A.P. 1719C & G.—P.N.

PILOT'S
AND
FLIGHT ENGINEER'S
NOTES

HALIFAX III & VII

FOUR HERCULES VI or XVI ENGINES

PROMULGATED BY ORDER OF THE AIR COUNCIL

RESTRICTED
(FOR OFFICIAL USE ONLY)

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.

A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
1	Incorporated in this Reprint		7		
2			8		
3			9		
4			10		
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.

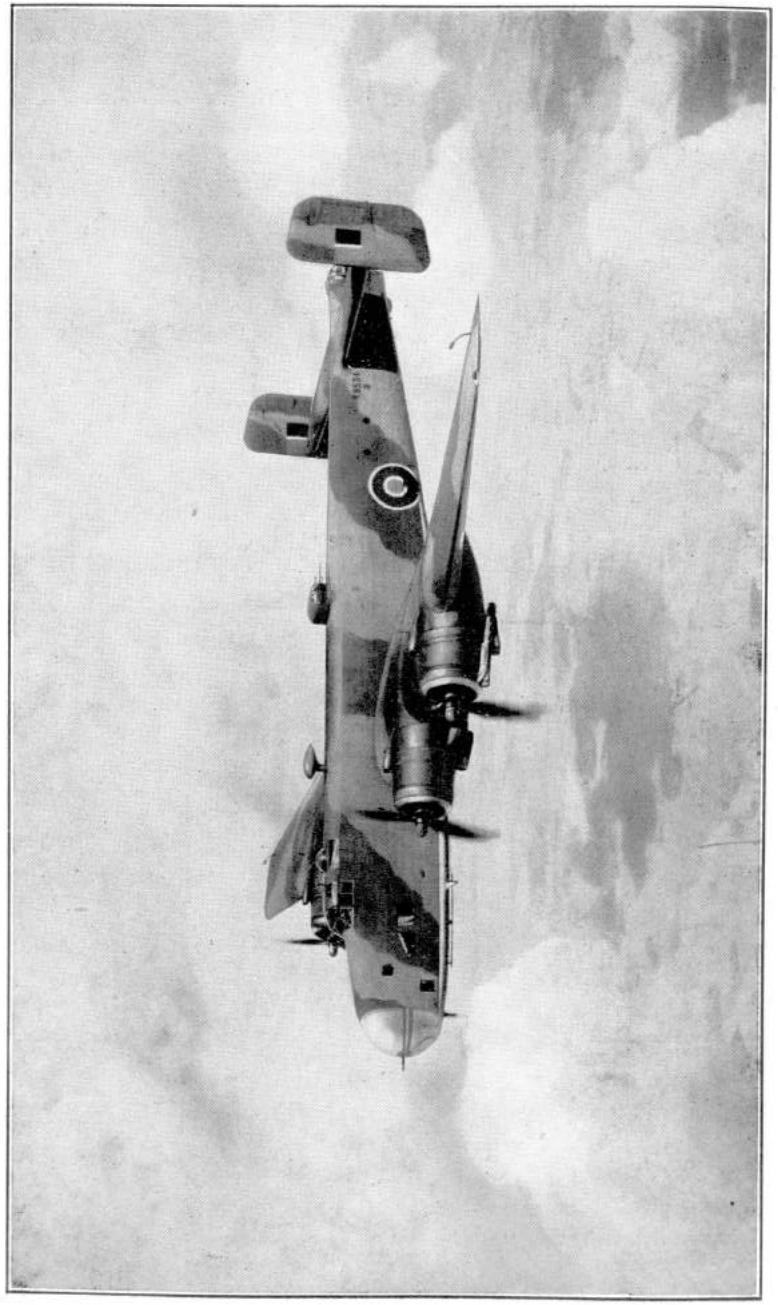
These Notes are complementary to A.P. 2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (*see* A.M.O. A93/43). Flight engineers should also have a copy of A.P. 2764 to be issued shortly in provisional form.

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

A.L.4 Notes to Users

Additional copies may be obtained by the station publications officer by application on Form 294A, in duplicate, to Command Headquarters for onward transmission to A.P.F.S., 81 Fulham Road, S.W.3 (*see* A.M.O. A.1114/44). The number of this publication must be quoted in full—A.P. 1719C and C—P.N.

Comments and suggestions should be forwarded through the usual channels to the Air Ministry (D.T.F.).



HALIFAX III

AIR MINISTRY
March 1944
(*Reprinted: October* 1944)

AIR PUBLICATION 1719C & G—P.N.
Pilot's and Flight Engineer's Notes

PILOT'S & FLIGHT ENGINEER'S NOTES HALIFAX III

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PART I—DESCRIPTIVE

PART I

DESCRIPTIVE

A.L.4 Part I Introduction

INTRODUCTION

The Halifax Mks. III and VII are heavy bombers powered by four Hercules VI or XVI engines driving 3-bladed fully-feathering hydromatic propellers. The Mk. VII is basically similar to the Mk. III, but has a re-designed fuel system, extended wing tips and servo tab ailerons.

FUEL AND OIL SYSTEMS

Mark III only

1. **Fuel Tanks.**—Fuel is carried in twelve self-sealing tanks. The capacities are:

2—No. 1 inboard tanks	.. 247	galls. each
2—No. 2 inner-wing nose tanks	.. 62	,,
2—No. 3 centre tanks	.. 188	,,
2—No. 4 outboard tanks	.. 161	,,
2—No. 5 outer engine tanks	.. 122	,,
2—No. 6 outer engine tanks	.. 123	,,

Each No. 5 tank is connected to the adjacent No. 6 tank so that tanks Nos. 5 and 6 together may be considered as one tank containing 245 gallons of fuel. Provision is made for the following auxiliary tanks:

(i) One, two or three self-sealing tanks of 230 gallons each, carried in the fuselage bomb bay.

(ii) Two self-sealing tanks of 96 gallons each, carried in the outer bomb compartments, one in each wing.

(iii) Two tanks for exceptional long-range operations may be fitted port and starboard on the rest seats in the centre fuselage.

A nitrogen fire protection system for all tanks is to be 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 be fully opened before any petrol is used. No further attention is necessary.

2. **Fuel cocks**

(i) The supply to each engine can be shut off by the master engine cock controls 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. The cock-control levers are fitted on the forward end of the rest seats.

(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; thus with these cocks 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. All cross-feed cocks should be kept closed at take-off and when the aircraft is over the target. The port and starboard cross-feed cock controls are mounted on the forward end of the rest seats, and the cocks should be opened only when it is necessary to feed two engines from one tank.

(iv) The distributing cocks for the three fuselage bomb-bay tanks are mounted under the step aft of the front spar. There are no cocks for the wing bomb-bay tanks, but where Mod. 981 has not been embodied, the fuselage bomb-bay distributing cocks must be set to No. 3 tanks before transferring fuel from the wing bomb-bay tanks.

3. **Immersed pumps.**—An immersed pump is fitted in each of the five auxiliary tanks. The pumps in the fuselage tanks transfer fuel to tanks Nos. 1 or 3, whichever is

selected, and the pumps in the wing bomb-bay tanks transfer fuel direct into tank No. 1. The switches to the pumps are under the control of the flight engineer.

4. **Fuel contents gauges.**—Gauges for tanks Nos. 1, 2, 3, 4, 5 and 6 (and the wing long-range tanks if fitted) are mounted on the engineer's panel. The contents gauges are direct reading and a circuit switch is mounted beside them. The fuel pressure warning lamps are mounted on the engineer's panel and duplicated at the fuel cock controls on the rest seats.
The fuselage bomb-bay tanks are fitted with direct reading contents gauges visible through the bomb-bay hatches in the fuselage floor.

5. **Fuel priming pumps.**—A priming pump together with carburettor and cylinder priming cocks is mounted on a panel at the rear of each undercarriage fairing and serves both engines on one side.

6. **Oil system**

(i) Two self-sealing oil tanks mounted in the nose portion of the intermediate wing on both sides serve the inner and outer engines. The outboard tanks contain 32 galls. of oil with 10 galls. air space, and the inboard tanks 39 galls. of oil with 5 galls. air space.

(ii) Four oil dilution switches (62) are fitted, adjacent to the engine starting switches (55) on the engineer's panel.

MAIN SERVICES

7. **Hydraulic system (Messier)**

(i) A Lockheed pump fitted on the starboard inner engine supplies power to feed the following services:

Undercarriage (and tailwheel on later aircraft)
Flaps
Bomb doors
Air-intake
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 (i.e. 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 air-intake and landing lamp circuits differ from the main circuits in that the pump operates the jacks in both directions.

IMPORTANT NOTE.—The undercarriage, flaps or bomb door levers, after having been operated, should be returned to the " neutral " position 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 at all times when the undercarriage is down, and the bomb doors lever should be operated on the descent as described in para. 28.

(ii) An hydraulic handpump is provided on the front spar on the port side of the fuselage, and should be used to operate the system through the normal pipe-lines and controls, when the engine-driven pump is not working.

(iii) Emergency circuits operated by the engineer are provided to lower the undercarriage and open the bomb doors. Control is effected by means of emergency cocks mounted on the front face of the front spar, and these cocks when opened, allow the engine-driven pump or handpump to perform the functions normally carried out by the accumulators.

8. **Pneumatic system.**—A Heywood compressor for operating the wheel brakes, and an R.A.E. compressor for operating the automatic pilot are mounted on the port inner engine. The R.A.E. compressor also works the computor for the Mark XIV bomb sight so that if the bomb sight is in use the gyro of the automatic pilot must be set to OUT. A Pesco vacuum pump on the port inner engine supplies the instrument flying panel, and

another Pesco pump on the starboard inner engine operates the Mark XIV bomb sight. A suction gauge (10) and a change-over cock (16) marked NORMAL and EMERGENCY is mounted on the instrument panel, and the starboard pump can be used for the instrument flying panel by setting the change-over cock to EMERGENCY, but in this event the Mark XIV bomb sight cannot be used.

9. **Electrical system.**—Three 1,500-watt generators, driven by the port outer and both inner engines are connected in parallel and feed two 24-volt, 40-amp. hr. batteries for supplying the usual electrical services, cowling gill motors and dorsal and rear gun turrets. An AC generator driven by the starboard outer engine supplies current for the special radio installations. A GROUND/FLIGHT switch is fitted on the starboard side of the fuselage at the flight engineer's station.

AIRCRAFT CONTROLS

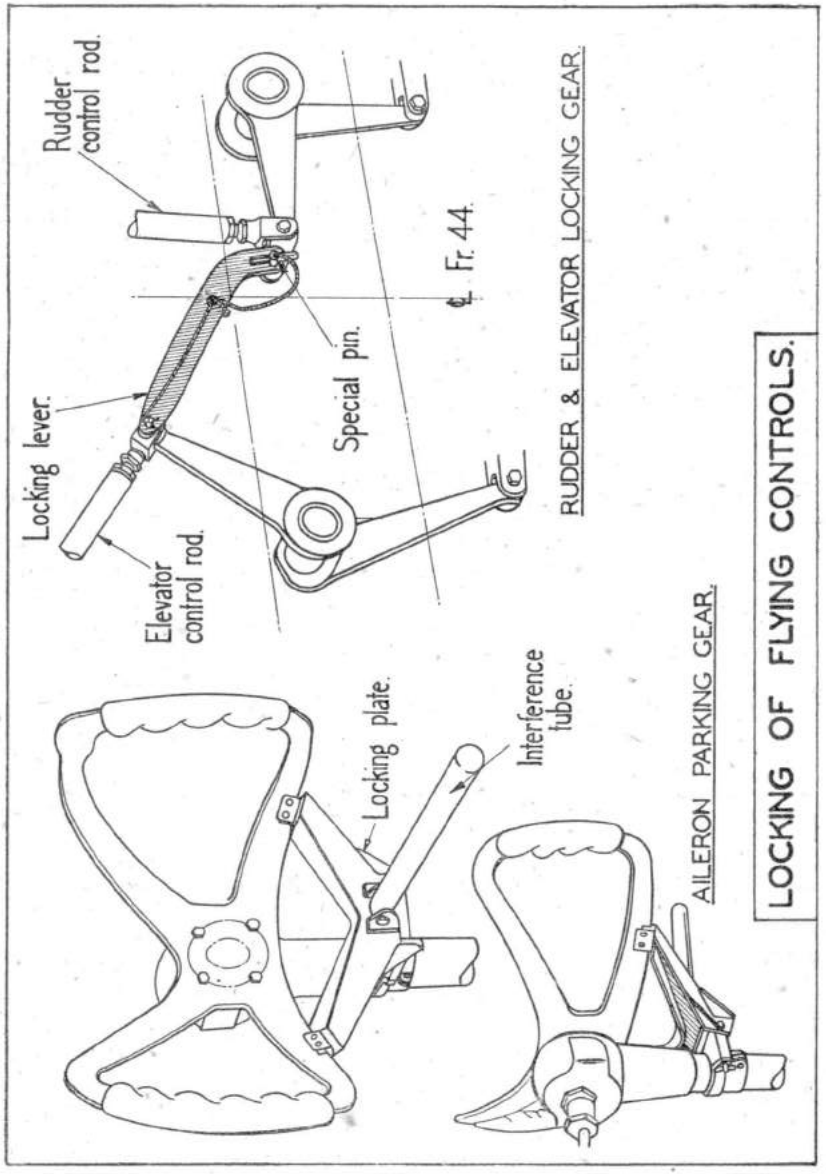
10. **Flying controls**

(i) The dual controls are not a permanent fitment but conversion sets are supplied and 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 adjustment can be made by a foot-operated centrally placed starwheel (33).

