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AIR PUBLICATION 1565 B

Pilots Notes

PILOT'S NOTES

SPITFIRE II A and II B AEROPLANES

MERLIN XII ENGINE

Prepared by direction of the

Minister of Aircraft Production

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Promulgated by order of the Air Council.

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AIR MINISTRY.

AIR PUBLICATION .....

Volume I

Pilot's Notes

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AIR PUBLICATION 1565B
Pilot's Notes

LIST OF SECTIONS

(A detailed Contents List is given at the beginning of each Section)

R.T.P./592.3550.6/40

INTRODUCTION

Note.- This Introduction and Sects.1 and 2 are also issued separately as "Pilot's Notes"

1. The Spitfire II is a single-seater fighter low-wing monoplane powered by a Merlin XII engine driving a Rotal variable-pitch airscrew which is governed by a constant-speed unit. The span of the aeroplane is 36 ft. 10 in. and the overall length is 29 ft. 11 in.

2. The fuselage is of stressed-skin construction and consists of four main longerons, frames of either hoop or U-shape, and alclad plating stiffened between the frames by intercostals; the fin is an integral part of the tail end of the fuselage. The tail plane is also of stressed-skin construction, but the elevators, rudder and ailerons are of metal construction with fabric covering. The main planes are of single-spar stressed-skin construction with a light auxiliary spar and alclad and duralumin sheet covering; there is no centre section, the planes butting against the side of the fuselage. Split-trailing-edge flaps are fitted between the inboard ends of the ailerons and the fuselage sides.

3. The alighting gear consists of two separate retractable undercarriage units and a non-retractable tail wheel unit. The undercarriage units retract upwards and outwards into recesses in the undersurface of the main planes. Pneumatic wheel brakes and oleo-pneumatic shock-absorber struts are fitted.

4. The flying controls are of conventional type and the rudder pedals are adjustable horizontally for leg reach. The control column and rudder bar are connected to the control surfaces by cables. Trimming tabs, controllable from the cockpit, are fitted on the rudder and elevators, but not on the ailerons.

5. The engine is mounted on a tubular structure attached to the fuselage front spar frame. Two fuel tanks, one above the other, are mounted in the fuselage forward of the cockpit. The oil tank is slung below the engine crankcase and two oil coolers, arranged one behind the other, are mounted on the underside of the port main plane. Pressure water-cooling is employed and the radiator is carried in a fairing on the underside of the starboard main plane; a flap, operated from the cockpit, is provided to control the flow of air through the radiator. A Coffman cartridge starter is installed and there is no hand-starting gear.

6. The hydraulic system for raising and lowering the undercarriage is operated by an engine-driven pump, but an emergency system employing compressed carbon-dioxide is provided for lowering the undercarriage. Compressed air for the pneumatic system is supplied by an engine-driven compressor and two storage cylinders and operates the trailing edge

flaps, the gun and camera gun firing and the lowering and raising of the landing lamps, which are mounted on the undersurface of the main planes.

7. Eight Browning .303 in. machine guns are housed in the main planes and fire through tubes in the leading edge. The ammunition boxes, each containing 300 rounds, are mounted in pairs between the guns. Stowage for a parachute flare is provided in the fuselage. A remotely-controlled combined transmitter-receiver is fitted behind the pilot's seat. Power for the electrical services is derived from an engine-driven generator and a 12-volt, 25 A.h. accumulator. A carbon-pile regulator is fitted in the electrical system.

SECTION 1 - PILOT'S CONTROLS AND EQUIPMENT

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

PILOT'S CONTROLS AND EQUIPMENT

Introduction

1. This Section gives the location and, where necessary, explains the function and operation of the controls and equipment in the pilot's cockpit. The layout of the various items is illustrated in figs.1 and 2; each item is given an individual reference number and a key to the items referenced faces each illustration.

AEROPLANE CONTROLS

Control column and rudder bar

2. The control column moves in a fore-and-aft direction for elevator control, and a joint below the spade grip (37) allows lateral movement of the top part for aileron control. The brake lever (see para.42) and gun-firing control (see paras.44 and 45) are mounted on the control column.

3. The rudder is controlled by pedals (41) on sliding tubes attached at their forward ends to a rudder bar. The pedals are adjustable for leg reach, by the rotation of star wheels (42) on the sliding tubes; the adjustment can be carried out in flight.

4. Control locking.- Control locking struts are stowed on the starboard side of the cockpit behind the seat. To lock the control column, the longer strut should be clamped to the control column handle at one end and the other end inserted in a key-hole slot in the starboard side of the seat. The fixed pin on the free end of the arm attached to this strut at the control column end should then be inserted in a lug (72) on the starboard datum longeron thus forming a rigid triangle between the column, the seat and the longeron. To lock the rudder pedals, a short bar with a pin at each end is attached to the other struts by a cable. The longer of the two pins should be inserted in a hole in the starboard star wheel bearing, and the shorter in an eyebolt (77) located on the fuselage frame directly below the front edge of the seat. The controls should be locked with the seat in the up position.

Elevator trimming tabs control

5. The trimming tabs on the elevators are controlled from a handwheel (7) on the port side of the cockpit. When the wheel is rotated clockwise (top in direction marked NOSE DOWN), the action of the tabs tends to depress the nose of the aeroplane and, when the wheel is rotated counter-clockwise (top in direction marked NOSE UP), the effect is reversed.

6. An indicator (21) on the port side of the instrument panel shows the position of the tabs relative to the elevators and is worked by bowden cable from the handwheel.

Rudder trimming tab control

7. The trimming tab on the rudder is controlled from a small

handwheel (3) situated on the port side of the cockpit below and aft of the elevator trimming handwheel. When the wheel is rotated clockwise, the action of the tab tends to turn the aeroplane to starboard and, when the wheel is rotated counter-clockwise, the effect is reversed.

8. A position indicator for the rudder tab is not fitted.

Undercarriage controls

9. The normal system for raising and lowering the undercarriage is hydraulic and is operated by an engine-driven pump. The action of the undercarriage units is governed by a control unit on the starboard side of the cockpit, the unit being operated by a lever (75) in a gated slot on the unit.

10. To raise the undercarriage, the lever should be pushed aft to the end of the quadrant, laterally through the gate and then forwards and upwards to the forward end of the quadrant. This is all the action necessary; as soon as the undercarriage is fully raised and locked, the lever will automatically spring into the gate opening at the forward end of the quadrant and move into engagement with the gate.

11. To lower the undercarriage, the lever should be pushed forward to the end of the quadrant, laterally through the gate and then aft and down to the aft end of the quadrant. As soon as the undercarriage is fully lowered and locked, the lever will automatically spring into the gate opening at the rear end of the quadrant and move into engagement with the gate.

12. The control valve lever must not be moved while the aeroplane is standing on the ground. When it is moved, it must be pushed or pulled to the full extent of the quadrant in order that it may be moved into the gate by means of the automatic cut-out. If the pilot wishes he may move the lever into its final position in the gate in the first instance rather then allow the cut-out to move it into position in the gate. This will not interfere with the working of the system but the lever must be in the appropriate gate at the end of the required operation of the undercarriage.

13. An indicator on the outboard side of the quadrant indicates whether the hydraulic fluid is idling round a by-pass circuit or is either raising or lowering the undercarriage.
Note.- It is important that the undercarriage be operated only at low flying speeds. If attempts be made to raise or lower it at high speeds or during a manoeuvre, the automatic cut-out may shut off the power before the locks are engaged.

Undercarriage position indicators and warning horn

14. Three separate means for indicating the position of the undercarriage units are fitted, one mechanically and two electrically operated.

15. Mechanical position indicator.- A position indicator in the form of a rod that extends through the top surface of the main plane directly behind the spar and about 3 ft. 6 in. from the fuselage side is fitted to each undercarriage unit. When the wheels are down, the rods protrude through the top of the main planes and when the wheels are up, the tops of the rods, which are painted red, are flush with the main plane surfaces.

16. Electrical visual indicator.- An electrically-operated visual indicator (22) is fitted on the port side of the instrument panel and has two semi-transparent windows on which the words UP on a red background and DOWN on a green background are lettered. These words are illuminated according to the position of the undercarriage units, UP when both units are fully retracted and locked and DOWN when both units are fully lowered and locked.

17. The switch for the "down" circuit of the indicator is mounted on the inboard side of the throttle quadrant and is moved to the on position by means of a striker on the throttle lever and should be returned to the off position by hand when the aeroplane is left standing for any length of time. The "up" circuit is not controlled by this switch.

18. The filament lamps behind the windows of the indicator are duplicated and wired in parallel. A roller blind is fitted at the top of the indicator and can be drawn down over the indicator to prevent dazzle during night flying.

19. Warning horn.- The horn for audible warning is mounted behind the pilot, close to his head, and sounds when throttling back if the wheels are not in the down position. The push switch controlling the horn is mounted on the throttle quadrant and is operated by a striker on the throttle lever. When, as during aerobatics or a long glide, it is desirable to stop the horn from sounding, even though the wheels are retracted and the engine throttled back, the pilot may do so by depressing the pushbutton (9) on the side of the throttle switch. As soon as the throttle is again advanced beyond about one-quarter of its travel the pushbutton is automatically released and the horn will sound again on the return.

Undercarriage EMERGENCY lowering

20. For use in event of failure of the normal hydraulic system, a separate system consisting of a sealed high-pressure cylinder containing carbon-dioxide and connected to the undercarriage operating jacks, is provided for lowering the wheels. The cylinder is mounted on the starboard side of the cockpit and can be punctured by means of a red-painted lever (76) beside it. The handle is marked EMERGENCY ONLY and provision is made for fitting a thin copper wire seal as a check against use.

21. If the system fails, the pilot should ensure that the undercarriage control lever is in the DOWN position (this is essential) and push the emergency lowering lever forward and downward.

22. The angular travel of the emergency lever is about 100° for puncturing the carbon-dioxide cylinder and then releasing the piercing plunger; it must be pushed through this movement and allowed to swing downwards. No attempt should be made to return it to its original position until the cylinder is being replaced.

Flaps control

23. The trailing edge flaps are operated pneumatically and are controlled from a finger lever (25) on the top port side of the instrument panel. The lever should be pulled down to lower the flaps. In flight, the air stream raises the flaps when the lever is moved to the UP position, but on the ground they are raised by a compression spring enclosed in a cylinder and connected to the flap.

ENGINE CONTROLS AND EQUIPMENT

Throttle and mixture controls

24. The throttle and mixture levers (10 and 11) are fitted in a quadrant on the port side of the cockpit. An interlocking arrangement between the throttle and mixture levers is provided to prevent the engine from being run on an unsuitable mixture, and a gate is provided for the throttle lever in the take-off position. Adjusters (8) for the stiffness of the controls are provided at the side of the quadrant.

Fuel cock controls

25. Fuel is carried in two tanks mounted one above the other forward of the cockpit and is delivered by an engine-driven pump. The fuel cock controls (38 and 39), one for each tank, are fitted at the bottom of the instrument panel near the centre-line of the aeroplane. In the up position of the levers, the tank cocks are open. Either tank can be isolated, if necessary.

Airscrew speed control

26. The control for the variable-pitch airscrew consists of a lever (12) mounted on the engine control quadrant. In the extreme aft position of the lever, the airscrew blades are held at their maximum coarse-pitch angles and the airscrew functions as a fixed-pitch airscrew. For all other positions of the lever, the airscrew is under constant-speed operation, provided that the airscrew and the constant-speed governor unit are within their limiting conditions; movement of the control forward will increase

the engine r.p.m. and movement aft will decrease the engine r.p.m.

Radiator flap control

27. In order to control the flow of cooling air through the radiator duct, the movable flap at the outlet end of the duct is operated by a lever (40) and ratchet on the port side of the cockpit. To open the flap, the lever should be pushed forward, after releasing the ratchet by depressing the knob at the top of the lever. The normal position of the flap lever for level flight is shown by a red triangle on the instruction plate fitted beside the lever. A notch beyond the normal position in the aft direction is provided for heating the guns at high altitudes.

Boost cut-out EMERGENCY control

28. If it is desired in an emergency to override the automatic boost control, this control can be cut-out by pushing forward the small red-painted lever (14) at the forward end of the throttle quadrant. The lever is sealed as a check against inadvertant operation.

Slow-running cut-out control

29. The slow-running cut-out control on the carburettor is operated by pulling the ring grip (74) adjacent to the priming pump

Engine instruments

30. The engine instruments are grouped on the starboard side of the instrument panel and consist of an engine-speed indicator (58), fuel pressure gauge (59), boost gauge (61), oil pressure gauge (69), oil temperature gauge (67), radiator temperature gauge (63) and fuel contents gauge (46).

Fuel contents gauge

31. The fuel contents gauge (46) on the starboard side of the instrument panel indicates the contents of the bottom tank. The gauge indicates only when the pushbutton inboard of it is pressed. A double scale is provided on the gauge to give a correct reading for both "tail on ground" and "flight" conditions.

Engine priming pump and starting switches

32. A hand-operated pump (44) for priming the engine is mounted on the bottom starboard side of the instrument panel.

The main magneto switches (17) are situated on the port side of the instrument panel and the cartridge starter pushbutton (47) is situated at the bottom of the panel near the centre.

Cartridge starter re-loading control

33. A type L.4 Coffman starter is fitted on the starboard side of the engine and the multi-breech is mounted on the engine mounting. The control (70) for reloading the breech is situated at the bottom starboard side of the instrument panel and is the means by which the breech is rotated to place a new cartridge in position for firing. The control is operated by slowly pulling on the finger ring and then releasing it.

Fuel, oil and coolant

34. The fuel, oil and coolant to be used with the Merlin XII engine are as follows:-

Fuel	100 Octane (Stores Ref.34A/75)
Oil	Specification D.I.D.109 (Stores Ref.34/32 and 33)
Coolant	70% water, 30% Ethylene-glycol Specification 116A (Stores Ref. 336/516)

35. The fuel system is filled through the top tank, the fuel running to the lower tank through a connecting pipe. It is an advantage to have both fuel cocks open during filling so that the normal feed pipes can also serve as a delivery line to the bottom tank; time should be allowed for the fuel to run through these pipes. Access to the oil tank filler cap is obtained through a door on the port side of the engine cowling. The filler is in such a position as to give the correct filling attitude with the aeroplane standing on the ground, tail down. The method of filling the coolant system is described in Section 4, Chapter 1.

HOOD, SEAT, ETC.

Hood

36. The sliding hood over the cockpit is provided with spring catches for holding it either open or shut; the catches are released by two finger levers at the forward end of the hood. From outside, with the hood closed, the catches can be released by depressing a small knob at the aft end of the windscreen. Provision is made on the door to prevent the hood from sliding shut if the aeroplane overturns on landing (see para.40)

37. A small knock-out panel for emergency use is provided on the port side of the hood.

Seat

38. The seat is constructed to take a seat-type parachute and is adjustable for height by means of a lever on the right-hand side of the seat. The lock for securing the seat at the desired height can be released by depressing the knob at the end of the lever.

39. Sutton harness is fitted to the seat and the shoulder straps are anchored to a special fitting on the fuselage structure in order that the pilot may lean forward without unfastening his harness. The extension is obtained by releasing the bolt-type catch (73) on the starboard datum longeron beside the seat. When the pilot leans back again, the catch automatically snaps home into position.

Protection of pilot

40. Sheets of armour plate are fitted behind the fireproof bulkhead forward of the upper fuel tank, on the back of the pilot's seat and on the fuselage frame behind the pilot's seat. A panel of extra thick glass is fitted on the windscreen to render it bulletproof. The lower fuel tank is covered with self-sealing rubber.

Cockpit door

41. To facilitate entry to the cockpit, a portion of the coaming on the port side is hinged. The door catches are released by means of a handle at the forward end. Two position catches are incorporated to allow the door to be partly opened before taking off or landing in order to prevent the hood from sliding shut if the aeroplane should overturn.

OPERATIONAL EQUIPMENT

Brakes control

42. A control lever for the pneumatic brakes is fitted on the control column spade grip; differential control of the brakes is provided by a relay valve connected to the rudder bar. A catch for retaining the brake lever in the on position for parking is fitted below the lever pivot. A triple pressure gauge (18), showing the air pressure in the pneumatic system cylinders and at each brake, is mounted on the port side of the instrument panel.

43. In connection with parking, it should be noted that, when parking the aeroplane in the open during windy weather, either the rudder control should be locked or the wheels chocked against movement to the rear (see A.M.O.114/38).

Gun-firing control

44. The eight guns are fired pneumatically by means of a pushbutton fitted in the control column spade grip. The compressed air supply is taken from the same source as the brake supply, the available pressure being shown by the gauge (18) referred to in para.42.

45. A milled sleeve, surrounding the pushbutton can be rotated by a quarter of a turn to a safe position in which it prevents operation of the button. The SAFE and FIRE positions are engraved on the sleeve and can also be identified by touch as the sleeve has an indentation which is at the bottom when the sleeve is in the SAFE position and is at the side when the sleeve is turned to the FIRE position.

Camera gun controls

46. A C.42B cine-camera is fitted in the leading edge of the port plane near the root end and is operated by the gun firing button on the control column spade grip, a succession of exposures being made during the whole time the button is depressed.

47. A footage indicator and an aperture switch are mounted on the wedge plate above the throttle lever. The switch enables either of two camera apertures to be selected, the smaller aperture being used for sunny weather. A stowage clip is provided to receive the electrical cable (13) when the indicator and switch are not fitted. A main switch (5) for the cine-camera gun is mounted on the port side of the cockpit.

Reflector gun sight

48. For sighting the guns a reflector gun sight (type G.M.2) is mounted on a bracket (53) above the instrument panel. A main switch (50) and dimmer switch (51) are fitted below the mounting bracket. The dimmer switch has three positions marked OFF, NIGHT and DAY. Three spare lamps for the sight are stowed in holders (60) on the starboard side of the cockpit.

49. The sight casts upon a tilted reflector glass an image consisting of a central dot surrounded by a circle from the circumference of which vertical and horizontal radial lines extend outwards. The range at which the sight is set depends upon the width of the gap between the inner ends of the two horizontal lines. The gap can be varied by the rotation of two engraved adjusting rings at the base of the sight; the upper ring is marked RANGE-YARDS and the lower one BASE-FEET.

The method of setting the sight on the target is as follows:-

(i) The range in yards at which fire will be opened having been previously decided, the upper adjusting ring should be set to this range

(ii) The identity of the target aircraft having been established, its span should be known approximately and the lower ring should be set to this span in feet.

(iii) When the target spans the gap between the inner ends of the horizontal lines the guns are ranged for opening fire.

50. When the sight is used during the day, the dimmer switch should be in the DAY position in order to give full illumination and, if the background of the target is very bright, a sunscreen (54) can be slid behind the windscreen by pulling on the ring (52) at the top of the instrument panel. For night use, the dimmer switch should be in the NIGHT position; in this position a low-wattage lamp is brought into circuit and a resistance, variable by rotating the switch knob, is interposed.

Landing lamps

51. The landing lamps, one on each side of the aeroplane, are housed in the undersurface of the main plane. The lamps are raised and lowered pneumatically and are controlled from a finger lever (36) on the port side below the instrument panel. The lever should be pulled down to lower the lamps, and pushed up to raise them. The lamps must not be lowered when flying at speeds above 140 m.p.h.

52. Each lamp has an independent electrical circuit and is controlled by a switch (16) above the pneumatic control lever. In the central position of the switch, both lamps are off and, when the switch knob is moved to starboard or to port, the starboard or the port lamp is illuminated, respectively.

53. Outboard of the pneumatic control lever, a lever (15) is provided to control the dipping of both landing lamps. To dip the beam, the lever should be pulled up.

Navigation and identification lamps

54. The switch (24) controlling the navigation lamps is fitted at the top port corner of the instrument panel.

55. The upward and downward identification lamps are controlled from the signalling switchbox (64) on the starboard side of the cockpit. This switchbox has a switch for each lamp and a morsing key and provides for steady illumination or morse signalling from each lamp or both. The switch lever has three positions marked MORSE, OFF and STEADY.

56. The spring pressure on the morsing key can be adjusted by turning the small ring at the top left-hand corner of the

switchbox, the adjustment being maintained by a latch engaging one of a number of notches in the ring. The range of movement of the key can be adjusted to suit the operator by opening the cover and adjusting the screw and locknut at the centre of the cover.

Wireless controls

57. The aeroplane is equipped with a combined transmitter-receiver, either type T.R.9D or T.R.1133, located behind the pilot's seat.

58. T.R.9D installation.- With the T.R.9D installation, a type C mechanical controller (19) is fitted on the port side of the cockpit above the throttle lever. The controls comprise a central knob and an upper and lower lever. The upper lever should be pushed forward for "receive", pulled backward for "transmit" and moved to the central position to switch off the wireless unit; the lever can be locked in the off position by means of a latch that engages in a notch on the controller casing. The lower lever operates the fine-tuning control and is used during flight to make slight adjustments only, the main tuning of the receiver being pre-set on the ground. The central knob is the volume control and should be turned clockwise to increase the volume.

59. A remote contactor (66) and contactor master switch are fitted on the starboard side of the cockpit. The master contactor is mounted behind the pilot's headrest on the port side and a switch controlling the heating element is fitted on the forward bracket of the mounting. The heating element should always be switched off when the pilot leaves the aeroplane.

60. The microphone-telephone socket is fitted on the starboard side of the fuselage adjacent to the seat.

61. T.R.1133 installation.- With the T.R.1133 installation, the contactor gear and microphone-telephone socket are as described in paras.59 and 60 but the type C mechanical controller is replaced by a pushbutton electrical control unit.

62. The pushbutton control unit has a number of pushbuttons, one for switching the unit off and the others for switching the unit on and selecting pre-determined communication channels. In addition, there is a switch lever, which can be moved to three positions, viz. "receive", "voice-operated" and "transmit", marked R, V.O. and T respectively. With the lever at V.O., the unit normally remains on "receive" but automatically switches to "transmit" when the pilot speaks into the microphone; if, however, the cockpit hood is open, the noise of the engine will keep the unit on "transmit" and in these circumstances the lever must be moved to R when reception is desired; when the guns are being used, a switch operated by the gun-firing pneumatic circuit keeps the unit on "receive" unless the lever is moved to T. A white lamp next to the switch lever is illuminated when the unit is

receiving and goes out when the unit is transmitting. By the side of each channel-selecting button is a green lamp which is illuminated when the unit is operating on that channel.

Parachute flare release control

63. The control handle (1) for releasing the parachute flare carried in the rear fuselage is located on the port side of the cockpit. The handle should be pulled upwards to release the flare.

Oxygen equipment

64. A single oxygen cylinder is stowed behind the seat within reach of the pilot. A standard regulator unit (23) is fitted on the port side of the instrument panel and a bayonet socket (66) for the low pressure supply to the mask is fitted on the starboard side of the cockpit. There is also a spring clip fixed to the starboard side of the cockpit beside the pilot's shoulder to hold the mask hose clear of his movements.

Pressure head heating switch

65. The heating element in the A.S.I pressure head is controlled from a switch (4) below the trimming tab hand-wheels. To prevent undue discharge of the battery the element should be switched off on landing.

MISCELLANEOUS EQUIPMENT

First-aid outfit

66. The first-aid outfit is stowed aft of the wireless equipment and is accessible through a hinged panel on the port side of the fuselage.

Navigational equipment

67. A metal case (6) for a writing pad and another (2) for maps, books etc. and a course and height indicator are fitted on the port side of the cockpit. Stowage (71) for a height and air-speed computor is provided below the wireless remote contactor.

Ventilator

68. A small adjustable flap on the starboard coaming above the instrument panel is provided for ventilation of the cockpit. The flap is opened by turning a knurled nut (57) underneath the flap.

