throttle back to +9 lb./sq.in. boost and test each magneto in turn. The drop should not exceed 150 r.p.m.

44. Taxying out

(i) Check brake pressure (90 lb./sq.in. Supply Pressure 250–300 lb./sq.in.).

(ii) DR compass to NORMAL.

(iii) If FN. 64 mid-under turret is fitted, it must be under control during taxying, take-off and landing. If the turret is left unattended, the guns may lower to the depressed position, and may foul the ground.

45. Final preparations for take-off

(i) For the shortest take-off run flaps should be set 35° down.

(ii) *Check list before take-off:*

Auto controls	Main switch OFF. Clutch IN. Gyro OUT. Exercise controls fully.
T—Trimming tabs	Rudder and aileron controls NEUTRAL. Elevator ½ division tail heavy.
P—Propellers	Speed controls up (INCREASE REVS.).
F—Fuel	Engineer checks cock settings (*see* para. 40).
F—Flaps	0°–35° down.
Superchargers	M ratio.
Radiators	SHUT.
Air intake	COLD.
Boost control cut-out . .	Correct position.
Throttle gate	Open (or closed if + 14 lb./sq.in. boost is required on Merlin 22).
Crew at stations	
All hatches closed	

46. **Take-off**

(i) Open the throttles slowly at first, then fully as the aircraft accelerates. There is a tendency to swing to port, but this can be checked initially on the throttles, and, as the speed increases, by the rudders.

(ii) The elevators are heavy at first, but when the aircraft has gathered speed the tail can be raised without undue force on the control column.

(iii) At 50,000 lb. the aircraft flies itself off: at 60,000 lb. it has to be pulled off the ground at just over 100 m.p.h. I.A.S.

(iv) Safety speed is 130 (140) m.p.h. I.A.S.

47. **Climbing**

(i) The initial speed for maximum rate of climb fully loaded is 140 (150) m.p.h. I.A.S.

(ii) After the undercarriage and flaps have been raised the flight engineer should close the flaps isolating cocks and engage the undercarriage mechanical up-locks.

48. **General flying**

(i) *Change of trim:*

Undercarriage up .. .. Nose slightly down.
Flaps up .. .. .. Nose slightly down.

(ii) *Trimming tabs.*—The tabs on all three flying controls are powerful, particularly the elevator tabs.

(iii) *Controls:*

(*a*) Where Mod. 814 (large fin) is embodied, the rudder is rather heavy, and is free from any tendency to lock over in sideslips.

(*b*) Where Mod. 814 has not been embodied, the rudder is light in comparison with the ailerons and elevator, and care is needed to avoid misuse of the rudder leading to sideslipping. Use the elevator early and progressively in the turn, rather than let the nose drop and apply top rudder.

(iv) *Rudder overbalance.*—On aircraft where Mod. 814 has not been embodied, a large skid or sideslip will stall the fins and cause the rudders to lock over, and the aircraft to go into a spiral dive. In this event:

PART II—HANDLING INSTRUCTIONS

(*a*) Put the nose down to gain at least 150 (160) m.p.h. I.A.S.—but not excessive speed.

(*b*) Throttle back the engines.

(*c*) Centralise the rudder.

Much opposite aileron should not be used as it will increase the sideslip.

(v) *Flying at low airspeeds.*—The aircraft is pleasanter to fly at speeds below 140 m.p.h. I.A.S. with the flaps lowered 30° to 40°.

49. **Stalling**

(i) *Characteristics at the stall.*—There is no warning of approach to the stall. The stall is gentle and straight, with no wing-dropping tendency; control is regained quite quickly on pushing the control column forward.

(ii) The stalling speeds in m.p.h. I.A.S. are:

Load	45,000 lb.	55,000 lb.
Flaps and undercarriage up ..	95(102)	105(113)
Flaps and undercarriage down	78(84)	86(92)

50. **Diving**

The aircraft becomes tail heavy at high speeds and requires trimming into the dive.

51. **Approach and landing**

(i) Check with flight engineer:

Radiator shutters closed.
Air intake heat control COLD.
Undercarriage up-locks disengaged and clips secured.
Fuel contents of tanks in use.
Total fuel and All-up weight.
Flaps isolating cocks open.

NOTE.—If there is a likelihood that the hydraulic system has been damaged, before opening the flaps isolating cocks the engineer checks with the pilot that the flaps lever is in the "neutral" position, and then turns both the isolating cocks half a turn simultaneously. The pilot tells him immediately if the flaps are dropping—if so the engineer can regulate their descent with the cocks.

(ii) Reduce speed to 140 (145) m.p.h. I.A.S. aided by 35° flaps, provided the flaps are not lowered above 150 (160) m.p.h. I.A.S.

(iii) *Check list before landing:*

Brakes	90 lb./sq.in. (supply pressure 250–300 lb./sq.in.)
U—Undercarriage	Down (check lights).
P—Propeller	Increase r.p.m. to approx. 2,850.
Superchargers	M ratio.
F.—Flaps	Fully down (80°) or less in high wind.

(iv) *Recommended speeds for the approach (at 50,000 lb.):*

Engine assisted	105 m.p.h. I.A.S.
Glide	115 m.p.h. I.A.S.

52. **Mislanding**

The aircraft becomes nose-heavy with normal trim when the throttles are opened fully with flaps and undercarriage down. After mislanding raise flaps to 40° down before selecting undercarriage up.

53. **After landing**

(i) Radiator shutters OPEN : flaps UP.

(ii) If brake pressure is ample, the inner engines may be stopped before taxying in, but the compressor is driven by an inboard engine. When parking ensure tail wheel is central.

(iii) Stop the engines by putting the engine master cocks to OFF; this operates the slow-running cut-outs. Switch OFF the ignition when the engine has stopped: then turn OFF all tank cocks.

(iv) Switch off undercarriage indicator (if switch is fitted).
Fuel contents gauges
Pressure-head heater
GROUND/FLIGHT switch to GROUND (if fitted)
D.R. Compass
T.R.9F.

(v) *Oil dilution—See* A.P. 2095 Pilot's Notes General.
The dilution period is 1 minute down to −10°C.
2 minutes below −10°C.
Damage may be done to the engine if this period is exceeded, but full benefit of the oil dilution will not be gained unless Mod. 238 incorporating ·089 in. jet has been fitted.

54. **Beam approach**

Stage	Indicated height ft.*	I.A.S.	R.P.M.	Approx. boost	Actions	Change of trim
Preliminary approach	1,500	140	2,400	+1	Lower flaps 35° ..	Tail heavy
					Lower undercarriage on QDM and heading for OMB	Slightly tail heavy
Outer marker beacon	700	120	2,650	+2		
Inner marker beacon	200	115	2,850		Lower flaps fully ..	Slightly tail heavy
Overshoot		100	2,850	Full throttle	Raise flaps to 40°, then raise undercarriage	Nose heavy

* After adjusting altimeter for QFE and touch-down error as follows:
At touch-down with full flap, altimeter reads +60 ft., so subtract 2·16 millibars from QFE to give zero reading at touch-down.

PART III

OPERATING DATA

55. Engine data—Merlin XX

(i) *Fuel*—100 octane only.

(ii) *Oil—See* A.P.1464/C.37.

(iii) The *maximum* permissible r.p.m. boost and temperatures for the conditions of flight and periods stated are as follows:

		R.p.m.	Boost lb./sq.in.	Temp. °C. Coolant	Temp. °C. Oil
TAKE-OFF TO 1,000 FT. OR 5 MINS. LIMIT	M	3,000	+12		
CLIMBING 1 HOUR LIMIT	M/S	2,850	+ 9	125	90
RICH .. .. CONTINUOUS	M/S	2,650	+ 7	105	90
WEAK .. CONTINUOUS	M/S	2,650	+ 4	105	90
COMBAT .. 5 MINS. LIMIT	M	3,000	+14*	135	105
	S	3,000	+16*	135	105

* Obtainable by pulling the boost control cut-out.

OIL PRESSURE:
NORMAL .. .. 60/80 lb./sq.in.
MINIMUM .. .. 45 lb./sq.in.

MINM. TEMP. FOR TAKE-OFF:
OIL .. .. 15°C.
COOLANT .. .. 60°C.

(iv) *Recommended temperatures for continuous cruising:*
OIL .. .. 55°—70°C.
COOLANT .. .. 85°—95°C.

and these temperatures should be maintained as far as possible throughout the flight.

56. Engine data—Merlin 22

(i) *Fuel*—100 octane only.

(ii) *Oil. See* A.P. 1464/C.37.

(iii) The *maximum* permissible r.p.m., boost and temperatures for the conditions of flight and periods stated, are as follows:

		R.p.m.	Boost lb./sq.in.	Temp. °C. Coolant	Temp. °C. Oil
TAKE-OFF TO 1,000 FT. OR 5 MINS. LIMIT	M	3,000	+14*		
CLIMBING .. 1 HOUR LIMIT	M/S	2,850	+ 9	125	90
†MAXIMUM .. CRUISING ..	M/S	2,650	+ 7	105	90
COMBAT .. 5 MINS. LIMIT	M	3,000	+14*	135	105
	S	3,000	+16*	135	105

*Obtainable by pulling the boost control cut-out.

† *See* Para. 59 for economical cruising.

OIL PRESSURE:
NORMAL .. .. 60/80 lb./sq.in.
MINIMUM .. .. 45 lb./sq.in.

MINM. TEMP. FOR TAKE-OFF:
OIL. .. .. 15°C.
COOLANT .. .. 60°C.

(iv) *Recommended temperature for continuous cruising:*
OIL .. .. 55°—70°C.
COOLANT .. .. 85°—95°C.

and these temperatures should be maintained as far as possible througout the flight.

57. Position error corrections

All handling speeds are quoted for aircraft with the static side of the A.S.I. connected to the Mark VIII pressure head. Position error corrections are as follows :

From	120	130	140	150	160	170	180	195	215	m.p.h.
To	130	140	150	160	170	180	195	215	260	I.A.S.
Add	11	10	9	8	7	6	5	4	3	m.p.h.

The static vent provided in the port side of the fuselage is not connected to the A.S.I., but if it should be connected at a later date, the position error correction is +2 at a speed of 140 m.p.h. I.A.S. and less than +1 at all speeds in excess of 160 m.p.h. I.A.S.

58. **Flying limitations**

(i) The aircraft is designed for manœuvres appropriate to a heavy bomber, and care must be taken to avoid imposing excessive wing loads with the elevators in recovery from dives and turns at high speeds. Violent use of the rudder is to be avoided at high speeds. Spinning and aerobatics are not permitted.