A.L.4 Part I Para. 11

11. **Locking of flying controls** (*see* page 11).—Before attaching the locking gear, the controls should be moved to the neutral position. The aileron control should be locked by applying the special locking plate to the first pilot's handwheel 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 hinders access to the seat before the aileron controls are unlocked. The locking gear must never be attached to the second pilot's control column. 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.

A.L.3 Part I Para. 12 (i)

12. **Trimming tabs**

(i) The trimming tab controls (77 & 79) for the starboard aileron and rudder are on the left-hand side of the cockpit and work in the natural sense. These controls have been raised a few inches on Mark VII aircraft and are more conveniently placed.

(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.

13. **Automatic pilot.**—The controls include main switch (68), clutch lever (78), control cock (76), attitude control (75), and steering control (69) 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.)

A.L.2 Part I Para. 14

14. **Undercarriage controls.**—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 of the pilot's seat. A " neutral " position is provided and after raising the undercarriage, the lever should be returned to this position. For raising the undercarriage the lever is pulled up. The flight engineer has mechanical up-locks under his control, one on each side of the fuselage above the rest seats. These must be engaged at all times when the undercarriage is retracted except during local flying and must be pulled out before the undercarriage is lowered. The control 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 through the " neutral " 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.

15. **Undercarriage indicators.**—A single instrument (23) on the pilot's sloping panel indicates whether the undercarriage or tailwheel is unlocked or locked in the down position. A control knob in the centre of the instrumen enables the lamps to be dimmed for night flying and may also be used to bring a duplicate set of lamps into operation in the event of breakage.

The operation of the instrument is as follows:

Upper lamps—red	Unlocked positions
Lower lamps—green	Locked down position
No lamps	Undercarriage up and mechanical up-locks engaged

16. **Undercarriage warning horn.**—A horn on the port side of the cockpit sounds to warn the pilot when any throttle is closed two-thirds or more and the undercarriage is not locked down.

17. **Flaps control.**—The control (30) for operating the flaps is the shorter (starboard) 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.

In emergency the flaps can be raised by use of the hand-pump. An isolating cock is fitted between the flaps hydraulic accumulator and the jacks, and is closed by the flight engineer when the flaps are not in use. If this isolating cock is not closed and one of the hydraulic pipe-lines is damaged, the flaps will immediately lower under the accumulator power which is thereby released.

18. **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.

19. **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

20. **Throttle controls.**—Three positions are marked in luminous paint on the throttle quadrants, viz. ECB (weak mixture cruising boost) and RB (climbing boost), and another line indicating the mid-position between these two settings. The rear faces of the throttle levers are also marked with a luminous line. 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.

21. **Mixture control**

(i) Where Hercules VI engines are fitted, a lever mounted in the centre of the bottom tier of the engine control box controls the mixture. The WEAK setting is the upper position and the RICH setting the lower position.

(ii) Where Hercules XVI engines are fitted the lever is inoperative and should be wired. Weak mixture is obtained with the throttle lever up to the ECB position and rich mixture with throttle lever more than 4° forward of this. Excessive cylinder temperatures may occur if the positions between these are used. When climbing

at high altitudes, the mixture strength at the RB setting is too rich, resulting in loss of power. The position midway between RB and ECB gives a mixture suitable when boost has fallen to + 3 lb./sq.in.

22. **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, and downwards to decrease the engine revolutions. A friction lever similar to the one described in para. 20 is fitted on the starboard side of the control box.

23. **Two-speed supercharger controls.**—A single lever (49) for the four superchargers is situated on the starboard side of the mixture control lever in the bottom tier of the control box. The upper position of the lever is for HIGH gear and the lower position for LOW gear.

24. **Carburettor air-intake heat control.**—The control lever is on the port side of the mixture control lever in the bottom tier of the engine control box. The lever has two positions marked HOT AIR and COLD AIR. The COLD AIR position should always be used unless the intake becomes iced up.

25. **Cowling gill controls.**—The gills are controlled electrically, the gill motor switches, warning lights which show when the gill motors are operating, and the gills indicators are mounted together on the flight engineer's lower instrument panel.

26. **Slow-running cut-outs.**—These are operated by closing the pilot's master engine cocks.

27. **Ignition and starting controls.**—The ignition switches are on the pilot's instrument panel; the booster coil and engine starting pushbuttons are on the flight engineer's panel.

OPERATIONAL CONTROLS AND EQUIPMENT

28. **Bomb doors control.**—The control (31) for operating the bomb doors is the longer (port) of the two levers on the hydraulic control box mounted between the two pilot's seats aft of the elevator trimming tab controls.

It is beside the lever operating the flaps but works in the opposite sense; when the lever is moved to the up position the bomb doors open. A "neutral" position is provided for the lever, and after the bomb doors have been opened or closed the lever must be returned to this position. An isolating cock is fitted between the bomb doors accumulator and the jacks. If this isolating cock is not closed and the hydraulic pipe-lines 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. In addition, a selective-closing valve (located on the rear of the pilot's bulkhead) also operated by the flight engineer, is incorporated in the bomb doors circuit. When this valve is closed the bomb doors may be opened in the normal manner, but the fuselage bomb doors cannot be closed again. The valve is normally left open and is only closed when large bombs are carried, which necessitate the fuselage bomb doors remaining partially open. In the latter case the bomb doors are partially closed by using the handpump before the engines are started, and then the selective-closing valve is closed and *must not* be opened until after the large bombs have been released.

NOTE.—On aircraft where Mod. 1085 is not incorporated, in order to relieve the pressure built up due to thermal expansion of hydraulic fluid on descending to warmer air after operating bomb doors over the target, the bomb doors lever should be momentarily operated 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 to neutral.

29. **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. 61.)

30. **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.

31. **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.

32. **Landing lamp control.**—The selector lever (20) for operating the landing lamp is mounted on the left-hand side of the throttle control box. The lever is normally in a central position and must be held in the down or up position until the landing lamp reaches the desired angle. The hydraulic circuit is operated in both directions by the engine-driven pump, but if necessary can be operated by the handpump.

PART II

HANDLING INSTRUCTIONS

NOTE.—All speeds quoted are for aircraft with the static side of the pilot's 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.

33. **Management of fuel system** (Mark III only. For Mark VII *see* Fig. 7)

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, it will then suck air and cause the engine to cut. Should the wing crossfeed cock be open, the other engine will also cut.

(*c*) All crossfeed cocks should remain closed at take-off and also when the aircraft is over the target. 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. As the fuel pressure warning lights are not visible to the pilot,

the flight engineer must inform him as soon as the lights show so that the relevant engine(s) may be throttled back before the tank change is made: re-open throttle(s) slowly after change-over. A tank should never be drained when flying below 3,000 feet, and tank changes should as far as possible be avoided below this height.

(*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 reassessed in the event of any of the fuel transfer pumps failing.

(*f*) No. 2 tanks should not be used for take-off or landing.

(*g*) 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.

(*h*) Specimen schedule of tank changes

Six wing tanks—1,806 galls.

	Tank contents at change					
	1	2	Cross-feed cock	3	4	5 & 6
Take-off on 1 and 3	247	62	closed	188	161	245
Use 80 galls. Change to 5 & 6	167	62	open	108	161	245
Use 220 galls. Change to 1 and 4	167	62	close	108	161	25
Use 60 galls. Turn off 1	107	62	open	108	101	25
Use 50 galls. Change to 2 and 5 & 6	107	62	close	108	51	25
Drain 5 & 6. Turn on 4	107	37	closed	108	51	0
Drain 2. Change to 1 and 3	107	0	closed	108	14	0

Six wing tanks and one fuselage tank—2,036 galls.

	Tank contents at change						
	Fuse-lage	1	2	Cross-feed cock	3	4	5 & 6
Take-off on 1 and 3	230	247	62	closed	188	161	245
Use 80 galls. Change to 5 & 6	230	167	62	open	108	161	245
Pump fuselage tank into 1 until full and remainder into 3 while using 220 galls. from 5 & 6. Change to 1 and 4	0	247	62	close	143	161	25
Use 120 galls. Change to 2 and 5 & 6	0	127	62	closed	143	41	25
Drain 5 & 6. Change to 4	0	127	37	closed	143	41	0
Drain 2. Change to 1 Drain 4. Change to 3	0	86	0	closed	102	0	0

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34. Preliminaries

(i) Before entering the aircraft, check:
Pitot head cover off
Visual check for oil and fuel leaks
Cowlings secure
Tyres for cuts and creep: oleo legs for even compression
Undercarriage accumulator pressure (250 lb./sq.in. minimum).

(ii) On entering the aircraft check:
All loose equipment stowed
Turrets central and engaged
All controls unlocked; locking gear stowed
GROUND/FLIGHT switch to FLIGHT
Indicators and lights
Tailwheel accumulator pressure (250 lb./sq.in.)
Flaps accumulator pressure (600 lb./sq.in. flaps up)
" " " (400 lb./sq.in. flaps down)
Flaps isolating cocks unscrewed
Up-locks disengaged and clips secured

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Bomb-doors accumulator pressure (1050 lb./sq.in. doors closed)
" " " (700 lb./sq.in. doors open)
All crossfeed cocks OFF
Fuel contents
Nitrogen valve on (if fitted)

(iii) Before starting engines, check:
Flaps up and landing lamp retracted
Undercarriage lever down, and flaps and bomb door levers neutral
Brake pressure: brakes on
Flying controls
Oxygen capacity and flow
Test visual call light system

35. Starting engines and warming up

(i) The engine starting and booster coil switches, gills, temperature gauges, pressure gauges and indicators 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 plugged in and GROUND/FLIGHT switch turned to GROUND: turn on master engine cocks and instruct flight engineer to turn ON tanks 1 and 3.

Set engine controls as follows:

Throttles	Just off rear stops
Mixture control (if fitted) ..	Down
Propeller	Fully up
Superchargers	M ratio
Air-intake heat control ..	COLD AIR
Gills	OPEN

(iii) Have each engine turned slowly by hand for at least two revolutions, to avoid the danger of hydraulicing.

(iv) Switch on the ignition, and press the starter and booster coil buttons. Turning periods must not exceed 20 seconds with a 30 seconds wait between each. The ground crew will work the priming pump while the engine is being

A.L.3 Part II Para. 35(iv)

turned: it should start after the following number of strokes if cold:

Air temperature °C.	+30	+20	+10	0	−10	−20
Normal fuel	1	1	2	3		
H.V. fuel (Mark VII)				1	2	4

It will probably be necessary to continue priming after the engine has fired and until it picks up on the carburettor.