Key to fig.1

Port side of cockpit

1. Flare release control
2. Log stowage box
3. Rudder trimming tab control
4. Pressure head heating switch
5. Camera gun master switch
6. Writing pad container
7. Elevator trimming tab control
8. Throttle and mixture friction adjusters
9. Push switch for silencing warning horn
10. Throttle lever
11. Mixture lever
12. Airscrew control lever
13. Connection for cine-camera footage indicator
14. Boost cut-out control
15. Landing lamp dipping lever
16. Landing lamps switch
17. Main magneto switches
18. Brake triple pressure gauge
19. Wireless remote controller
20. Clock
21. Elevator trimming tabs position indicator
22. Undercarriage position indicator
23. Oxygen regulator
24. Navigation lamps switch
25. Flaps control

27. Instrument flying panel
28. Airspeed indicator
29. Artificial horizon
30. Altimeter
31. Direction indicator
32. Setting knob for (31)
33. Compass deviation card holder
34. Cockpit lamp dimmer switches
35. Brake lever
36. Landing lamp lowering control
37. Control column
38. Fuel cock lever (top tank)
39. Fuel cock lever (bottom tank)
40. Radiator flap control lever
41. Rudder pedals
42. Rudder pedal leg reach adjusters

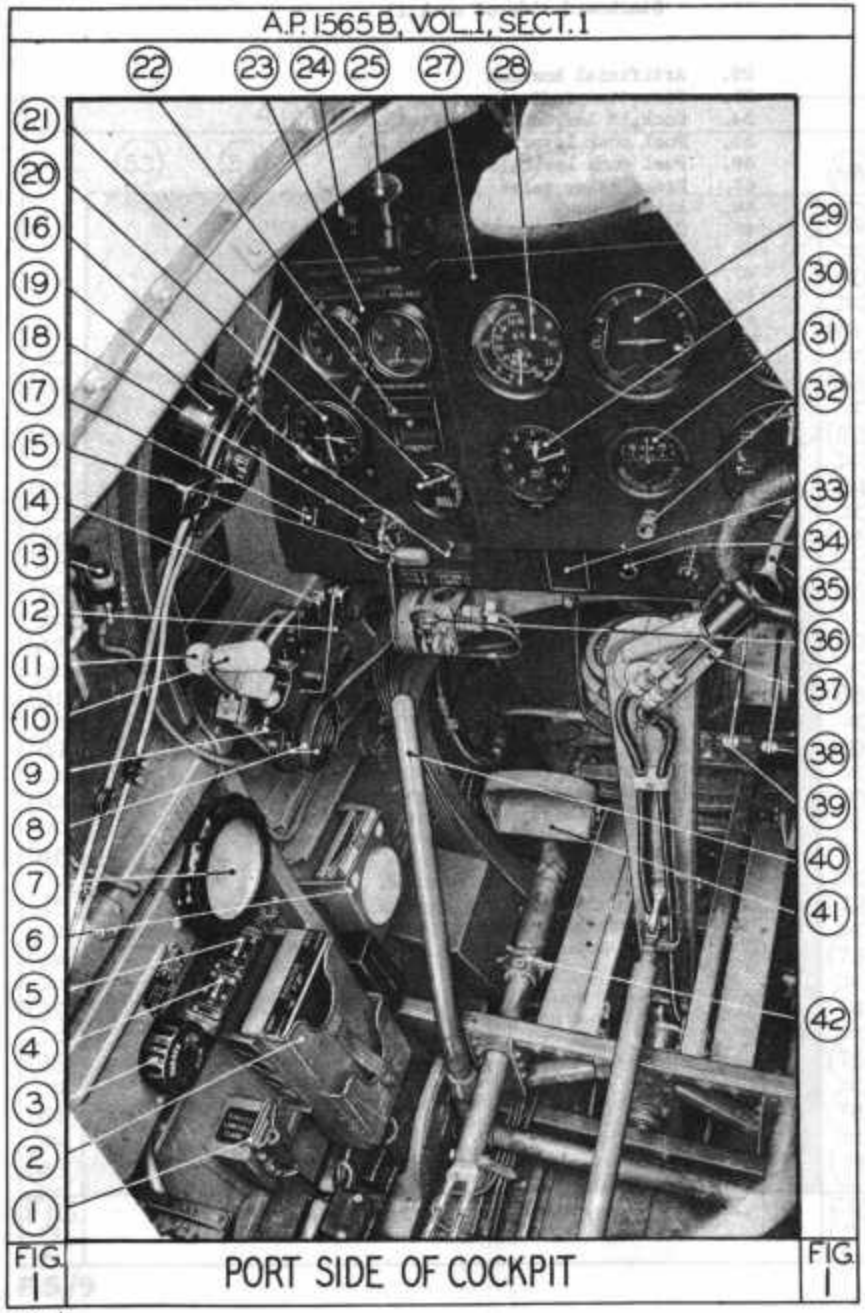

FIG. 1 PORT SIDE OF COCKPIT FIG. 1

Key to fig.2

Starboard side of cockpit

29. Artificial horizon
31. Direction indicator
34. Cockpit lamp dimmer switch
38. Fuel cock lever (top tank)
39. Fuel cock lever (bottom tank)
43. Brake relay valve
44. Priming pump
45. Compass
46. Fuel contents gauge
47. Engine starting pushbutton
48. Turning indicator
49. Rate of climb indicator
50. Reflector sight main switch
51. Reflector sight lamp dimmer switch
52. Lifting ring for dimming screen
53. Reflector gun sight mounting
54. Dimming screen
55. Ammeter
56. Generator switch
57. Ventilator control
58. Engine speed indicator
59. Fuel pressure gauge
60. Spare filaments for reflector sight
61. Boost gauge
62. Cockpit lamp
63. Radiator temperature gauge
64. Signalling switch box
65. Oxygen socket
66. Wireless remote contactor mounting and switch
67. Oil temperature gauge
68. Engine data plate
69. Oil pressure gauge
70. Cartridge starter reloading control
71. Height and airspeed computor stowage
72. Control locking lug
73. Harness release
74. Slow-running cut-out control
75. Undercarriage control lever
76. Undercarriage emergency lowering lever
77. Control locking lug

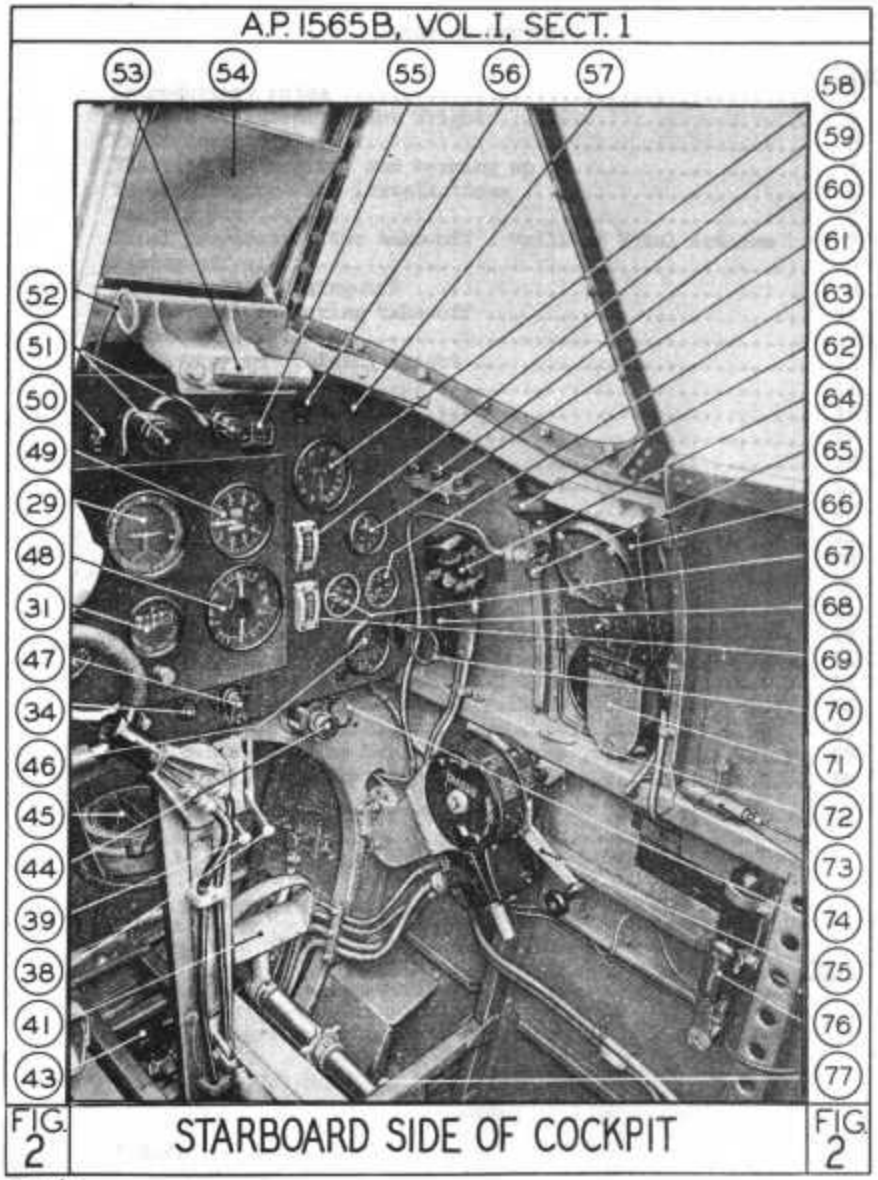

FIG. 2 STARBOARD SIDE OF COCKPIT FIG. 2

SECTION 2 - HANDLING AND FLYING NOTES FOR PILOT

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LIST OF ILLUSTRATIONS

SECTION 2

HANDLING AND FLYING NOTES FOR PILOT

INTRODUCTORY NOTES

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

(i) Hydraulic system.- This operates the undercarriage by means of an engine-driven hydraulic pump. The pilot's control consists of a selector lever having two positions, i.e. CHASSIS UP and CHASSIS DOWN. The lever should be always in the CHASSIS DOWN gate when the aeroplane is on the ground. The method of operating the system is given in Section 1.

(ii) Undercarriage EMERGENCY lowering gear.- This is provided to lower the undercarriage in the event of the normal system failing. It consists of a separate pressure system with a control in the cockpit. The pressure is obtained from a $C.O_2$ cylinder specially installed for the purpose. For method of operation and further particulars see para. 52 and Section 1.

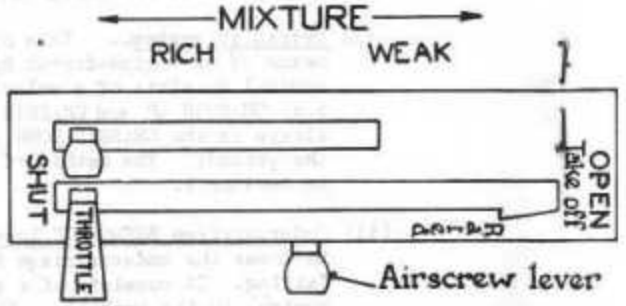
(iii) Undercarriage position indicators.- Mechanical indicators, one for each undercarriage unit, are situated in the main planes. These are flush with the surface of the plane when the undercarriage is UP. In addition the usual warning horn and red and green light indicator are provided. The mechanical indicators show the position of the undercarriage units throughout their travel whilst the light indicator shows that the units are locked in the up or down position:- RED (up) GREEN (down).

(iv) Pneumatic system.- This operates the wing flaps, wheel brakes, landing lamps, gun firing mechanism and cine camera. An engine-driven pump supplies air pressure to air bottles in the fuselage.

(v) Flaps.- These are split flaps, having only two positions - UP and fully DOWN, at an angle of 85°. They are operated by pneumatic pressure from an air bottle controlled by a small finger-operated lever. They are for slow speed and landing only, and cannot be used to assist take-off.

(vi) Wheel brakes.- These are of the differential type, operated from the pneumatic system by a hand lever.

Note:- It is important to keep a check of the contents of all the tanks during flight. Any tank that is emptying should be turned OFF before it is completely exhausted to prevent sucking air into the fuel system



THROTTLE AND MIXTURE AND AIRSCREW CONTROLS

NOTE:- Relief valves integral with pump

FIG. 1

FUEL SYSTEM DIAGRAM

FIG. 1

(vii) Landing lamps.- These are stowed flush with the under surface of the wing, on each side, and are put down and up by the pneumatic system, controlled by a small lever similar to the flaps lever. Their beam is also adjustable by another lever. They must NEVER be down except at low speed.

(viii) Gun-firing system.- Operated by the pneumatic system, controlled by a press-button mounted on the top of the control column spade grip.

(ix) Trimming tabs.- These are fitted to the elevator and rudder, and are controlled by wheels on the left of the cockpit. The elevator trimming tabs are very sensitive at moderate and high speeds; they may be used to assist in manoeuvres, and recovery from a dive, provided they are always used slowly and carefully.

(x) Airscrew.- This is a Rotol variable-pitch type governed by a constant-speed unit. The pilot's control regulates the engine r.p.m. through the action of a governor unit which controls the airscrew pitch according to the power output and in relation to the airspeed. The pitch range is so great (35°) that a steep dive at maximum permissible airspeed may be done without an increase in cruising r.p.m. originally selected by the pilot.

(xi) Mixture control.- This is automatic, but the pilot has a "switch" lever which selects either NORMAL (when mixture is kept constant, automatically weakening with increase of height, at the optimum value); or WEAK (when the mixture is similarly controlled, but at a weaker value, for greater economy at low cruising speeds).

(xii) Automatic boost control.- This prevents the maximum permissible boost of +9 lb./sq.in. from being exceeded when the throttle lever is in the rated position. Below this figure the pilot controls the boost by the throttle. With the throttle lever in the take-off position 12½ lb./sq.in. boost is obtained at low altitude.

(xiii) Radiator flaps and thermostatic control.- The coolant temperature is controlled by a thermostatic control (automatic) and a radiator flap which regulates the flow of air through the radiator, but which cannot be fully closed. The position of the radiator flap affects the lateral trim of the aircraft (the radiator being under the starboard wing), and can usually be kept in the closed position during cruising flight.

(xiv) Cockpit hood.- This can be locked either closed or open, but not in any other position. Air pressure at high speed acts in such a direction that it tends to keep the hood forward, and it is very difficult to open it in a dive. Great care is necessary to avoid getting the arm out into the airflow when operating it at speed, (over about 140 m.p.h. A.S.I.). The arm could easily be dislocated at high speed.

(xv) EMERGENCY EXIT.- A hinged door is fitted to the left side of the cockpit, the locking catches of which are operated by a small lever. It is essential that the hood should be fully open, as otherwise it runs in a groove on top of this door, and prevents its being opened. The door is provided with a double lock which is designed to give a "half-cock" position for use when taking off and landing. With the hood fully open and the door at "half-cock" the hood cannot slide forward if the aeroplane were to turn over when landing.

(xvi) Ventilation.- A controllable inlet for fresh air is provided to the right of the windscreen.

(xvii) Rudder pedal adjustment.- Independent adjustment to each pedal is fitted.

(xviii) Fuel system.- A diagram and particulars of the fuel system are given in fig.1. Fuel is fed to the engine by a fuel pump which draws fuel from one or both fuel tanks. These are mounted one above the other, contain 48 gallons (upper) and 37 gallons (lower) - 85 gallons total - and communicate with each other by an open pipe, so that the lower tank is kept full as long as there is fuel in the upper tank. A cock is provided to each tank, so that fuel may be drawn from the upper tank alone, or from the bottom of the lower tank.

(xix) Fuel, oil and coolant filling points.- These are situated as follows:-

(a) Fuel.- Top of fuselage in front of windscreen.

(b) Oil.- Through a door in the engine cowling on the port side. Correct level is obtained when the aircraft is standing with its tail on the ground.

(c) Coolant.- Through a door in the engine top cowling panel, (access to the header tank).

FITNESS OF AEROPLANE FOR FLIGHT

2. Ensure that the total weight and disposition of the load are in accordance with the Weight Sheet Summary, and ascertain that the aeroplane is in all other respects fit for flight.

PRELIMINARIES

3. On entering the cockpit make the following preparations. See that.-

(i) The ignition switches are - OFF.

(ii) The undercarriage selector lever is in the DOWN gate, and the indicator shows the word "IDLE".

(iii) Switch on the light indicator and check by the green lights that the undercarriage is locked in the down position.

(iv) The flaps are - UP.

(v) The landing lamps are - UP.

(vi) The wheel brakes are - ON.

Check.-

(vii) The contents of the fuel tanks.

(viii) The movement of the flying controls.

STARTING THE ENGINE AND WARMING UP

Note.- For full details of the Merlin XII engine see A.P.1590F, Volume I.

4. Whenever possible the pilot should start the engine himself; this will ensure that he has ample time to carry out all the checks, and that unnecessary running of the engines is avoided.

(i) Set mixture control back to NORMAL.

(ii) Set pitch controls fully forward to FINE PITCH.

(iii) Set radiator shutter fully OPEN.

(iv) Raise both fuel cock levers to ON.

(v) Prime the cylinders, by injecting five effective shots of fuel. See that pump is screwed down after priming.

(vi) Ensure that everyone is clear of the airscrew.

(vii) Cartridge starting.- Switch ON ignition switches, keep the throttle open slightly and press the starter button until the engine is firing evenly.

Note.- Do not oscillate the throttle lever, but open it slowly to get the engine running smoothly at a fast tick-over; if the engine begins to fade, or "spit back", close the throttle quickly and open it up again very slowly.

(viii) See that the oil pressure is satisfactory.

(ix) Warm up at a fast tick-over until the oil temperature is at least 15°C., and the radiator temperature reaches about 70°C.

TESTING ENGINE AND INSTALLATIONS

5. The engine should not be run at full power for more than a few seconds - just long enough to test magnetos and observe oil pressure, boost and r.p.m.

Important.- The engine should on no account be opened up with the airscrew in coarse pitch (control lever back) as the blade angle is too coarse and severe detonation will result.

During warming up

(i) Fuel pressure - 2½ to 3 lb./sq.in.

(ii) Brake pressure - Reservoir pressure at least 120 lb./sq.in.

(iii) Pneumatic system - put flaps down and up again.

(iv) Set altimeter and directional gyro.

(v) Ensure that the hood is locked open. Set emergency exit door at half-cock position.

(vi) Harness release in "fixed" position.

(vii) Make any other general preparations for flight.

Note.- Warming up should not be unduly prolonged, as the temperature rises quickly, and some margin must be kept in hand for taxying. If it is 130° before the aeroplane taxies out, it will become excessive if there is any distance to taxy downwind. The engine should not idle for any length of time in a light wind, and the aircraft should always face into wind.

(viii) Test the engine as follows:-

(a) Open up (in fine pitch) to rated gate. Ensure that there are TWO men holding down the tail.

Check - Boost - +9 lb./sq.in.

R.p.m. - 2,750 to 2,850

Oil pressure - 60 lb./sq.in. (at NORMAL temperature).

(b) Test separate magnetos at full throttle (take-off). Ensure that the r.p.m. drop does not exceed 80. This must be done with the airscrew lever in the fully forward position to give maximum r.p.m.

(c) Test the airscrew-pitch control.- With throttle at rated gate pull back the airscrew control slowly until the r.p.m. drop to 2,400 (no further). Then throttle down a little and observe that the r.p.m. are maintained at 2,400 in spite of throttle movements, though the r.p.m. will, of course, drop if the throttle is brought right back. Return to fine pitch after test.

(d) Wave away the chocks.

TAXYING OUT

6. Before taxying out ensure that:-

(i) The parking brake is released.

(ii) The radiator shutter is fully open.

(iii) There is ample brake pressure. If this fails while taxying, for any reason, such as a blown union, apply full brake at once in order to stop while there is still some pressure left.

(iv) Note the following:-

(a) Use the brakes as little as possible in taxying, in order to save wear.

(b) It may be found that one wing tends to remain down while taxying. This is due to stiffness in the undercarriage leg, especially in a new machine, and does not matter, except when taxying in a gale; it would then be advisable to have men at each wing tip.

(c) The throttle friction adjustment should not be slackened off, even if taxying would then be easier; if the pilot is in the habit of keeping it tight, he will never be subject to the risk of loss of engine power, while

taking off, due to the throttle coming back when his hand is not on the throttle lever (when raising the undercarriage).

(d) Clearing engine before take-off.- The engine should not be allowed to idle too slowly, and should be "cleared" before taking off by opening up to moderate r.p.m. against the brakes, care being taken to hold the stick fully back, and not to raise the tail by opening up to too high a power. Ensure that the maximum temperature limit is not exceeded (120°C.).

FINAL PREPARATION FOR TAKE-OFF - DRILL OF VITAL ACTIONS

7. On reaching the take-off position, stop across wind, facing the aerodrome circuit, and carry out the Drill of Vital Actions. Some of this may already have been done, but must invariably be checked before every take-off. A convenient catch-phrase is applied to this drill "T.M.P. and Flaps".

(i) - T - Trimming tabs - Elevator about one division nose down from neutral. Rudder about central or, if preferred fully to starboard.

(ii) - M - Mixture control - Back to NORMAL

(iii) - P - Pitch control - FULLY FINE (lever fully forward)

and

Flaps - UP (These must never be down when taking-off, as they would be at 85°).

Note.- The aeroplane would, however, take-off with flaps down, and if, by a serious omission of drill, the pilot leaves them down, he must on no account raise them until speed is at least 120 m.p.h. A.S.I. at a safe height.

TAKING-OFF

8. Turn into wind, steady the aeroplane, and move forward slowly to straighten up the tail wheel; then open to full throttle and take-off by holding the aeroplane to a constant attitude. The tail need not be raised much - the take-off run is only about 150 yards, and the time less than 9 seconds. Any tendency to swing left can easily be counteracted by coarse rudder control. Hold down almost to level flight.

ACTIONS AFTER TAKING-OFF

9. Proceed as follows:-

Immediate actions.- After taking-off carry out the following Drill of Vital Actions. Catch-phrase - "U.P."

(i) As soon as the aeroplane is FINALLY clear of the ground, wait for a few seconds (not more than about five) to ensure that the aeroplane is gathering speed, and that it will not touch the ground again, and then, after observing carefully that the aeroplane is several feet clear, especially if the aerodrome surface rises,

U - Raise the undercarriage. On no account must the climb be started at this stage; the aeroplane should be held almost to level flight until a safe speed of 140 m.p.h. A.S.I. is reached (it should then be, roughly speaking between 10 to 20 feet clear of the ground or obstructions). Ensure that the red indicator light - UP - comes on (it may be necessary to hold the lever hard forward against the quadrant until the indicator comes ON)

(ii) Then start a gradual climb, throttle down to the rated (+9 lb./sq.in. boost) position and:-

P - Move pitch control back to give 2,850 r.p.m.

(iii) Continue to accelerate until the airspeed reaches a climbing speed of 185 m.p.h. A.S.I. at +9 lb./sq.in. boost and then adjust the attitude to maintain this speed.

Subsequent actions.- These may be performed at leisure, though without undue delay.

(iv) Observe oil pressure (60 lb./sq.in.). The habit should be formed of looking at this first and foremost. An engine can seize up in less than a minute if the oil pressure fails.

(v) Fully close the emergency exit door and then close the cockpit hood.

(vi) Close the radiator shutter (unless a high power climb is done, when the lever should be a little forward).

(vii) Make any further adjustments to the engine and airscrew controls as desired.

(viii) Note the radiator and oil temperatures.

(ix) Lock round the cockpit systematically.

10. Feet may be taken off the rudder control to save fatigue, as its use is only necessary when taking-off, landing, flying at low speed or aerobatics. Even aerobatics, such as rolls, can be done with feet clear of the rudder control, but rudder would be needed

for recovery if the manoeuvre were badly done. It is advisable to acquire the habit of flying without rudder control, as this is best when flying by instruments, especially when in difficulties in clouds (apart from a spin). See "Flying by instruments", para.15.

ENGINE FAILURE DURING TAKE-OFF

11. In case of engine failure during take-off, the first and foremost essential is MAINTAIN AMPLE FLYING SPEED.

Act as follows:-

(i) Put the nose down.

(ii) If the undercarriage selector lever is not in UP, put it there. This should be enough to cause the undercarriage to collapse on touching the ground, or very soon after.

(iii) Lower the flaps (if there is time); but this is of lesser importance.

(iv) Land straight ahead. ON NO ACCOUNT attempt to turn, as this invariably leads to disaster, unless the aeroplane is dived down close to the ground before any turn is started.

(v) If there is ample height and if there is no hope of getting the engine to run, the fuel cocks and switches should be turned OFF; but fuel cocks are usually awkward, and no attempt should be made to turn them off if this will interfere with full control.

CLIMBING

12. This aeroplane may be climbed for periods of thirty minutes at a boost pressure of +9 lb./sq.in. and 2,850 r.p.m. In this condition the best climbing speed is about 160 m.p.h. A.S.I. up to the rated altitude (13,000 ft.). For normal climbing, however, the following speeds are recommended:-

Ground level to	13,000 ft.	- 185 m.p.h. A.S.I.
	15,000 ft.	- 180 m.p.h. A.S.I.
	20,000 ft.	- 160 m.p.h. A.S.I.
	25,000 ft.	- 140 m.p.h. A.S.I.
	30,000 ft.	- 125 m.p.h. A.S.I.
	35,000 ft.	- 110 m.p.h. A.S.I.