(ii) Maximum speeds in m.p.h. I.A.S.

Diving	320(320)
Undercarriage DOWN	150(160)
Flaps DOWN	150(160)
Bomb doors (standard) opening or closing	320(320)
Bomb doors (large) opening or closing ..	200(205)
Bomb doors (large) fully open	270(270)

(iii) *Maximum weights*

Take-off	60,000 lb.
Landing	50,000 lb.

(iv) *Bomb clearance angles*

Diving 30°
Climbing 20°
Bank 10°—Except for the 250 lb. "B" bomb, for which the maximum angle of bank is 2½°.

59. **Maximum performance**

(i) *Climbing.*—For maximum rate of climb, climb at 140 (150) m.p.h. I.A.S. at 2,850 r.p.m. and maximum boost not exceeding +9 lb./sq.in. Engage S ratio when the boost in M ratio has fallen to +6 lb/sq.in. and reduce I.A.S. to 130 (140) m.p.h.

(ii) *All-out level.*—Use S ratio if boost obtainable in M ratio is 2 lb/sq.in. below the maximum permissible.

60. **Maximum range** (*see curves, pages* 40 *and* 41)

(i) *Climbing*

(*a*) If a rich mixture climb is adopted, climb at the conditions for maximum rate of climb given in para. 58 (i).

(*b*) If, for some operations, a slow weak mixture climb can be adopted, climb at 150 (160) m.p.h. I.A.S. at 2,650 r.p.m. and maximum obtainable boost not exceeding +4 lb./sq.in. (+7 lb/sq.in. for Merlin 22). Change to S ratio when +4 lb./sq.in. boost can no longer be obtained in M ratio, and, as the weak mixture climb in S ratio is unsatisfactory, continue to climb at 130 (140) m.p.h. I.A.S. at 2,850 r.p.m. and maximum obtainable boost not exceeding +9 lb./sq.in.

(ii) *Cruising.*—Fly in M ratio at maximum obtainable boost not exceeding +4 lb./sq.in. (+7 lb./sq.in. for Merlin 22), and reduce air speed by reducing r.p.m. which may be as low as 1,800 if this will give the recommended air speed and vibration is not excessive.

Fully loaded (outward journey) ..	160(170) m.p.h. I.A.S.
Lightly loaded (homeward journey)	150(160) m.p.h. I.A.S.

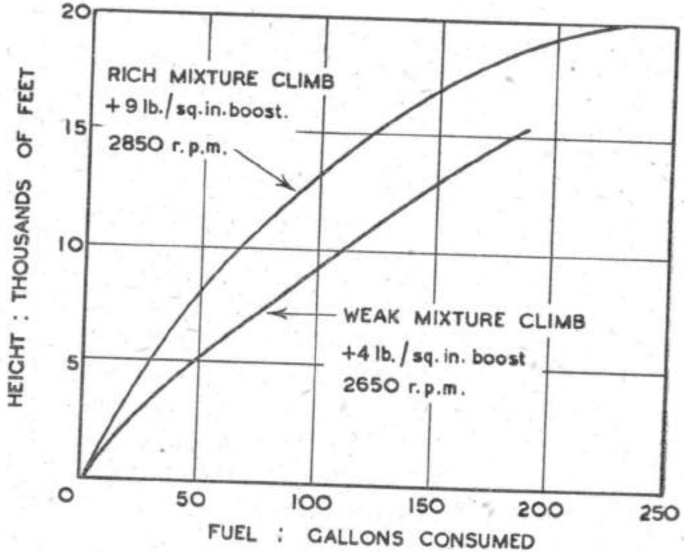
Higher air speeds than those recommended may be used if obtainable in M ratio at the lowest possible r.p.m. Engage S ratio if, at 2,650 r.p.m. in M gear you cannot maintain the recommended I.A.S., but only if the boost in M ratio is less than +2 lb/sq.in.

(iii) The use of warm air intakes reduces range by about 16 per cent, but on this installation there will probably be no need to use warm air intakes. *See* A.P. 2095 Pilot's Notes General.

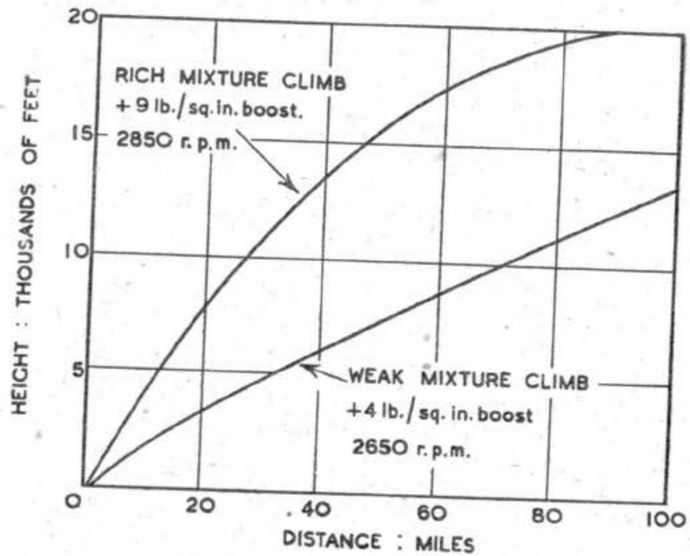
(iv) Maximum range is obtained at heights at which the recommended speed can be obtained in M ratio at 2,100 to 2,400 r.p.m. (i.e. about 12,000 ft. when heavily loaded).

(v) If it is necessary to open radiator shutters, they should be opened only the minimum amount. This also improves the cabin heating.

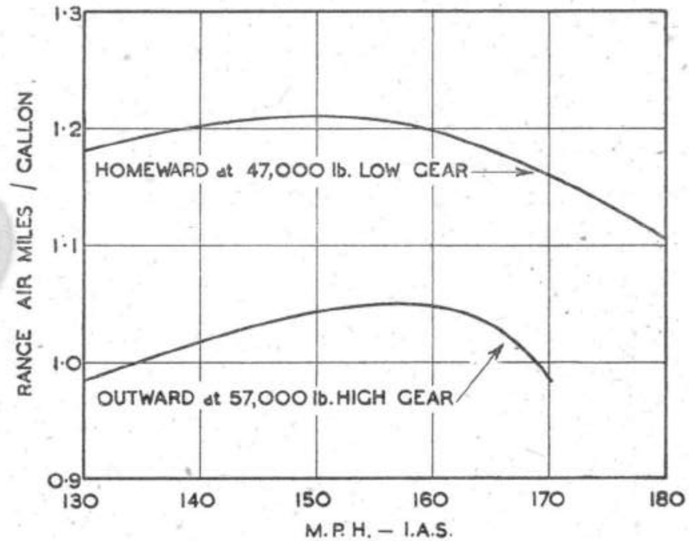
FUEL CONSUMED ON CLIMB



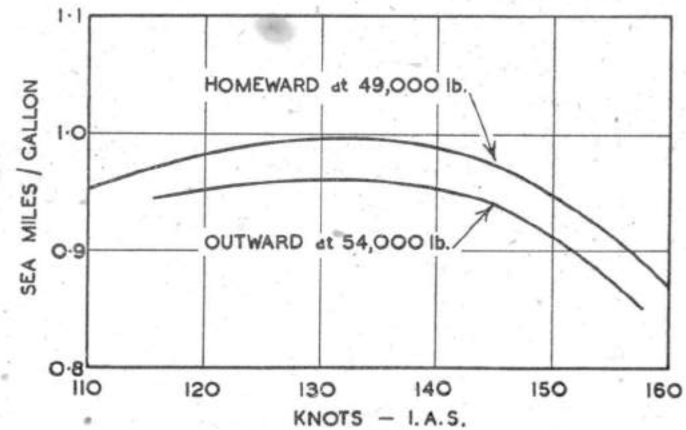
DISTANCE TRAVELLED ON CLIMB



AIR MILES PER GALLON (BOMBER VERSION) AT 15,000 FEET



SEA MILES PER GALLON (COASTAL VERSION) AT 5,000 FEET



(vi) *Maximum range and endurance at very low altitudes (for Coastal Command aircraft).*
The recommended speed is 140 knots I.A.S. Fly in M ratio at maximum weak boost and reduce r.p.m. down to 1,800 to give recommended air speed. If at 1,800 r.p.m. the recommended I.A.S. is exceeded, reduce boost.

61. **Fuel consumptions**

(i) Approximate fuel consumptions for the aircraft in the weak mixture range are shown in gals./hr. in the table below. These figures apply above 8,000 ft. in M ratio and above 14,000 ft. in S ratio.

Boost lb./sq.in.	R.P.M.		
	2,650	2,300	2,000
+7*	260	230	212
+4	228	204	188
+2	212	188	172
0	192	172	156
−2	172	156	140
−4	152	136	124

* Merlin 22 only.

(ii) Approximate fuel consumptions in the rich mixture range for the aircraft are as follows :

R.P.M.	Boost lb./sq.in.	Total Gallons per hour
3,000	+12	460
3,000	+ 9	400
2,850	+ 9	380
2,650*	+ 7	320

* Merlin XX only.

FUEL CAPACITY

Two No. 1 tanks	494 gallons
Two No. 2 tanks	200 gallons
Two No. 3 tanks	376 gallons
Two No. 4 tanks	322 gallons
Two Nos. 5 and 6 tanks ..	490 gallons
Total	1882 gallons

62. **A.S.I. conversion table**

M.P.H.	Knots	M.P.H.	Knots
78	68	130	113
84	73	135	117
86	75	140	122
92	80	145	126
95	82	150	130
102	89	155	134
105	91	160	139
113	98	170	148
115	100	200	174
120	104	270	234
125	109	320	278

PART IV

EMERGENCIES

63. **Engine failure during take-off**

(i) The aircraft can be kept straight on any three engines at take-off power provided that 130 m.p.h. I.A.S. has been attained.

(ii) With flaps in the take-off position and undercarriage up, it will be possible to climb at take-off power at 130(140) m.p.h. I.A.S. except at heavy loads. At over 55,000 lb. height will be gained only in favourable weather conditions.

64. **Engine failure in flight**

(i) Feather the propeller of the failed engine and close its engine master cock.

(ii) Where Mod. 814 has not been embodied, do not allow the indicated air speed to fall below 140 (150) m.p.h. Keep the aircraft straight by judicious use of the rudder trim. Never use the rudder violently and fly with as little bank as possible so that the aircraft will not sideslip. If speed is allowed to fall below 140(150) m.p.h. I.A.S. rudder overbalance may occur at large rudder angles resulting in a spiral dive (usually in the opposite direction to the turn). If the pilot is unable to take off the rudder, increase speed to at least 150(160) m.p.h. I.A.S. by movement of the control column, and throttle back engines. The rudder can then be centralised. Avoid the use of opposite aileron to the direction in which the aircraft is diving. This will only increase sideslip.