(v) When the engine is running satisfactorily, remove finger from the booster coil button. The ground crew will screw down the priming pump and turn off the priming cocks.

(vi) Open up each engine gradually to 1,000 r.p.m. and warm up at this speed.

(vii) DR compass to ON and SETTING.

(viii) Ground battery disconnected: GROUND/FLIGHT switch to FLIGHT.

36. Testing engines and installations

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising the flaps. Test each magneto as a precautionary check.

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.

(ii) Open up to 1,500 r.p.m.; exercise and check operation of two-speed supercharger. Oil pressure should drop momentarily at each change and r.p.m. should fall when S ratio is engaged. Return control to M ratio.

(iii) At +2 lb./sq.in. boost, check operation of constant-speed propeller. Return lever fully up.

(iv) Open throttle and check take-off boost and static r.p.m., which should be 2,800 at take-off boost. Throttle back until boost is below + 6 lb./sq.in. and a slight drop in r.p.m. is noted, then test magnetos by switching off each in turn. The additional drop in r.p.m. must not exceed 50.

NOTE.—It may be found that, although the drop in r.p.m. is hardly perceptible, undue rough running is experienced, in which case the ignition system should be checked.

37. Check list before taxying

Wheel brakes: Brake pressure (90 lb./sq.in.)
Supply pressure (200 lb./sq.in. minimum)

DR compass switches to ON and NORMAL

Auto-controls:	Switch ..	OFF
	Clutch ..	IN
	Gyro ..	OUT
Instrument flying panel	..	Check vacuum on each pump
Pitot-head heater switch	..	ON

38. Check list before take-off

T—Trimming tabs ..	Elevator: 2 divisions tail-heavy Rudder: neutral Aileron: neutral
M—Mixture control (if fitted)	Down
P—Propeller speed control	Fully up
F—Fuel	Engineer checks cock settings
F—Flaps	0°–35° down
Superchargers ..	M ratio
Gills	⅓ open
Air-intake	COLD AIR

A.L.2 Part II Para. 39 (i)

39. Take-off

(i) Open up to −2 lb./sq.in. boost against the brakes to see that the engines are responding evenly, then throttle back and release the brakes. Open the throttles slowly at first, then fully as the aircraft accelerates. There is a slight tendency to swing to starboard but the aircraft can be kept straight initially on the throttles, and, as the speed increases, by the rudders.

(ii) The tail comes up easily as speed develops. The forward force required on the control column is not large.

(iii) At 55,000 lb. the aircraft can be pulled off the ground at 95 (105) m.p.h. I.A.S.; at 63,000 lb. it can be pulled off at 100 (110) m.p.h. I.A.S.

(iv) Safety speed is 145 (155) m.p.h. I.A.S.

A.L.4 Part II Paras. 40 to 42

40. Climbing

(i) The initial speed for maximum rate of climb is 130 (140) m.p.h. I.A.S., at which speed gills must be fully open, but since at this speed if an outer engine fails, control can only be retained by throttling back the opposite outer, a climbing speed of 145–150 (155–160) m.p.h. I.A.S. with gills closed is recommended.

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

41. General flying

(i) *Stability.*—The aircraft is stable about all three axes at all speeds.

(ii) *Change of trim*

Undercarriage up	Slightly nose up
Flaps up	Slightly nose down
Bomb doors open	Slightly nose up

Both marks of aircraft display a considerable change of directional trim with changes of speed and power and the rudder trimming tab control should be used to trim out the heavy foot loads induced. On the Mk. VII there is, in addition, a change of lateral trim with changes of speed so that for " hands off " flight the aileron trimming tab control should be used as necessary.

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

(iv) *Controls.*—On the Mk. III all controls are moderately heavy. The heaviness increases with increase in speed. On the Mk. VII, the rudders and elevators are similar to those on the Mk. III, but the ailerons, which incorporate servo tabs, are light at low speeds, but increasingly heavy at speeds above 240 m.p.h. I.A.S.

(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 35°.

42. Stalling

(i) *Characteristics at the stall.*—There is a slight warning of the stall by a snatching of the ailerons occurring at about 5 m.p.h. above the stall. The stall is gentle and straight with no wing-dropping tendency; control is regained without difficulty on pushing the control column forward.

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

	at 46,000 lb.	55,000 lb.	65,000 lb.
Flaps and undercarriage up ..	96 (106)	105 (115)	112 (122)
Flaps and undercarriage down	74 (87)	85 (98)	92 (105)

A.L.3 Part II Paras. 42 (ii) to 44.

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

	46,000 lb.	55,000 lb.
Flaps and undercarriage up	96 (106)	105 (115)
" " " down ..	74 (87)	85 (98)
Flaps 30° down: undercarriage up ..	81	90

A.L.4 Part II Paras. 42 & 43

(iii) *Stalling in turns.*—On the Mk. III there is considerable warning of the approach of a stall in turns to the left, but in turns to the right there is negligible warning and at the stall the right wing drops sharply. Normal recovery action is effective in both cases, but must be applied immediately if the stall has occurred during a turn to the right to prevent the wing dropping further.
On the Mk. VII the stall in a turn in either direction is gentle and recovery is straightforward and easy.
It should be noted that the stalling speed will be increased in turns, e.g., under an acceleration of 2*g* (the acceleration imposed in a sustained 60° banked turn) the stalling speed at 55,000 lb. will be approx. 150(160) m.p.h. I.A.S. and at 60,000 lb. it will be approx. 160(170) m.p.h. I.A.S.

43. Diving

(i) The aircraft becomes increasingly tail heavy as speed increases and should, therefore, be trimmed into and during the dive. There is a strong tendency for the left wing to drop and for the aircraft to yaw to the left. This tendency can be counteracted on the Mk. III by the use of the rudder trimming tab alone, but on the Mk. VII the aileron trimming tab should be used as well. On both marks of aircraft retrimming is especially important if a type D tail turret and its associated equipment are fitted.

(ii) If a spiral dive is allowed to develop through failure to use the trimming tabs as described above, or following engine failure, recovery will be greatly simplified by throttling back the outer engine opposite to the spiral.

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

(ii) Reduce speed to 150 (160) m.p.h. I.A.S. and lower flaps 30°–40°; then reduce speed to 140 (150) m.p.h. I.A.S. and lower undercarriage.

(iii) *Check list for landing:*

Auto-pilot	OUT
Superchargers	M ratio
Air-intake	COLD AIR
Gills	As required
U—Undercarriage	DOWN
M—Mixture control (if fitted)	DOWN
P —Propeller	2,400 r.p.m.
F —Flaps	Fully down on final approach, or less in high wind

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

Engine assisted	110 (115) m.p.h. I.A.S.
Glide	120 (125) m.p.h. I.A.S.

45. **Beam approach** (static vent connected)

Stage	Indicated height ft.*	I.A.S. m.p.h.†	R.P.M.	Approx. boost	Actions	Change of trim
Preliminary approach	1,500	150	2,400	−3	Lower flaps 35° ..	Tail heavy
		140	2,400	−2½	Lower undercarriage on QDR at OMB	Slightly nose heavy
Outer marker beacon	700	135	2,400	−2	Maintain steady rate of descent	
			2,400	−1	Should give level flight	
Inner marker beacon	200	125	2,500		Lower flaps fully ..	No change
Overshoot	Up to 100 ft.	120	2,500	+6	Raise flaps to 40°, then raise undercarriage. Adjust boost and revs. at 1,000 feet	No change

* After adjusting altimeter for QFE and touch-down error as follows:
(i) With static vent connected, altimeter reads zero at touch-down with full flap.
(ii) With Mark VIII pressure head, altimeter reads +60 feet at touch-down with full flap, so subtract 2·2 millibars from QFE to give zero reading at touch-down.
†Subtract 5 m.p.h. for aircraft using Mark VIII pressure head.

46. **Mislanding**

The aircraft shows no change of trim when throttles are opened with flaps and undercarriage down unless the elevator trim has been wound fully back. Climb away at 100 (105) m.p.h. I.A.S., raise flaps to 40° down, and then raise undercarriage, then increase speed to 145–150 m.p.h. I.A.S.

NOTE.—If propellers are set to 2,400 r.p.m., set fully up immediately should it be necessary to use more than +6 lb./sq.in. boost.

47. **After landing**

(i) Before taxying, raise flaps; engineer opens gills.

(ii) When aircraft is taxied to dispersal the tailwheel should be left straight, thus eliminating unnecessary strain on the tailwheel centralising spring.

(iii) *Shutting down procedure:*

(*a*) Open up gradually and evenly, and run the engine for about 5 seconds at −2 lb./sq.in. boost.

(*b*) Close the throttle slowly and evenly, taking about 5 seconds until speed is reduced to 800–1,000 r.p.m.

(*c*) Run at this speed for a further two minutes.

A.L.4 Part II Para. 47 (iii) (*d*)

(*d*) **Operate the slow-running cut-outs by turning OFF the engine master cocks, and, *when the engine has stopped,* switch OFF the ignition. Should a backfire occur at any stage the above procedure should be repeated.**

(iv) Turn off all fuel tank cocks.
Switch off:

Pressure-head heater switch
Fuel contents gauges
DR compass and other equipment
Turn GROUND/FLIGHT switch to GROUND

(v) *Oil dilution.*—The correct dilution period for this aircraft is 4 minutes, and the dilution operation is to be carried out at an engine speed not exceeding 1,000 r.p.m.

PART III

OPERATING DATA

48. Engine data—Hercules VI or XVI

(i) *Fuel.*—100 octane only.

(ii) *Oil.*—*See* A.P. 1464/C37.

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

		R.P.M.	Boost lb./sq.in.	Temp. °C. Cylinder	Oil
TAKE-OFF TO 1,000 FT.	M	2,800	+8¼		
CLIMBING 1 HR. LIMIT	M	2,400	+6	270	90
	S	2,500			
RICH CONTINUOUS	M	2,400	+6	270	80
	S				
*WEAK CONTINUOUS	M	2,400	+2	270	80
	S				
COMBAT 5 MINS. LIMIT	M	2,800	+8¼	280	100
	S				

*Weak mixture conditions are obtained on Hercules XVI engines at or below +2 lb./sq.in. boost.

OIL PRESSURE
NORMAL .. .. 80–90 lb./sq.in.
MINIMUM .. .. 70 lb./sq.in.

OIL TEMPERATURE FOR TAKE-OFF
RECOMMENDED .. .. 15°C.
MINIMUM .. .. 5°C.

MAXIMUM CYLINDER TEMPERATURE
TAKE-OFF .. .. 230°C.
STOPPING ENGINES .. .. 230°C.

49. 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 in recovery from dives and turns at high speed. Spinning and aerobatics are not permitted. Violent use of the rudder should be avoided at high speeds.

A.L.4 Part III Para. 49 (ii) and (iii)

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

Diving	320(320)
Undercarriage DOWN	150(160)
Flaps DOWN	150(160)
Bombs door OPEN	320(320)

(iii) *Maximum weights:*

Take-off (operational)	65,000 lb.
Take-off (non-operational)	63,000 lb.
Landing	55,000 lb.
Landing	53,000 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°.

50. Position error correction

(i) Aircraft with static side of pilot's A.S.I. connected to the Mark VIII pressure head.

From ..	120	140	160	180	210	m.p.h.
To ..	140	160	180	210	240	I.A.S.
Add ..	12	10	8	6	4	m.p.h.

(ii) The position error correction for aircraft with static vent connected is + 1 m.p.h. at all speeds.

51. Maximum performance

(i) For maximum rate of climb:

(*a*) Climb at 130 (140) m.p.h. I.A.S. at full climbing power with gills fully open.

(*b*) Change to S gear when boost falls to + 3 lb./sq.in. and increase r.p.m. to 2,500.

(*c*) Close gills fully at 15,000 feet.

(*d*) When boost falls to + 3 lb./sq.in. retract throttles to the position marked mid-way between RB and ECB.

(*e*) When boost falls to + 2 lb./sq.in. retract throttles to the ECB position and increase speed to 150 (160) m.p.h. I.A.S.

(ii) *All-out level.*—Use S ratio if maximum boost obtainable in M ratio drops below +5 lb./sq.in.