Note the following:-

(i) Watch the radiator and oil temperatures, and adjust the

radiator shutter if necessary.

(a) Maximum radiator temperature 120°C.
(b) Maximum oil inlet temperature 90°C.

(ii) This aeroplane climbs at a very steep attitude and there is a large blind area in front. Care should be taken not to climb straight for too long in case of the approach of hostile aircraft from ahead. A slight turn only need be made.

THE ENGINE IN CRUISING FLIGHT

13. The engine should normally be run at the lowest speed necessary for the occasion, to reduce maintenance and economise fuel; but avoid running it at a rough period. The limits of r.p.m. and boost are as follows:-

(i) All-out level (less than 5 minutes).- The limiting figures are 9 lb./sq.in. boost and 3,000 r.p.m. for 5 minute periods. The aeroplane should never be flown all-out except in emergency; it may shorten the life of the engine.

(ii) Continuous cruising.- The limiting figures are as follows:-

(a) Maximum continuous cruising (NORMAL).- With the mixture control lever at NORMAL, +7 lb./sq.in. boost and 2,650 r.p.m. must not be exceeded.

(b) Maximum continuous cruising (WEAK).- With the mixture control lever at WEAK, +3¾ lb./sq.in. boost and 2,650 r.p.m. must not be exceeded.

Note.- These are the upper limits, and indicate that the engine should be run at less than these speeds and boost.

(iii) Economical cruising.- The lower the engine speed the lower the fuel consumption, in gallons per hour, but, to obtain "most miles per gallon", which will give the maximum range on the fuel carried, a slightly higher speed than the minimum at which the aeroplane will fly, gives the best results. The greatest range will be obtained at a speed of about 200 m.p.h. A.S.I. The airscrew pitch should be adjusted to give about 1,700 r.p.m.

Note.- Approximately the same range will be obtained at the same A.S.I. reading at any height; for example, the range will be about the same whether the aircraft is flown at 2,000 ft. at 200 m.p.h. A.S.I., or at 20,000 ft. at 200 m.p.h. A.S.I. (a much higher true speed, but with a higher consumption to maintain it).

(iv) Engine temperature.- The limits laid down must never be exceeded: the radiator flap should be used to control the radiator, and, indirectly, the oil temperature.

(v) Mixture controls.- The automatic mixture control will weaken the mixture as height is increased, whether the lever is back to NORMAL or forward to WEAK. Weak mixture must not be used at more than +3¾ lb./sq.in. boost, except for momentary bursts which may be required for keeping station when flying in formation.

(vi) Engine data plate.- Use this for reference, keeping strictly within the limits set out.

(vii) Minimum speed to hold height.- This is about 90 m.p.h. A.S.I. No boost is indicated, but r.p.m. should be kept (by means of the airscrew control) high enough to prevent rough running of the engine.

(viii) Relation between speed and r.p.m.- The best results will be obtained if the speed and r.p.m. are kept approximately as indicated by the following table:-

A.S.I. reading 200 m.p.h.	-	1,700 r.p.m.
A.S.I. reading 220 m.p.h.	-	1,750 r.p.m.
A.S.I. reading 240 m.p.h.	-	2,000 r.p.m.
A.S.I. reading 260 m.p.h.	-	2,400 r.p.m.
A.S.I. reading 280 m.p.h.	-	2,600 r.p.m.
A.S.I. reading 325 m.p.h.	-	2,600 r.p.m.

GENERAL FLYING

14. This aeroplane is stable, and rock-steady in flight at high speed. The controls are not ideal, because it will be found that the aileron control becomes exceedingly heavy at high speed, while the elevator remains comparatively light and sensitive. Individual aeroplanes vary slightly, but in most cases care is needed in the use of the elevator control at high speed, to avoid sudden increases of load factor, or "g". During a tight turn or loop in bumpy conditions, movements of the pilot's body due to bumps are liable to cause movement of the controls and so large and sudden fluctuations in "g". It is then advisable to press the elbow into the side to steady it. All normal flying should be done by aileron and elevator control, and it will reduce fatigue if the feet are taken off the rudder pedals, as rudder control is only required in certain aerobatics and to assist extra rapid increase of bank if desired. It is particularly important that the feet should be off the rudder when flying by instruments.

out of the dive too early, because the semi-stalled condition of the wings persists until considerable excess speed has been gained in the dive, and if the stick is brought back too soon, another spin will result. Allow the aeroplane to gather a speed of well over 150 m.p.h. A.S.I. before gradually easing out, if there is ample height. If not, great care would be needed, because more height will be lost if another spin results from premature pulling out, than if a slightly prolonged dive is made.

GLIDING

19. Gliding may be carried out at any speed up to that of a dive, and down to the safe margin of about 25% above stall. Lowering the flaps causes a distinct change of attitude, the nose being lower at a particular speed. Rate of descent, and angle of glide path are also increased. Note the following:-

(i) Long distance gliding.- With flaps and undercarriage up the glide is very flat, and long distances can be covered when gliding at the optimum speed of about 100 m.p.h. A.S.I. A switch is provided to stop the undercarriage warning horn at such a time.

(ii) Approach glides.- Before lowering the flaps the minimum gliding speed should be about 120 m.p.h. A.S.I., or more if turns are done. With flaps down, the correct gliding speed for this final glide before flattening out is about 90 m.p.h. A.S.I. This will allow a smooth flattening out and a little float.

(iii) Gliding turns.- Speed should be increased, especially if turns have to be done at a low altitude or with flaps down, when controls are a little sluggish unless speed is well over 100 m.p.h. A.S.I. Gliding turns near the ground should be avoided.

(iv) Effect of fine pitch.- With the airscrew in fully fine pitch, the glide path is distinctly steeper and the rate of descent is slightly higher, and so, for an engine-off approach, a little more speed should be used.

(v) Engine-assisted glide.- Opening up the engine to a fast tick-over will flatten the glide path and the attitude of the aeroplane, reduce the rate of descent and enables the pilot to regulate the glide path by use of the engine. Airspeed should be about 80 to 85 m.p.h. A.S.I.

(vi) Effect of rudder.- Applying rudder has the effect of increasing the rate of descent and steepness of the glide slightly. Therefore, it is important not to use the rudder, unless a deliberate sideslip is done, when gliding in to land, because it may cause the aeroplane to undershoot.

(vii) Flaps.- The flaps must be UP at speeds over 120 m.p.h. A.S.I. If this speed is exceeded with flaps DOWN, they will partially retract.

SIDESLIPPING

20. This aeroplane sideslips quite satisfactorily with the flaps UP or DOWN. Maintain speed (slightly above the normal gliding speed) when sideslipping.

DIVING

21. The maximum permissible diving speed is 450 m.p.h. A.S.I. Note the following:-

(i) Constant-speed airscrew.- At maximum r.p.m. 3,000 , the throttle must be 1/3 open. The pitch control need not be brought back to reduce r.p.m., the range of pitch is enough to hold down the r.p.m. at any airspeed.

(ii) The flaps must be up at over 120 m.p.h. A.S.I.

(iii) The aeroplane should be trimmed in the dive, i.e. the trimming tab control should be set to give no load on the elevator. This will lessen the possibility of excessive "g" being induced in easing out of the dive particularly if the pilot should release his hold on the stick owing to "blacking-out" or any other reasons. No difficulty in easing out of the dive will be experienced even if the aeroplane is trimmed in the dive as the elevator control is comparatively light and recovery from the dive is not resisted by excessive stability in pitch. Elevator tabs may be used, very carefully, as described in para.14.

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

AEROBATICS

22. General remarks.- The Spitfire is an exceptionally good aeroplane for aerobatics, but spinning is prohibited and aerobatics must not be performed below 5,000 ft. Aerobatics on this aeroplane may be done only by pilots who have adequate flying experience of the aeroplane and who have written authority from their Squadron Commander. The Air Ministry and local regulations in force must be rigidly obeyed.

(i) Trimming tabs.- Complete trim can be obtained, (for flight "hands and feet off") by means of the two tabs, elevator and rudder. If lateral trim is out, the rudder tab can be used to counteract the turning effect. For example, if the pilot finds on attempting to fly straight hands off that the right wing goes down and the aeroplane turns to the right, he can adjust left rudder bias until the tendency to yaw left counteracts the tendency to bank and turn right, and the aeroplane will then fly straight, though perhaps with the right wing slightly down. The elevator trimming tab is somewhat sensitive, and must be used slowly and carefully at all times (except at low speed in the extreme position). It may be used to assist manoeuvres and recovery from a dive, provided the pilot remembers the following points:-

(a) At high speed, rapid movement will strain the aeroplane.

(b) It relieves all loads on the elevator control, and the pilot must be careful not to continue winding it back (during a turn or loop, however slowly) beyond the point where the desired or safe tightness of turn, or load factor "g" is reached.

(c) If the pilot trims the aeroplane in a dive, he should keep his hand on the tab control, and use it, very gently, in recovery. Otherwise he might find it difficult to ease out of the dive, against nose heaviness.

(ii) Slow-flying.- Flying at low speeds, down to the stall, should be practised at a safe height, so that the pilot may become familiar with the feel of the controls. Feet should be kept on the rudder at low speed, as it might be needed if the aeroplane stalled.

(iii) Stability in pitch.- This aeroplane, though just stable in a dive, tends to be a little unstable in pitch (or fore-and-aft) during turns; as the turn is tightened up so the elevator control tends to become lighter, or, at least, fails to increase in weight to a desirable extent. Therefore, care must be used with this control, especially in rapid manoeuvres. When flying in bumpy conditions at high cruising speed, the pilot's body is bumped severely on the seat, and this is very uncomfortable, even for a short time.

FLYING BY INSTRUMENTS

15. It has already been mentioned that this aeroplane can best be flown without use of rudder control, as perfect co-ordination of controls is thereby achieved automatically without the pilot's assistance. This is particularly important when flying by instruments, as the extra mental concentration required of the pilot is eliminated.

16. Instrument flying on this aeroplane is normal. If the atmosphere is very bumpy the toes may be used to steady the rudder, but not for steering, which must be done by aileron control. If the aeroplane has been subjected to rapid manoeuvres just before the need for flying by instruments, the artificial horizon, if not fitted with a caging device, may take five or ten minutes to settle down and so the Directional Gyro must be used for keeping a straight course. If the pilot suddenly runs into bad weather and flying by instruments becomes necessary (for instance a cloud bank which cannot be avoided) and if he is uncertain of his direction he must use patience to allow the compass to settle down - fly absolutely straight for three or four minutes, if necessary, until the compass is quite steady, then set the Directional Gyro to its reading and then turn on to the correct course.

STALLING

17. Though the stall usually occurs at low speed, it must not be forgotten that it can happen at any speed if the stick can be brought back far enough to put the wings at stalling incidence. This is possible, on this aeroplane, owing to the partial instability in pitch mentioned in para. 14. At high speed the stall is extremely "rough", there is a violent shudder and clattering noise throughout the aeroplane, which tends to flick over laterally and unless the stick is put forward instantly, a rapid roll and spin results, which may severely strain or break the aeroplane. At minimum speed the stall is the same as on most aeroplanes of similar type, i.e. one wing drops sharply and the aeroplane spins if not prevented by use of controls. Note the following:-

(i) Stalling speed with flaps UP - 79 m.p.h. A.S.I.
Stalling speed with flaps DOWN - 71 m.p.h. A.S.I.

(ii) Stalling should be practised, at a safe height, by holding the aeroplane in level flight, engine off, gradually bringing the stick back until the stall takes place (see remarks in next para. 18).

SPINNING

18. Deliberate spinning is prohibited. If an accidental spin occurs, there is no difficulty in recovering, provided the standard method is correctly used, i.e. full opposite rudder (maintained until the spin stops) and stick slowly forward when recovery begins, the rotation first speeds up, as the nose goes down, for at least one turn. The nose then goes farther down, and not until then does the spin stop. About 2,000 ft. will be lost, so a margin of 5,000 to 6,000 ft. should be allowed, if possible. It is most important that no attempt is made to pull

23. Characteristics and precautions.- The chief characteristics of this aeroplane affecting aerobatics, and the precautions necessary are as follows:-

(i) High speed in the dive. This, coupled with the fact that the very effective elevator control, and comparative instability in pitch of this aeroplane, makes it very easy for the pilot to impose high load-factors, or "g", when looping, doing tight turns, or pulling out of a dive. Although the safety factor of the aeroplane is about 10, it is well within the pilot's power to exceed "10g"; the wings would certainly fail if this figure is much exceeded. In very bumpy atmosphere, care is needed when manoeuvring with high "g", to prevent the arm from jerking the stick, owing to the jerking of the body in bumps, causing sudden fluctuations of "g", between about "2g" and "6g". A sudden upward bump bends the pilot's body and jerks the stick back, unless he jams his elbow against his body or the side of the cockpit.

(ii) Rapid loss of height in a dive. An ample margin of height must be allowed for diving either deliberately or if there is any chance of an accidental dive.

(iii) Great loss of height in the event of loss of control, such as a complete stall, flick roll, or spin. This is not only because of the rapid loss of height when stalled, or spinning, but also because of the need for gathering ample speed in the recovery dive, before beginning to ease out, owing to the fact that a semi-stalled condition of the wings persists well above stalling speed, and premature pulling out will cause another "flick", or a spin.

(iv) The high wing loading of the aeroplane. This is the chief cause of the characteristics already mentioned.

(v) Rather too effective elevator control and instability in pitch at large angles of attack (when turning or looping at high "g"). The results are already described in sub-para.(i).

(vi) Violent stall at high speed. Severe shudder and clatter is produced if the aeroplane is stalled at high speed (see para.17).

(vii) Great reserve of power.

(viii) Effective aileron control at all speeds down to the stall. It is, at the same time, excessively heavy at high speed. It should not be used with too much strength at very high speed, as it tends to twist the wings, which may already be under high torsional stress.

24. General precautions.- Note the following:-

(i) The pilot should ensure that the harness is tight enough, and be especially careful, for inverted flying, that it is not caught up in any way. This frequently happens, and causes the pilot's body to drop suddenly an inch or two, when the kink frees itself. This is most disconcerting.

(ii) See that the neighbouring sky, especially below, is clear of aircraft.

(iii) Do not use more power or higher r.p.m. than is necessary - on no account exceed the limits laid down. Many aerobatics, such as rolls, may be done at much less than full throttle. Cruising r.p.m. should be used (2,850) - if reduced below this, detonation might occur if the throttle is opened up to +9 lb./sq.in. boost, for any reason.

(iv) Use too high a speed rather than too low, especially when doing aerobatics on this aircraft for the first time, as there is then less likelihood of losing control, but handle the aeroplane correspondingly more carefully at the higher speeds.

(v) Do not continue any manoeuvre if vision fades owing to high "g", (see further remarks under Looping, para.25).

25. Looping.- This should be started at not less than about 300 m.p.h. A.S.I. When thoroughly proficient the pilot can do it at slower speed, but there will then be a tendency to get too slow on the top, with a consequent likelihood of a flick-out or spin when the angle of attack is brought to stalling incidence if the stick is pulled back too far. Large loops may be started at any speed up to the maximum permissible, but the beginning of the loop must then be EXTREMELY GRADUAL, and the elbow pressed into the body or leg to prevent jerking of the over-sensitive elevator control in bumps. The method of looping is normal, (see Flying Training Manual, Chapter III). The pilot should endeavour to maintain constant "g", that is, to tighten up the start of the loop very gradually to about "3g", and then maintain this by very gradually continuing to tighten up the loop as speed decreases. The pilot has no way of telling the value of "g", but a rough guide is that the average pilot begins to lose vision at about "4½g", and so, if the loop is done well short of this "blacking out" point, it will be about "3g" or so. When loss of vision is approaching the pilot will experience a sensation of downward pull behind the eyes and ears, and vision will begin to fade. No manoeuvre should be continued if sight is lost, as the pilot loses one of his guides to the rate of loop, and might increase "g" to the point where the brain fails altogether or the wings break.

Note the following:-

(i) The elevator trimming tab may be used, either in the loop or in the recovery from the dive, but, if so, great care must be taken to move it slowly and not to continue moving it back beyond the point giving about "3g". Remember too, that if a vertical dive is started at a slow speed with the tab control too far back, (for example, if the speed gets too slow on the top of the loop, and the aeroplane is allowed to fall into a dive without "flicking-out"), the "g", or load factor, will rapidly become excessive as the aeroplane gathers speed.

(ii) The Rocket Loop, Large Loop, and other variations may also be done effectively.

(iii) The following example of the airspeed at various stages of a typical loop may be of interest:-

		Start	-	300 m.p.h. A.S.I.
90°	-	Vertical	-	200 m.p.h. A.S.I.
180°	-	Inverted	-	115 m.p.h. A.S.I.
360°	-	Level	-	290 m.p.h. A.S.I.

26. Rolling.- Rolling is very easy, though the aileron control is extremely heavy at high speed. It may even be done with feet off the rudder pedals, if it is "barrelled" a little, that is, a slight amount of positive pitch (or loop) maintained during the roll. Rolling is done in the normal way, as described in the Flying Training Manual, Chapter III. A roll may be either moderately slow, slow, or barrel, ("slow" refers to rate of roll, not airspeed). The moderately slow roll is the best, as the engine can be kept running normally throughout. It should be started at a speed of anything over about 160 m.p.h. A.S.I. Slower speed than this is possible, even down to 110 m.p.h., but at this extreme there is danger of stalling and spinning if the stick is pulled back at all. At higher speeds than 200 m.p.h. or so, aileron control becomes excessively heavy, and at 300 m.p.h. or over the roll should be done extremely slowly, by easing the nose up 30° or 40° above the horizon and then using only enough aileron control to roll slowly, avoiding the use of any considerable force. The best method, to keep the engine running, is to ease the nose up to about 20° or 30° above the horizon, and then start the roll at moderate rate by aileron control, assisted, if desired, by a little rudder at first; (this is unnecessary). As the aeroplane rolls on to its back it must be kept straight, and the nose allowed to come down very slightly, but not below the horizon. As the aeroplane rolls out, top rudder should be used to keep the nose up, aileron control used, as required, to steady the roll (that is, to check any tendency to roll out quickly) and the aeroplane kept straight so that the nose is pointing just above the horizon in the original direction after the roll. First attempts should be made with slight barrelling - the roll started with the nose about 30° up, and the nose allowed to come down almost on to the horizon

when inverted, and, as the aeroplane rolls out, to come slightly round the horizon and then up a little as the aeroplane levels. When proficient, the pilot will be able to cut out this barrelling completely, keeping the nose straight, just above the horizon, throughout the roll, the engine continuing to run. If the engine shows signs of beginning to fade, the stick should be brought back a little, almost imperceptibly.

27. The true slow roll.- This can be done, if high speed is used at the start, but the engine will cut when inverted. This is done in the normal way, the nose being kept pointing straight in a constant direction, except when the wings are vertical at the start and finish, when it should be raised a little by top rudder, to prevent loss of height. If the engine is throttled back as the roll is started, it will be possible to get the engine going again earlier in the final stages of the roll.

28. The barrel roll.- This may be done with feet off the rudder, and is an exaggeration of the barrel type of moderate slow roll already described.

29. A series of rolls.- These can be done very easily on this aeroplane, either to left or right, at about 0 lb./sq.in. boost, and cruising r.p.m. at a speed of about 180 m.p.h. A.S.I. (or even less - 160 m.p.h.). They should be barrelled at first, the rate of roll being slowed down in the last quarter of each roll to regain speed lost when the nose was up; but when proficient, the pilot can do these with the nose up about 10° or so with very little barrelling.

30. Climbing rolls and gliding rolls.- These can also be done, the principles being the same. In doing gliding rolls, on a slightly down hill path, the pilot must be careful not to let the nose drop into a steep dive, and then pull out roughly. They are the most difficult type of roll to do properly.

31. Upward roll.- This is a useful exercise, but should not be overdone - on no account should the engine be over-revved; but speed at the start should be high, and the aeroplane eased up very gradually at first. When pointing vertically, rudder may be used to assist aileron, but not enough to deflect the nose appreciably. Do not hold the vertical attitude too long (watch the airspeed and start "recovery" while speed is still well over 100 m.p.h. A.S.I.). Otherwise a tail slide will result, which may break the control surfaces or connections, unless these are held rigidly central, which may be impossible. Finish off by cartwheeling and quarter rolling, or by allowing the nose to drop forward (not sharply enough to stop the engine), or by completing a loop to the inverted position and half-rolling out.

32. Downward roll.- This is useful in combat, at the start of a vertical dive, before speed has become excessive. Rolls may be done equally well either to left or right, and pilots should practise this to avoid becoming "one-sided".

33. Half roll off the top of the loop.- The loop should be started with more speed than for a plain loop, and the roll begun directly the opposite horizon comes into view, as the pilot looks "up" through the dome of the hood, while the nose is still about 30° or 40° above the horizon. It should be regulated in such a way that the nose continues to come down gradually, as the aeroplane rolls out, until it is just above the horizon at the end. This will keep the engine running and ensure that the aircraft continues to gain height during the roll out. The aeroplane should then be travelling on exactly the opposite course to its original. This also may be done equally well to left or right. The pilot's weight should not come on to the shoulder straps at any time.

34. Flick manoeuvres.- The high-speed variety of flick-roll or flick half-roll must ON NO ACCOUNT be done. It is liable to cause severe strain, is clumsy and uncomfortable, and, being extremely easy, has no training or other value of any kind. But a flick-roll at low speed, and low r.p.m. done very gently, is a useful exercise in timing and control at low speeds, and prevention of spin. It is done by throttling well back, slowing down to about 140 m.p.h. A.S.I., and then very gently easing the stick back and, at the same time, applying rudder. The nose will rise and yaw, and, as the control angles are steadily increased, the aeroplane will suddenly start to "auto-rotate", or flick. If the stick is kept back the aircraft would then spin, but, as soon as the aeroplane approaches an even keel (at about the moment when the wings are vertical) the stick is put forward, and, as the flick ceases, the controls used to steady the aeroplane until the roll is completed. If this is done too late the aeroplane will continue to flick, until it does part of a turn of a spin; if done too soon the flick will stop, and the rest of the roll must be done by aileron control, in the normal way.

ON NO ACCOUNT CARRY OUT FLICK MANOEUVRES EXCEPT AT LOW SPEEDS, but remember that low speed makes spinning more likely if the controls are mishandled. Ample height should be allowed (see Stalling and Spinning, paras. 17 and 18). Other variations of loops, rolls and so on may be carried out.

35. Inverted flying.- This is normal. Ensure that the harness is tight, and follow each strap to its attachment to ensure that it has a straight "run" and is not doubled over or caught up. Keep the seat well down to avoid bumping the head. Do not use rudder control when turning inverted. It is best to half-roll into and out of the inverted position. If recovery is made in a half-loop, the elevator tab should be used, very carefully, as the aeroplane may tend to get nose heavy as it gathers speed. DO NOT trim with the tab when inverted, for this reason - keep the nose up by the necessary force on the elevator control, if the aeroplane is nose-heavy. Do not fly inverted unless provision is made to

prevent fouling the engine and aircraft with oil or coolant. Watch oil pressure, and do not open up the engine again until oil pressure is restored.

COMBAT MANOEUVRES

36. Aerobatics, though vitally important as training for mastery of the aeroplane, and for tactical manoeuvres, are not of the slightest use for such manoeuvre and combat, if carried out as aerobatics. That is to say, they are none of them used, because they are too slow, except one or two of the simplest when merged into simple, smooth and rapid changes of position.

37. In air fighting the pilot, when climbing or manoeuvring for position before the attack, must obtain the last ounce of performance from his aeroplane. Aerobatics are not the quickest way of getting from position A to position B in the air. When actually attacking, the pilot concentrates on nothing else except bringing his guns to bear on the target. Therefore all his manoeuvres are simple turns, or a smooth combination of pitch and roll merged uniformly into one another. To give two examples:-

(i) If the pilot wishes to attack an enemy aircraft passing 500 ft. overhead on an opposite course, he does NOT do a half-loop followed by a half-roll - it takes too long; he makes a quick, smooth, and absolutely uniform climbing turn in the best direction (not necessarily free from skidding, if this will help speed up the turn without loss of speed).