(iii) *One engine failed.*—Level flight is easily possible up to about 12,000 feet. Even if above 12,000 ft. use M ratio and descend to this or a lower height. The best speed for covering distance is about 150 (160) m.p.h. I.A.S. Level flight in weak mixture will generally be possible if the weight is below about 48,000 lb.

(iv) *Two engines failed.*—Use full climbing power in M ratio and at a speed of not less than 140(150) m.p.h. I.A.S. keeping the aircraft straight with use of rudder trim and foot load using as little bank as possible. Level flight should be possible below 12,000 ft. if the weight is below about 46,000 lb. Bombs should be jettisoned immediately.

(v) For landing, undercarriage and flaps should be lowered at a considerable height, so that excessive power is not required of the live engines.

(vi) Auto pilot may be used except when two engines have failed on one side. *See* A.P. 2095 Pilot's Notes General.

65. **Feathering and unfeathering**

(i) To feather a propeller:

(*a*) Set propeller speed control fully back through the gate.
(*b*) Close throttle immediately.
(*c*) Hold the button in until feathering is complete.
(*d*) Turn off fuel and switch off ignition when the engine has stopped.

(ii) To unfeather a propeller:

(*a*) Set throttle closed or slightly open and ignition and fuel on.
(*b*) Set propeller speed control just forward of the gate.
(*c*) Press feathering button until the propeller is constant-speeding. If the propeller does not unfeather, move the propeller speed control slightly forward to take up any backlash in the control.

66. **Messier hydraulic system emergency operation**

(*a*) *Undercarriage:*

(i) The undercarriage control lever (29) must be placed in the DOWN position, and the mechanical up-locks must be released.

NOTE.—In extreme emergency when the mechanical up-locks cannot be released or are inaccessible, the mechanism is designed with a " weak link " (Mod. 780), so that the application of hydraulic power to the jacks will break the lock and lower the undercarriage.

(ii) If the engine pump has failed, the undercarriage may be lowered normally by the power in the accumulators and raised through the normal hydraulic lines by use of the handpump. Use the port handpump and only use the starboard handpump if the port one fails to complete the operation.

(On early aircraft where two engine pumps are fitted, it is necessary to use both handpumps.)

(iii) Emergency lowering of the undercarriage after damage to the accumulators may be accomplished by either engine or handpump through separate pipe lines from the pumps direct to the downside of the jacks. This system comes into operation when special cocks are opened by the engineer as under:

(*a*) On early aircraft where two engine pumps are fitted, there are two emergency cocks, one for the port undercarriage and the other for the starboard. Open the cock relevant to the faulty undercarriage thus opening the direct line from the pump to the jack.

(*b*) On later aircraft fitted with a single engine pump, there is only one emergency cock which is common to both undercarriage units.

(iv) Should the hydraulic system have failed completely, lowering may then only be accomplished by an arrangement of elastic cords fitted on the radius rod which will gradually lower and lock the undercarriage automatically when the pilot's control lever is in the DOWN position and the engineer's up-locks have been released.

(*b*) *Bomb doors:*

(i) Emergency opening of the bomb doors, operated by the flight engineer, may be accomplished by engine or handpump in the event of pipe or accumulator damage. The emergency circuit consists of separate pipe lines connecting the output of the pump through an emergency cock (marked B and located under cover on front spar), directly to the jacks. The pilot's control lever (30) must be placed in the OPEN position but the accumulator isolating cock should be closed.

(ii) Having opened the bomb doors by the emergency system, they may be closed once by the normal engine or handpump method (making sure that emergency cock B has been closed), but if the doors are opened a second time on the emergency system, and a second attempt is made to close them, not enough fluid will be available to complete the operation.

(iii) If the bomb doors have opened normally, but will not close again, it may indicate the failure of the engine-driven pump, and the appropriate handpump should be used.

(*c*) *Flaps*

The flaps are not served by emergency pipe lines and if they cannot be lowered by their accumulators they cannot be lowered at all.

67. Dowty hydraulic system emergency operation

(*a*) *Undercarriage:*

(i) The mechanical up-locks must be released.

(ii) If one engine pump is out of action the other will operate the system though at a reduced speed when the undercarriage control lever is placed in the DOWN position.

(iii) If both engine pumps are out of action, the undercarriage lever should be left in the DOWN position, and an attempt should be made to lower by handpump through the normal pipe line.

(iv) Should the hydraulic system have failed completely, the undercarriage will lower automatically under its own weight assisted by an arrangement of elastic cords fitted on the radius rods. The control lever must be DOWN. If Mod. 498 has not been incorporated the undercarriage will only lock down at low airspeeds: flaps should therefore be lowered 40° and speed reduced until the undercarriage locks down.

(*b*) *Bomb doors:*

(i) If one engine pump is out of action, the other will operate the system, though at a reduced speed, when the control lever is in the appropriate position.

(ii) If both engine pumps are out of action the bomb doors may be opened or closed through the normal pipe lines and controls by means of the handpump.

(iii) Should the hydraulic system have failed completely, the doors will be opened by compressed air when the engineer opens the air release valve. The pilot's selector lever should be in the doors OPEN position if operable. The emergency system will not close the doors.

(*c*) *Flaps:*

(i) If one engine pump is out of action, the other will operate the system through the normal controls.

(ii) If both engine pumps are out of action the flaps may be raised or lowered by the handpump through the normal controls.

(iii) Should the hydraulic system have failed completely, the flaps will be lowered by compressed air when the engineer opens the air release valve. The flaps lever should be in the DOWN position if operable. The emergency system will not raise the flaps.

68. **Bomb jettisoning**

(i) The controls cannot be operated unless the bomb door warning lights are showing.

(ii) Jettison bomb containers first by pressing the button (44) under the flap directly below the left hand warning light on the main instrument panel.

(iii) Jettison main load by pulling out the bomb-jettison handle (14) above the warning lights on the main instrument panel.

69. **Parachute exits**

(i) The hatch in the floor of the nose compartment.

(ii) The main entrance door on the port side of the rear fuselage.

(iii) The opening exposed by rotating the rear turret through 90 degrees.

(iv) The paratroop cone (if fitted).

(v) *Parachutes.*—Stowage for the first pilot's parachute is situated above the lower step on the starboard side adjacent to the wireless operator for whom parachute stowage is provided inside the lower step. Stowage for a detachable type parachute is also provided adjacent to each crew station, whilst the second pilot's parachute is stowed beneath the navigator's seat.

70. **Crash exits**

(i) The opening formed by raising or jettisoning a hinged transparent panel in the roof over the first pilot's seat.

(ii) The hatch at the astral dome (on early aircraft).

(iii) The hatch in the fuselage roof aft of the centre plane rear spar.

(iv) By lowering the hatchway in the fuselage roof just aft of the front spar (this hatchway is not fitted on earlier aircraft).

71. **Fire-extinguishers.**—Semi-automatic fire-extinguisher system is installed, and is crash operated by gravity and impact switches. The system may be operated manually by manipulating the pilot's pushbutton switches (64) mounted on the port side of the cockpit. There are four such buttons, one for each engine bay. Hand operated fire-extinguishers are stowed on the following positions:

Type No. 3 fire-extinguishers:

On the fuselage roof above the navigator's position.

On the flight engineer's lower instrument panel.

Type No. 5 fire-extinguishers:

On the forward face of the pilot's bulkhead adjacent to torch stowage.

Starboard side of the fuselage forward of the main electrical panel.

Above the starboard rest position instrument panel.

Starboard side of the fuselage forward of the instrument panel at the flare launching station.

Starboard side of the fuselage above the rear gunner's instrument panel.

72. **Marine distress signals.**—Three marine distress signal flares are stowed on the starboard side of the fuselage aft of the rear spar.

73. **Crash axe.**—An axe for emergency use is stowed on the starboard side of the fuselage immediately opposite the entrance door. Three axes are provided on later aircraft.

74. **First-aid outfits.**—Three first-aid packs are carried; two are stowed on the port side of the rear fuselage just aft of the step over the bomb compartment and one in the nose, aft of the gun turret on the starboard side.

75. **Portable oxygen sets.**—Stowages for portable emergency oxygen sets are provided at all the crew stations and one in the rest position.

76. **Ditching**

(i) Ditching should be carried out with flaps 35° down.

(ii) The dinghy stowed on the port side of the centre plane, is automatically released by

(*a*) Manual release adjacent to roof escape hatch aft of the rear spar. Give handle half turn and pull.

(*b*) Immersion switch fitted under the nose of the fuselage.

(ii) The dinghy is provided with three marine distress signals together with emergency rations, sea markers, first-aid outfit and paddles in a separate valise attached to the dinghy by a cord. On early aircraft three marine distress singals are provided in the dinghy.

Emergency pack No. 7 and liquid rations are stowed on the port side of the fuselage aft of the rear spar above the 4½ inch flares.

Emergency radio T1333 is stowed on the port side of the fuselage just aft of the front spar above the rest seat.

77. **A.R.I. 5000 and 5033 emergency switches.**—Two detonator switches of the pushbutton type are mounted under a small flap (5) marked DANGER on the port side of the fuselage immediately aft of the pilot's sloping instrument panel for use with A.R.I's 5000 (or 5025) and 5033. Similar pushbuttons are mounted at both the navigator's and wireless operator's stations.

PART V

ADDITIONAL DATA FOR FLIGHT ENGINEER

78. **Damage by enemy action**

The flight engineer must carry out the drills given in A.P. 2764 Flight Engineer's Notes General and in addition must check:

(*a*) All hydraulic accumulator pressures.

(*b*) All oxygen equipment.

79. **Landing away from base**

The flight engineer proceeds as detailed in A.P. 2764 Flight Engineer's Notes General, but should the landing have been made due to fuel shortage only:

(*a*) Check batteries are disconnected or GROUND/FLIGHT switch is at GROUND and pitot-head cover is on.

(*b*) Instruct duty crew to fill an even amount of fuel into tanks 1, 2, 3 and 4 [provided take-off weight is below 55,000 lb. *See* para. 40 (1) (*f*)], sufficient for the flight with a safety margin depending on the weather conditions. Supervise filling procedure.

(*c*) Instruct duty crew to check oil. Check grade of oil and supervise filling procedure.

(*d*) Check brake pressure and have system recharged if necessary.

(*e*) Arrange that 24-volt ground battery is available for starting.