52. Maximum range

(i) Recommended operational climb:

(*a*) Climb at 150 (160) m.p.h. I.A.S. using maximum weak mixture cruising boost with gills closed. Select boost as follows: After take-off retract the four throttles together until boost falls just below +2 lb./sq.in., then progress throttles until + 2 lb./sq.in. exactly is regained. Check that weak mixture boost is not exceeded by comparison of the four exhaust glows.

(*b*) When boost falls to +1 lb./sq.in., change to S gear. Keep within cylinder temperature limitations by increasing speed where necessary, even to the extent of cruising in level flight for a short period. Do not progress throttles to the mid-position at any time.

(ii) *Cruising*

(*a*) Fly in M ratio at maximum obtainable boost not exceeding +2 lb./sq.in. obtaining the recommended airspeed by reducing r.p.m.

(*b*) The recommended speeds are:

Fully loaded ..	..	165 (175) m.p.h. I.A.S.
Lightly loaded ..	..	160 (170) ,, ,,

53. Fuel capacity and consumptions

(i) Capacity

2—No. 1 Inboard tanks ..	..	494 gallons
2—No. 2 Inner wing nose tanks ..		124 ,,
2—No. 3 Centre tanks ..	..	376 ,,
2—No. 4 Outboard tanks ..	..	322 ,,
2—No. 5 Outer engine tanks	..	244 ,,
2—No. 6 Outer engine tanks	..	246 ,,
		1,806 ,,

(ii) Rich mixture consumption (approx.)—M ratio at 5,000 feet:

R.p.m.	Boost lb./sq.in.	Approx. total consumption galls./hr.
2,800	+8¼	640
2,400	+6	478

(iii) Weak mixture consumptions (approx.) in galls./hr.

Boost lb./sq.in.	M ratio at 5,000 ft. R.P.M.				S ratio at 15,000 fet. R.P.M.			
	2,400	2,200	2,000	1,800	2,400	2,200	2,000	1,800
+2	236	220	204	188	232	220	212	192
0	212	196	184	160	208	200	192	176
−2	188	176	164	148	188	180	172	160
−4	168	160	148	136	172	164	156	—

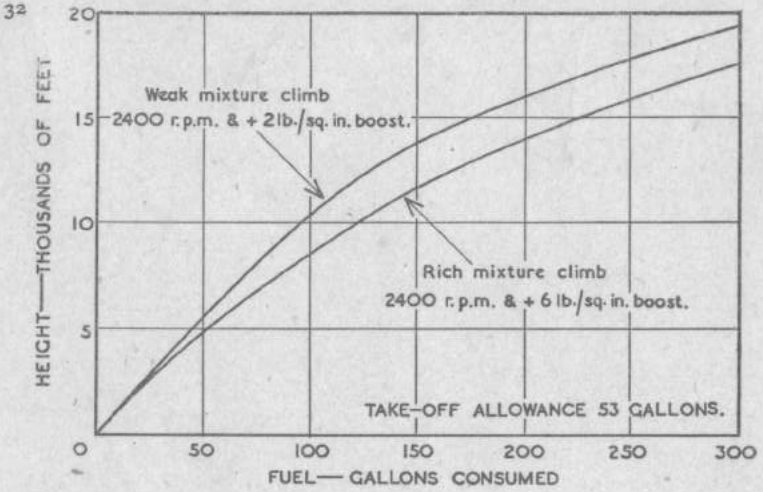
M gear:
For every 1,000 ft. above height quoted add 1 gall./hr.
,, ,, ,, ,, below ,, ,, deduct 1 gall./hr.

S gear:
For every 1,000 ft. above height quoted add 2 galls./hr.
,, ,, ,, ,, below ,, ,, deduct 2 galls./hr.

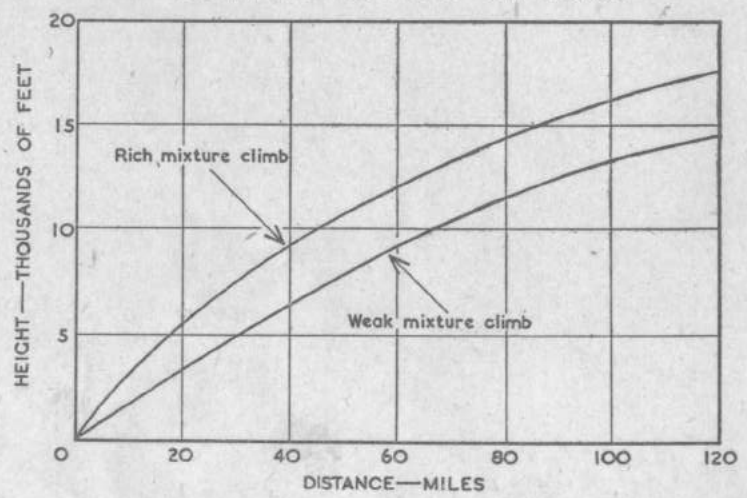
54. A.S.I. conversion table

M.p.h.	Knots	M.p.h.	Knots
74	64	130	113
80	70	135	117
81	71	140	122
90	78	145	126
95	82	150	130
100	87	155	134
105	91	160	139
110	96	165	143
115	100	170	148
120	104	200	174
125	109	320	278

FUEL CONSUMED ON CLIMB



DISTANCE COVERED ON CLIMB



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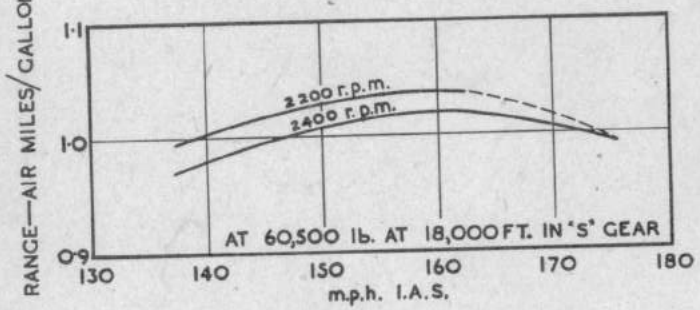
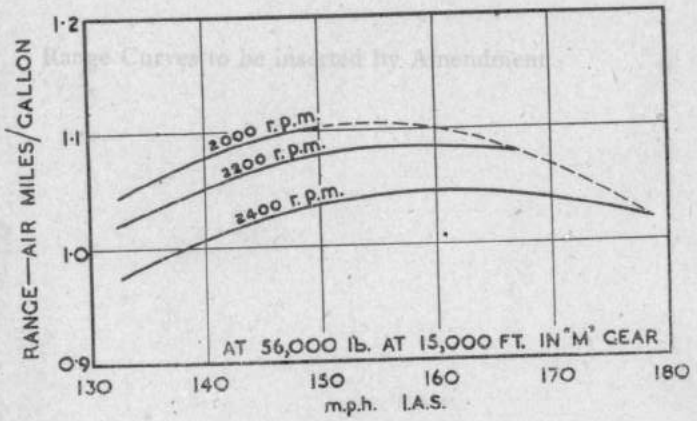
STILL AIR RANGE





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PART IV—*EMERGENCIES*

55. **Engine failure on take-off**

(i) The aircraft can be kept straight on any three engines at take-off power at full load provided a safety speed of 145 (155) m.p.h. I.A.S. has been attained.

(ii) In the event of an outer engine failure below safety speed, control will be lost unless the opposite outer engine is immediately throttled back, at least partially. Feather the propeller of the failed engine, retrim, and reopen the throttle of the live outer engine.

(iii) After control has been retained as described above, it will be possible to climb with flaps in the take-off position and undercarriage up on three engines at take-off power at 130 (140) m.p.h. I.A.S. at light loads.
At heavy loads or if the engine failure has occurred at a low height immediately after take-off it will be necessary to land straight ahead using the two inner engines to control the rate of descent.

56. **Engine failure in flight**

(i) At full load, flaps and undercarriage up, at climbing power, control can be retained with rudder and aileron provided speed is not below 150 (160) m.p.h. I.A.S. If an outer engine fails below this speed it will be necessary to throttle back the opposite outer engine, at least partially, until rudder trim can be applied and the dead engine feathered. After trim has been applied, reopen the throttle of the live outer engine slowly: cases have occurred of propeller overspeeding due to a too rapid return of power after the propeller has fined its pitch.

(ii) *One engine failed.*—At 54,000 lb. use weak mixture cruising boost. Trim to fly without foot load at 140 (150) m.p.h. I.A.S. Height can normally be maintained to 18,000 feet.

(iii) *Two engines failed.*—Speed should not be allowed to fall below 135 (145) m.p.h. I.A.S.; lower speed will not reduce the rate of descent, and at this speed no undue strain is required to keep straight with two engines failed on one side. Fly in M gear and allow the aircraft to descend until height can be maintained. At light weights with symmetrical power available this may be possible in weak mixture up to about 12,000 feet, but at heavy loads or with two engines failed on one side, full climbing power may be necessary at about 5,000 feet.

(iv) The auto-pilot is of sufficient power to be used in all cases of engine failure except two engines failed on one side. The compressor, however, is driven by the port inner engine.
NOTE.—Increasing the r.p.m. on all engines will reveal the failed engine, but this test should not be carried out above cruising speed.

(v) *Landing on three engines.*—Lowering flaps to 35°, and undercarriage, may be carried out as in a normal circuit. Full flap should not be lowered nor rudder trim wound off until it is certain that the airfield can be reached comfortably on a straight approach. Final approach should be made at 120–125 m.p.h. I.A.S. using as little power as possible.

(vi) *Landing on two engines (asymmetric power).*—The circuit must be made with the two good engines on the inside of the turn, in which speed should not be allowed to fall below 140 (150) m.p.h. I.A.S. Operation of the undercarriage and flaps should be left as late as practicable. Aim at having the undercarriage locked down just before the final approach. Keep extra height if possible and approach in a glide at a speed of 125–130 m.p.h. I.A.S. Do not lower flaps nor wind off rudder trim until it is certain that the airfield can be reached comfortably in a glide. Some power may be required in the early stages of the approach.

(vii) *Propeller overspeeding.*—At low speeds the difficulties of control may be accentuated by an overspeeding windmilling propeller and will require special precautions. If overspeeding of any engine occurs:
(*a*) Close throttle of affected engine at once.
(*b*) Close throttle of corresponding engine on the other side in order to assist control.
NOTE.—Unless it is essential to retain height, the simplest immediate action is to close all four throttles.
(*c*) Normal corrective action should be taken (*see* A.P. 2095 Pilot's Notes General) but it should be noted that this may involve reducing speed below safety speed.

57. **Feathering and unfeathering**

(i) To feather a propeller:
(*a*) Hold the button (37) in only long enough to ensure that it stays in by itself.
(*b*) Close throttle immediately.
(*c*) Switch off only when engine has stopped and turn off master fuel cock.

(ii) To unfeather a propeller:
(*a*) Speed should not be greater than 160 (170) m.p.h. I.A.S.
(*b*) Set propeller control fully down and throttle slightly open.
(*c*) Turn on ignition and master fuel cock.
(*d*) Press and hold in feathering button until 1,000 to 1,300 r.p.m. is reached. If the propeller does not return to normal constant-speed operation, open throttle slightly.

58. **Undercarriage emergency operation**

(i) The mechanical up-locks must be released and the undercarriage control lever must be placed in the DOWN position.
NOTE.—The mechanism has been designed with a "weak link" so that in extreme emergency if the mechanical up-locks cannot be released or are inaccessible, the application of hydraulic power will break the lock and allow the undercarriage to lower.

(ii) If after releasing the mechanical up-locks and setting the undercarriage lever to DOWN the accumulator power will not lower the undercarriage, open the emergency cock on the front face of the front spar, leaving the undercarriage lever at DOWN. Either the engine-driven pump or handpump should then operate the undercarriage through the emergency pipe-lines.

(iii) In the event of complete failure of the hydraulic system the undercarriage will descend and lock down under its own weight assisted by the pull of the elastic cords fitted to each radius rod. Reduce speed if necessary.