(ii) Diving on to an enemy is done in the simplest and quickest way - by a swift and smooth roll, turn, cartwheel, dive and pull-out all merged into one - NOT by a complete half-roll followed by a quarter loop, and perhaps half a downward roll and pull-out, "by numbers" - it would take longer. The simplest possible manoeuvre is the most efficient.

38. Turning circle.- Never attempt a "tail-chase" with an enemy aeroplane having a smaller turning circle that the Spitfire. It is likely that most aircraft of lesser top speed (though it does not necessarily depend on that, but rather on stalling speed and other things) will be able to out-turn the Spitfire. Therefore the pilot should break off an attack the instant his gun-sights cease to "bear". It is not intended here to say more about fighter tactics, but this is a matter concerning the aerodynamic control of the aeroplane. If a turn of the smallest diameter, or at the quickest rate of change of direction is required at any time, the pilot must not tighten it up too closely to the stalling incidence. Even if the aeroplane does not begin to shudder or otherwise indicate an imminent stall, it may not be turning quite as quickly as it would if the stick is very slightly eased forward. If stalling incidence is

reached, the aeroplane usually does a violent shudder, with a loud "clattering" noise, and comes out of the turn with a violent flick. This would be a serious loss of advantage in a combat.

39. Manoeuvreability.- Manoeuvreability in combat consists of two separate and distinct features:-

(i) Quickness of rate of change of direction, or rate of turn - and, secondary to this, smallness of turning circle (treated above). Very roughly speaking, this is a function of the stalling speed, - that is, an aeroplane with a high stalling speed has a large turning circle.

(ii) Quickness of change of attitude - that is, shortness of time necessary to go from straight flight to vertical bank. Seconds may be gained at the beginning of a tail-chase by light and effective aileron control. An aeroplane cannot reach its best rate of turn until it is in a vertical bank (though bank must, of course, be reduced to less than the vertical if the turn is sustained for more than about 180°). The Spitfire is not good in this respect; its aileron control is very heavy at high speed (over 300 m.p.h.) and rudder should be used to assist rapid roll, if necessary.

40. Blacking-out.- Never increase the load factor, or "g", in tightening up a turn or loop, or pulling out of a dive, to such an extent that loss of vision (or "blacking-out") occurs. It has several disadvantages:-

(i) It is dangerous,. partly because it may lead to complete unconsciousness if "g" is further increased, and partly because the pilot loses all guides to the control of the aeroplane except his (often misleading) physical senses, and may either (supposing he is in a steep dive) fail to complete pulling out, and continue into the ground, or pull out too quickly, - quite easy to do owing to the rather over-effective elevator of the Spitfire, coupled with this aeroplane's comparative lack of stability in pitch, - this might result in complete unconsciousness or break-up of the aeroplane.

(ii) The pilot is immediately at a disadvantage. In combat he loses sight of the enemy, and at any time he cannot complete the manoeuvre efficiently.

Note.- Every pilot should practise subjecting himself to high "g", but short of the blacking-out point. This will increase his capacity to withstand it, and give him an advantage over an opponent who blacks-out at a lower "g" than he does.

APPROACH AND LANDING

41. General remarks.- The landing must always be made with flaps DOWN. This aeroplane, in spite of its high speed, is very easy to land. The following features are mentioned:-

(i) Rather bad view straight ahead; the pilot's head is lower than in the Hurricane relative to the engine.

(ii) Steep angle of descent. When gliding speed is low the aeroplane may appear to have insufficient speed to flatten out, but when it comes near the ground, cushioning effect causes considerable "float" unless speed is the minimum.

42. Preliminary approach.- General preparations for landing should be made, while the aeroplane nears the aerodrome, these include:-

(i) Open and lock back the cockpit hood.

(ii) Ensure that the mixture control is back to NORMAL.

(iii) Stow maps.

Note.- There is no need to open the radiator shutter, provided flying at low speed is not unduly prolonged. The correct drill avoids this.

43. Drill of Vital Actions before landing.- This should be carried out quickly and decisively when the right moment arrives, when approaching the lee side of the aerodrome. A convenient catch-phrase is applied to this drill, "U.P. and Flaps", that is:-

(i) - U - Undercarriage - DOWN (Watch indicators and ensure that the green light comes ON, see note below)

(ii) - P - Pitch and - fully FINE (Lever fully forward)

(iii) - Flaps - DOWN (This should not be done before the aeroplane turns in towards the aerodrome to land).

Note.- If the undercarriage green indicator light does not come ON the control lever should be held back and down hard against the quadrant and still in the LOWER position. When the light comes ON the lever may be released to allow the cut-out to return the unit to IDLE. Of all the indicators are not showing the undercarriage to be fully down and locked, or if there is still doubt, the control lever should be returned firmly to the RAISE position. When the red UP indicator light comes ON, the LOWER movement should be repeated. If the indicators still do not show the undercarriage to be fully down and locked, the emergency lowering system should be used.

44. Methods of approach and landing.- This aeroplane can easily be landed without the assistance of the engine, and, when there is ample room and conditions are good, this method is recommended, in order that the pilot can be fully at home in case of a forced landing. (Gliding speed about 90 m.p.h. A.S.I.). Otherwise, the normal method is the Engine-assisted approach, in which the engine is used to regulate the approach (which should

NOT be on a flat path, but almost on a glide path) and then, at a fast tick-over, to flatten the glide path and reduce the rate of descent; throttle back immediately after flattening out, (Gliding speed with engine, 80 to 85 m.p.h. A.S.I.). These two methods can be combined, for practice, the engine-assisted approach being used down to 500 ft. (no lower) and the aeroplane brought within gliding distance, engine shut off, and glide and landing made without engine (glide about 90 m.p.h. A.S.I.). Lastly there is the Creeper, a method, only to be used in emergency, for landing in a small field, by flying in close to the ground at minimum safe speed, closing the throttles as the lee boundary is crossed (but only after getting close to the ground) and landing.

45. Three-point landing.- The stick should be brought right back in landing (but this must not be misjudged and brought right back if the pilot is uncertain how high up - one foot or five feet - the aeroplane is). The tail comes down satisfactorily, in fact, if the stick is brought right back before the aeroplane touches, with the wheels a few inches off the ground, the tail wheel will sometimes run 100 yds. on the ground before the main wheels touch. This may be due to the cushioning effect of the air between the wings and the ground.

46. Wheel brakes.- These should always be used with care, but can generally be put almost full on without lifting the tail. It is a good plan to get into the habit of gripping the ring-grip on the stick with the third and little fingers and thumb and the break lever with the first and second fingers only. This facilitates quick release in case the tail lifts, without a tendency to let the stick go forward.

47. Mislanding.- Open up to full throttle and remain in the air. Do not raise the flaps until a speed of 120 m.p.h. is attained (at a safe height, though there will be no sink at this speed).

48. Landing across wind.- This aeroplane can be landed across wind, but, unless the pilot is very skilful in eliminating drift, it should not be attempted in too high a wind owing to the narrow-track undercarriage. Drift may be eliminated either by:-

(i) Sideslipping.

(ii) Flat turn towards the drift at the moment of landing.

Note.- For full details of the latest technique of approach and landing, applicable to modern aeroplanes, see Flying Training Manual. Part I, Chapter III.

PROCEDURE AFTER LANDING

49. Immediately after landing, look round to ensure that no aircraft are coming in, and taxy clear of the landing area, to the aerodrome perimeter. Then stop, and proceed as follows:-

(i) Raise flaps.

(ii) Open radiator shutter.

(iii) Taxy in. Run the engine slowly for about a minute, before or after turning OFF fuel cocks. Pull out the slow-running cut-out and hold until engine stops, then switch OFF.

(iv) Switch OFF indicator lights and all other electrical switches.

UNDERCARRIAGE EMERGENCY OPERATION

50. A $C.O_2$ cylinder is provided to supply pressure to force the undercarriage down in case of failure of the normal system. The system is independent of the latter, except the mechanical parts of the undercarriage units.

(i) Method of use.- The undercarriage is lowered and finally locked down by first selecting CHASSIS DOWN with the normal selector lever and then pushing the emergency lever, painted RED, forwards and downwards (through a little more than a right angle); this causes a pin to puncture the $C.O_2$ cylinder. After use of the emergency system the following action is necessary:-

(a) Replace the $C.O_2$ cylinder and seal the lever.

(b) Inspect, rectify and refill the normal hydraulic system. (If the emergency system has been used accidentally, and there has been no failure of the normal system, refilling only will be necessary.)

FLYING IN RAIN AND BAD VISIBILITY

51. When flying in conditions of bad visibility with the ground in sight, or if flying in formation, open the cockpit hood if the view becomes too bad with it closed. A break-out panel is fitted to the cockpit hood which can be pushed out by a blow with the elbow, with the heel of the hand or fist, if for any reason, such as severe ice-accretion, the hood cannot be opened. It is advisable, in order to facilitate navigation and to obviate the risk of collision with suddenly rising ground, greatly to reduce speed. In extreme cases flaps may be lowered and the aeroplane flown at as low a speed as 120 m.p.h. A.S.I. Radiator shutter must be opened (radiator temperature will stabilize at about 100°C) and the airscrew should be set to give about 1,500 r.p.m. If

conditions are such that higher speed is safe, then the flaps should be raised, and the throttle set to give a speed of about 180 m.p.h. A.S.I. Lowering the undercarriage, with flaps up enables a slightly lower speed to be maintained, 160 m.p.h A.S.I. The flaps cannot be lowered to increase drag above 120 m.p.h. A.S.I. because they affect the flow of air to the radiator, and cause the engine temperature to rise above the limit.

Note.- Flaps up. Reduce speed to about 180 m.p.h. and set the airscrew pitch as coarse as will allow smooth running.

Flaps down. 120 m.p.h. - pitch set to give higher r.p.m. than above. Watch temperatures.

52. Flying with the undercarriage down might be necessary for purposes of recognition as a friendly aircraft; this is satisfactory, as the undercarriage has far less drag than the flaps.

FORCED LANDING OWING TO ENGINE FAILURE

Note.- See also para.11 - "Engine failure during take-off".

53. The principles of forced landing this aeroplane are the same as for any other type, the first actions being to maintain ample gliding speed, select a landing ground, glide towards it and then try to rectify the trouble. If a landing without engines is inevitable, act as follows:-

(i) Switch off the engine and put fuel cocks down to OFF.

(ii) Decide whether the undercarriage is to be used or not and act accordingly.

Note.- The question of whether or not to lower the undercarriage is decided by the size and surface of the landing ground, bearing in mind that a landing on the fuselage does far less damage than turning over.

IF IN DOUBT, LAND WITH UNDERCARRIAGE UP.

It is a partial air brake, and so should be left up to extend the initial glide towards suitable country, if necessary, whether or not it is to be lowered finally.

iii) Approach and land in the normal way, as described in para. 44. Flaps may be left up until after turning in towards the field, in order that the pilot can hold them in reserve - the aeroplane tends to overshoot (flaps up) and then, at the right moment, flaps are lowered. The aeroplane sideslips with flaps down quite effectively, and is, therefore, not difficult to land accurately in a forced landing without assistance of engine.

POSITION ERROR TABLE

54. The corrections for position error are as follows:-

At 300	m.p.h.	A.S.I.	reading	subtract	8½ m.p.h.
" 280	"	"	"	"	9 "
" 260	"	"	"	"	9½ "
" 240	"	"	"	"	8 "
" 220	"	"	"	"	7½ "
" 200	"	"	"	"	6 "
" 180	"	"	"	"	3½ "
" 160	"	"	"	"	1 "
" 140	"	"	"	add	3 "
" 120	"	"	"	"	7 "

NOTES CONCERNING THE MERLIN XII ENGINE

(Rated altitude 13,000 ft.- Fuel 100 octane)

55. The following should be carefully noted:-

(i) Limiting operational conditions.-

Take-off (up to 1,000 ft. or for 3 mins.)	Maximum r.p.m. Minimum r.p.m. at maximum boost (+12 lb./sq.in.)	3,000 2,270
Climb (30 min. periods)	Maximum r.p.m. at maximum boost (+9 lb./sq.in.)	2,850
Maximum cruising (Mixture control NORMAL)	Maximum r.p.m. at maximum boost (+7 lb./sq.in.)	2,650
Maximum cruising (mixture control WEAK)	Maximum r.p.m. at maximum boost (+3¾ lb./sq.in.)	2,650
All-out level (5 mins. limit)	Maximum r.p.m. at maximum boost (+9 lb./sq.in.)	3,000
Maximum dive (20 seconds limit)	Momentary maximum r.p.m. at maximum boost (+ 9 lb./sq.in.)	3,600

(ii) Oil pressures.-

Normal	60 lb./sq.in.
Emergency minimum	45 lb./sq.in.

(iii) Oil inlet temperatures.-

Minimum for opening up	15°C.
Maximum for continuous cruising	90°C.
Maximum for climbing	90°C.
Emergency maximum	95°C.

(iv) Coolant temperature.- The engine which employs an ethylene glycol solution as the cooling medium, should not be opened up to full power until the radiator temperature exceeds 60°C. The maximum permissible temperature in flight is 120°C. and the recommended cruising temperature should not exceed 100°C.

FUEL AND OIL CAPACITY AND CONSUMPTIONS

56. Note the following:-

(i) Oil capacity.- The oil tank has a total capacity of 7.5 gallons and an effective capacity of 5.8 gallons.

(ii) Effective fuel capacity.-

Two main tanks - top tank	48 gallons
bottom tank	37 gallons
Total effective capacity	85 gallons

(iii) Fuel consumptions.- The following information will be found useful in determining endurances:-

Maximum fuel consumptions (at altitudes stated)

Climbing - 2,650 r.p.m.	93.5 gallons per hour at 13,000 ft.
All-out level - 3,000 r.p.m.	98 gallons per hour at 14,500 ft.
Maximum cruising (mixture control NORMAL) - 2,650 r.p.m.	77.5 gallons per hour at 13,000 ft.
Maximum cruising (mixture control WEAK) - 2,650 r.p.m.	55.5 gallons per hour at 13,000 ft.

SAPPHIRE PRODUCTIONS, 16, THE FRIARS, CHIGWELL, ESSEX. England 01-500 1657

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AIR PUBLICATION 1564B & D

Pilot's Notes

PILOT'S NOTES

HURRICANE IIA, IIB, IIC, IID AND IV AIRCRAFT

MERLIN XX ENGINE

Prepared by direction of the Minister of Aircraft Production

A. V. Roberts.

Promulgated by order of the Air Council

AIR MINISTRY

AIR PUBLICATION 1564B.

Volume I

Pilot's Notes

AMENDMENT CERTIFICATE

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

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

Amendt. List No.	1	2	3	8	11	12	13	17	18	21
Prelimy. matter	✓								✓	
Leading Partics.										
Introducn.									✓	
Section 1				✓		✓		✓		
Section 2		✓	✓	✓	✓	✓	✓	✓	✓	✓
Section 3										
Section 4										
Section 5										
Section 6										
Section 7										
Section 8										
Section 9										
Section 10										
Section 11										
Section 12										
Date of incorpn.	INCORPORATED HEREIN									SEP 1943

Amendt. List No.	24	25	29							
Prelimy. matter										
Leading Partics.										
Introducn.										
Section 1										
Section 2	✓	✓	✓							
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Section 8										
Section 9										
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NOTES TO OFFICIAL USERS

Air Ministry Orders and Vol. II leaflets as issued from time to time may affect the subject matter of this publication. It should be understood that amendment lists are not always issued to bring the publication into line with the orders or leaflets and it is for holders of this book to arrange the necessary link-up.

Where an order or leaflet contradicts any portion of this publication, an amendment list will generally be issued, but when this is not done, the order or leaflet must be taken as the over-riding authority.

Where amendment action has taken place, the number of the amendment list concerned will be found at the top of each page affected, and amendments of technical importance will be indicated by a vertical line on the left-hand side of the text against the matter amended or added. Vertical lines relating to previous amendments to a page are not repeated. If complete revision of any division of the book (e.g. a Chapter) is made this will be indicated in the title page for that division and the vertical lines will not be employed.

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Air Ministry
March 1944

Amendment List P
to
AIR PUBLICATION 1564B
Pilot's Notes

HURRICANE II AIRCRAFT

MERLIN XX ENGINE

Note: Amendment Lists to this Air Publication which affect the Pilot's Notes are now allotted a letter only. The letters run consecutively, omitting I and O. The Pilot's Notes will be complete when this Amendment List has been incorporated.

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(1)	PRELIMINARY MATTER	Remove existing Front Cover and substitute new cover supplied herewith.
(2)	SECTION I	Remove existing sheets bearing Paras.1 to 50, together with those bearing Figs.1 to 4 and their corresponding keys, and substitute new sheets supplied herewith.
(3)	SECTION 2	Remove existing sheets bearing Paras.1 to 23 and any amendment list instruction sheets at end of Section and substitute new sheets supplied herewith.

NOTE: This Amendment List applies to A.P.1564B, Pilot's Notes, only. A corresponding amendment list, No.42, to A.P.1564B, Volume I, is being distributed separately by A.P.P.S., Harrogate.

RTP/2240. 4725. 3/44.

LIST OF SECTIONS

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

R.T.P./722. 4500. 12/40

SECTION I

PILOT'S CONTROLS AND EQUIPMENT

LIST OF CONTENTS

INTRODUCTION

1. The Hurricane Mks.II and IV are each fitted with a Merlin 20 engine and a Rotol 35° propeller. The Mks.IID and IV are low-level attack versions of the earlier Marks and are equipped to carry various alternative armaments. The aircraft controls, including the undercarriage, flaps and brakes are identical with those on Mark I aircraft.

FUEL, OIL AND COOLANT SYSTEMS

2. Fuel tanks (See Figs.5 and 5A).-

(i) Main and Reserve tanks.- The main tanks are housed within the centre section, one on each side of the fuselage, and a reserve tank is carried between the fireproof bulkhead and the instrument panel. Fuel is delivered to the engine by an engine-driven pump. These tanks are self-sealing and their effective capacities are as follows:

Main tanks:	33 gallons each.
Reserve tank:	28 gallons.

To meet the possibility of engine cutting due to fuel boiling in warm weather at high altitudes, these tanks can be pressurised (operative above 20,000 feet). Pressurising, however, impairs the self-sealing of tanks and should, therefore, be used only when the fuel pressure warning light comes on, or when auxiliary drop tanks are used (see below).

(ii) Auxiliary tanks: When not fitted with under-wing armament or containers, a pair of auxiliary tanks may be carried, one under each wing. The types of tank and their capacities are as follows:

Fixed:	44 gallons each.
Drop:	45 or 90 gallons each.

With the exception of some fixed tanks which are used for combat duties, these tanks are non-self-sealing. Fuel in the fixed tanks is delivered to the main tanks by electrically driven immersed pumps, but fuel in the drop tanks is supplied direct to the engine fuel pump by air pressure.

3. Fuel cocks.-

(i) The main fuel cock control (48) on the left-hand side of the cockpit has a spring safety plate which prevents the fuel supply being turned off inadvertently. The control can only be turned to the OFF position whilst the safety plate is held depressed.

(ii) A switch for the electric pump in each fixed auxiliary tank is fitted on the left-hand side of the cockpit, either just above the elevator trimming tab control, or on the lower part of the electrical panel.

(iii) The fuel cock control (73) and jettison lever (74) for the drop tanks are mounted together on the right-hand side of the cockpit, below the windscreen de-icing pump. The cock control has three positions: OFF, PORT and STARBOARD. The pressurising cock must be turned on when the tanks are used. The jettison lever is pulled down to jettison both tanks simultaneously, but cannot be moved until the fuel cock is set to OFF. When the lever is operated, the air pressure supply is automatically cut off.

(iv) The tank pressurising cock (22) is fitted on the left-hand side of the cockpit, below the throttle quadrant, and is marked ATMOSPHERE and PRESSURE.

4. Fuel contents gauge.- A gauge (49) on the right-hand side of the instrument panel indicates selectively the contents of each of the three main tanks. A switch unit (48), comprising a combined selector and pushbutton, is fitted above the gauge.

5. Fuel pressure warning light.- The warning light (50) on the right-hand side of the instrument panel comes on if the pressure drops to 6 lb/sq.in.

6. Oil system.- The self-sealing oil tank, which has an effective capacity of 9 gallons, forms the port leading edge of the centre section. The oil passes through a filter before entering the engine and then through a cooler inside the coolant radiator. Pressure (54) and temperature (53) gauges are fitted on the instrument panel. When 90-gallon fuel drop tanks are carried, an auxiliary oil tank of 4 gallons capacity is fitted behind the seat, the cock control for which is on the left-hand side of the seat, above the radiator flap control quadrant.

7. Coolant system.- The system is thermostatically controlled, the radiator being by-passed until the coolant reaches a certain temperature. The header tank is mounted on the fireproof bulkhead and is fitted with a pressure relief valve. The air flow through the radiator is controlled by a flap lever in the cockpit.

MAIN SERVICES

8. Hydraulic system.- An engine-driven hydraulic pump supplies the power for operating the undercarriage and flaps. The system is automatic, selection of the desired operation of the undercarriage or flaps, by means of the selector lever, being sufficient to commence the operation. A handpump (71) is provided for use in the event of engine failure or engine-driven pump failure.

9. Electrical system.- A 12-volt generator, controlled by a switch (3) on the left-hand side of the cockpit, supplies an accumulator which in turn supplies the whole of the electrical installation. There is a voltmeter (31) on the left-hand side of the cockpit. and a red light (36) marked POWER FAILURE on the instrument panel comes on when the generator is not charging the accumulator.

10. Pneumatic system.- The wheel brakes and the gun-firing mechanism are operated pneumatically, air being supplied by an engine-driven compressor and stored in a cylinder at a maximum pressure of 300 lb/sq.in.

AIRCRAFT CONTROLS

11. Flying controls.- The control column is of the spade-grip pattern and incorporates a gun-firing pushbutton and the brake lever. The rudder bar is adjustable for leg reach by means of a star-wheel midway between the two pedals.

12. Trimming tabs.- The elevator trimming tabs are controlled by a handwheel (24) on the left-hand side of the cockpit and an indicator is fitted next to it. Forward rotation of the hand-wheel corrects tail heaviness. The automatic balance tab on the rudder can be set for trimming purposes by means of a small control wheel (23) on the left-hand side of the cockpit, which is turned clockwise to apply right rudder.

13. Undercarriage and flap control.- The selector lever (76) for the undercarriage and flaps is on the right-hand side of the cockpit and works in a gate, having a neutral position and an UP and DOWN position for both undercarriage and flaps, the positions for operating the flaps being outboard. The catch on the side of the lever must be pressed in order to release it for movement from an operative position, but the lever can be moved from the neutral position without first releasing the catch. To obviate inadvertent selection on the ground of the wheels up position, a safety catch (77) is provided on the gate which must be turned in a clockwise direction to permit entry of the selector lever into the wheels UP slot. For emergency lowering of the undercarriage see Para.35.

14. Undercarriage indicator.- The electrical indicator (41) is on the left-hand side of the instrument panel and has duplicate pairs of lamps, the green lamps indicating when the undercarriage is locked in the DOWN position, and the red lamps when the undercarriage is fully retracted and locked. There are two switches to the left of the indicator, the left-hand one (38) being the ON-OFF switch for the green lamps, and the right-hand one (39) being the change-over switch for the duplicate sets of lamps. A dimmer switch is provided in the centre of the indicator. When the undercarriage is retracted, the wheels are visible through two small windows in the bottom of the cockpit.

15. Undercarriage warning light.- A red light on the instrument panel comes on at any time when the throttle lever is less than one-third open and the undercarriage is not locked down. When the throttle is opened again or the undercarriage is lowered the light goes out.

16. Flap indicator.- This (72) is mechanically operated, the pointer moving along a graduated scale marked UP and DOWN at its extremities. It is situated immediately below the hydraulic selector lever.

17. Wheel brakes.- The brake lever is fitted on the control column spade-grip and a catch for retaining it in the on position for parking is fitted below the lever pivot. A triple pressure gauge, showing the air pressure in the pneumatic system cylinder and at each brake, is mounted forward of the foot of the control column.

18. Flying control locking gear.- The locking struts, interference bar and bracket are stowed in a canvas bag in the starboard side of the wireless bay. The bracket clips on to the control column, just below the spade grip, for locking of the aileron control and the two struts, attached to the bracket by shackles, lock the rudder bar and control column. The spring loaded interference bar fits on to the bracket and is inserted in a slot in the back of the seat.