(*f*) Carry out pre-flight check.

(*g*) Ground test engines if necessary. Give instructions, before starting, of drill used.

80. Coolant system

(i) The coolant system is as normal for all Merlin engines. The rate of cooling is as controlled by hydraulically operated radiator shutters.

(ii) Filling procedure after an emergency landing:

(*a*) The system should be allowed to cool before refilling.

(*b*) If the system is extremely low, open radiator vent cocks.

(*c*) Close vent cocks when coolant flows from them, then complete filling.

(*d*) Check for leaks, and lock vents closed.

81. Oil system

A separate oil tank is provided for each engine; those for the inner engines are mounted in the leading edge of the centre plane and those for the outer engines are mounted in the engine nacelles aft of the fireproof bulkhead. The pressure pump is situated in the crank case sump and draws oil from the tank through a filter and circulates oil through the engine. On early aircraft the contents of the tanks are registered by electrically operated gauges mounted on the panel at the rear of the inner engine nacelles. The gauge-operating switch is fitted immediately below the gauges. The filler neck of each inner engine oil tank is beneath a panel on the upper surface of the leading edge of the centre plane. The filler neck of each outer engine oil tank is in the port side of the nacelle beneath the leading edge. A two-way cock is fitted to the sump and when the cock lever is forward the tank is connected to the engine. For filling or draining, the sump cock lever should be in the aft position. In the case of the inboard tanks this cock is mechanically interconnected to a cock in the overflow pipe and, when the sump cock lever is in the forward position, the overflow pipe is closed. When the sump cock lever is in the aft position, the overflow pipe is open, thus making it impossible to overfill the tank. A short length of tube is welded to the sump cock lever which prevents the replacement of the

access door unless the cock lever is set in the forward position. A drain cock is fitted at the right-hand side of the rear face of the inner engine diaphragms in the oil vent pipe-line. The drain cock should be opened between flights to drain any oil that may have collected.

82. Hydraulic system (Messier)

Tanks.—The hydraulic fluid is stored in three tanks mounted on the front spar behind the inner engine diaphragms. The starboard tank is only used in an emergency when the port main and auxiliary tanks are empty or punctured. Each tank is provided with a filter in the suction line and a filling filter, the bottom of which serves as a filling level for the fluid.

Handpumps. — There are two double-acting pumps attached to the front spar of the centre section. The port handpump draws fluid from the tank return pipe and will operate the entire system in the same manner as the engine pump. The starboard handpump draws fluid direct from the starboard tank and is only used in the event of the port handpump failing to complete an operation. The port pump is also used for ground operation of any part of the system.

Distributors.—The distributors for the undercarriage, flaps, and bomb doors are remotely controlled through linkage members by a group of hand levers situated to the right of the pilot's seat. The distributor for the radiator shutters is mounted on the engineer's instrument panel. The undercarriage, bomb doors and flaps distributors have a hidden three-position gate; the central position being " neutral ". The flaps may be stopped in any desired intermediate position by returning the lever to this neutral position. The radiator shutter distributor levers and the landing lamp distributor levers are spring loaded to remain in the neutral position and have to be held in the " open " or " shut " position while the operation is in progress, normally 3 or 4 seconds for the radiator shutters, and somewhat longer for the landing lamp.

Isolating valves.—A manually operated isolating valve is fitted between the top of each flap jack and accumulator, and one in the accumulator line leading to the underside of all the bomb door jacks. These isolating valves, when closed, prevent the complete lowering of the flaps and bomb doors by accumulator pressure, in the event of damage to the pipes. When the pilot's levers are selected to "doors open" and "flaps down" with their respective isolating valves closed, however, this has the same effect as breaking the pipe-lines on the opposite side of the jack to its accumulator and allows the weight of the flaps or bomb doors to react against the jacks thereby forcing fluid from the jacks to return through the distributor back to the tank. The amount of opening and lowering varies according to conditions. If the pilot's levers are selected when on the ground as stated above, the flaps will tend to lower themselves fully and the bomb doors partly open. In flight, however, the flaps will tend to fall only slightly, and the bomb doors will open a varying amount according to conditions. It is important, therefore, that the pilot's levers be returned to neutral after a particular circuit has been operated.

Mechanical locks.—The undercarriage jacks are fitted with positive mechanical locks which operate when the jacks are in the extended position only.

Jack emergency valves.—Valves of the simple non-return type normally prevent the accumulator pressure from passing down the emergency pipe-lines, but allow that part of the jack fed from the accumulator to be fed through the emergency circuit by engine or handpump, when the emergency cocks are opened.

Accumulators.—The accumulators, with the exception of the power accumulator in the system with the Lockheed pump, are not fitted with separator pistons, as the circuits are sealed by the jack pistons thus preventing leakage of air into the system. The locations of the accumulators in the aircraft are as follows:

(i) Undercarriage and undercarriage doors accumulators are attached to the front spar aft of the inner engines.

(ii) Bomb door accumulator is aft of the front spar attached to the port side of the fuselage.

(iii) Flap accumulators are behind the rear spar, one on each side of the fuselage.

(iv) Power accumulator for Lockheed pump system only is mounted on the diagonal member of the front spar in the port inner nacelle.

(v) Radiator shutters and landing lamp accumulator, for Messier pump system only, is mounted immediately behind the engineer's instrument panel.

Gauge relay.—The gauge relay is fitted in the pipe-line to the pressure gauge of the main hydraulic circuit and is designed to isolate the gauge in the event of a fault in the gauge or the pipe-line.

Lockheed engine pump.—This is of the multi-cylinder high-speed radial type. This pump runs continuously, the strain on the pump being relieved between operational demands by a hydraulic cut-out valve. The pump is mounted on a right-angle drive underneath the crank case on the port inner engine.

Cut-out valve (with the Lockheed pump).—An automatic cut-out valve is fitted in the pump delivery line, and is mounted on the rear face of the port inner engine diaphragm. When the engine pump has charged the power accumulator to 2,450–2,550 lb./sq.in. the valve isolates the system from the pump and by-passes the fluid back to the tank.

Pressure-limiting valve.—The pressure-limiting valve is used to limit the pressure attainable by the pump to 2,500 lb./sq.in. (Messier pump) and 2,800 lb./sq.in. (Lockheed pump.) The valve is of a special inverted type so that there is no tendency to dribble: increase in pressure causes the valve to seat more firmly whilst a spring is being compressed, until finally the valve is automatically lifted from its seat by a positive stop.

Safety valve.—A safety valve is fitted in each undercarriage accumulator line which limits to 600 lb./sq.in. the pressure which can be applied to the accumulator in the event of damage to the hydraulic locks or jacks.

Flexible pipes.—The flexible pipes are steel cored high pressure hoses. They are suitable only for use with the specified hydraulic fluids and should not be brought into contact with other fluids, particularly mineral oils.

83. **Dowty Hydraulic system**

Engine-driven pumps.—Two Lockheed engine-driven pumps operate the system. They are of the high-speed type and are mounted on the rear of each inner engine.

Handpump.—A double acting pump, situated on the front spar on the starboard side, operates the entire hydraulic system when the engine pumps are not working. A pressure relief valve is incorporated in the pump to prevent excessive pressures being built up.

Power accumulator.—The only accumulator in the system is mounted under the port rest station. It is the pressure reservoir for the system and is fed by either or both of the engine-driven pumps or by the handpump. A cut-out valve on the front spar is provided in the pump delivery line to by-pass the fluid back to the tank when the power accumulator reaches a pressure of 2,300–2,400 lb./sq.in.

Reservoir.—The reservoir is in the fuselage mounted on the port side of the front spar. There is a window in the tank enabling the fluid level to be checked.

Variable flow valve.—This is attached to the underside of the jack piston on the line of the wing flap circuit and prevents the flaps being raised too quickly. It is situated in the fuselage bomb bay on the starboard side just aft of the centre bomb door jack.

Emergency air bottle.—This is mounted under the crew's port rest station. It is a bi-cell bottle with an inflation connection and pressure gauge at each end. The forward end is connected through an air release valve and an automatic isolation valve to the bomb doors circuit, and the aft end through similar valves to the wing flaps circuit. The air release valves are mounted on the aft face of the front spar, the one on the port side is for operation of the bomb doors, and the one on the starboard side is for operation of the wing flaps. The levers for operating

the valves are reached by lifting the flap on which is an instruction plate explaining the method of using the emergency gear. In the event of failure of the hydraulic system, the operation of the valves admits compressed air from the bottle to the jack line and enables the bomb boors to be opened and the flaps to be lowered.

Emergency air isolation valves.—When the wing flaps or bomb doors emergency system is operated these valves automatically shut off the hydraulic fluid in the pump pressure line, thus isolating the high-pressure air from the hydraulic fluid except for that in the jack lines of the services concerned. The valves are situated on the starboard side of the fuselage bomb bay just aft of the centre bomb door jack.

Rotary control valves.—The rotary control valves for the undercarriage, flaps, and bomb door circuits are mounted behind the pilot's bulkhead, inside the fuel cock controls cover, and are operated through linkage members by a group of hand levers situated on the floor to the right of the first pilot's seat. Each lever moves in a gate which has a central stop. The undercarriage and wing flaps are lowered and the bomb doors closed by placing their respective levers in the lower position; the central stop is neutral. The flaps may be stopped in any desired intermediate position by returning the lever to the neutral position.

Distributors.—The radiator shutter distributor, which is a quadruple valve, is mounted behind the engineer's lower instrument panel, and the four operating levers, one for the control of each shutter, protrude through the front of the panel and operate the distributors. The levers are spring-loaded to remain in the neutral setting and have to be held in the " OPEN " or " SHUT " setting during the operation of the shutters. The distributor which controls the landing lamp is mounted on the side of the pilot's throttle box, and its operation is similar to that for the radiator shutters. If the operating lever is held in the forward position the light beam lowers, and if held in the aft position the beam rises. The distributor consists of two spring-loaded poppet valves which are depressed by a rocker arm attached to the operating lever.

With this arrangement the delivery from the pumps is always connected directly to the underside of the jack pistons. When one valve is opened, the fluid above the jack pistons is allowed to return to the tank, but when the other valve is opened the fluid pressure from the pumps is transmitted to both sides of the jack pistons, and owing to the smaller effective area below the jack piston due to the piston rod, the jack extends.

84. Pneumatic system

Air services.—The air supply is obtained from a Heywood compressor driven by the port inner engine; the air passes through a pressure regulator mounted behind the compressor, then through an oil trap and along the false spar to the air bottle in the fuselage. The air bottle is situated on the port side of the fuselage aft of the engineer's armour plate bulkhead. On early aircraft the system is different and the air passes through the oil trap first and thence to the pressure regulator at the bottom of the air bottle. When the air bottle is charged to the normal working pressure of 300 lb./sq.in. the regulator cuts off the supply to the air bottle.