A.L.4 Part IV Para. 59

59. **Bomb doors emergency operation**

Should the bomb doors fail to open when the pilot selects bomb doors OPEN, close the isolating cock then open the emergency cock on the front face of the front spar. Either the engine-driven pump or handpump should then operate the doors.

NOTE.—If the undercarriage is raised or the bomb doors closed after using either of the emergency circuits there may be insufficient fluid left in the system to lower the undercarriage a second time. When closing the bomb doors the isolating cock must be opened and the emergency cock closed.

60. **Air-intake and landing lamps**

These hydraulic services can be operated by the hand-pump if the engine-driven pump fails. There are no separate emergency pipe-lines.

61. **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.

62. **Parachute exits**

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

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

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

(iv) The paratroop cone (if fitted).

63. **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 in the fuselage roof aft of the front spar.

(iii) The hatch in the fuselage roof aft of the rear spar. A folding escape ladder is fitted below this exit.

EMERGENCY EQUIPMENT

64. **Fire-extinguishers.**—A semi-automatic fire-extinguisher system is installed, and is operated by gravity and impact switches. The system may be operated manually by manipulating the pilot's pushbutton switches (65) mounted on the port side of the cockpit. There are four such buttons, one for each engine bay. Hand-operated fire-extinguishers are stowed in the following positions:

Type No. 3 fire-extinguishers:

On the fuselage roof above the navigator's position.

In the roof of the flight engineer's position, port side of the astral dome.

Type No. 5 fire-extinguishers:

On the forward face of the pilot's bulkhead to the pilot's right hand.

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

Above the starboard rest seat.

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

Starboard side of the fuselage just forward of the rear gun turret.

65. **Dinghy.**—A dinghy stowed on the port side in the centre plane is released by

(*a*) A manual release on the port side of the rear roof escape hatch. Give handle a half turn counter clockwise and pull.

(*b*) Immersion switches under the nose of the fuselage.

A signal pistol and cartridges, emergency rations, sea markers, first-aid outfit and paddles are provided in a valise attached to the dinghy by a cord.

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

PART V

ADDITIONAL DATA FOR FLIGHT ENGINEER

66. **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.

67. **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 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. 33 (*g*) 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.

NOTE.—The carburettor must not be primed unless it is known that the float chambers are empty, in which case not more than three strokes of the pump must be given.

68. **Hydraulic system**

Tank.—The hydraulic fluid is stored in a tank in the starboard engine nacelle. The tank is provided with a filling filter, the bottom of which serves as a filling level for the fluid.

Handpump.—A double-acting pump is attached to the front spar on the port side in the fuselage. The pump draws fluid from the tank return pipe and will operate the entire system in the same manner as the engine pump.

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 levers 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 landing lamp distributor lever is spring-loaded to remain in the neutral position and has to be held in the operating position while the operation is in progress. The air-intake distributor lever has two positions only.

Isolating valves.—A manually-operated isolating valve is fitted between the top of the flap jacks 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 up-locks.—The controls for the mechanical up-locks are above the rest seats one on either side of the fuselage. The red lights on the pilot's undercarriage indicator remain on until the up-locks are engaged by pushing in the control handles.

Accumulators.—The accumulators, with the exception of the power accumulator, 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 are as follows:

(i) Undercarriage 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) Flaps accumulator is aft of the rear spar, on the starboard side of the fuselage.

(iv) Power accumulator is mounted on the front spar in the starboard inner nacelle.

(v) Tailwheel accumulator (fitted on later aircraft) is aft of the rear fuselage bay bulkhead.

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. The gauge is adjacent to the handpump.

Engine pump.—This is of the multi-cylinder high-speed radial type. The pump runs continuously, the strain on the pump being relieved between operational demands by an hydraulic cut-out valve. The pump is mounted on the gear box of the starboard inner engine.

Cut-out valve.—An automatic cut-out valve is fitted in the pump delivery line, and is mounted on the rear face of the starboard inner engine diaphragm. When the

pump has charged the power accumulator to 2,400–2,500 lb./sq.in. the valve isolates the system from the pump and by-passes the fluid back to the tank. The valve continues to by-pass fluid until the accumulator pressure has dropped to 2,000 lb./sq.in.

Pressure limiting valve.—This valve is fitted to limit the pressure obtainable by the pump to 2,800 lb./sq. in.

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

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 such as paraffin and petrol.

69. **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. 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. For ground filling purposes the air-charging valve is situated in the rear of the port inner engine nacelle and is accessible through the undercarriage doors.

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

70. **Engine-driven accessories**

The engine-speed indicator generator and the constant-speed unit are part of the basic power plant. Accessories are fitted as follows.

(i) *Starboard outer:*

(*a*) A 500-watt 24-volt A.C. generator to supply the special A.R.I.s.

(ii) *Starboard inner:*

(*a*) A 1,500-watt 24-volt D.C. generator. (Alternatively a 1,000-watt D.C. generator with a 24-volt alternator driven in tandem where special A.R.I.s are fitted.)

(*b*) A Pesco vacuum pump to supply the Mark XIV bomb-sight, or the instrument flying panel in emergency.

(*c*) A Lockheed pump for the hydraulic system.

(iii) *Port inner:*

(*a*) A 1,500-watt 24-volt D.C. generator.

(*b*) A Pesco vacuum pump to supply the instrument flying panel.

(*c*) A Heywood compressor for the pneumatic system.

(*d*) An R.A.E. compressor for the supply to the automatic pilot.

(iv) *Port outer:*

(*a*) A 1,500-watt 24-volt D.C. generator.

NOTE.—All the D.C. generators are connected in parallel and supply the lighting and general services of the aircraft.

71. Main pressures

	lb./sq.in.
R.A.E. compressor to auto-pilot	60
Engine oil pressure (minimum)	70
,, ,, ,, (normal)	80–90
Brake pressure (minimum)	90
Inflation pressure undercarriage accumulator	250
Brake pressure (supply)	300
Inflation pressure bomb doors accumulator (OPEN)	700
,, ,, flaps accumulator (flaps DOWN)	400
,, ,, power accumulator ..	1,850
Lockheed cut-out operation (in)	2,000
,, ,, ,, (out) ..	2,400–2,500
Pressure limiting valve setting	2,800

PART VI

LOCATION OF CONTROLS AND ILLUSTRATIONS

PART VI

ILLUSTRATIONS AND LOCATION OF CONTROLS NOT ILLUSTRATED

Page 44

LOCATION OF CONTROLS

E. denotes controls operated by flight engineer.

Aircraft controls

Aileron locking gear	Bag on starboard side aft of engineer's armour plate door
Rudder and elevator locking gear	Bag on port side of rear fuselage forward of rear turret

Fuel system

Master engine cocks	Bulkhead aft of pilot
E. Tank selector cocks (Mark III)	Forward end of rest seats
E. Wing crossfeed cocks	Forward end of rest seats (Mark III)
E. Centre crossfeed cock	Aft face of rear spar
E. Long-range fuel distribution cocks	Under step aft of front spar
Fuel pressure warning lights	Engineer's panel Duplicated at rest station (Mark III)
Priming pump	Rear of each undercarriage fairing (Mark III) Engineer's station (Mark VII)

Hydraulic system

E. Undercarriage mechanical uplock controls	Above rest seats
E. Flaps isolating cock	Central on aft face of rear spar
E. Bomb doors isolating cocks	Under bomb doors accumulator port side, aft of front spar
E. Bomb doors selective closing cock	Aft of pilot's bulkhead
E. Hydraulic handpump	Port side, front spar
E. Undercarriage emergency cock	Front face, front spar
E. Bomb doors emergency cock	" " " "

Electrical controls

E. GROUND/FLIGHT switch	Starboard side of fuselage opposite engineer's station
Ground battery connection	Starboard side under leading edge
Electrical control panel Main generator fuses Generator warning lights Voltmeter and ammeter	Right-hand side of W/T operator's station

Operational controls and equipment

E. Heating controls	On ducts aft of front spar
E. Oxygen main valve	At foot of engineer's panel
E. Signal pistol	Fuselage roof aft of pilot's bulkhead
Signal pistol cartridges stowage	Rear face of bulkhead
Flying rations Vacuum flasks Drinking water	Aft of engineer's bulkhead
Aldis lamp	Bomb aimer's station

Emergency equipment

Fire-extinguishers	See Part IV
Dinghy manual release	Adjacent to rear roof escape hatch
Dinghy emergency pack	Port side, aft of rear spar
Dinghy emergency radio	Port side, above rest seats
Crash axes (three)	Starboard side, opposite flight engineer's station Starboard side, aft of rear spar Rear turret door
First-aid outfits (three)	Two on port side just forward of entrance door One on starboard side, bomb aimer's station
Emergency rations	Rear fuselage at the step up to floor over bomb-bay
Emergency oxygen	All crew stations
Incendiary bombs (aircraft)	Cover plate to engineer's panel

Key to *Fig. 1*

INSTRUMENT PANEL

1. Camera warning light
2. Oxygen flow meter
3. D.R. compass repeater
4. Flaps indicator
5. A.R.I. destruction switches (under cover)
6. Beam approach indicator
7. Bomb steering indicator
8. Instrument flying panel
9. Boost gauges
10. Suction gauge
11. Landing lamp switch
12. D.F. indicator
13. Engine-speed indicators
14. Bomb jettison handle
15. Bomb doors warning lights
16. Suction changeover cock
17. Troop signalling lamps and switch
18. Throttle friction adjusting lever
19. Brakes and supply pressure gauge
20. Landing lamps dipping lever
21. Bomb-firing switch
22. Starboard ignition switches
23. Undercarriage indicator
24. Port ignition switches
25. Horn warning light
27. Air temperature gauge
28. Auto-pilot pressure and trim gauge