ENGINE CONTROLS

19. Throttle.- The throttle lever (7) works in a slot in the decking shelf on the left-hand side of the cockpit. The take-off position is gated. There is a friction adjuster (16) on the inboard end of the lever spindle. The mixture control is fully automatic and there is no pilot's control lever.

20. Boost control cut-out.- The automatic boost control may be cut out by pulling the knob (34) on the left-hand side of the instrument panel.

21. Propeller control.- The speed control lever (10) on the left-hand side of the cockpit varies the governed rpm from 3,000 down to 1,800. A friction adjuster is fitted on the inboard side of the control.

22. Supercharger control.- The push-pull control (17) is fitted below the left-hand side of the instrument panel, and must be pushed in for low (M) gear and pulled out for high (S) gear.

23. Radiator flap control.- The airflow through the coolant radiator and oil cooler is controlled by a lever (26) on the left-hand side of the pilot's seat. In order to release the lever for operation the thumb-button must be depressed.

24. Slow-running cut-out.- The control on the carburettor is operated by pulling out the knob (64) immediately to the right of the undercarriage and flap selector lever.

25. Cylinder priming pump.- The priming pump (59) is fitted below the right-hand side of the instrument panel.

26. Engine starting.- The starter and booster coil pushbuttons (32 & 33) are to the left of the ignition switches (58) on the instrument panel. An external supply socket for the starter motor is accessible through a removable panel in the starboard engine cowling, and two handles for hand starting are stowed in the undercarriage whe recess under the centre section.

27. Oil dilution.- The pushbutton (4) for operating solenoid valve is on the left-hand side of the cockpit.

OTHER CONTROLS

28. Gun controls.- The machine guns and cannon are normally fired by the pushbutton on the control column spade grip. The two 40 mm guns on Mk.IID and IV aircraft are fired electro-pneumatically by the pushbutton in the throttle lever; they cannot be fired, however, until the master switch (11) on the decking shelf, forward of the throttle quadrant, is switched on. The cocking lever (28) on the electrical panel to the left of the seat should be pushed down in the event of a misfire.

29. R.P.controls.- The projectiles are fired by the pushbutton in the throttle lever and a selector switch (40) below the left-hand side of the windscreen enables them to be fired in PAIRS or as a SALVO. They must not be fired with the flaps lower

30. Bomb controls.- There are two selector switches and two nose and tail fusing switches on a small panel (67) on the right-hand side of the cockpit. The bombs are released by the pushbutton in the throttle lever.

31. S.C.I. controls.- These are operated by the pushbutton in the throttle lever and there is a container jettison pushbutton (63) on the right-hand side of the cockpit.

32. Camera gun control.- The camera gun operates only when the guns and cannon or the R.P. are fired, or when the lower pushbutton on the control column spade grip is depressed.

33. Landing lamps.- The landing lamps, one in the leading edge of each wing, are controlled by a two-way switch (15) to the left of the instrument panel, which enables either lamp to be used; both lamps are off when the switch is in the upright position. A dipping lever (5) on the left-hand side of the cockpit can be held in any position by tightening the knurled wheel; when the wheel is unscrewed, the lever is pulled aft into the UP position by a return spring in each of the lamp units.

34. Recognition device.- The flares are selected and released by a single lever (25) immediately aft of the trimming tab control. The slot is marked SELECT and FIRE.

EMERGENCIES

35. Undercarriage emergency operation.-

(i) In the event of failure of the engine-driven hydraulic pump, the undercarriage may be lowered by moving the selector lever to the WHEELS DOWN position and then operating the handpump.

(ii) If the handpump fails to lower the undercarriage the selector lever should still be left in the WHEELS DOWN position and the red-painted foot pedal (21), outboard of the port heelrest, should be firmly pushed forward. The wheels should then fall and lock down under their own weight.

(iii) If difficulty is experienced in operating the undercarriage and flap selector lever it may be overcome by first selecting the opposite to that which is required. If, for example, the selection of undercarriage down is found to be difficult, the lever should first be moved into the undercarriage up position and then immediately moved to the down position.

36. Hood jettisoning.- To jettison the hood the lever aft of the radiator flap control should be pulled sharply forward and upwards. If the hood does not readily leave the aircraft it should be assisted by pushing it upwards, or failing that, by releasing the emergency exit panel (see below) in addition to operating the jettison control.
Note: When jettisoning the hood it is advisable to lower one's head as far as possible so as to avoid injury when it leaves the aircraft.

37. Emergency exit panel.- The large detachable panel on the starboard side of the cockpit is secured by horizontal spring-loaded plungers and a bolt operated by the cockpit hood. To jettison the panel, the hood must first be fully opened and the release lever (66) then moved aft and upwards.

38. Abandoning by parachute.- When abandoning the aircraft by parachute it is important to decrease speed and then dive over the side immediately. The pilot must not stand on the seat and delay in jumping or he will hit either the aerial mast or the tailplane.

39. Forced landing.- In the event of having to make a forced landing the glide may be lengthened considerably by moving the propeller speed control fully back and gliding at about 130 mph IAS. With undercarriage and flaps up the gliding angle at speeds of 120-140 mph IAS is very flat.

40. Ditching (See A.P.2095, Pilot's Notes General)

(i) In general, the pilot should if possible abandon the aircraft by parachute.

(ii) In the event of having to ditch, auxiliary drop tanks, bombs, or containers (if fitted) should be jettisoned and the following procedure should be observed:

(a) The cockpit hood should be jettisoned.

(b) Flaps should be lowered fully in order to reduce landing speed as much as possible.

(c) The undercarriage should be retracted.

(d) Safety harness should be kept on, with straps tight, and the R/T plug disconnected.

(e) The engine, if available should be used to help make the touch-down in a tail-down attitude at as low a speed as possible.

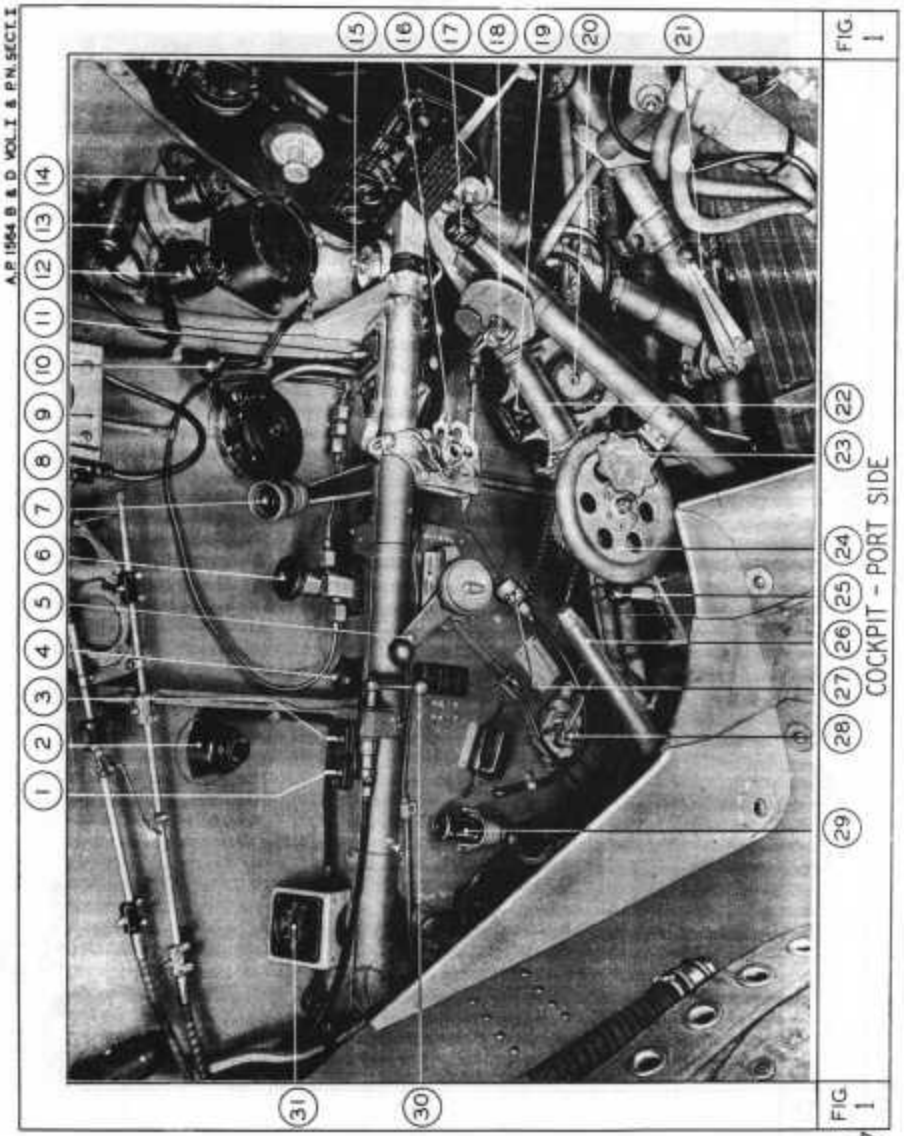
(f) When about to touch the water a normal banked turn, with full rudder, should be made so as to prevent "hooking" the radiator into the water.

41. First-aid outfit.- The first-aid outfit is attached to the inside of a detachable panel on the port side of the cockpit and is accessible by kicking in the panel, breaking the stringers, and tearing the fabric.

42. Crowbar.- A crowbar, for use in an emergency, is stowed in clips to the right of the seat.

KEY TO FIG.1

1. Radio contactor master switch.
2. Cockpit light dimmer switch.
3. Generator switch.
4. Oil dilution pushbutton.
5. Landing lamp control lever.
6. Oxygen supply cock.
7. Throttle lever (incorporating pushbutton).
8. Socket for footage indicator plug.
9. Wedge plate for camera gun footage indicator.
10. Propeller speed control.
11. Cannon master switch.
12. Compass light dimmer switch.
13. Cockpit light.
14. Cockpit light dimmer switch.
15. Landing lamp switch.
16. Friction adjuster.
17. Supercharger control.
18. Fuel cock control.
19. T.R.9D contactor switch.
20. Radio contactor.
21. Undercarriage emergency release lever.
22. Fuel tank pressurising control.
23. Rudder trimming tab control.
24. Elevator trimming tab control.
25. Recognition device selector lever.
26. Radiator flap control lever.
27. Heated clothing socket.
28. Cannon cocking lever.
29. Microphone/telephone socket.
30. Hood catch control.
31. Voltmeter.



KEY TO FIG.3

59. Cylinder priming pump.
60. Cockpit light.
61. Cockpit light dimmer switch.
62. Signalling switch box.
63. Container jettison pushbutton.
64. Slow-running cut-out.
65. Windscreen de-icing pump.
66. Emergency exit panel jettison lever.
67. Bomb fusing and selector switches.
68. Sutton harness release.
69. I.F.F. master switch.
70. I.F.F. pushbuttons.
71. Hydraulic handpump.
72. Flap indicator.
73. Drop tank fuel cock control.
74. Drop tank jettison control.
75. Seat adjustment lever.
76. Undercarriage and flap selector lever.
77. Undercarriage selector safety catch.

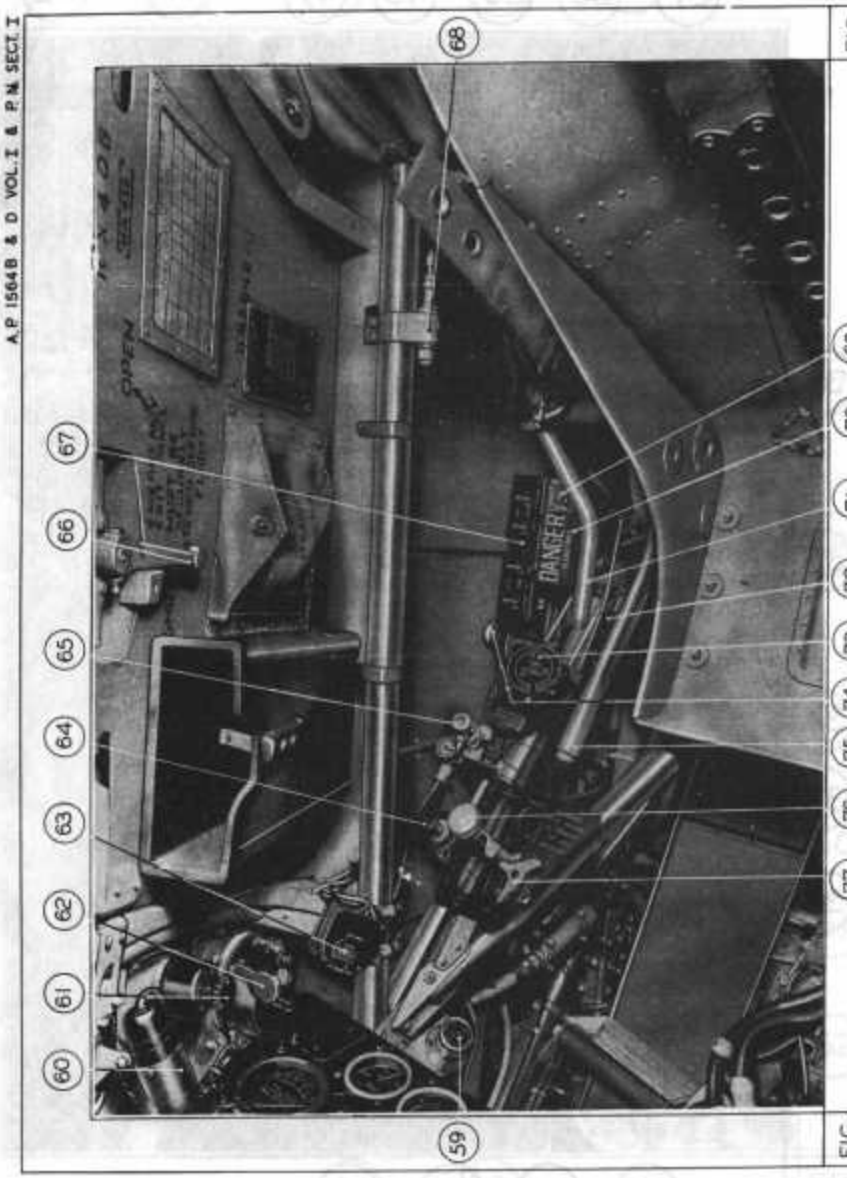


FIG. 3 COCKPIT - STARBOARD SIDE

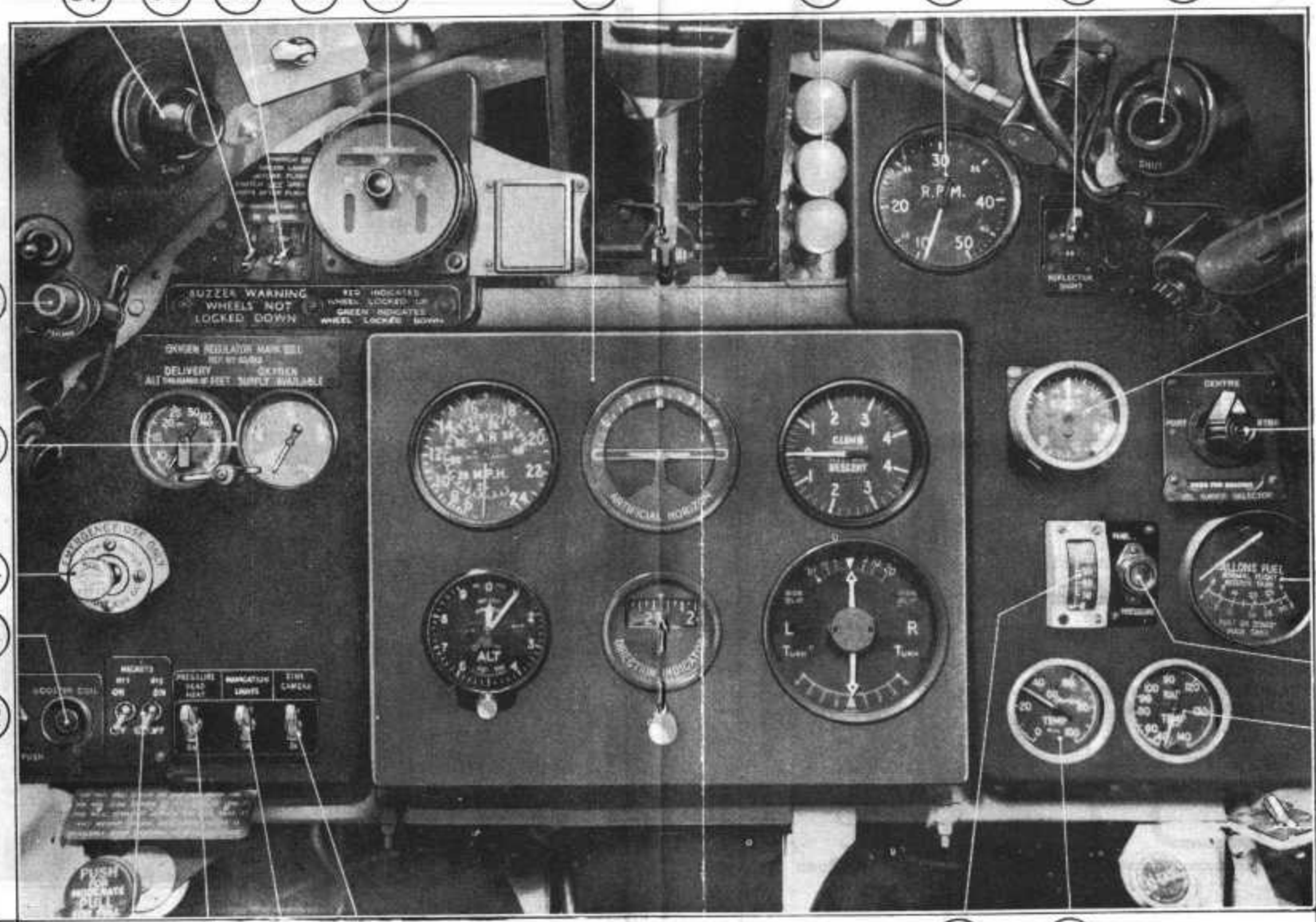


FIG. 2 INSTRUMENT PANEL FIG. 2

KEY TO FIG.2

32. Engine starter pushbutton.
33. Booster coil pushbutton.
34. Boost control cut-out.
35. Oxygen regulator.
36. Power failure warning light.
37. Cockpit ventilator.
38. Undercarriage indicator ON-OFF switch.
39. Undercarriage indicator change-over switch.
40. R.P. selector switch.
41. Undercarriage indicator.
42. Instrument flying panel.
43. Reflector sight spare lamps.
44. Engine speed indicator.
45. Reflector sight switch.
46. Cockpit ventilator.
47. Boost gauge.
48. Fuel contents gauge selector switch.
49. Fuel contents gauge.
50. Fuel pressure warning light.
51. Radiator temperature gauge.
52. Beam approach master switch.
53. Oil temperature gauge.
54. Oil pressure gauge.
55. Camera gun switch.
56. Navigation lights switch.
57. Pressure head heater switch.
58. Ignition switches.

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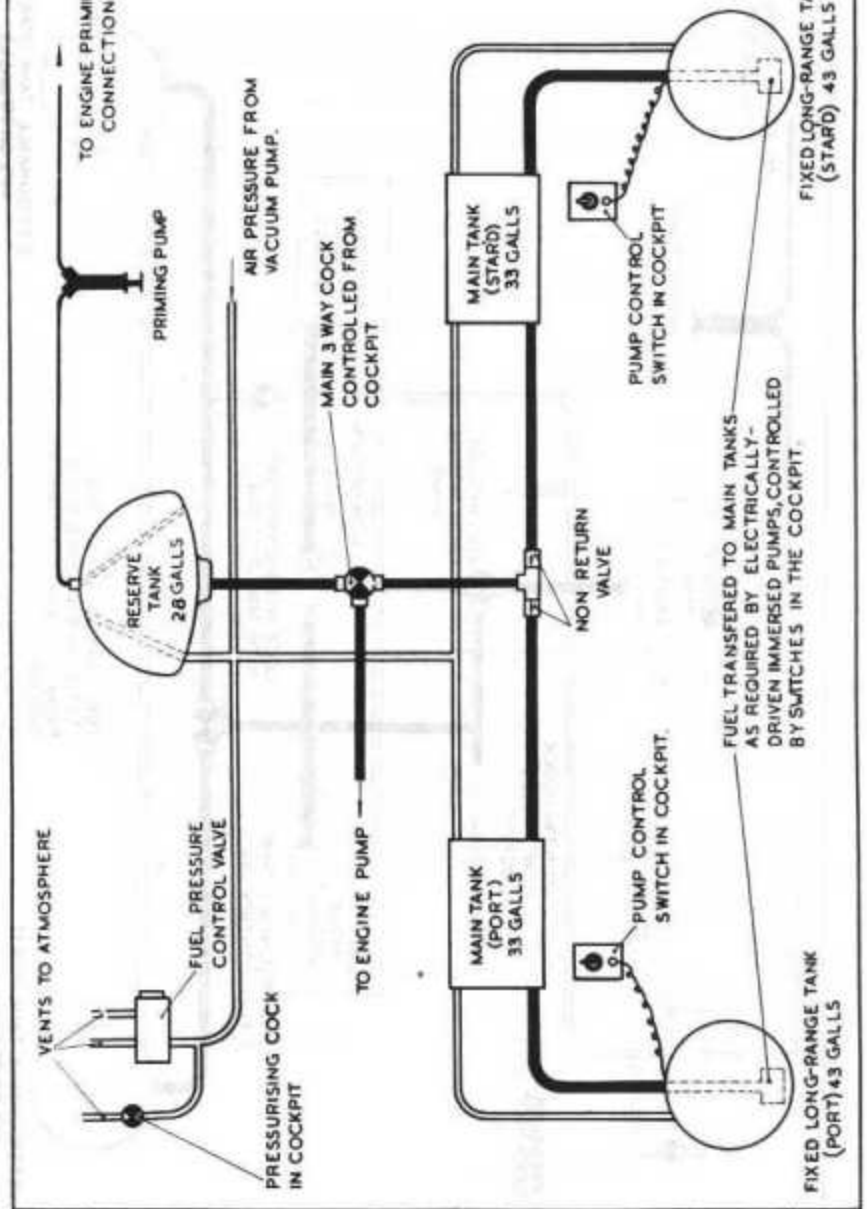

FIG. 5 FUEL SYSTEM DIAGRAM – WITH FIXED LONG-RANGE TANKS. FIG. 5

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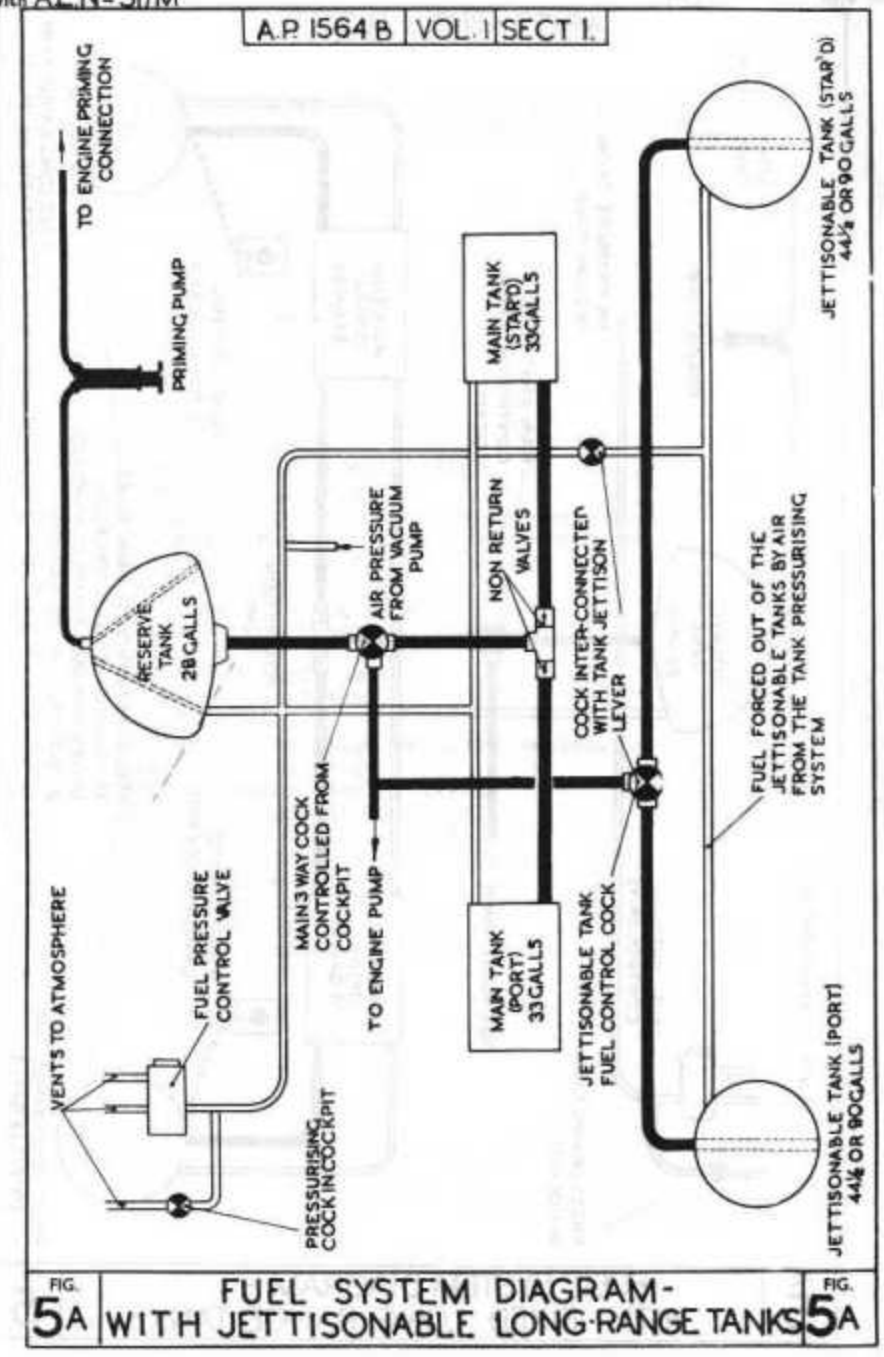


FIG. 5A FUEL SYSTEM DIAGRAM - WITH JETTISONABLE LONG-RANGE TANKS FIG. 5A

SECTION 2

HANDLING AND FLYING NOTES FOR PILOT

1. ENGINE DATA: MERLIN XX

(i) Fuel: 100 octane only.