Brake system.—The air from the bottle passes through an air filter to the differential control unit, and thence to the brakes. A triple pressure gauge on the pilot's instrument panel indicates the pressure in the supply line from the air bottle and the supply lines to each brake. For ground filling purposes the air-charging valve is situated on the rear face of the port inner engine diaphragm and is accessible through the undercarriage doors. On early aircraft this valve is situated on the port side of the fuselage bomb bay.

Wheel brake unit.—The wheel brake unit is a Dunlop component and is described in A.P. 2337.

Air-intake control.—The air pressure supply for the air-intake control is obtained from the pipe-line between the air filter and the union in the fuselage floor on later aircraft, or from the pipe-line between the air-charging valve and air filter on early aircraft, and is controlled by a valve mounted on the port side of the fuselage just forward of the front spar.

85. Engine-driven accessories

The accessories driven by the engines are as follows:

Port outer engine:

(i) An auxiliary generator for the engine-speed indicator. This is mounted aft of the engine on the upper tube of the left-hand mounting. A flexible drive connects the generator to the rear end of the left-hand camshaft.

(ii) A constant-speed control unit for the propeller. This is mounted on the forward end of the propeller reduction gear casing on the left-hand side of the engine.

(iii) *A 1,000-watt, 24-volt generator for the operation of the rear gun turret and bomb slip heating. This is mounted on the left-hand side of the engine and is driven from the supercharger compound gear through a layshaft and idler gear.

Starboard outer engine:

(i) An auxiliary generator for the engine-speed indicator, mounted as on the port outer engine.

(ii) A constant-speed control unit for the propeller, mounted as on the port outer engine.

(iii) A 24-volt alternator for the TR.1335 radio installation. This is mounted and driven in a similar manner to the 1,000-watt generator on the port outer engine.

Port inner engine:

(i) An auxiliary generator for the engine-speed indicator, mounted as on the port outer engine.

(ii) A constant-speed control unit for the propeller, mounted as on the port outer engine.

(iii) *A 1,000-watt, 24-volt generator for the majority of the lighting and general services and mid-turret supply, mounted as on the port outer engine.

(iv) A Pesco vacuum pump to supply the instrument flying panel and on early aircraft only, the de-icing equipment for the tail plane, fins and aerial masts. This pump is mounted on the right-hand front end of the propeller reduction gear casing.

*On later aircraft three 1,500 w. generators are fitted. *See* para. 12 (ii).

(v) A Messier pump for the hydraulic services to the port undercarriage, flaps, radiator shutters and landing lamp. On later aircraft the pump supplies all hydraulic services.

The pump is mounted behind the divisional diaphragm and is driven by an extension shaft from the rear end of the port side camshaft. On aircraft fitted with a Lockheed pump, this is mounted on a right-angle drive underneath the crank case.

(vi) A Heywood compressor for the operation of the pneumatic system. This is mounted on the right-hand side of the engine and is driven by a splined coupling from the camshaft.

(vii) An R.A.E. compressor for supply to the automatic pilot. This is driven from a gear at the rear end of the port camshaft.

Starboard inner engine:

(i) An auxiliary generator for the engine-speed indicator mounted as on the port outer engine.

(ii) A constant-speed control unit for the propeller, mounted as on the port outer engine.

(iii) *A 1,000-watt, 24-volt generator for certain of the lighting and general services, propeller feathering and engine starting. This is mounted as on the port outer engine.

(iv) A Pesco vacuum pump to supply the instrument flying panel. This is mounted as on the port inner engine.

(v) On early aircraft only a Messier pump for the hydraulic services to the starboard undercarriage and bomb doors, mounted as on the port inner engine.

(vi) On Mark V aircraft a Lockheed pump mounted on a right angle drive underneath the crank case.

*On later aircraft three 1,500 w. generators are fitted. *See* para. 12 (ii).

86. **Main pressures**

	lb./sq.in.
Fuel pressure	6–10
Engine oil pressure (minimum)	45
Engine oil pressure (normal)	60–80
R.A.E. compressor to auto-pilot	60
Brake pressure (minimum)	90
Inflation pressure undercarriage accumulator ..	180
Brake pressure (normal supply)	250–300
Inflation pressure bomb-doors accumulator (bomb doors OPEN)	350–400
Inflation pressure flaps accumulator (flaps DOWN)	350–400
Inflation pressure undercarriage doors accumulator	400
Rotol constant-speed output	550
Inflation pressure air bottle (Dowty)	1,200
Inflation pressure Lockheed power accumulator (Messier)	1,300
Inflation pressure Lockheed power accumulator (Dowty)	1,850
Lockheed cut-out operation	2,000
Line pressure (Messier system, Messier pump)	2,250
,, ,, (Dowty system)	2,400
,, ,, (Messier system, Lockheed pump)	2,500
Pressure limiting valve setting (Messier pump)	2,500
Pressure limiting valve setting (Lockheed pump)	2,800

PART VI

LOCATION OF CONTROLS AND ILLUSTRATIONS

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Port side of cockpit	„ 4
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Messier hydraulic system circuit diagram (Lockheed pump)	„ 6
Dowty hydraulic system diagram (Mark V)	„ 7
Parachute exits and emergency equipment	„ 8

PART VI

ILLUSTRATIONS AND LOCATION OF CONTROLS NOT ILLUSTRATED

LOCATION OF CONTROLS

Aircraft controls

Aileron locking gear	Bag on starboard side aft of armour plate door, or just forward of rear spar.
Rudder and elevator locking gear	Bag on port side of rear fuselage forward of rear turret.
Flaps isolating cocks (Mark II only)	Under flaps accumulators aft of rear spar.
Undercarriage mechanical up-locks release	Above rest seats.

Fuel system

Master engine cocks	Bulkhead aft of first pilot.
Crossfeed cock	Aft face of rear spar.
Wing crossfeed cocks	Aft face of rear spar (early aircraft) or forward end of rest seats.
Tank selector cocks	Under rest seats (early aircraft) or forward end of rest seats.
Long-range fuel transfer cocks	Aft face of front spar.
Fuel pressure warning lights	Top of engineer's panel, on later aircraft duplicated at rest station
Priming pump	Rear of each undercarriage fairing.
Nitrogen fire protection valve (if fitted)	Port side of fuselage at rest station.

Engine controls

Air-intake heat control	Port side of fuselage forward of front spar.
Engine starting switches	Bulkhead aft of first pilot.

Electrical controls

GROUND/FLIGHT switch (if fitted)	Starboard side of fuselage, engineer's station.
Electrical control panel (fuses, generator warning lights, voltmeter)	Right hand side of W/T operator's station.
Ground battery connection	Starboard side of fuselage just below leading edge.

Operational equipment

Heating controls	On ducts aft of front spar.
Oxygen main valve	Engineer's station
Bomb doors isolating cocks (Mark II only)	Under bomb doors accumulator on port side aft of front spar.
Bomb doors selective closing cock	Rear of pilot's bulkhead.
Bomb selector switchbox	Bomb aimer's station.
Recon. flares	Opposite main entrance door.
Signal pistol	Roof of fuselage aft of pilot's bulkhead.
Signal pistol cartridges stowage	Rear face of bulkhead

Emergency equipment

Hydraulic handpump	On front face of front spar.
Undercarriage emergency cock (Mark II only)	Front face of front spar.
Bomb doors emergency cock (Mark II only)	Front face of front spar.
Flaps emergency air release valve (Mark V only)	Aft face of front spar (starboard valve).
Bomb doors emergency air release valve (Mark V only)	Aft face of front spar (port valve).
Dinghy manual release	Near roof escape hatch aft of rear spar.
Crash axe	Starboard side of fuselage opposite entrance door.
First-aid equipment	Two on port side of rear fuselage. One on starboard side in the nose.
Portable oxygen sets	At all crew stations and rest station.

KEY TO *Fig. 1*

INSTRUMENT PANEL

1. Camera warning light
2. Pilot's oxygen flowmeter
3. D.R. compass repeater
4. Flaps indicator
5. A.R.I. destruction switches (under cover)
6. Beam approach visual indicator
7. Bomb steering indicator
8. Instrument flying panel
9. Boost gauges (four)
10. Suction gauge
11. Landing lamps switch
12. D.F. indicator
13. Engine speed indicators (four)
14. Bomb jettison handle
15. Bomb doors warning lights (three)
16. Suction change-over cock
17. Special troop signalling lamps
18. Throttle friction adjuster lever
19. Brakes and supply pressure gauge
20. Landing lamps dipping lever
21. Pilot's bomb-firing switch
22. Starboard engines ignition switches
23. Undercarriage indicator
24. Port engines ignition switches
25. Undercarriage indicator switch (deleted on later aircraft)
26. Horn warning light
27. Air temperature gauge
28. Auto-controls pressure gauge