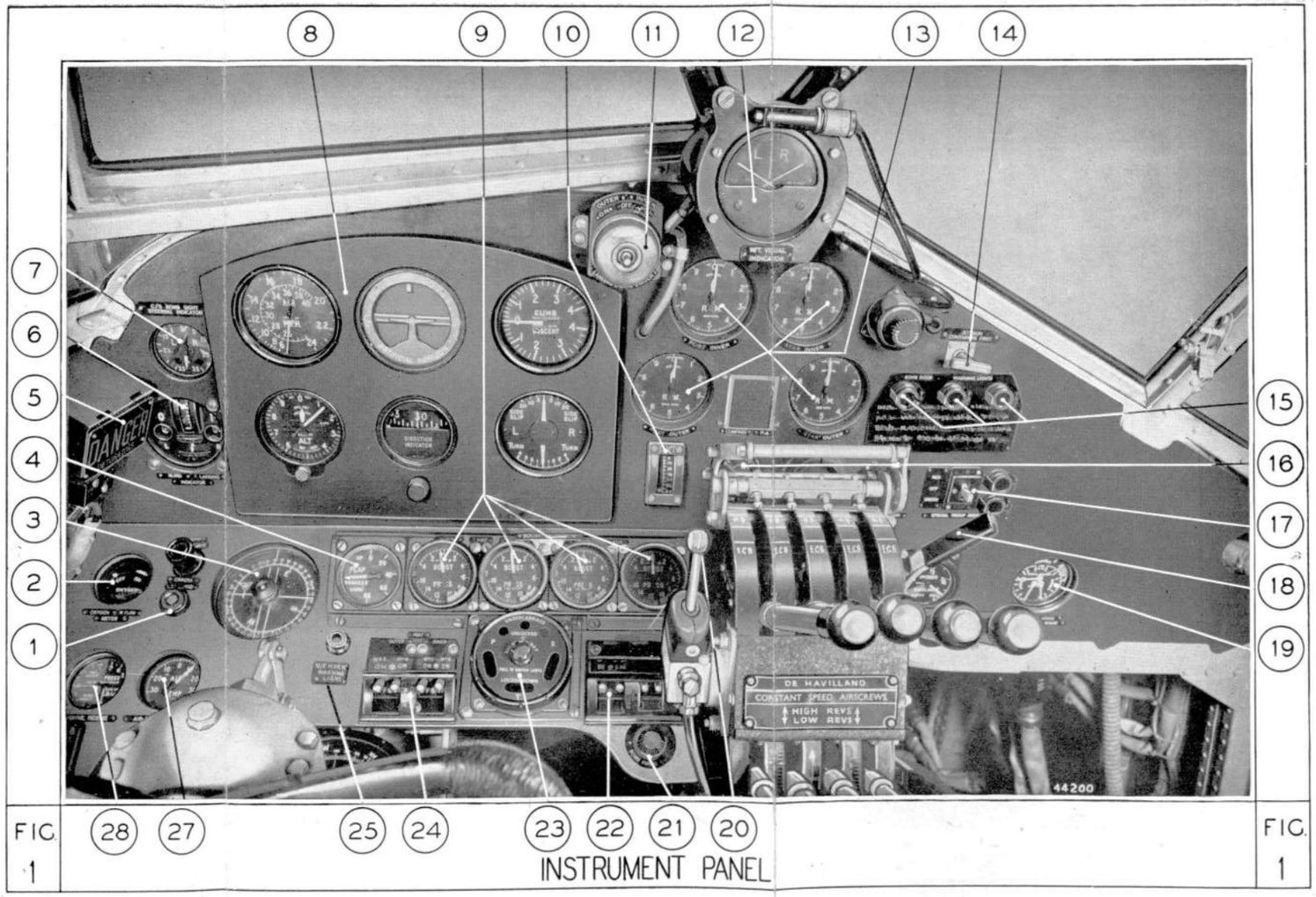


FIG. 1 INSTRUMENT PANEL FIG. 1

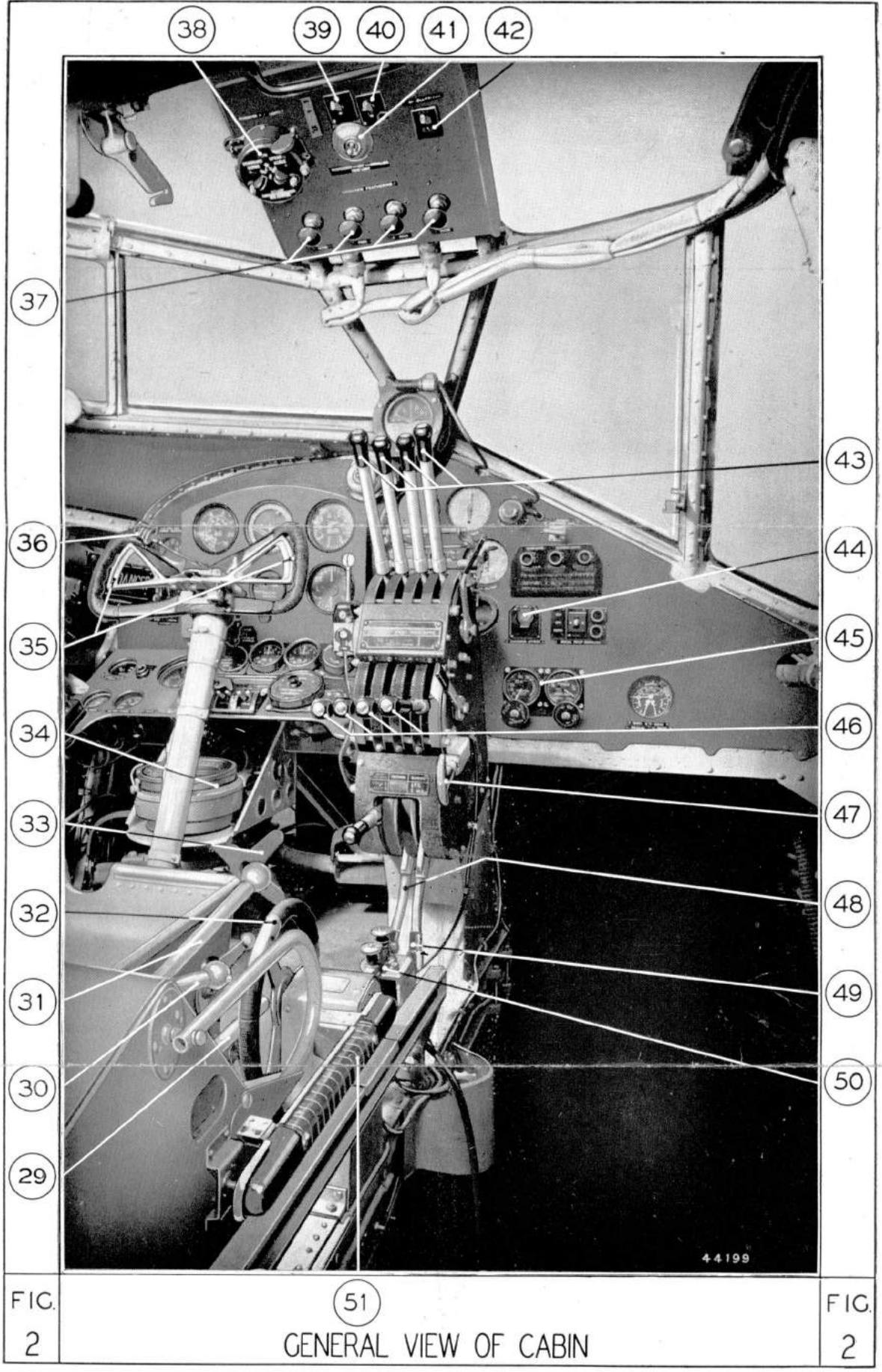


FIG. 2 — 51 — GENERAL VIEW OF CABIN — FIG. 2

Key to *Fig. 2*

GENERAL VIEW OF CABIN

29. Undercarriage lever
30. Flaps lever
31. Bomb doors lever
32. Elevator trimming tab control
33. Rudder pedals adjusting starwheel
34. Compass
35. Wheel brakes lever
36. "Press to transmit" switch
37. Feathering buttons
38. Recognition lights switchbox
39. Navigation lights switch
41. Headlamp switch
42. Formation lights switch
43. Throttle levers
44. Bomb containers jettison switch
45. Oxygen regulator
46. Propeller speed control levers
47. Glider release control
48. Mixture lever
49. Superchargers control
50. Windscreen de-icing pump
51. Elevator trimming tab indicator

Key to *Fig. 3*

FLIGHT ENGINEER'S PANEL

52. Cowling gills, motor controls and indicators
53. Gills position indicators
54. Booster-coil buttons
55. Engine starting buttons
56. Fuel contents gauges
57. Fuel contents gauges switch
58. Oil temperature gauges
59. Cylinder temperature gauges
60. Oil pressure gauges
61. Fuel pressure warning lights
62. Oil dilution switches
63. Fuel transfer pumps ground testing buttons
64. Immersed pump switches