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

(iii) Engine limitations:

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

Note:

* Combat boost is obtained by operating the boost control cut-out.

‡ 115°C coolant temperature is permitted for short periods at cruising rpm.

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

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

FUEL PRESSURE: 8-10 lb/sq.in.

2. FLYING LIMITATIONS

(i) Maximum speeds (mph IAS):

Diving:	390
Undercarriage down:	120
Flaps down:	120

(ii) At AUWs in excess of 8,750 lbs. care is necessary in ground handling and the aircraft should be taken off only from concrete or equivalent runways.

(iii) Spinning is prohibited at all times of Mark IID and IV aircraft, and of Mark IIA, B and C aircraft only when carrying 90-gallon drop tanks, bombs, SCI, containers, or RP.

(iv) Aerobatics are prohibited and violent manoeuvres must be avoided when carrying 90-gallon drop tanks, bombs, SCI, containers, or RP (Mk. IIA, B and C aircraft only).

(v) Aircraft carrying drop tanks should not be dived.

(vi) Mark III containers must not be dropped at speeds in excess of 150 mph IAS and at heights lower than 500 feet.

(vii) Bombs should be jettisoned and RP fired, if possible, before landing.

3. POSITION ERROR CORRECTIONS

From To	100 120	120 150	150 180	180 210	210 270	270 320	mph IAS mph IAS
Add Subtract	4	2	0 0	2	4	6	mph mph

4. MANAGEMENT OF FUEL AND OIL SYSTEMS

(i) The Main Tanks should be used first, but if the Reserve Tank is used before the Main Tanks, the following precautions must be observed:

(a) Change over to MAIN TANKS ON before emptying the Reserve tank.

(b) If this has not been done and the engine cuts, close the throttle (to avoid over-revving when the engine picks up) and change over to MAIN TANKS ON at once.

(c) In order to displace air drawn into the fuel system from the empty reserve tank, the engine must be windmilled at high speed, when it will pick up after a few seconds. It is emphasised that the pick-up will not be immediate after the change-over.

(ii) If fitted with fixed auxiliary tanks:

(a) Start and take-off in the normal way on the main tanks.

(b) As soon as the contents gauge registers only 5 gallons in the main tanks, switch ON the auxiliary tank pumps.

(c) Switch OFF the pumps immediately the contents gauge registers 25 gallons.

(d) When the contents of the MAIN TANKS are again reduced to 5 gallons, switch ON the pumps until the contents gauge again registers 25 gallons and then switch OFF the pumps. The auxiliary tanks will then be practically empty.

(iii) If fitted with drop tanks:

(a) Start and take-off in the normal way on the main tanks.

(b) At a safe height (say 2,000 feet) change over to a drop tank and turn the pressurising cock to PRESSURE. Turn OFF the main tanks.

(c) When the drop tank is empty and the fuel pressure warning light comes on, change-over to the second drop tank and at the same time turn ON the reserve tank, which should still be full. This will enable the engine to pick up more quickly and when it does so, turn OFF the reserve tank and change-over to the second drop tank.

(d) When the second drop tank is empty and the fuel pressure warning light comes on, turn ON the main tanks and turn OFF the drop tank. If the engine does not pick up on the main tanks, prime the system by using the reserve tank as before.

(e) The cock for the auxiliary oil tank (if fitted) should be turned on about 3½ hours after take-off, but not before this time. After having been turned on, the cock cannot afterwards be turned off during flight.

(f) On reinforcing flights, under maximum range engine conditions (2,650 rpm and +4 lb/sq.in. boost on climb to height, and level flight at 190 mph I.A.S reducing to 160 mph I.A.S after jettisoning tanks) oil consumption is considerably reduced and, therefore, the auxiliary oil tank should not be turned on until after approximately 5 hours flight, when there will be sufficient space in the main tank to accommodate the extra 4 gallons. The normal oil tank should be filled to 8 gallons only.

5. PRELIMINARIES

(i) If fitted with R.P. and a drop tank or A.P. and a bomb, the aircraft should be trimmed carefully to relieve stick load.
The recommended aileron tab setting is neutral at full load. Then with a drop tank fitted under the port wing, changes in load will cause the following alterations in trim:

Tank empty:	Slightly right wing low
Tank empty and R.P. fired:	Trim satisfactory.
Tank jettisoned and R.P. fired:	Slightly right wing low
Tank jettisoned, R.P. not fired:	Right wing low.

(ii) Switch on the undercarriage indicator and check green lights. Test the change-over switch.

(iii) See that the short (lower) arm of the hydraulic selector safety catch is across the wheels up slot of the gate.

(iv) Check that the throttle pushbutton master switch is OFF.

(v) Check contents of fuel tanks. If fitted with auxiliary tanks see that the pump switches or cock control are OFF.

(vi) Test operation of flying controls.

(vii) See that the cockpit hood is locked open.

6. STARTING THE ENGINE AND WARMING UP

(i) Set fuel cock to MAIN TANKS ON.

(ii) Set the controls as follows:

Throttle	-	½ inch open
Propeller control	-	Fully forward
Supercharger control	-	MODERATE
Radiator shutter	-	OPEN

(iii) If an external priming connection is fitted, high volatility fuel (Stores ref. 34A/111) should be used for priming at air temperatures below freezing. Work the priming pump until the fuel reaches the priming nozzles; this may be judged by a sudden increase in resistance.

(iv) Switch ON the ignition and press the starter and booster coil pushbuttons. Turning periods must not exceed 20 seconds, with a 30 seconds wait between each. Work the priming pump as rapidly and vigorously as possible while the engine is being turned; it should start after the following number of strokes if cold:

Air temperature °C:	+30	+20	+10	0	-10	-20
Normal fuel:	3	4	7	12		
High volatility fuel:				4	8	18

(v) At temperatures below freezing it will probably be necessary to continue priming after the engine has fired and until it picks up on the carburettor.

(vi) Release the starter button as soon as the engine starts and as soon as it is running satisfactorily release the booster coil pushbutton and screw down the priming pump.

(vii) Open up slowly to 1,000 rpm, then warm up at this speed.

7. TESTING THE ENGINE AND INSTALLATIONS

While warming up:

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

After warming up, with two men on the tail:

Note: The following tests constitute a comprehensi check to be carried out after inspection or repair, or at the pilot's discretion. In normal circumstances they may be reduced in accordance with local instructions.

(ii) Open up to +4 lb/sq.in. boost and exercise and check operation of the two-speed supercharger. Rpm should fall when S ratio is engaged.

(iii) At +4 lb/sq.in. boost exercise and check operation of the constant speed propeller. Rpm should fall to 1,800 with the control fully back. Check that the generator is charging; the power failure light should be out and the voltage 14 or over.

(iv) With the propeller control fully forward open the throttle up to +12 lb/sq.in. boost and check static boost and rpm which should be 3,000.

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

(vi) Before taxying check brake pressure (100 lb/sq.in. minm.) and pneumatic supply pressure (220 lb/sq.in.).

8. CHECK LIST BEFORE TAKE-OFF

T - Trimming tabs	- Rudder: Fully right Elevator: Neutral
P - Propeller control	- Fully forward
F - Fuel	- Check contents of main tanks. - MAIN TANKS ON - Aux. tank cock or pumps - OFF - Pressurising cock - ATMOSPHERE
F - Flaps	- UP (28° down - two divs. on indicator - for shortest take-off run).
Supercharger control	- MODERATE
Radiator shutter	- Fully OPEN

9. TAKE-OFF

(i) Open the throttle slowly to the gate, or fully if full take-off boost is necessary.

(ii) Any tendency to swing can be counteracted by the rudder. When fitted with 2 x 500 lb. bombs the tendency to swing left is slightly more pronounced.

(iii) After raising the undercarriage return the selector lever to neutral, and retrim nose heavy.

(iv) Do not start to climb before a speed of 140 mph IAS is attained.

10. CLIMBING

(i) The speeds for maximum rate of climb are as follows:

Up to 16,000 feet:	140 mph IAS
At 21,000 feet:	135 mph IAS
At 26,000 feet:	130 mph IAS
At 31,000 feet:	125 mph IAS

Change to S ratio when the boost has fallen by 5 lb/sq.in.
At full load 155 mph IAS is the most comfortable climbing speed.
Considerable surging may be experienced above 8,000 feet on aircraft on which the air intake duct has been removed.

(ii) When fitted with 2 x 90-gallon drop tanks the aircraft are longitudinally unstable on the climb.

(iii) When fitted with 2 x 500 lb. bombs there is a similar tendency to pitch if the rudder is not held steady.

(iv) The fuel tank pressure control should normally be kept to ATMOSPHERE (except when required to supply fuel from the drop tanks), but should be turned on (PRESSURE) if the fuel pressure warning light comes on.

11. GENERAL FLYING

(i) Stability: The aircraft are normally just stable longitudinally, but when carrying 90-gallon drop tanks, or R.P. and one 90-gallon drop tank, they become unstable longitudinally and, in the first case, 190 mph IAS is the minimum comfortable flying speed. In conditions of absolute calm this can be reduced to 180 mph IAS. When carrying bombs, R.P., or containers, longitudinal stability is unaffected.

(ii) Change of trim:-

Undercarriage down	-	Nose slightly down
Flaps down	-	Nose down

(iii) In steep turns there is a tendency to tighten up.

(iv) In bad visibility near the ground, flaps should be lowered to about 40° (3 divisions) and the propeller speed control set to give 2,650 rpm. Speed may then be reduced to about 110 mph IAS. The radiator shutter must be opened to keep the temperature at about 100°C.

(v) When operating in tropical conditions prolonged flying at maximum cruising power should be avoided when top speed is not essential.

12. MAXIMUM PERFORMANCE

(i) Climbing

See Para.10(i).

(ii) Combat

Use S ratio if the boost in M ratio is 2 lb/sq.in. below the maximum permitted.

13. ECONOMICAL FLYING

(i) Climbing: Climb at 2,850 rpm and +9 lb/sq.in. boost at the speeds recommended for maximum rate of climb (See Para.10).

(ii) Cruising: For maximum range fly in M ratio and at maximum obtainable boost not exceeding +4 lb/sq.in. and reduce speed by reducing rpm which may be as low as 1,800, but check that the generator is charging. On some early aircraft it will not do so at below 2,000 rpm. If at 1,800 rpm (or 2,000 if necessary) the speed is higher than that recommended, reduce boost.
S ratio should only be used if at 2,600 rpm the recommended speed cannot be obtained in M ratio.

(iii) The recommended speeds (mph IAS) for maximum range are:

Standard aircraft:	160
When fitted with 2 x 44 or 45 gal. tanks:	160
When fitted with 2 x 90 gal. tanks:	170 or as near as possible.
When fitted with 2 x 250 lb. bombs:	170
When fitted with 2 x 500 lb. bombs:	180

Below 5,000 feet these speeds should be increased by about 10 mph.

14. STALLING

(i) At the stall one wing usually drops sharply, often over the vertical, with flaps either up or down.

(ii) The average stalling speeds (mph IAS) for the aircraft at various AUW (from 7,600 lbs to 9,200 lbs.) are:

Undercarriage and flaps UP:	80-90
Undercarriage and flaps DOWN:	60-75

The speeds for individual aircraft may vary by 5 mph.

15. SPINNING

(i) Spinning of Mk.IID and Mk.IV aircraft is prohibited at all times.

(ii) On Mark IIA, B and C aircraft spinning is prohibited when carrying 90-gallon drop tanks, bombs, S.C.I. or R.P.

(iii) Recovery is normal, but the loss of height involved in recovery may be very great and the following limits are to be observed:

(a) Spins are not to be started below 10,000 feet.

(b) Recovery is to be initiated before two turns are completed.

(iv) A speed of 150 mph IAS should be attained before starting to ease out of the resultant dive.

16. AEROBATICS

(i) The following speeds are recommended:

Loop:	At least 280 mph IAS
Roll:	220-250 mph IAS
Half roll off loop:	At least 300 mph IAS
Upward roll:	300 mph IAS.

17. DIVING

(i) Speed builds up slowly in the dive and the aircraft becomes tail heavy as the speed increases. The elevator trimming tabs should be used with care.

(ii) Care should be taken not to allow the aircraft to yaw to the right, as this produces a marked nose-down pitching tendency.

(iii) If fitted with bombs, S.C.I., or containers, the aircraft should be eased out of the dive gently. If fitted with drop tanks it should not be dived.

18. CHECK LIST BEFORE LANDING

(i) Check brake pressure (100 lbs/sq.in. minm.).

(ii) Reduce speed to 120 mph IAS and check that cockpit hood is locked open.

U - Undercarriage - DOWN (check green lights)

P - Propellor control - Fully forward

Supercharger control - MODERATE

F - Flaps - DOWN

19. APPROACH AND LANDING

(i) Approach speeds (mph IAS) at normal load:

		(flaps up)
Engine assisted:	95	(105)
Glide:	105	(115)

Note: If carrying drop tanks, bombs, or R.P., the normal engine assisted approach should be made at about 110 mph IAS.

(ii) Undercarriage: The lever should have been left in neutral, but if it has been left in the UP position, be careful to disengage the thumb catch by easing the selector lever forward before trying to move it to the DOWN position, otherwise the lever may become jammed. Return the lever to neutral as soon as the undercarriage is down.

(iii) Flaps: If 120 mph IAS is exceeded with the flaps fully down, they will be partially raised by the airflow. They will automatically move to the fully down position when speed is reduced sufficiently, provided that the selector lever is left at DOWN.

(iv) Landing with R.P. only on one wing should be made at as high a speed as possible and care must be taken to counteract dropping of the wing.

20. MISLANDING

(i) Raise the undercarriage immediately.

(ii) Climb at about 90 mph IAS.

(iii) Raise the flaps at a safe height of about 200-300 feet, at a speed of not less than 120 mph IAS.

(iv) With one 500 lb. bomb stuck up open the throttle slowly and speed on the initial climb should be 110 mph IAS before raising flaps at 120 mph IAS.

21. AFTER LANDING

(i) Raise the flaps before taxying.

(ii) To stop the engine, idle for ½ minute at 800-900 rpm, then pull the slow-running cut-out and hold it out until the engine stops.

(iii) Turn OFF the fuel cock and switch OFF the ignition.

(iv) Check that the hydraulic selector safety plate is covering the WHEELS UP position.

(v) Oil dilution.- (See A.P.2095 Pilot's Notes General) The correct dilution period for these aircraft is:

Atmospheric temperature above -10°C: 1 minute
Atmospheric temperature below -10°C: 2 minutes

22. FUEL CAPACITIES AND CONSUMPTION

(i) Fuel capacities:

(a) Normal:

Two Main tanks (33 gals. each):	66 gallons.
One Reserve tank:	28 gallons.
Total:	94 gallons.

(b) Long-range (totals):

With 2 fixed under-wing tanks (44 gallons each):	182 gallons.
With 2 x 45 gallon drop tanks:	184 gallons.
With 2 x 90 gallon drop tanks:	274 gallons.

(ii) The approximate consumptions (gals/hr.) in WEAK mixture are as follows:

Boost lb/sq.in.	M ratio at 8,000 - 20,000 ft. R.p.m. 2,650	2,300	2,000	S ratio at 14,000 - 30,000 ft. R.p.m. 2,650	2,300	2,000
+4	56	50	46	57	51	47
+2	52	46	42	53	47	43
0	47	42	38	48	43	39
-2	42	37	34	43	39	35
-4	37	33	30	38	34	31

(iii) The approximate consumptions in RICH mixture are as follows:

R.p.m.	Boost lb/sq.in.	Galls/hr.
3,000	+12	115
3,000	+ 9	100
2,850	+ 9	95
2,650	+ 7	80

23. BEAM APPROACH

STAGE	Indicated height(feet)*	I.A.S. m.p.h.	R.p.m.	Approx. Boost	Actions	Change of trim and Remarks
PRELIMINARY APPROACH	1,500	120	2,400	-2	Flaps down 30°	Strongly nose down
	1,500	120	2,400	-1	Lower u/c on Q.D.R. over I.M.B.	Slightly nose down
AT OUTER MARKER BEACON	600	95-100	3,000	-4	Flaps down to 60°	Nose down
			3,000	0		Should give level flight
AT INNER MARKER BEACON	100	90-95	3,000			
OVERSHOOT	Up to 400	95-100	3,000	Full throttle	Raise u/c and retrim. Raise flap to 30° and retrim Raise flaps fully and retrim. Adjust boost and r.p.m. at 1,000 feet	Nose up Nose up Nose up

* Altimeter adjusted for Q.F.E. and touch-down error as follows:
At take-off, with no flap, the altimeter reads -30 feet.
At touch-down, with 60° flap, the altimeter reads -55 feet,
so add two millibars to Q.F.E. to give zero reading at touch-down.

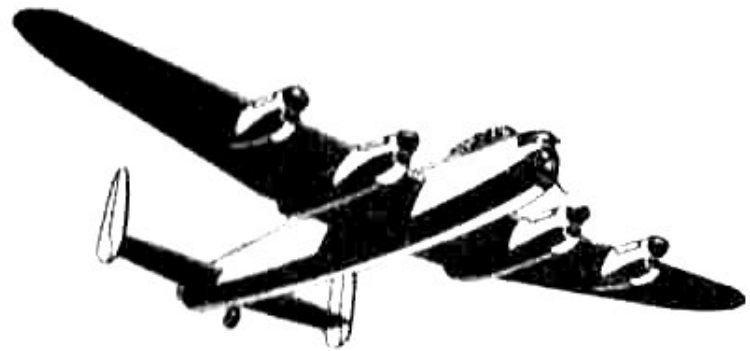
Note: The above speeds should be increased by 5 m.p.h. for Mark IID and IV aircraft.

SAPPHIRE PRODUCTIONS, 16 THE FRIARS, CHIGWELL, ESSEX.
England 01-500 1657

SAPPHIRE PRODUCTIONS, 6 HILLTOP CLOSE, LOUGHTON, ESSEX
ENGLAND

A.P. 2062A—P.N. (3rd Edition)
A.P. 2062C—P.N. (2nd ")
A.P. 2062F—P.N. (1st ")

PILOT'S
AND
FLIGHT ENGINEER'S
NOTES



LANCASTER

A.L.2 Front Cover

MARK I FOUR MERLIN XX, 22, or 24 ENGINES
MARK VII FOUR MERLIN 24 ENGINES
MARK III & X FOUR MERLIN 28, 38 or 224 ENGINES

PROMULGATED BY ORDER OF THE AIR COUNCIL

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			7		
2			8		
3			9		
4			10		
5			11		
6			12		

Photo by CHARLES E. BROWN

LANCASTER I, III & X

NOTES TO USERS

THIS publication is divided into six parts: Descriptive, Handling, Operating Data, Emergencies, Supplementary Notes for Flight Engineer, and Illustrations and Location of Controls.

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 when issued.

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. 2062A, C and F—P.N.

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

AIR MINISTRY
May 1944
(*Reprinted—April* 1945)

AIR PUBLICATION 2062A, C, & F—P.N.
Pilot's and Flight Engineer's Notes

LANCASTER I, III & X
PILOT'S & FLIGHT ENGINEER'S NOTES

LIST OF CONTENTS

PART I

A.L.2 Part I Para. 1

INTRODUCTION

1. The Lancaster I, III, VII and X are heavy bombers, the difference between them being mainly in the power plants. The Lancaster I is fitted with Merlin XX, 22 or 24 engines, which have SU carburettors; the Lancaster VII is the Austin built version of the Mark I, with Merlin 24 engines, having the Glenn Martin 250 CE 23 turret installed in the forward mid-upper position. The Lancaster III and X are fitted with Merlin 28, 38 or 224 engines, which have Bendix Stromberg pressure-injection carburettors; hydromatic propellers are fitted to all marks. Lancaster X are Canadian built and differ from British-built Lancasters in some of the instruments and in the electrical system. The Lancaster Mk. III with Mod. 1480 incorporated is known as the Lancaster ASR Mk. III. Mod. 1480 introduces navigational equipment and suitable gear for dropping an airborne lifeboat.

2. **Fuel tanks.**—Three self-sealing tanks are fitted in each wing, numbered 1, 2 and 3 outboard of the fuselage between the front and rear spars. On some aircraft the tanks may be marked Inner, Centre and Outer instead of Nos. 1, 2 and 3. The positions are:

No. 1 (Inner): Between the fuselage and the inner engines
No. 2 (Centre): Between the inner and outer engines
No. 3 (Outer): Outboard of the outer engines.

Capacities are:

Port and starboard	No. 1:	580 gallons	each	
„ „ „	No. 2:	383 „	„	
„ „ „	No. 3:	114 „	„	
		1,077 „	„	side
		or 2,154 „	in all.	

Provision is made on some aircraft for carrying one or two 400-gallon tanks fitted in the bomb cells; these tanks are connected so that their contents may be transferred into either or both No. 1 wing tanks and thence to the engines. When the maximum bomb load is carried, the No. 2 tanks should be filled first, and the remainder of the fuel put in No. 1 tanks. This is on account of strength considerations of the aircraft structure.

3. **Fuel cocks.**—The pilot controls four master engine cocks (24, 30). On Lancaster I aircraft, the master engine cocks also control the slow-running cut-outs. The flight engineer controls two tank selector cocks (77) which select No. 1 or No. 2 tank on each side. (No. 3 tank replenishes No. 2, see below). A cross-feed cock (marked BALANCE COCK) connects the port and starboard supply systems, and is on the floor just forward of the front spar, with the handle visible through a hole in the spar cover.

When the 400-gallon tanks are fitted in the bomb cells they each have an ON-OFF cock situated behind the front spar in the centre of the fuselage.

4. **Vapour vent system** (Lancaster III and X aircraft only).—A vent pipe from each carburettor is connected to the No. 2 tank on the same side of the aircraft, and allows vapour and a small quantity of fuel (approx. ½ gal. per hour, per carburettor, but some later carburettors may have a second vent allowing 10 gallons per hour) to return to the tank. This carburettor is designed to work full of fuel, and it therefore requires the vent to carry away any petrol vapour and dissolved air. It also assists in re-establishing the flow of fuel to the carburettors when the pipe-lines and pump have been run dry due to a tank emptying.

5. **Electric fuel booster pumps**

(i) Originally, on Lancaster I aircraft, immersed pumps were fitted in all tanks; Mod. 594 (temporary) removed the immersed pumps from No. 1 tanks and fitted stack pipes in their places.