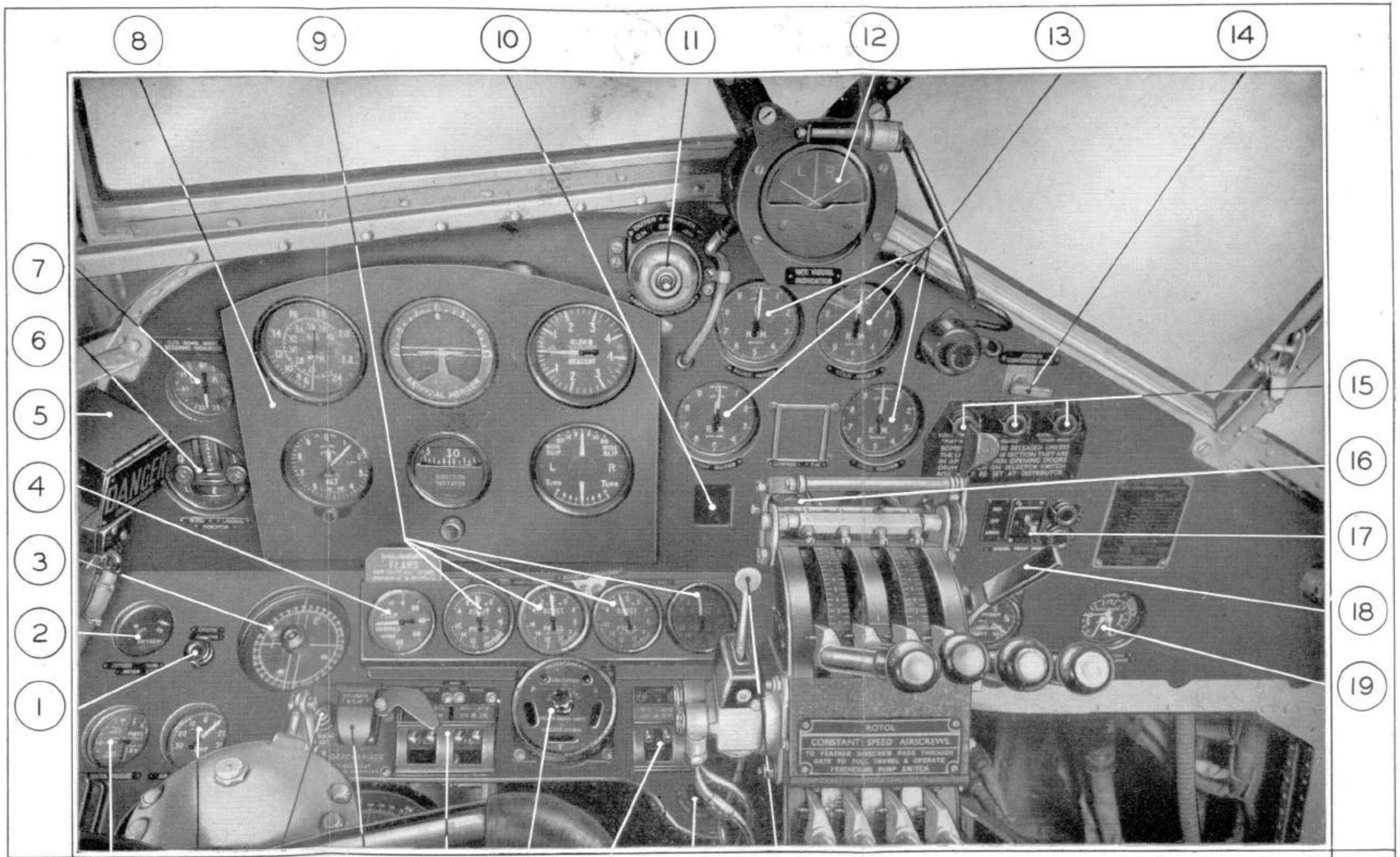


FIG 1 INSTRUMENT PANEL FIG 1

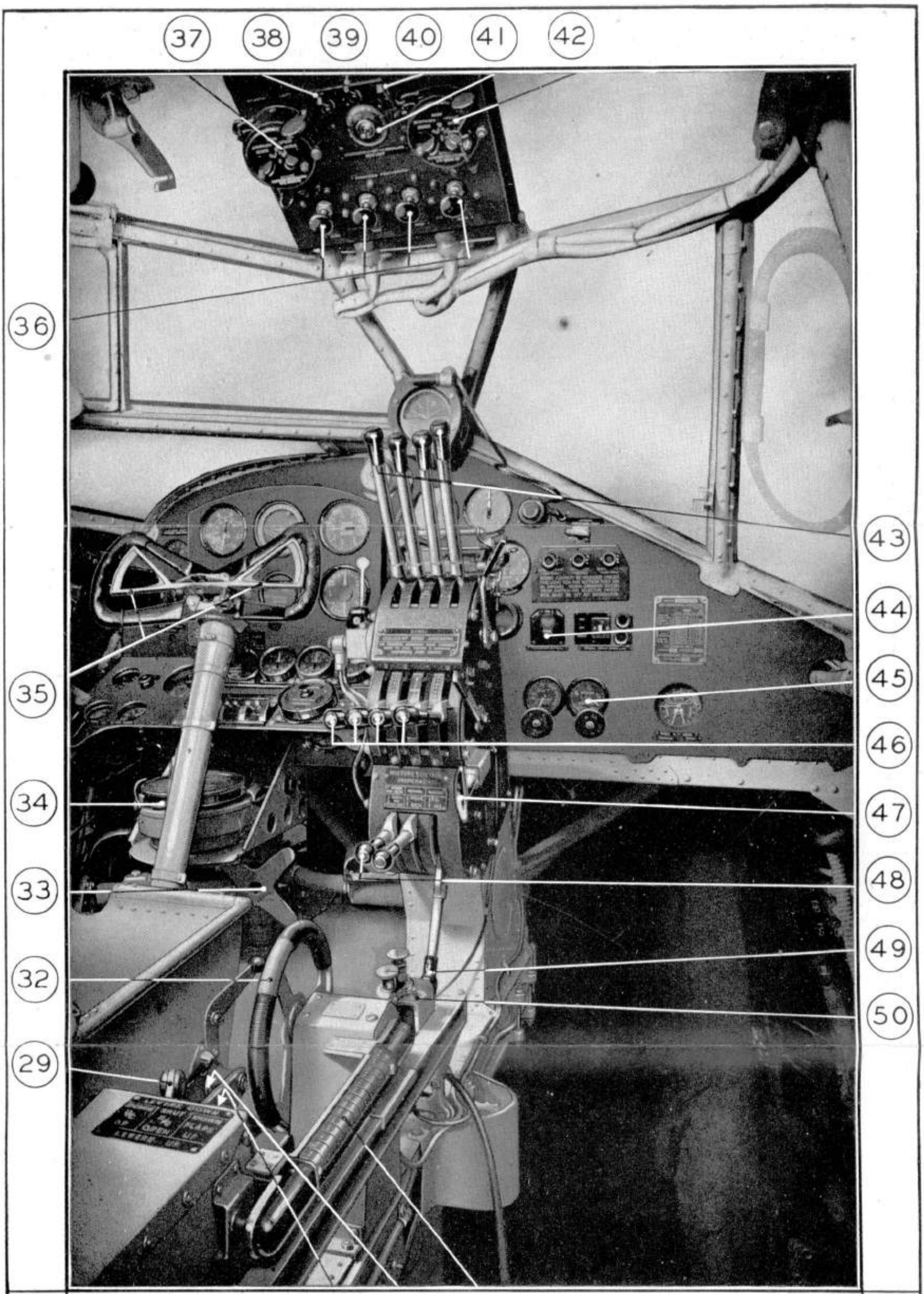


FIG 2 GENERAL VIEW OF CABIN FIG 2

KEY TO *Figs. 2 and 3*

29. Undercarriage lever
30. Bomb doors lever
31. Flaps lever
32. Elevator trimming tab control
33. Rudder adjusting starwheel
47. Glider release control
48. Boost control cut-out.
49. Superchargers control.
50. Windscreen de-icing pump
51. Elevator trimming tabs indicator

34. Compass
35. Wheel brakes levers
36. Feathering buttons (four)
37. Recognition lights switchbox
38. Fuel contents gauges switch
39. Navigation lamps switch
40. Pressure-head heater switch
41. Head-lamp switch
42. Formation keeping lights switchbox
43. Throttle control levers (four)
44. Bomb containers jettison switch
45. Oxygen regulator
46. Propeller speed control levers (four)
52. Oil dilution pushbuttons (under covers)
53. Starting magneto switches (four)
54. Radiator shutters controls (four)
55. Radiator temperature gauges (four)
56. Oil pressure gauges (four)
57. Fuel contents gauges (eight)
58. Fuel pressure warning lights (four)
59. Oil temperature gauges (four)
60. Fuel contents gauges (four)
61. Fuel transfer pump switches (three)
62. Fire extinguishers
63. Fuel transfer pumps ground testing buttons (three)