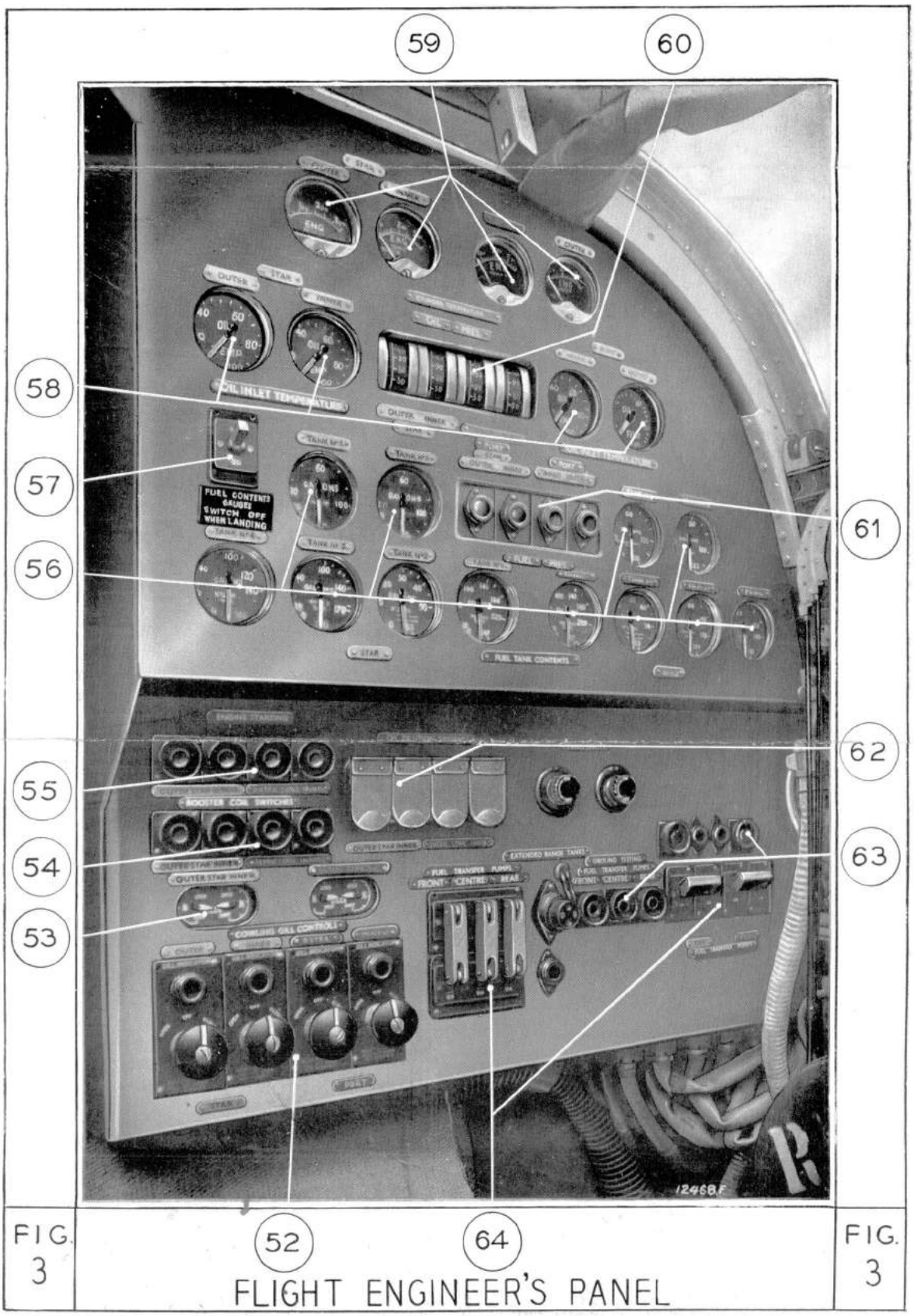


FIG. 3 — FLIGHT ENGINEER'S PANEL — FIG. 3

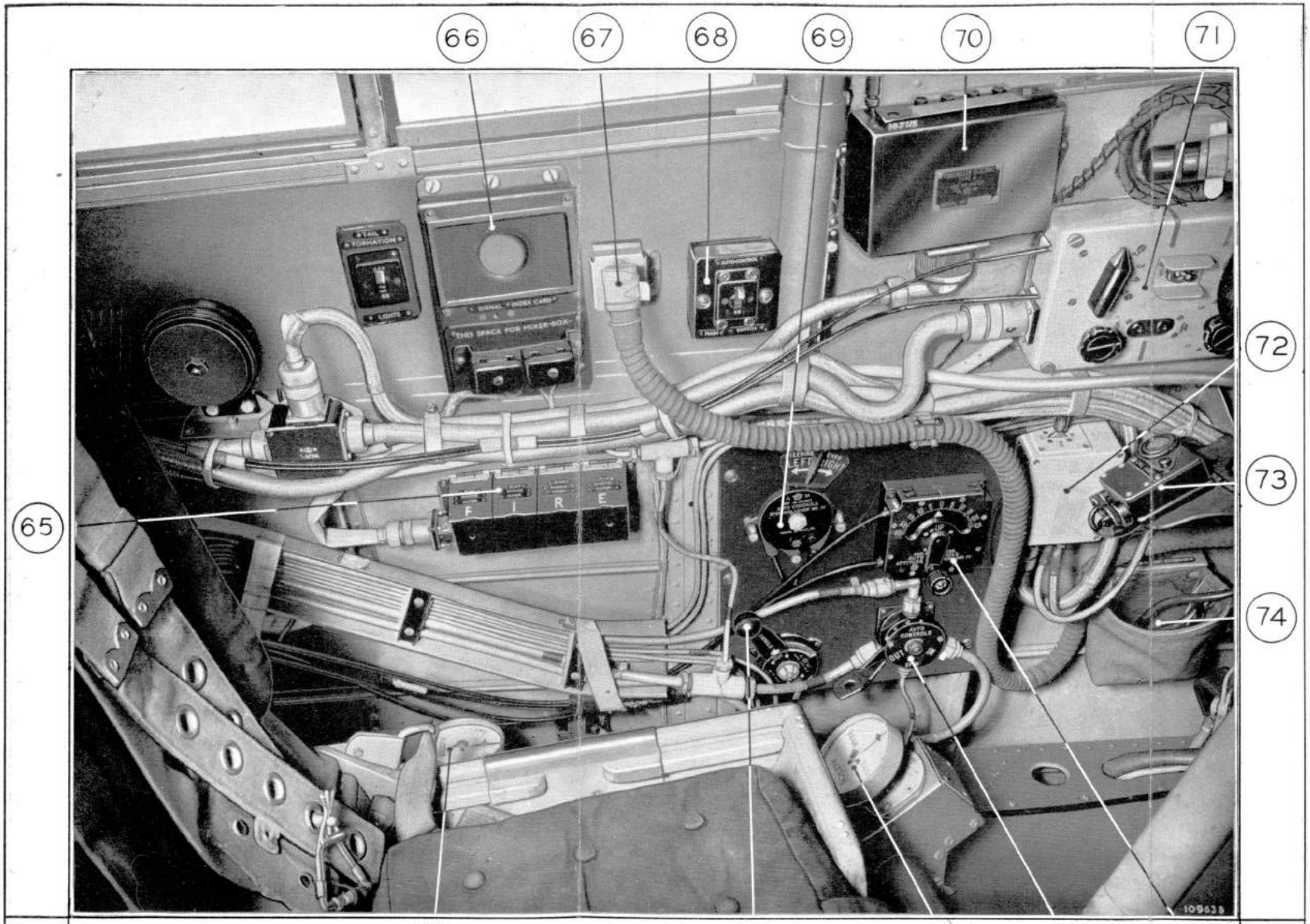


FIG 4

COCKPIT - PORT SIDE

FIG 4

Key to *Fig. 4*

COCKPIT—PORT SIDE

65. Fire-extinguisher pushbuttons
66. Signal index card holder
67. Pilot's oxygen connection
68. Auto-pilot main switch
69. Auto-pilot steering lever
70. T.R.1196 control box
71. Beam approach control unit
72. Beam approach mixer box
73. Pilot's call light
74. Heater socket stowage
75. Auto-pilot attitude control
76. Auto-pilot control cock
77. Aileron trimming tab control
78. Auto-pilot clutch lever
79. Rudder trimmer tabs control

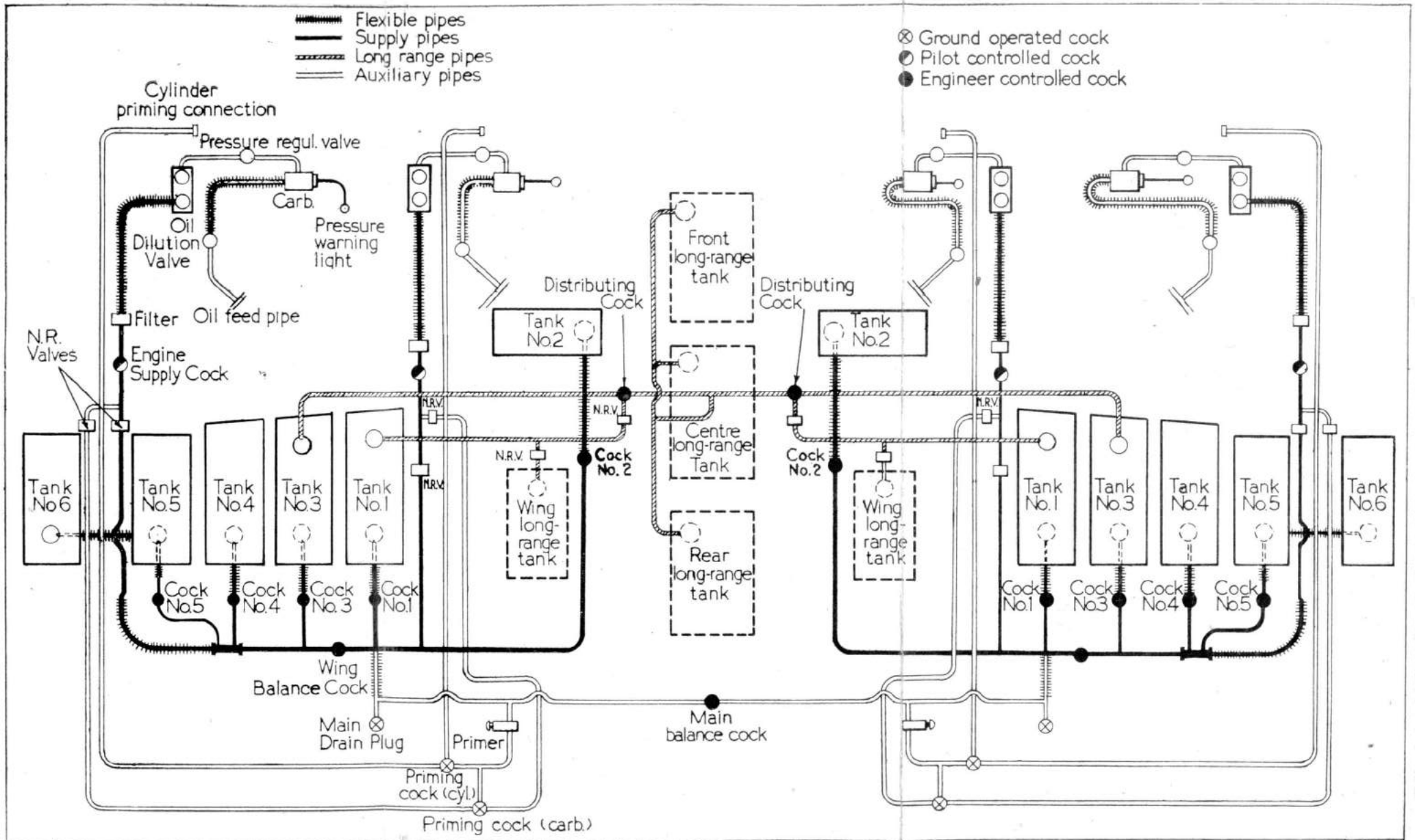


FIG. 5

FUEL SYSTEM DIAGRAM

FIG. 5

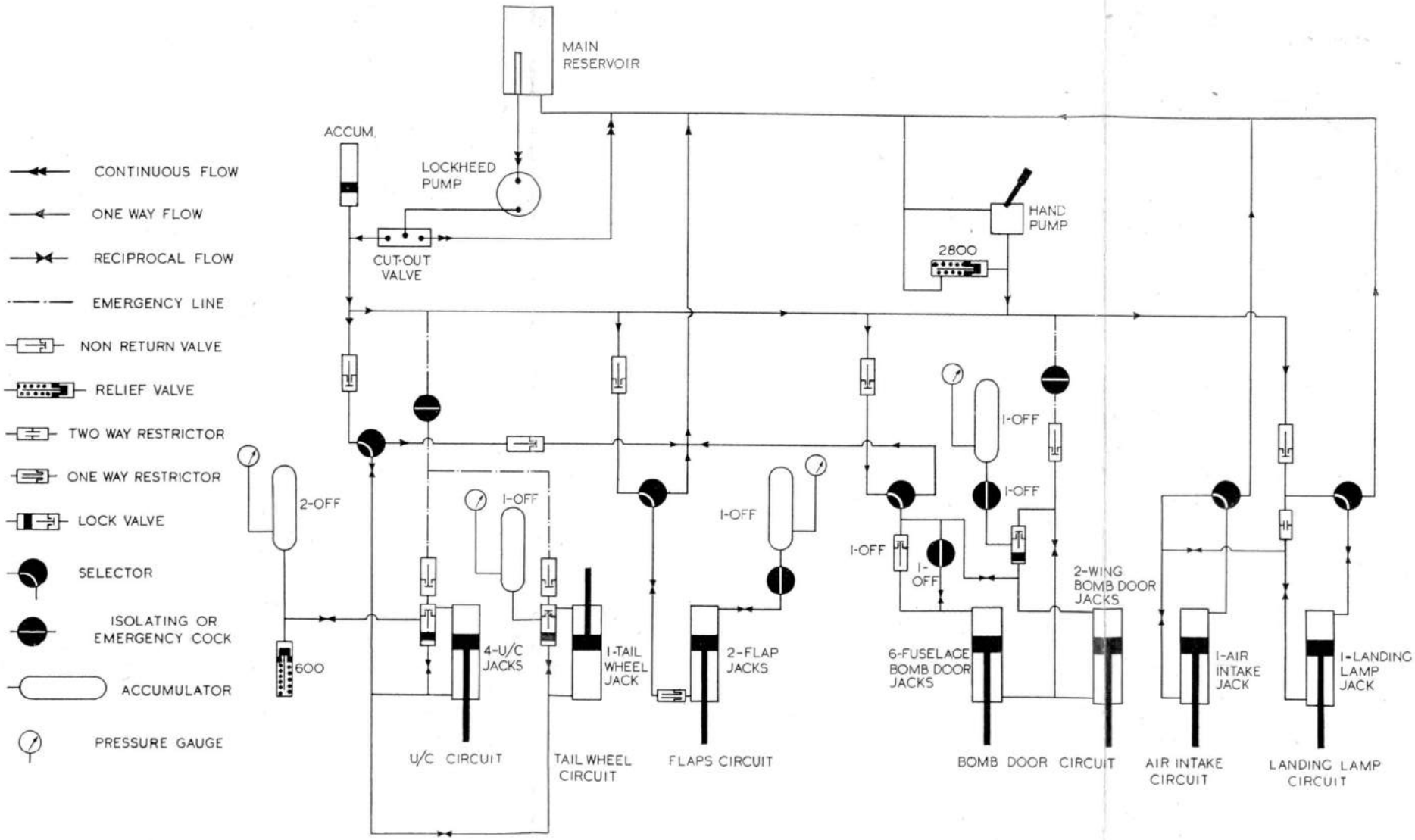
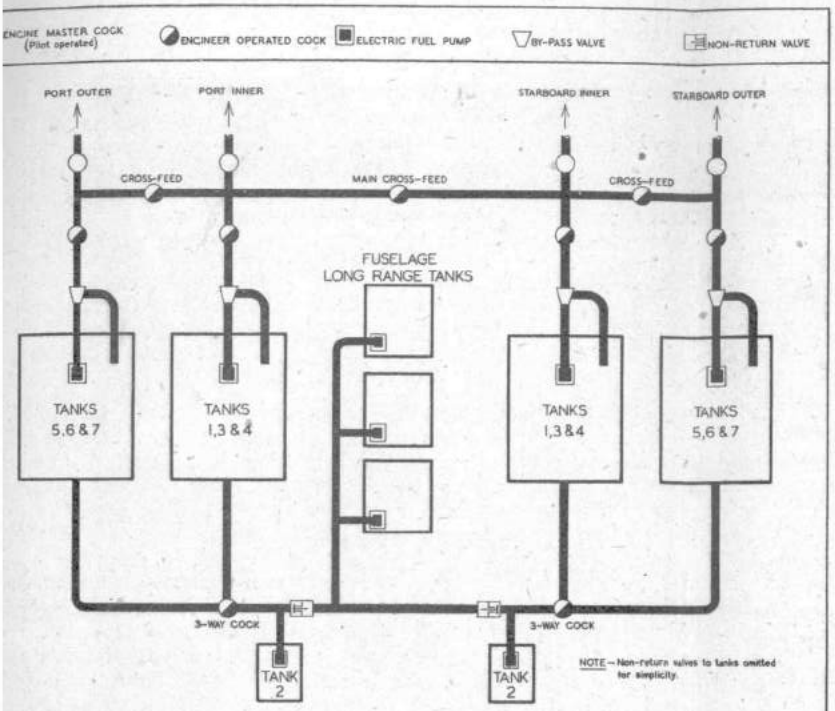


FIG. 6

HYDRAULIC SYSTEM — SIMPLIFIED DIAGRAM

FIG. 6



MARK VII—SIMPLIFIED FUEL SYSTEM DIAGRAM FIG. 7

1. *Fuel tanks.*—Fuel is carried in fourteen self-sealing tanks in the wings. The seven tanks in each wing are so connected that they may be considered as two groups of three tanks, each group feeding one engine, and one replenishment tank from which fuel may be transferred into either group in that wing.
The capacities in each wing are:

Inboard group	Tank 1 .. 62 gal. Tank 3 .. 247 gal. Tank 4 .. 188 gal.	..	497 gal.
Replenishment tank	Tank 2 .. 150 gal.	..	150 gal.
Outboard group	Tank 5 .. 161 gal. Tank 6 .. 122 gal. Tank 7 .. 165 gal.	..	448 gal.
	Total	..	1,095 gal.