A later Mod. 512 put back the immersed pumps in No. 1 and No. 2 tanks and incorporated suction by-pass lines to allow fuel to be drawn from the tanks when the pumps are not in use. In aircraft incorporating Mod. 539, including all Lancaster III aircraft, a Pulsometer FB Mk. I pump is fitted in each tank and by-pass lines are incorporated at No. 1 and No. 2 tanks. On Lancaster X aircraft, Thomson pumps, similar to the Pulsometer pumps, and by-pass lines are fitted.

No. 3 tank is used to replenish No. 2 tank (*see* Figs. 5 & 6) by switching on the No. 3 tank pump. When the 400-gallon tanks are fitted in the bomb cells they each have a similar pump fitted to transfer their contents to the No. 1 tanks.

(ii) The main use of the electric fuel pumps in No. 1 and No. 2 tanks is to maintain fuel pressure at altitudes of approximately 17,000 ft. and over in temperate climates, but they are also used for raising the fuel pressure before starting and to assist in re-starting an engine during flight. If one engine fails during take-off and the electric fuel pump is not ON, air may be drawn back into the main fuel system before the master engine cock of the failed engine can be closed, thus causing the failure of the other engine on the same side; therefore at take-off the pumps in Nos. 1 and 2 tanks must be switched on; this is also a precaution against fuel failure during take-off as an immediate supply is available by changing over the tank selector cock. The pump in each tank in use should also be switched on at any time when a drop in fuel pressure is indicated or when it is necessary to run all engines from one tank by opening the cross-feed cock.

A.L.2 Part I Para. 6

6. **Fuel contents gauges.**—On Lancaster I and III, the switch (76) on the flight engineer's panel must be set ON before the fuel contents gauges will indicate. On Lancaster X there is no fuel contents gauge switch; the gauges will indicate whenever electrical power is available. Mods. 1198 and 1384 introduce "Gallons-gone" fuel flowmeters which are also under the control of the flight engineer.

7. **Fuel pressure indicators**—Fuel pressure warning lights (79) show when the fuel pressure at the carburettor falls below 6 lb./sq.in. on Lancaster I aircraft, and 10 lb./sq.in. on Lancaster III aircraft. They are switched off by the fuel contents gauges switch (76), and this switch must, therefore, always be on in flight. On Lancaster X, fuel pressure gauges (73) are fitted on the flight engineer's panel. They will indicate whenever battery power is available.

A.L.2 Part I Para. 8

8. **Priming pumps.**—There is one cylinder priming pump in each inboard engine nacelle, drawing fuel from the No. 1 tank on that side; each pump serves one inboard and one outboard engine. On Lancasters I, III and VII aircraft this is accomplished by having two priming cocks fitted in each nacelle. On Lancaster X the priming pump handle is turned to the left to prime the left engine, to the right to prime the right engine, and to the mid-position for off.

A.L.2 Part I Para. 8 (*contd.*)

On Lancaster I, III and VII the priming pumps may be type K40 (40 ccs.) with a T-handle, or A.M. type B (10 ccs.) with a round handle. The American type priming pumps fitted on Lancaster X have approximately the same capacity as the A.M. type B pump. Another cock and a short pipe may be fitted beside the priming pump and can be used to connect an outside supply of high volatility fuel for cold weather starting.

9. **Oil tanks.**—Each engine has its own tank; capacity 37½ gallons of oil with 4½ gallons air space.

10. **Oil dilution.**—The four push-buttons (81) are on the flight engineer's panel.

MAIN SERVICES

11. Hydraulic system

A.L.2 Part I Para. 11 (i)

(i) Each turret is operated by an individual engine-driven pump.

Port outer ...	...	Tail turret.
Starboard inner ...	...	Front turret.
Starboard outer ...	...	Mid-upper turret (except on Lancaster VII where the mid-upper turret is electrically operated.)

(ii) Two pumps (one on each inboard engine), with a hand-pump as an alternative, charge a small accumulator and operate:

Undercarriage
Flaps
Bomb doors
Carburettor air intake shutters
Fuel jettisoning

Owing to the large capacity of the flap and undercarriage jacks, it is not normally possible to operate them by the hand-pump in the time available in an emergency.

12. Pneumatic system

A.L.2 Part I Para. 12 (i)

12. **Pneumatic system**

(i) A compressor on the starboard inner engine charges an air bottle and operates:

Wheel brakes
Radiator shutters
Supercharger rams (on all aircraft except early Lancaster I)
Idle cut-off rams (on Lancaster III and X aircraft only)

The air bottle charges to 300 lb./sq. in. except when Lincoln type undercarriage is fitted (Mod. 1195) when the bottle charges to 450 lb./sq. in.

A.L.2 Part I Para. 12 (i) (*contd.*)

A pressure-maintaining valve in the supply line from the air bottle only allows pressure to be supplied to the radiator shutters, superchargers and idle cut-off rams, if the pressure in the air bottle exceeds 130 lb./sq. in. (160 lb./sq. in. when Mod. 1195 is fitted). This is to ensure sufficient pressure for the brakes, which operate at 80 lb./sq. in. (125 lb./sq. in. when Mod. 1195 is fitted). It is necessary therefore to check on the triple pressure gauge that pressure is sufficient before S ratio is engaged, or radiator override switches or idle cut-off controls are operated.

(ii) A vacuum pump is fitted on each inboard engine, one for operating the instruments on the instrument flying panel, and the other for operating the gyros of the Mark XIV bombsight; the change-over cock (17) is on the right of the instrument panel beside the suction gauge (23), and in the event of failure of the vacuum pump supplying the flying instruments the changeover cock can be used to connect the serviceable pump with the flying instruments and cut out the bombsight. It is not possible to operate flying instruments and bombsight on one vacuum pump.

A.L.1 Part I Para. 12 (iii)

(iii) A compressor fitted on the port inboard engine operates the Mark IV or Mark VIII Automatic Pilot, and the computor unit of the Mark XIV bombsight. For operation of the Mark XIV bombsight, the automatic pilot control cock must be set to OUT except on those aircraft in which Mod. 1161 is incorporated.

A.L.2 Part I Para. 13

13. **Electrical system.**—Two 1,500 w. generators are fitted on all aircraft except Lancaster VII which have two 3,000 w. generators. The generators are fitted one on each inboard engine and connected in parallel, charge the aircraft batteries (24 volt) and supply the usual lighting and other services including

Propeller feathering pumps
Flaps and undercarriage indicators
Pressure head heating
Fuel booster pumps
Radio equipment
Landing lamps
Engine starting and booster coils
Dinghy inflation
Controls for radiator shutter and supercharger gear-change rams
Controls for idle cut-off rams (on Lancaster III and X aircraft).
Mid-upper turret (on Lancaster VII aircraft).

Bomb gear and bombsight
Fire-extinguishers
Fuel contents gauges
Fuel pressure warning lights or gauges
Camera
Heated clothing
DR compass

An alternator may be fitted to each outboard engine, to supply any special radio equipment.

A ground/flight switch on the starboard side of the fuselage, immediately aft of the front spar, isolates the aircraft batteries when the aircraft is parked or when using a ground starter battery. Two generator switches are provided on the electrical control panel.

AIRCRAFT CONTROLS

14. **Trimming tabs.**—The elevator (62), rudder (63) and aileron (61) tab controls (on the right of the pilot's seat) all operate in the natural sense and each has an indicator.

A.L.1 Part I Paras. 14 & 14A

14A. **Automatic pilot.**—On early aircraft the Mark IV Automatic Pilot, and on later aircraft the Mark VIII Automatic Pilot, is fitted, driven by a compressor on the port inboard engine. *See* A.P. 2095 for operation, which is normal except on some aircraft in which Mod. 1161 is incorporated, when a stop is provided to prevent the control cock from being moved from the SPIN to the OUT position.

15. **Undercarriage control.**—The undercarriage lever (64) is locked in the DOWN position by a safety bolt (65) which has to be held aside in order to raise the lever. The bolt engages automatically when the lever is set down. The undercarriage may be lowered in an emergency by compressed air (*see* Part IV, para. 56).

WARNING.—There is no automatic lock to prevent the undercarriage being raised by mistake when the aircraft is on the ground.

16. **Undercarriage indicator** (39).—On Lancasters I and III the indicators show as follows:

Undercarriage	locked down:	Two green lights
,,	unlocked:	Two red lights
,,	locked up:	No lights

The indicator switch (4) is interlocked so that it must be on when the port engine ignition switches are on. An auxiliary set of green lights can be brought into operation by pressing the central knob if failure of the main set is suspected. The red lamps are duplicated so that failure of one lamp does not affect the indication of undercarriage

unlocked. The lights can be dimmed by turning the central knob. On Lancaster X a pictorial type of indicator is fitted. When the indicator switch is on and electrical power is available, the pictorial indicator shows the position of the undercarriage wheels and wing flaps at all times. The disappearance of small red flags shows when the wheels are locked up or down.

17. **Undercarriage warning horn.**—The horn sounds if either inboard throttle is closed when the undercarriage is not locked down. The outboard throttles do not operate the horn. A testing pushbutton and lamp are behind the pilot's seat, on the cockpit port rail.

A.L.1 Part I Para. 18

18. **Flaps control.**—If the flaps have been selected partly down, and it is desired to lower them fully, it may be found that the flaps will not lower further for some considerable time. This is due to the pressure in the accumulator having fallen below the pressure required to operate the flaps, but not sufficiently to cause the hydraulic pumps to cut in. To overcome this, move the flaps selector (60) to UP, and then immediately put it fully DOWN; this causes the hydraulic pumps to cut in. After the flaps have been selected fully down for landing, the flaps selector (60) should be left DOWN until landing is complete, to avoid any possibility of the flaps creeping up.

On Lancasters I and III the flaps position indicator (26) is switched on by a separate switch (27).

In an emergency the flaps may be lowered by compressed air after lowering the undercarriage (*see* para. 57).

19. **Bomb doors.**—The control (43) has two positions only. The bomb release system is rendered operative soon after the doors begin to open and before they are fully open. The position of the doors must therefore be checked visually before releasing bombs. If the bomb doors open only part way and then stop, it is probably due to icing around the hinges and joints, which raises the hydraulic pressure sufficiently to bring the cut-out into operation, which stops any further movement of the doors. If the bomb doors selector is moved to SHUT and then immediately to OPEN, the doors will usually open further; it may be necessary to repeat this several times to get the doors fully open.

As strenuous pumping for 15 minutes is required to open the doors with engines stopped, they should be opened before stopping engines if the aircraft is to be bombed up before the next flight.

For emergency operation of bomb doors by compressed air, *see* Part IV, para. 58.

ENGINE CONTROLS

20. **Throttle controls**

(i) *Merlin XX, 22, 28 and 38 engines.*—Climbing boost +9 lb./sq.in. is obtained with the throttle levers (28) at the gate. On Merlin XX installations, and originally on Merlin 22, 28 or 38 installations, going through the gate gives a boost of +12 lb./sq.in. at ground level only. A later modification to Merlin 22, 28 or 38 engines gives +14 lb./sq.in. boost at ground level only with the throttle levers through the gate.

The boost control cut-out (32) gives +14 lb./sq.in. in M gear and +16 lb./sq.in. in S gear on all the above Merlins.

(ii) *Merlin 24 engines.*—Originally no boost control cut-out was fitted and no climbing gate. The fully forward position of the throttle lever gave +18 lb./sq.in. boost for take-off and combat. On these installations the automatic boost control does not allow the butterfly to open fully to maintain +9 lb./sq.in. boost up to full throttle height unless the throttle levers are progressively advanced to the fully forward position during the climb. However, a modification is now being introduced which overcomes this, and when this is incorporated a boost control cut-out is fitted which gives +18 lb./sq.in. for take-off and combat; the throttle quadrant is fitted with a gate at +9 lb./sq.in. boost, and the fully forward position gives + 14 lb./sq.in. at ground level only, for take-off at moderate loads.

A.L.1 Part I Para. 20 (iii)

(iii) *Merlin 224 engines.*—The throttle quadrant is fitted with a gate at +9 lb./sq.in. boost; the fully forward position gives +14 lb./sq.in. at ground level only, for take-off at moderate loads. The boost control cut-out gives +18 lb./sq.in. for maximum take-off and combat.

21. **Mixture control**

(i) *Merlin XX, 22 and 24 engines (Lancaster I).*—S.U. carburettors are fitted. The mixture strength is automatically controlled by boost pressure, and the pilot has no separate mixture control. A weak mixture is obtained below +7 lb./sq.in. boost (+4 lb./sq.in on Merlin XX). The carburettor slow-running cut-outs are operated by closing the master engine cocks.

A.L.3 Part I Para. 21 (ii)

(ii) *Merlin 28, 38 and 224 engines (Lancasters III and X).*—Bendix-Stromberg pressure injection carburettors are fitted. There is no pilot's mixture control, the mixture strength being regulated by the power, so that an economical mixture is obtained below +7 lb./sq.in. boost.

The carburettor idle-cut-outs, which are used in starting and for stopping the engines, are operated by electro-pneumatic rams controlled by four two-position switches (11) or four pushbuttons (if Mod. 1753 is fitted) mounted on the pilot's panel above the engine starter buttons. When two-position switches are fitted the top position is the ENGINE RUN position, and the bottom position is the IDLE-CUT-OFF position; when pushbuttons are fitted, they have to be held in to keep them in idle cut-off.

NOTE.—If the pneumatic supply pressure is less than 130 lb./sq.in. (160 lb./sq.in. when Mod. 1195 is embodied) it is possible to start the engines with the slow running cut-out switches in the IDLE-CUT-OFF position; then, when the supply pressure builds up the idle cut-off rams will operate and all four engines will stop.

22. **Propeller controls.**—The speed control levers (29) for the Hydromatic propellers vary the governed r.p.m. from 3,000 down to 1,800. The feathering buttons (19) are on the right of the instrument panel. For feathering and unfeathering procedure *see* Part IV, paras. 53, 54.

23. **Supercharger controls**

(i) On early Lancaster I aircraft the supercharger controls for all four engines are operated mechanically by one lever.

(ii) On later Lancaster I and on all Lancaster III and X aircraft, the superchargers are operated by electro-pneumatic rams of the single-action spring-return type. In the case of electrical or pneumatic failure the rams will return to the M ratio position. A switch, fitted to the pilot's instrument panel immediately below the engine speed indicators, controls all four engines simultaneously, and a red warning light beside it (25) indicates S ratio on the ground only (i.e. when the undercarriage is down).

A.L.2 Part I Paras. 24 to 26

24. **Radiator shutters.**—The shutters are automatically controlled when the switches forward of the flight engineer's panel are in the up position. When the switches are down the thermostatic control is over-ridden, and the shutters are opened; this position should be used for all ground running, taxying and marshalling.

25. **Carburettor air-intake heat control.**—A single lever for the hydraulic operation of all four carburettors' warm air intakes is on the left of the pilot's seat.

When Mod. 1198 is fitted the control has 3 positions, COLD, WARM and HOT (emergy.). If the control is at WARM, air is then drawn into each engine through the warm air-intake inside the bottom engine cowling. When moved to HOT, a flap in the bottom engine cowling is opened by an electro-pneumatic ram and allows hot air to be drawn from the radiator to the engine. The WARM position may be used to prevent the formation of ice when flying in icing conditions, but this will reduce the range (see para. 49 (iii)).

If the flight is continued, instead, in COLD until carburettor icing becomes evident, the HOT position should then be used, but only until the ice has cleared.

If Mod. 1198 is not fitted, there are only two positions COLD and WARM, but the latter position should be regarded as having a similar function to the HOT position when the 3-position control is fitted, as air is drawn from the radiator to the engine through a hole in the engine cowling when the control is at WARM.

OTHER CONTROLS

26. **Intercommunication.**—On Lancaster X, Bendix interphone station boxes are fitted. For inter-communication the selector switch must be set to INTER and the INCREASE OUTPUT control set full on.

A.L.1 Part I Para. 26A

26A. **Fuel jettison control**

The control for the jettison valves in No. 1 tanks is on the floor to the left of the pilot's seat, and is painted red. It is pulled up and turned anti-clockwise to jettison fuel.

NOTE.—The fuel jettisoning system must not be operated unless the pressure in the hydraulic accumulator is more than 650 lb. sq.in. When the flaps are lowered prior to jettisoning, the accumulator pressure should build up rapidly to 650–850 lb. sq.in. If, however, the gauge indicates a lower pressure, one of the main hydraulic systems should be operated momentarily, e.g. the bomb doors control should be moved to OPEN and then returned at once to CLOSED. This will cause the hydraulic cut-out valve to function and the pumps will build up pressure in the system. To ensure the most efficient operation of the jettison system the control valve should be opened as the rising pressure passes 650 lb. sq.in., and a member of the crew should watch the gauge and signal the pilot at this moment.

PART II

HANDLING

NOTE.—All speeds quoted are for aircraft with the Pilot's A.S.I. connected to the static vent (*see* para. 47).

A.L.2 Part II Para. 27 (i), (ii)

27. Management of fuel system

(i) *Testing electric fuel booster pumps.* Before starting the engine, each booster pump should be tested by ammeter (most aircraft have a permanent ammeter fitted on the flight engineer's panel while some early Lancaster I aircraft may have an ammeter test socket into which the ammeter must be plugged); to do this the switch for each pump (on Lancaster I, III and X aircraft) should in turn be set to the up (TEST) position, after ensuring that the idle cut-off switches are in the IDLE CUT-OFF position and air supply pressure is greater than 130 lb./sq. in (160 lb./sq. in. if Mod. 1195 is fitted) on Lancaster III and X aircraft. On Lancaster VII aircraft the pump switches are two-position switches and the pumps are tested by pressing the test-buttons above the switches.

The ammeter reading should be perfectly steady and should be between 4 and 7 amps for a Pulsometer FB1 Mk. I pump, between 7 and 9 amps for a Pulsometer FB1 Mk. II pump (which were fitted in place of FB1 Mk. I pumps by Mod. 1358), between 3 and 5 amps for a Thomson pump (fitted on Lancaster X), or between 2 and 4 amps for an immersed pump (fitted on early Lancaster I). Aircraft with Pulsometer pumps may be recognised by the small blisters on the underside of the wings.

(ii) *Use of tanks:*

Structural considerations render it advisable that fuel should always be kept outboard as much as possible.

(*a*) No. 2 tanks should be used for starting, warming up, take-off and the first hour of flight. This will allow space for carburettor venting, where applicable. (See Part I, para. 4.) When overload tanks are used it may be necessary to re-select No. 2 tanks from time to time in order to prevent them from over-filling.

The electric fuel booster pumps in Nos. 1 and 2 tanks must be switched on for take-off, so that if for any reason the fuel supply from No. 2 tanks should fail, fuel pressure will be available immediately on turning the tank selectors to No. 1 tanks. See also Part I, para. 5.

A.L.2 Part II Para. 27 (ii) (Contd.)

(*b*) After the first hour of the flight No. 1 tanks should be selected. When nearly empty, transfer the fuel from the fuselage overload tanks, if in use, by turning on both long-range fuel cocks (behind front spar) and switching on overload tank pump switches. The fuel contents gauge should also be switched on. Transfer of fuel from long-range tanks takes approximately one hour. Turn off each long-range tank cock and pump switch when the tank is empty.

(*c*) Continue to run on No. 1 tanks until empty; then re-select No. 2 tanks and use until approximately 200 gallons remain in each. Then transfer the contents of No. 3 tanks by switching on the No. 3 booster pumps. Switch off the pumps when No. 3 tanks are empty.

A.L.2 Part 9 Page 17

9. Fuel jettisoning

On aircraft embodying Mod. 1370 fuel may be jettisoned, if required, from No. 1 tanks, and the control for the jettison valves is on the cockpit floor to the left of the pilot's seat. It is painted red and should be pulled up and turned anti-clockwise to jettison fuel.

the engine cuts owing to exhaustion of fuel in one tank, back-firing may occur on turning on to another tank. For when the tank empties, the fuel pressure drops, and when the pressure falls to 4 lb./sq.in. fuel injection ceases. When the new tank is turned on, the carburettor restarts and delivers the fuel already in it, but this supply is followed by vapour from the fuel pipelines, causing weak mixture and back-firing until fuel is delivered from the new tank.

When an engine cuts due to exhaustion of one tank:

(*a*) Close the throttle and change over to another tank.

(*b*) Idle the engine till it runs smoothly and open up slowly.

(*c*) The use of the booster pump in the tank turned on will help to restart the engine.

28. Preliminaries

(i) *Before entering aircraft.*—Check pitot head covers removed.

Check all cowling and inspection panels, and leading edge secured. Check tyres for creep.

A.L.2 Part II Para. 28 (ii)

(ii) *On entering aircraft* check security of emergency escape hatches. Check emergency air bottle pressure (1,100-1,200 lb./sq. in.) if gauge is fitted.

Check hydraulic accumulator pressure (220 lb./sq. in. minm., under no hydraulic pressure).

Check fuel cross-feed cock OFF.

Check position of all circuit breaker (overload) switches on Lancaster X aircraft (see para. 79).

Turn ground/flight switch to FLIGHT.

Switch on undercarriage indicator and flaps indicator switches (if fitted) and check indicators.

Switch on fuel contents gauges switch (if fitted) and leave it on, and check fuel contents.

Check master engine cocks OFF.

A.L.3 Part II Para. 29

29. Starting the engines and warming up.

(i) Test the fuel booster pumps by ammeter (*see* para. 27).

On Lancaster III and X aircraft the fuel booster pumps must never be switched on with the engine master cock open and the engine stationary, unless the slow-running cut-out switch (or pushbutton, if Mod. 1753 is fitted) is in the IDLE-CUT-OFF position, and the air supply pressure not less than 130 lb./sq.in. (160 lb./sq.in. if Mod. 1195 is fitted).

(ii) Have the ground/flight switch turned to GROUND and have a ground starter battery plugged in.

(iii) Set the engine controls as follows :

Master engine cocks ...	OFF
Slow-running cut-out controls	ENGINE RUN
Throttles	¼ inch open.
Propeller controls ...	Speed control levers fully up.
Supercharger control ...	Low gear (warning light not showing).
Air intake heat control ...	COLD
Radiator shutters	Over-ride switches at AUTOMATIC.

AUTOMATIC

A.L.3 Part II Para. 29 (contd.)

(iv) Have a fire extinguisher ready in case of emergency.

(v) Turn tank selector cock to No. 2 tank (*see* para. 27 (ii)) and turn on only the master engine cock of the engine to be started.

(vi) Prime the carburettor of the engine to be started by putting the slow running cut-out switch to IDLE-CUT-OFF, or by holding the pushbutton in, if Mod. 1753 is fitted (on Lancaster III and X) and switching the booster pump in the No. 2 tank on for a period of 10 seconds. Switch off the booster pump and then return the slow-running cut-out to the ENGINE RUN position.

(vii) High volatility fuel (stores ref. 34A/111) should be used if outside priming connection is fitted, for priming at air temperatures below freezing. The ground crew will work the priming pump until the fuel reaches the priming nozzles ; this may be judged by an increase in resistance.

(viii) Switch on the ignition and booster coil, and press the starter button. Turning periods must not exceed 20 seconds with a 30 second wait between each. The ground crew will work the priming pump as firmly as possible while the engine is being turned ; it should start after the following number of strokes if cold :

Air temp. °C.	+30	+20	+10	0	−10	−20
Normal fuel	3	4	7	12		
High-volatility fuel ...				4	8	18

NOTES.—(*a*) If the large priming pump, type K40 (with T-handle) is fitted (*see* para. 8) only one-quarter of these strokes will be required.

(*b*) The amount of priming given above applies when the engine is cold. Less priming will be required when it is warm, and when it is hot it is unlikely that any priming will be necessary. However, since individual engines differ in this respect the pilot should always discuss the amount of priming required with the ground crew concerned.

(ix) It will probably be necessary to continue priming after the engine has fired, and until it picks up on the carburettor. When the engine is running smoothly proceed to prime the carburettors and start the other engines in turn.

(x) When all the engines are running satisfactorily, switch off the booster-coil switch. The ground crew will screw down the priming pumps and turn off the priming cocks (if fitted).

(xi) Have the ground/flight switch turned to FLIGHT and the ground battery removed.

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

(xiii) Switch DR compass ON and SETTING.

30. **Testing engines and installations**

While warming up:

(i) Check temperatures and pressures, and test operation of hydraulic system by lowering and raising flaps and bomb doors—but do not test bomb doors if a bomb load is on board.