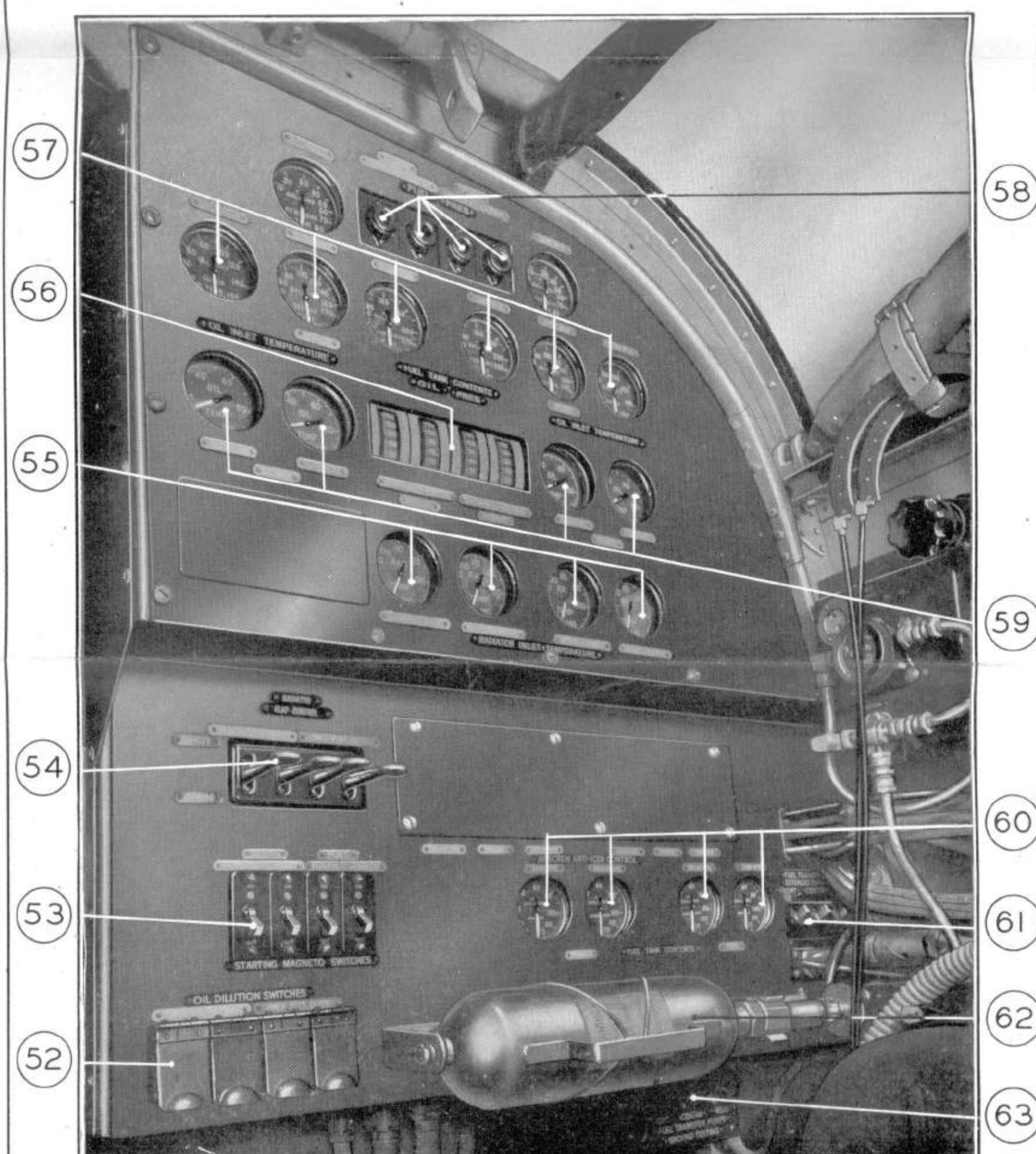
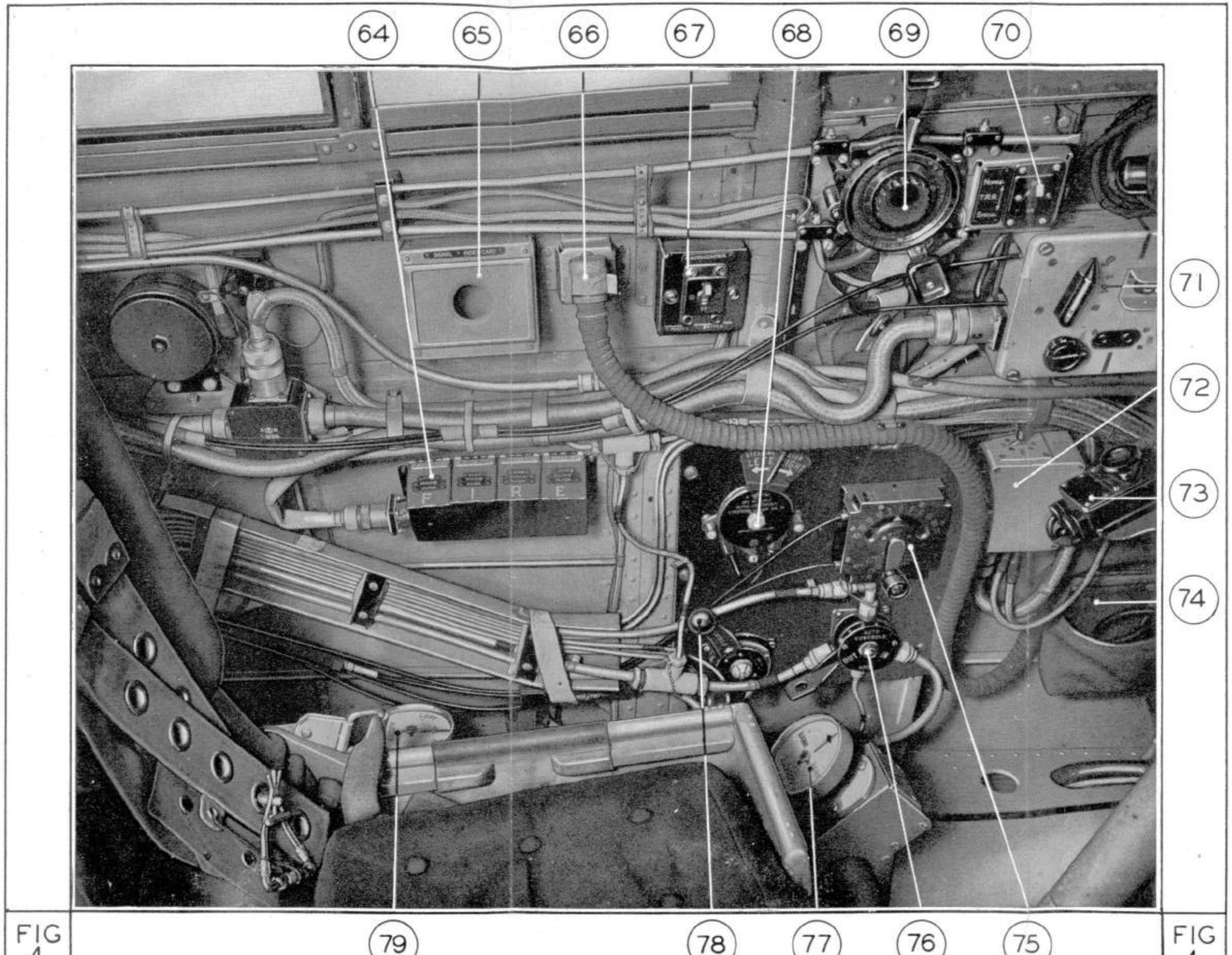


FIG 3 FLIGHT ENGINEER'S PANEL FIG 3



PORT SIDE OF COCKPIT

KEY TO *Fig. 4*

COCKPIT—PORT SIDE

64. Fire-extinguisher pushbuttons (four)
65. Signal index card holder
66. Pilot's oxygen connection
67. Auto-controls master switch
68. Auto-controls steering lever
69. T.R.9 control
70. T.R.9. NORMAL/SPECIAL switch
71. Beam approach control unit
72. Beam approach mixer box
73. Pilot's call light
74. Heater socket stowage
75. Auto-controls attitude control
76. Auto-controls control cock
77. Aileron trimming tab control
78. Auto-controls clutch control
79. Rudder trimming tabs control