Provision is made for fitting three self-sealing 230 gallon long-range tanks in the fuselage bomb-bay. A nitrogen fire protection system for all tanks is installed; nitrogen being 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 be fully opened before any petrol is used.

2. *Master engine cocks.*—The supply to each engine can be shut off by the appropriate master engine cock control lever mounted on the bulkhead aft of the pilot. Moving the levers to the down position closes the cocks and also operates the slow-running cut-outs.

3. *Fuel cocks.*—The layout of tanks and cocks is symmetrical about the centre line of the aircraft and the system in each wing should be operated independently with the centre crossfeed cock on the aft face of the rear spar kept closed. Each group of tanks is controlled by one ON-OFF cock; a crossfeed cock is fitted in the gallery pipe between the inner and outer groups and when this crossfeed cock is closed the inboard group feeds the inner engine and the outboard group the outer engine. Controls (103 & 104) for all these cocks are provided at the flight engineer's station below the instrument panel. Two three-way cocks are provided at the rear of the front spar to select the group of tanks into which fuel is to be transferred from the replenishment tanks. These cocks are also used when transferring fuel from the bomb bay tanks. The arrangement of the non-return valves is such that when both cocks are open (either group can be selected) the fuel will be transferred to both wings simultaneously from the long-range tanks, whereas fuel can only be transferred from the replenishment tanks into a group in the same wing, and any balancing of fuel from wing to wing must be done through the centre crossfeed cock.

4. *Electric pumps*

(i) Each group of tanks is provided with an electric booster pump. These pumps are fitted in a well compartment partitioned off at the rear of tanks 3 and 5 and into which the other tanks of the group drain. A by-pass valve on each pump limits the pressure in the feed pipe to 10 lb./sq.in. and returns the excess fuel being pumped, back to the tank. The by-pass valve also allows fuel to be drawn direct to the engine-driven pump if the electric pump is not working.

(ii) Electric transfer pumps are provided in each replenishment tank and each long-range tank and are used to transfer fuel to a selected group, or groups of tanks.

(iii) Switches to all pumps are mounted at the bottom of the flight engineer's panel together with ground testing equipment.

5. *Fuel contents gauges.*—The fuel contents of all wing tanks are registered on gauges, one for each tank, on the flight engineer's panel; but as described in para. 1, tanks 1, 3 and 4 can only be used as a unit and tanks 5, 6 and 7 as another, since no provision is made for isolating individual tanks. A circuit switch is provided adjacent to the gauges.
The long-range tanks are fitted with direct reading contents gauges visible through the bomb hatches in the fuselage floor.

6. *Fuel pressure warning lights:*

(i) Four fuel pressure warning lights are mounted on the flight engineer's panel and indicate low fuel pressure at the carburettors.

(ii) A fuel pressure warning light (95) for each replenishment tank and one (83) for the three long-range tanks are mounted on the lower portion of the flight engineer's panel. These lights warn when a tank is empty and the relevant pump should be switched off.

7. *Priming.*—A handpump for induction priming is mounted on a bracket on the port side of the fuselage at the flight engineer's station, and serves all engines. The supply of fuel is taken from tank 1 in the port wing. Provision is made for the use of high volatility fuel to facilitate starting in cold weather; the cock and connection is adjacent to the priming pump. There is no handpump for priming the carburettors and this must be done by operating the electric pump in the relevant group of tanks. The pump should not be left running while the engine is stationary.

8. *Management of fuel system.*—For normal operation one group of tanks should feed one engine, i.e. all tanks ON, and all crossfeed cocks OFF. The outboard group of tanks contains approx. 50 gallons less fuel than the inboard group and should be replenished from tank 2 as required by setting the transfer cock to the outboard group and switching on the pump in No. 2 tank. Take-offs should be made with the tank group pumps on and these pumps should also be used to augment fuel pressure at altitude (approx. 9,000 feet).

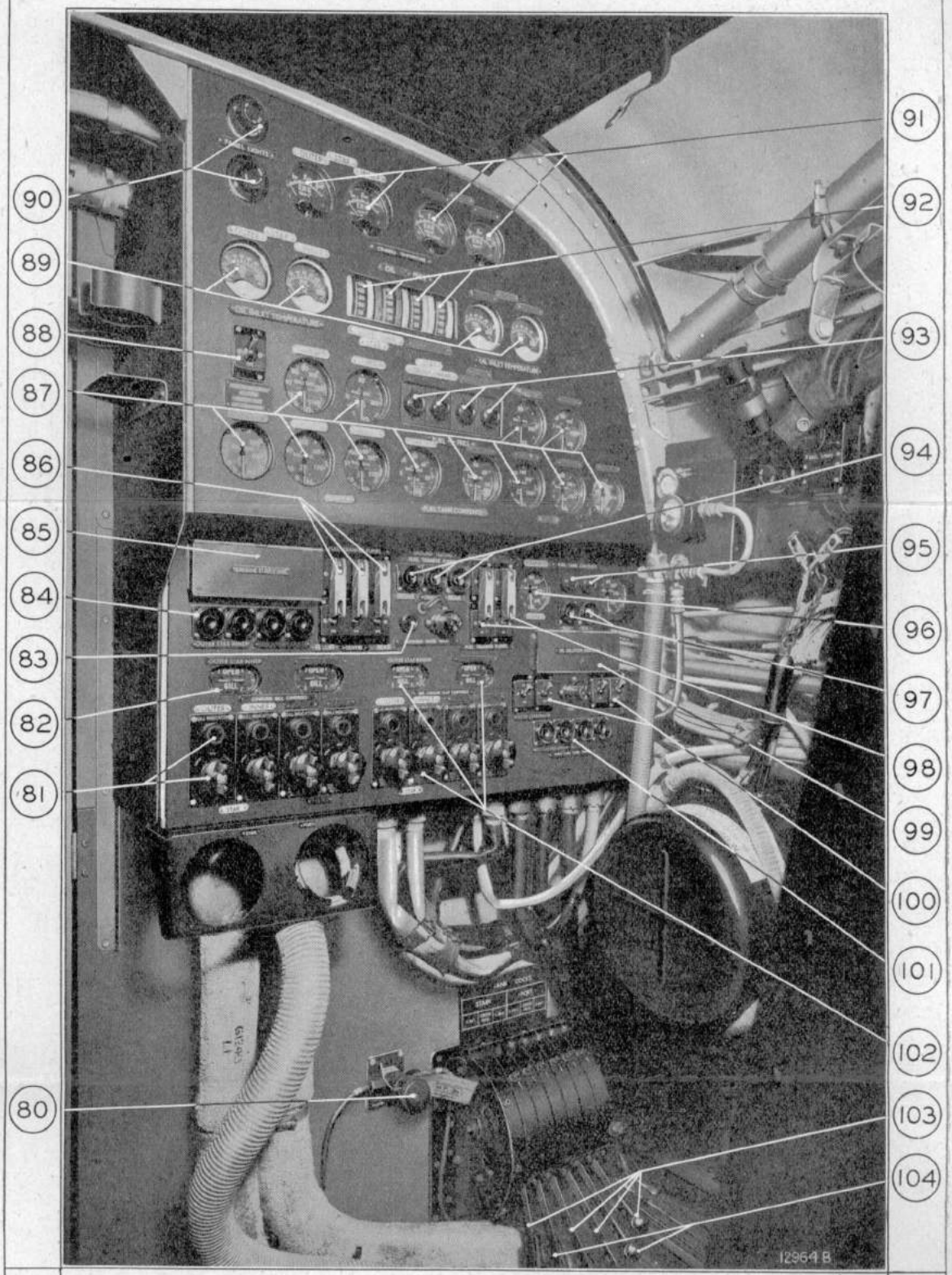


FIG. 8 MARK VII - FLIGHT ENGINEER'S PANEL FIG. 8

Key to *Fig. 8* — FLIGHT ENGINEER'S PANEL

80. Main oxygen valve
81. Cowling gills motor controls and indicators
82. Gills position indicators
83. Long-range fuel pressure warning light
84. Booster-coil buttons
85. Engine starting buttons
86. Long-range fuel pump switches
87. Fuel contents gauges
88. Fuel contents gauges switch
89. Oil temperature gauges
90. Panel light switches
91. Cylinder temperature gauges
92. Oil pressure gauges
93. Fuel pressure warning lights
94. Long-range fuel pumps ground test buttons
95. Replenishment fuel pressure warning lights
96. Replenishment tanks fuel contents gauges
97. Warning light test buttons
98. Replenishment tanks pump switches
99. Oil dilution switches
100. Tank group pump switches
101. Tank group pump ground test buttons
102. Oil cooler flaps motor controls, indicators and position indicators (inoperative on this Mark of Halifax)
103. Tank group fuel cock control levers
104. Crossfeed cock control levers

RESTRICTED

For Official Use Only

AIR MINISTRY
September 1944

Amendment List No. 3
to A.P. 1719C. & G—P.N

HALIFAX III & VII

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

A.L.	PARA.	AMENDMENT
Previous amendments still current:		
1	Front cover	*Alter* to read "A.P. 1719C & G—P.N. HALIFAX III & VII"
	1	*Add* note in margin " Mark III only ".
2	6 (i)	Line 3—after " 32 galls " *insert* " of oil ".
		Line 4—after " 39 galls " *insert* " of oil ".
	7 (iii)	Line 4—for " rear spar " *read* " front spar ".
	8	Line 15—for " Mark XVI " *read* " Mark XIV ".
	14	First 16 lines *amended* by gummed slip.
	15	Line 8—for " lamp " *read* " instrument ".
	34	Sub. para. (i), Line 6 —for " 180 " *read* " 250 ".
		Sub. para. (ii) Line 7 —for " 200 " *read* " 250 ".
		Line 12—for " 600 " *read* " 1050 ".
		Line 13—for " 400 " *read* " 700 ".
	37	Line 2. *Delete* " (250-300 lb./sq. in.) " and *substitute* " (200 lb./sq. in. minimum) ".
	39 (i)	*Amended* by gummed slip.
	39 (iv)	For " (150) " *read* " (155) ".
	40 (i)	*Amended* by gummed slip.
	41 (ii)	*Amended* by gummed slip.
	46	*Add* at end of para. and before NOTE " then increase speed to 145–150 m.p.h. I.A.S."
	55, 56, 57 & 58	*Amended* by gummed slips.
	65	*Add* sub. para. (c), " Ditching should be carried out with flaps 35° down ".
	68	*Isolating valves*, line 2. *Amend* " each flap jack " to read " the flap jacks ". *Engine pump*, line 5. *Delete* " underneath the crank case " and *substitute* " on the gear box ".
	71	*Amend* the following pressures: Undercarriage accumulator .. 250 lb./sq.in. Bomb door accumulator .. 700 lb./sq.in.

P.T.O.

(1595) Wt. 8183/N956 3,500 10/44 C.P. Ltd. Gp. 9. 8. 2.

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