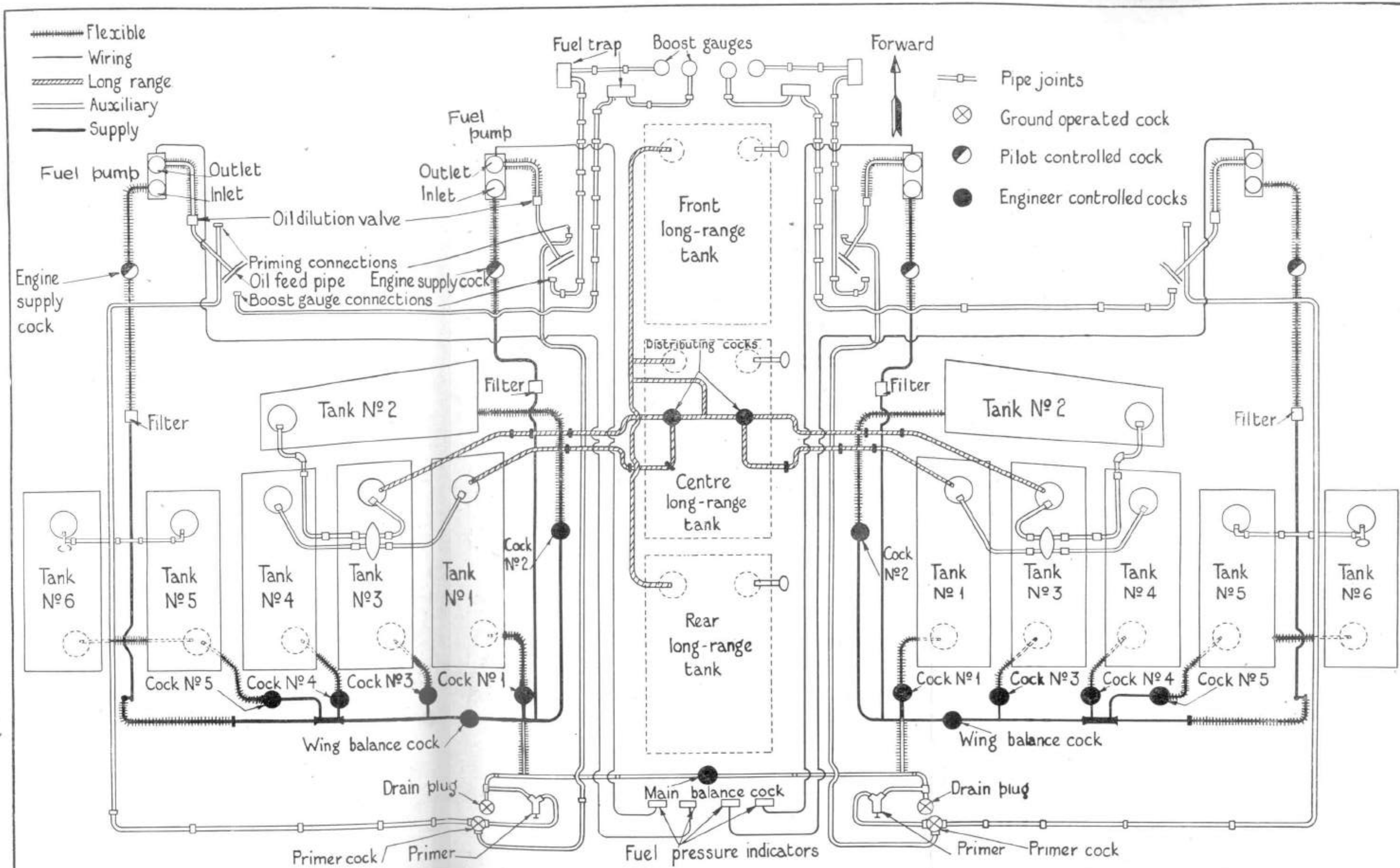


FIG. 5 FUEL SYSTEM DIAGRAM

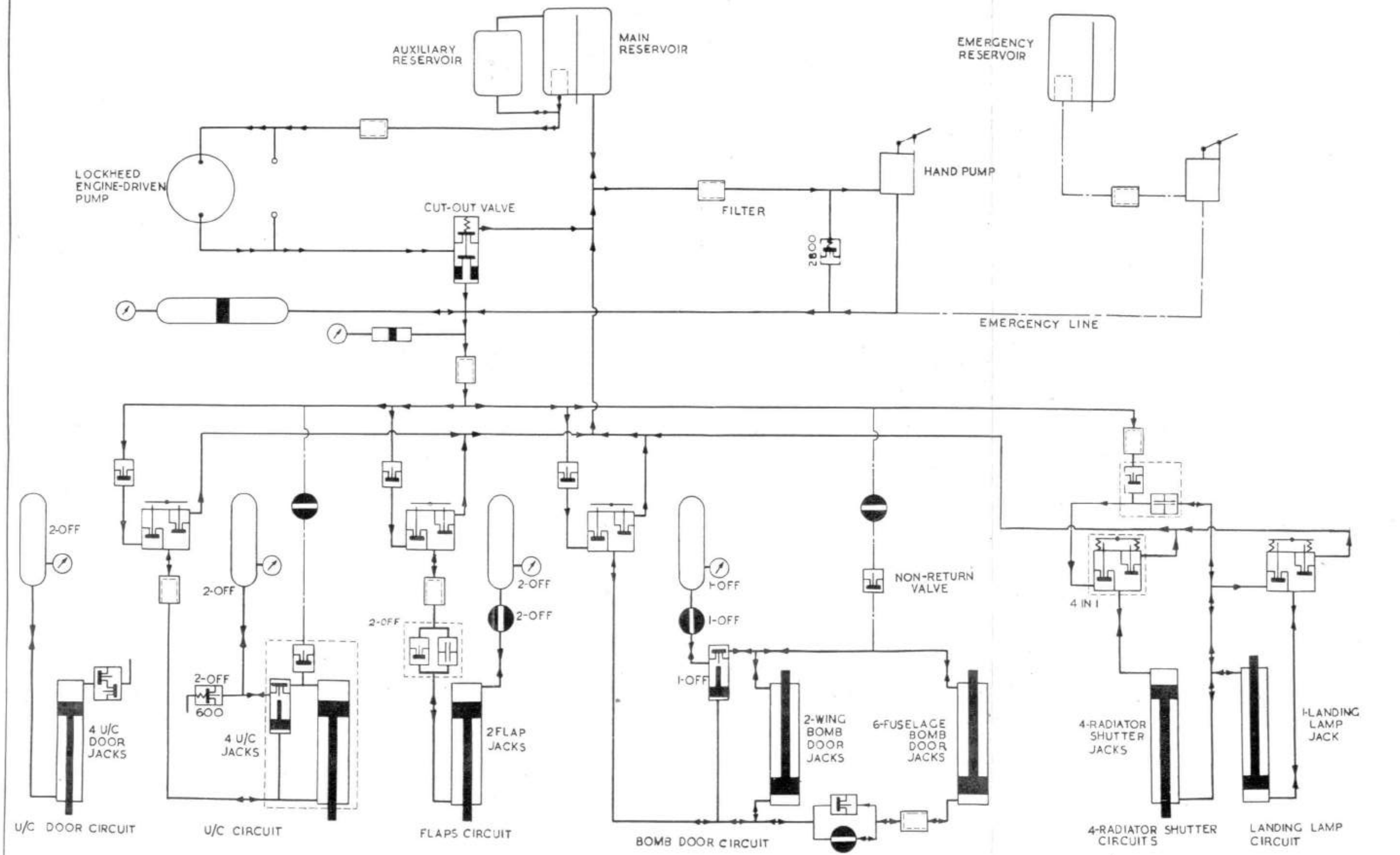


FIG. 6 MESSIER HYDRAULIC SYSTEM CIRCUIT DIAGRAM (LOCKHEED PUMP) FIG. 6

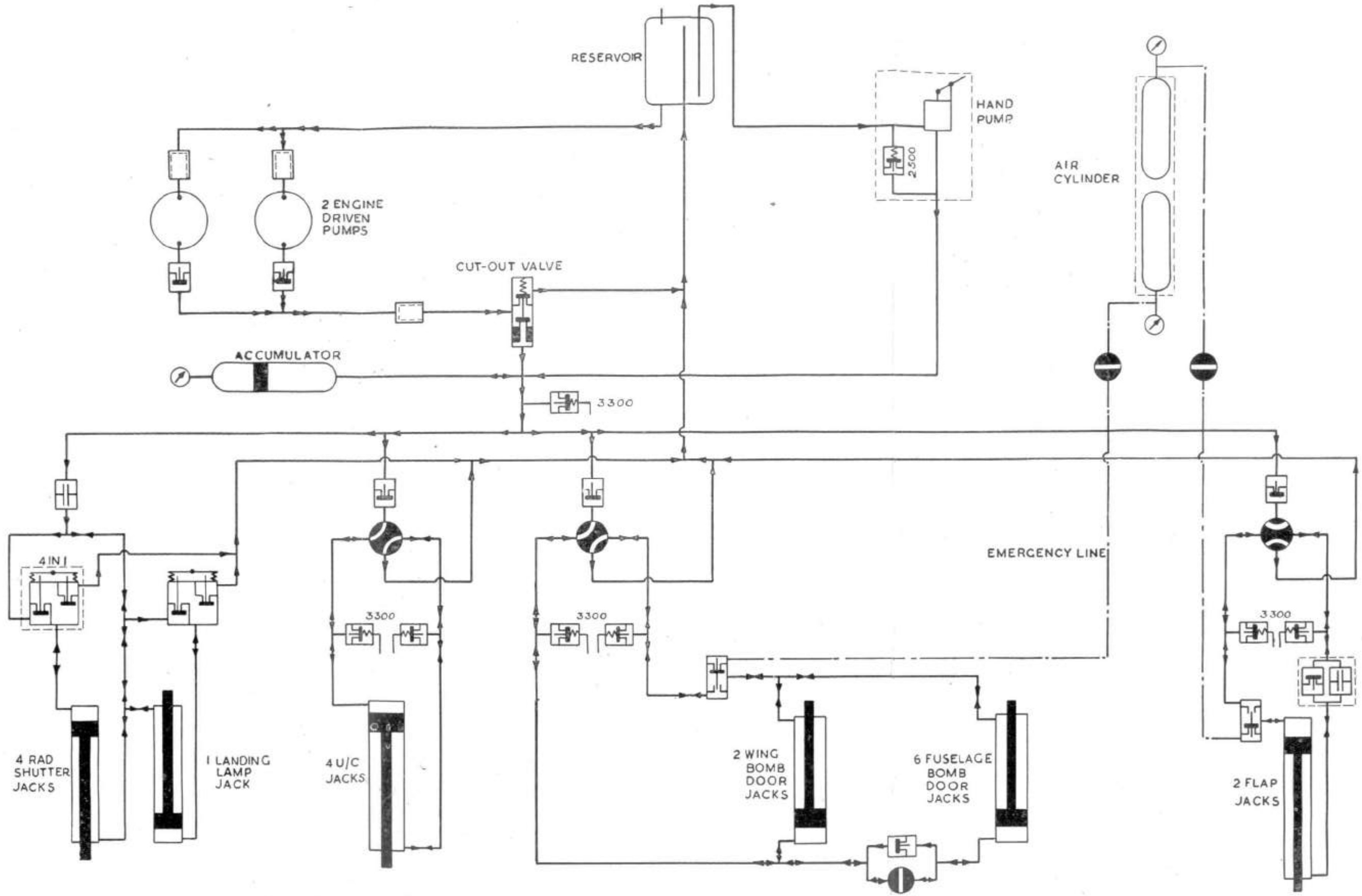


FIG. 7 DOWTY HYDRAULIC SYSTEM DIAGRAM (MARK V) FIG. 7

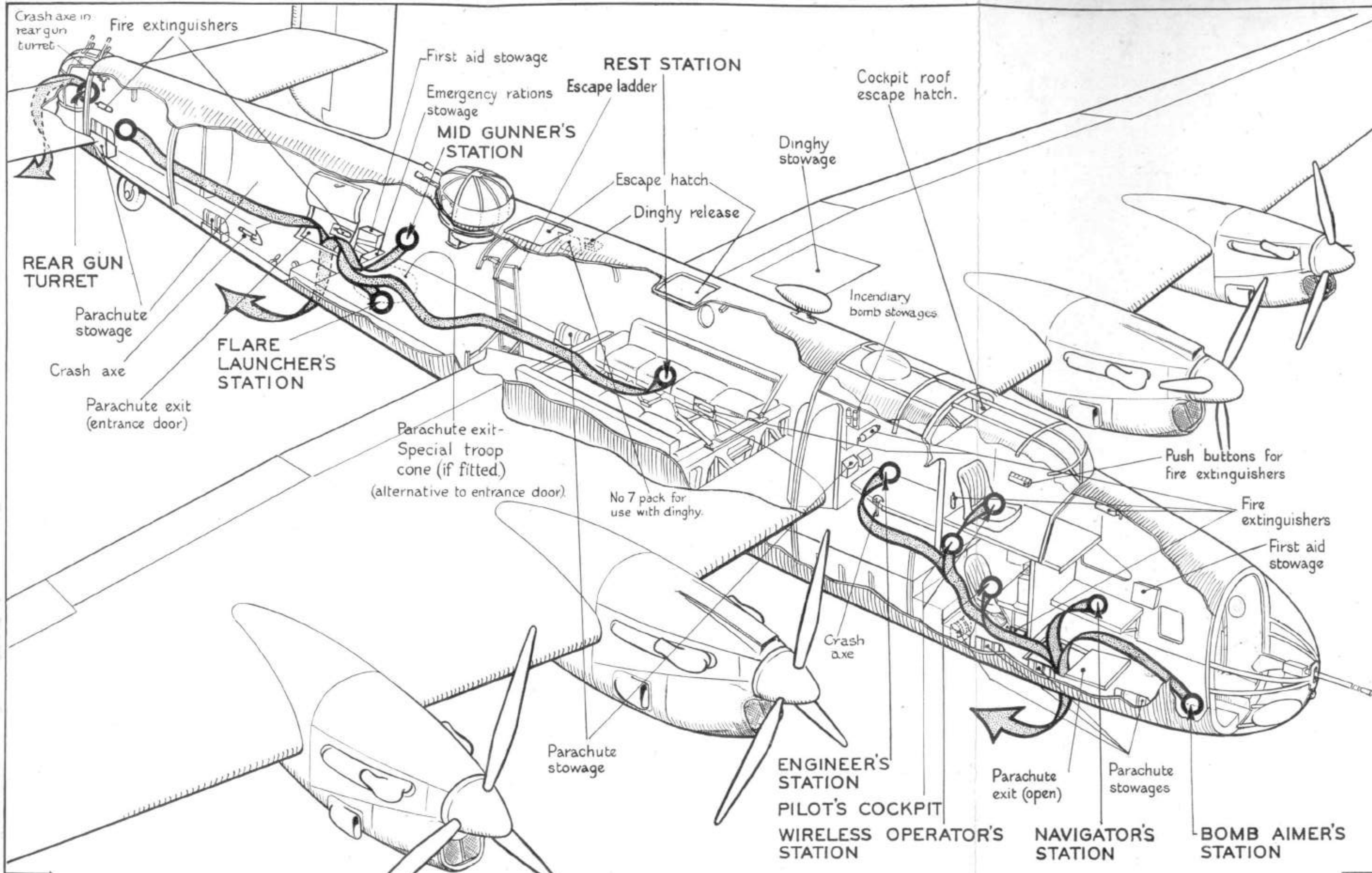


FIG. 8 PARACHUTE EXITS AND EMERGENCY EQUIPMENT FIG. 8

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These are being listed for the benifit for people interested in British or Commonwealth Aircraft

While it did cost me a great sum of money to aquire these documents, all I ask in return is some credit.

~JimSan