A.L.2 Part II Para. 30 (ii)-(viii)

(ii) ~~Switch off electric fuel booster pump so as to test engine-driven pumps.~~

(iii) After warming up until the oil temperature is 15°C. and the coolant temperature is 60°C., switch the radiator shutters over-ride switches to OPEN, and at 1,500 r.p.m. test each magneto as a precautionary check before increasing power further.

(iv) Open up all four engines together to 0 lb./sq.in. boost and check operation of two-speed superchargers. R.p.m. should fall when S ratio is engaged, and on aircraft with electro-pneumatically operated supercharger gear-change, red warning light should come on. Return to M ratio.

(v) At the same boost exercise the constant speed propeller at least twice by moving the speed control lever through its full range. With the control lever fully down r.p.m. should fall to 1,800 r.p.m.

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

(vi) For each engine in turn open throttle to the take-off position and check take-off boost and r.p.m.—see para. 20.

(vii) Throttle back to +9 lb./sq.in. check that r.p.m. fall below 3,000 and if not, throttle back until a drop is shown, to ensure that the propeller is not constant speeding. Then test each magneto in turn. The drop should not exceed 150 r.p.m.

in turn. The drop should not exceed 150 r.p.m.

31. **Check list before taxying**

Ground/flight switch	FLIGHT
Navigation lights ..	On if required
Altimeter	Set
Instrument flying panel	Check vacuum on each pump $-4\frac{1}{2}$ ~~lb./sq.in.~~
Radiator shutter switches	OPEN
Brakes pressure ..	Supply 250–300 lb./sq.in.

A.L.1 Part II Page 21

32. **Check list before take-off**

Autopilot	Clutch IN Control cock OUT (or SPIN, if Mod. 1161 is incorporated)
DR compass	NORMAL
Pitot head heater switch	ON
T—Trimming tabs ..	Elevator— $4\frac{1}{2}$ divs. nose heavy at ~~55,000 lb.~~ $2\frac{1}{2}$ divs. nose heavy at 55,000 lb. Rudder neutral Aileron neutral
P—Propeller controls	Fully up
F—Fuel	Check contents of tanks Master engine cocks ON Tank selector cocks to No. 2 tanks Crossfeed cock OFF Booster pumps in Nos. 1 and 2 tanks ON
Superchargers ..	MOD
Air intake ..	COLD
Radiator shutters switches	AUTOMATIC
F—Flaps	15°–20° down

A.L.2 Part II Para. 33

33. **Taking off**

(i) Align the aircraft carefully on the runway, making certain that the tailwheel is straight.

(ii) Open up to 0 lb./sq.in. boost against the brakes to check that all four engines are responding evenly.

(iii) Release the brakes gently and open the throttles slowly to the take-off position.

(iv) Keep straight by coarse use of the rudder and by differential throttle opening.

(v) As speed is gained, ease the control column forward to raise the tail. Do not attempt to raise the tail by exerting a heavy push force on the control column during the very early stages of the take-off run.

(vi) At 65,000 lb. ease the aircraft off the ground at 105 m.p.h. I.A.S. and at 72,000 lb. at 120 m.p.h. I.A.S.

(vii) When comfortably airborne brake the wheels and retract the undercarriage.

(viii) With flaps 20° down, safety speed at 65,000 lb. is 165 m.p.h. I.A.S. when using +18 lb./sq.in. boost and 3,000 r.p.m; at 72,000 lb. it is 175 m.p.h. I.A.S. In view of these high speeds power should, where practicable, be reduced early after take-off.

(ix) Raise the flaps in stages above 300 feet. Then return the selector to neutral.

(x) Switch off the electric fuel booster pumps in Nos. 1 and 2 tanks after the initial climb, but if a warning light comes on (or on Lancaster X fuel pressure gauge shows less than 10 lb./sq. in.), switch on No. 2 pumps immediately.

34. Climbing

(i) The recommended speed for a quick climb is 160 m.p.h. I.A.S. The most comfortable climbing speed is about 175 m.p.h. I.A.S.

(ii) Switch on electric fuel pumps of tanks in use, at any signs of fuel starvation (at approximately 17,000 feet in temperate climates).

35. General flying

A.L.2 Part II Para. 35 (i)—(ii)

(i) *Stability.* At normal loadings and speeds stability is satisfactory. At loads above 67,000 lb. there is a tendency for the aircraft to wallow. It is not advisable to attempt to correct this as use of the controls may aggravate it.

(ii) *Controls.* The elevators are relatively light and effective but tend to become heavy in turns. The ailerons are light and effective but become heavy at speeds over 260 m.p.h. I.A.S., and also at heavy loads.

The rudders also become heavy at high speeds.

A.L.1 Part II Para. 35 (iii) & 36

(iii) *Change of trim:*

Undercarriage UP	Slightly nose up
Undercarriage DOWN	Slightly nose down
Flaps up to 25° from fully DOWN ..	Slightly nose down
Flaps up from 25°	Strongly nose down
Flaps down to 25°	Strongly nose up
Flaps fully DOWN from 25°	Slightly nose up
Bomb doors open	Slightly nose up

(iv) *Flying at low airspeeds.*—Flaps may be lowered about 15°–20°, r.p.m. set to 2,650, and the speed reduced to about 130 m.p.h. I.A.S.

36. Stalling

(i) Warning of the stall is given by slight tail buffeting, which generally commences some 4 m.p.h. before the stall itself. At the stall the nose drops gently. Recovery is straightforward and easy.

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

	At maximum landing weight 55,000 lb.	At moderate load 62,000 lb.	At full load 65,000 lb.
Undercarriage and flaps up	105	112	118
Undercarriage and flaps down	85	92	100

(iii) *High speed stall.*—Adequate warning of the approach of a stall in a turn is given by strong rudder and elevator buffeting. At the stall the inner wing and nose drop gently together. Recovery is immediate on pushing the control column forward.

A.L.1 Part II Paras. 37–39

37. Diving

(i) On aircraft in which Mod. 1101 or 1131 is incorporated it is possible to recover from dives to the limiting speed without the assistance of the elevator trimming tab, even if the aircraft has been trimmed into the dive. If the elevator trimming tab is used, it should be applied with care, since it is powerful and sensitive.

(ii) On unmodified aircraft there is a strong nose-down change of trim as speed is gained in the dive. On these aircraft the elevator trimming tab should never be used to assist entry, but should be used to reduce the very heavy pull force otherwise necessary for recovery.

The flight engineer should be prepared to assist the pilot if required.

38. Check list before landing

Autopilot control cock ..	OUT (or SPIN if Mod. 1161 is incorporated) Clutches may be left IN
Supercharger	M (low) ratio
Air intake	COLD
Brake supply pressure ..	250–300 lb./sq.in.
Reduce speed to below 200 m.p.h. I.A.S. and carry out the following drill:	
Flaps	20° down on circuit
U—Undercarriage ..	DOWN (check by indicator, visually, and horn)
P—Propeller speed control	Up to at least 2,850 r.p.m.
F—Flaps	DOWN on final approach (leave selector DOWN)
F—Fuel	Booster pumps ON in tanks in use

A.L.2 Part II Para. 39

39. Approach speeds

Recommended final* approach speeds in m.p.h. I.A.S. are:

	At maximum landing weight 55,000 lb.	At overload 63,000 lb. (emergency only)
Flaps fully down		
Engine assisted	110	120
Glide	120	—
Flaps up		
Engine assisted	115	—

* These are the speeds at which the airfield boundary is crossed. The initial straight approach should, however, be made at a speed some 15-20 m.p.h. above these figures.

40.

(i) The aircraft will climb satisfactorily with the undercarriage and flaps down.

(ii) Climb at about 140 m.p.h. I.A.S. and, after raising the undercarriage, start raising the flaps a little at a time, retrimming as necessary.

41. Beam approach

	Indicated height: feet	I.A.S. m.p.h.	R.p.m.	Approx. boost: lb./sq.in.	Actions	Change of trim
Preliminary approach	1,500	135	2,400	−1	Set 25° flap for all manœuvring	Nose up strongly
On QDR +30°	1,500	135	2,650	+2	Undercarriage down	Nose down slightly
At outer marker	600	130	2,650	−2 to 0 (descent at 400 ft./min.) +2 (level flight)		
At inner marker	150	120	2,850	0 to +2	Flaps fully down	Nose up slightly
Overshoot	up to 300	130–140	2,850	+9	Raise flaps to 25° Raise undercarriage	Nose down slightly Nose up slightly

All four throttles should be used together throughout the approach. An increase in the rate of sink has no effect on the controls.

42. After landing

(i) Before taxying, raise the flaps and open the radiator shutters.

A.L.2 Part II Para. 42 (ii)

(ii) On reaching dispersal open up all four engines to not more than 0 lb./sq.in. boost and exercise the two-speed superchargers by changing to S (high) ratio, running in that ratio for 30 seconds and then changing back to M (low) ratio. Throttle back slowly and idle the engines for a short period at 1,000-1,200 r.p.m.

(iii) Before stopping the engines, open the bomb doors for bombing up (if required).

(iv) Switch off all booster pumps before stopping engines.

(v) *Stopping engines, Merlin XX, 22, 24.* With the engines running at 800 r.p.m., turn OFF the master engine cocks and switch OFF the ignition after the engines have stopped.

A.L.2 Part II Para. 42 (vi)

(vi) *Stopping engines, Merlin 28, 38 or 224.* To stop an engine check that the air pressure gauge reads at least 130 lb./sq. in. (160 lb./sq. in. if Mod. [redacted] is fitted). If not, open up starboard inner engine to charge the compressor, and then move the slow-running cut-out switch to the IDLE CUT-OFF (down) position with the engine running at about 800 r.p.m. If Mod. 1753 is incorporated it is necessary to hold the push button in.

NOTE.—Merlin 28, 38 and 224 engines must not be stopped by turning off the master engine cock, as this will empty the carburettor of fuel and fill it with air. This entails much trouble when starting the engine again.

When all the engines have stopped, switch off the ignition and turn off the engine master cocks.

Check again that all the booster pumps are OFF, then set the slow running cut-out switches to the ENGINE RUNNING position and the radiator shutter over-ride switches to AUTOMATIC.

NOTE.—If the slow-running cut-out switches are left in the IDLE CUT-OFF position or the radiator shutter over-ride switches are left in the OVER-RIDE position, the rams will return to the ENGINE RUNNING and AUTOMATIC positions respectively as soon as the master switch is turned to GROUND. Then, if any ground maintenance work is carried out which necessitates turning on and off the master switch, the rams are being continually operated.

(vii) Switch off all electrical switches and turn master electrical switch to GROUND.

(viii) *Oil dilution.—See Pilot's Notes General A.P.* 2095. The correct dilution period for this aircraft is:

Air temperatures above—10°C. .. One minute
" " below—10°C. .. Two minutes

A.L.1 Part II Para. 42A

42A. A.S.I. conversion table

M.p.h.	Knots
85	74
92	80
100	87
105	91.5
110	96
112	97.5
115	100
118	103
120	104
125	109
130	113
135	117.5
140	122
145	126
150	130
155	135
160	139
165	144
170	148
175	152
180	157
190	165
200	174
360	313

PART III

OPERATING DATA

A.L.1 Part III Paras. 43 & 44

43. Engine data—Merlin XX

(i) *Fuel.*—100 octane only.

(ii) *Oil.—See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

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

OIL PRESSURE:
MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:
OIL .. .. 15° C.
COOLANT .. .. 60° C.

44. Engine data—Merlin 22, 28 or 38

(i) *Fuel.*—100 octane only.

(ii) *Oil.—See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

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

OIL PRESSURE:
MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:
OIL .. .. 15° C.
COOLANT .. .. 60° C.

A.L.1 Part III Para. 45

45. Engine data—Merlin 24 or 224

(i) *Fuel.*—100 octane only.

(ii) *Oil.*—*See* A.P. 1464/C.37.

(iii) *Engine limitations* with 100 octane fuel:

		R.p.m.	Boost lb./sq.in.	Temperature °C. Coolant	Oil
MAX. TAKE-OFF TO 1,000 FEET	M	3,000	+18*		
MAX. CLIMBING 1 HOUR LIMIT	M	2,850	+ 9	125	90
	S				
MAXIMUM CONTINUOUS	M	2,650	+ 7	105	90
	S				
COMBAT 5 MINS. LIMIT	M	3,000	+18*	135	105
	S				

* +18 lb./sq.in. boost must not be used below 2,850 r.p.m.

OIL PRESSURE:

MINIMUM IN FLIGHT .. .. .. 30 lb./sq.in.

MINIMUM TEMPS. FOR TAKE-OFF:

OIL .. .. 15° C.

COOLANT .. .. 60 °C.

46. Flying limitations

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

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

Diving	360
Bomb doors open	as for diving
Undercarriage down ..	200
Flaps down	200

A.L.2 Part III Para. 46 (iii)—47

(iii) *Maximum weights*

Take-off and straight flying	63,000 lb.
" " " "	‡64,000 lb.
" " " "	†65,000 lb.
" " " "	*72,000 lb.
Gentle manoeuvres	63,000 lb.
Landing and all forms of flying	55,000 lb.
Landing	*60,000 lb.

* These weights are permitted if Merlin 24 or 224 power plants are fitted, paddle-bladed propellers are fitted, Lincoln type undercarriage and tyres (Mod. 1195) are fitted and special adjustments are made to the tyre and oleo leg pressures. A careful check on aircraft structure must be kept and runways only must be used.

† This weight is permitted provided the following mods. are incorporated: Mod. 503 or 518, Mod. 588 or 598, Mod. 811 or SI/RDA. 600 and Mod.1004.

‡ This weight is permitted for Lancaster ASR. Mk. III.

(iv) *Bomb clearances angles:*

Dive	30°
Climb	20°
Bank	10° (with S.B.C.25°)

(v) *Airborne lifeboat Mk. IIA* (fitted on Lancaster ASR. Mk. III)

(*a*) The lifeboat may be dropped at any speed up to 138 m.p.h. (120 knots) I.A.S. provided the aircraft is in straight and level flight, without sideslip.

(*b*) The lifeboat may be jettisoned at any speed up to the limiting speed of the aircraft.

47. Position error correction

(i) All handling speeds are quoted for aircraft without H_2S blister with the pilot's ASI connected to the static vent in the port side of the fuselage. The position error correction is −1 m.p.h. at all speeds from 140 m.p.h. I.A.S. upward.

(ii) When H_2S blister is fitted, the position error correction for static vent is as follows:

From	130	145	170	210	m.p.h. I.A.S.
To	145	170	210	250	
Subtract	1	2	3	4	m.p.h.

(iii) For early aircraft in which the static vent connection has not been made correction is as follows:

From	120	140	160	180	200	m.p.h. I.A.S.
To	140	160	180	200	250	
Add	12	10	8	6	4	m.p.h.

(iv) On Lancaster ASR Mk. III the corrections are as follows:

(*a*) When the lifeboa: is being carried, the correction is +3 m.p.h. at speeds below and +2 m.p.h. at speeds above 160 m.p.h. I.A.S.

(*b*) When the lifeboat is not being carried the correction varies from +1 m.p.h. at 110 m.p.h. I.A.S. to −1 m.p.h. at 250 m.p.h. I.A.S.

48. **Maximum performance**

(i) *Climbing:*

160 m.p.h. I.A.S. to 12,000 ft.
155 m.p.h. I.A.S. from 12,000 to 18,000 ft.
150 m.p.h. I.A.S. from 18,000 to 22,000 ft.
145 m.p.h. I.A.S. above 22,000 ft.

Change to S ratio when boost has fallen to +6 lb./sq.in.

(ii) *Combat.*—Use S ratio if the boost obtainable in M ratio is more than 3 lb./sq. in. (4 lb./sq.in. with Merlin 24 or 224) below maximum combat boost.

49. **Maximum range**

(i) *Climbing.*—160 m.p.h. I.A.S. at +7 lb./sq.in. boost with Merlin 22, 24, 28, 38 or 224 + 4 lb./sq.in. with Merlin XX, and 2,650 r.p.m. Change to S ratio when maximum boost obtainable in M ratio has fallen by 3 lb./sq.in.

(ii) *Cruising* (including descent):

(*a*) Fly in M ratio at maximum obtainable boost not exceeding +4 lb./sq.in. with Merlin XX, +7 lb./sq.in. with Merlin 22, 24, 28, 38 or 224 obtaining the recommended airspeed by reducing r.p.m. which may be as low as 1,800 if this will give the recommended speed. Higher speeds than those recommended may be used if obtainable in M ratio at the lowest possible r.p.m.

(*b*) The recommended speeds are:

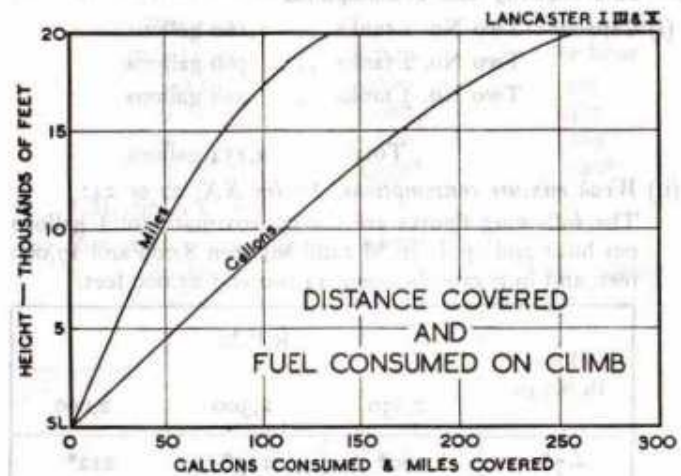
Fully loaded (outward journey):

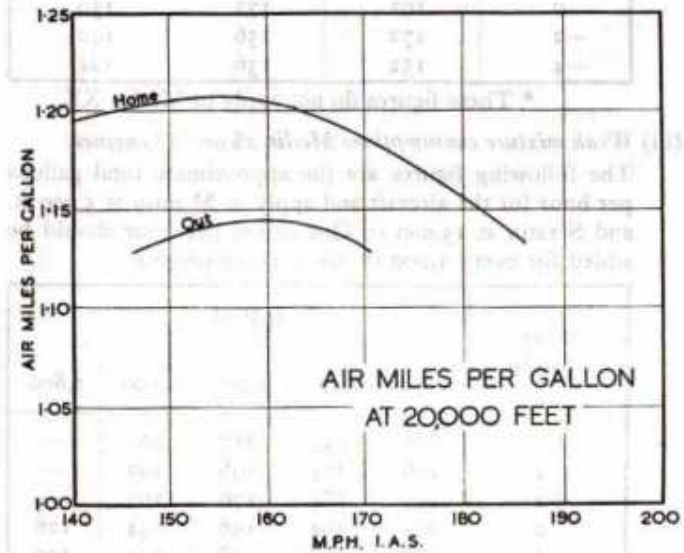
Up to 15,000 ft., 170 m.p.h. I.A.S.
At 20,000 ft. in S ratio, 160 m.p.h. I.A.S.

Lightly loaded (homeward journey):
160 m.p.h. I.A.S.

(*c*) Engage S ratio when the recommended speed cannot be maintained at 2,500 r.p.m. in M ratio.

(iii) The use of warm intakes will reduce air miles per gallon considerably. On this installation there is no need to use warm air unless intake icing is indicated by a drop of boost. *See* A.P. 2095—Pilot's Notes General.





50. Fuel capacity and consumptions

(i) Capacity:

Two No. 1 tanks	..	1,160 gallons
Two No. 2 tanks	..	766 gallons
Two No. 3 tanks	..	228 gallons
Total	..	2,154 gallons

(ii) *Weak mixture consumptions, Merlin XX, 22 or 24:*
The following figures are the approximate total gallons per hour and apply in M ratio between 8,000 and 17,000 feet, and in S ratio between 14,000 and 25,000 feet.

Boost lb./sq.in.	R.P.M.		
	2,650	2,300	2,000
+7*	260*	225*	212*
+4	228	204	188
+2	212	188	172
0	192	172	150
−2	172	156	140
−4	152	136	124

* These figures do not apply to Merlin XX.

(iii) *Weak mixture consumptions Merlin 28 and 38 engines:*
The following figures are the approximate total gallons per hour for the aircraft and apply in M ratio at 5,000 ft. and S ratio at 15,000 ft. One gallon per hour should be added for every 1,000 ft. above these heights.

Boost lb./sq.in.	R.P.M.				
	2,650	2,400	2,200	2,000	1,800
+7	240	235	217	200	—
+4	216	204	196	180	—
+2	196	184	176	164	—
0	172	164	156	144	128
−2	148	140	128	124	112
−4	124	120	108	104	96

(iv) *Rich mixture consumption, Merlin XX, 22, 24:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+14	3,000	500
+12	3,000	460
+ 9	2,850	380
+ 7*	2,650*	320*

* Merlin XX only.

(v) *Rich mixture consumptions, Merlin 28, 38:*

Boost lb./sq.in.	R.p.m.	Total gallons per hour
+9	2,850	420

PART IV

A.L.2 Part IV Para. 51

51. Engine failure during take-off

(i) If for any reason the booster pumps in the tanks being used are not ON the master fuel cock of the failed engine must be turned off before feathering.

A.L.2 Paras. *1A and *1B Page 38

51A. Instrument appoach

The following peeds, together with the appropriate flap and approxnate power settings, are recommended for use during ustrument approaches with the undercarriage lowerec—

	Best lb./s in.	R.p.m.	Flaps	Airspeed (knots)
Pattern	3	2,400	20°	140
Final	2	2,850	35°-40°	115
Glide Path	2	2,850	35°-40°	115

51B. Flying in turlent conditions

In turbulent cditions the aim should be to maintain a speed of apprimately 160 knots.

A.L.2 Para. 69 Page 46

The pilot should, iowever, press the fire-extinguisher button as well, when the propeller has stopped turning. If the warning light is not on, pressin: the feathering pushbutton will not operate the extinguisher. The fire extinguishers are also operated automatically by a crah switch.

and X, set mixture control to IDLE CUT-OFF.

A.L.2 Part IV Para. 52 (iii)

(iii) *Handling on three engines.* The aircraft will maintain height at loads up to 65,000 lb. on any three engines at 10,000 feet. and can be trimmed to fly without foot load. Maintain at least 145 m.p.h. I.A.S. The automatic pilot has sufficient power to maintain a straight course with either outboard engine out of action, but only if assisted by the rudder trimming tab. When an engine fails the automatic pilot should, however, be disengaged and the aircraft trimmed to fly hands off before re-engaging. See A.P. 2095.

A.L.2 Part IV Para. 52 (iv)-(vi)

(iv) *Landing on three engines.*—Lowering of flaps to 20° and of undercarriage may be carried out as normally on the circuit but further lowering of the flaps should be left until final straight approach, which should be made at a speed of 110-115 m.p.h. I.A.S.—see A.P. 2095.

(v) *Handling on two engines.*—It should be possible to maintain height below 10,000 feet at 140 m.p.h. I.A.S. on any two engines after release of bombs and with half fuel used; but with two engines dead on one side, the foot load will be very heavy. The automatic pilot will not cope with flight with two engines dead on one side.

(vi) *Landing on two engines.*—A left-hand circuit can safely be made, and is recommended, irrespective of which engines have failed. Keep extra height in hand, if possible, and lower the undercarriage as late as practicable, aiming to have it locked down just before commencing the straight approach to the airfield. The flaps may be lowered 20° before the undercarriage is lowered but they should not be lowered further until it is clear that the airfield is within easy reach. The final approach should be made at a speed of 115-120 m.p.h. I.A.S. See A.P. 2095.

may be necessary in the early stages. (*See* A.P. 2095, Part IV, Notes C and D.)

(vii) Do not attempt to maintain height above 10,000 feet, either on three or two engines.

(viii) *Fuel system.*—The cross-feed cock should only be turned on when it is desired to feed fuel from port (or starboard) tanks to starboard (or port) engines. In this case all live engines should be fed from one tank and the fuel booster pump for this tank should be on. The fuel selector for the tanks on the other side of the aircraft should be off. At all other times, the cross-feed cock should be off.

A.L.2 Part IV Para. 53 (i) (Page 35)

53. Feathering

(i) If possible engine master cock should be turned off immediately before feathering (see para. 52 (i)).

(ii) Close the throttle and (on Lancaster III and X aircraft) move the slow-running cut-out switch to IDLE-CUT-OFF position.

A.L.2 Part IV Para. 53 (ii)—(iv) (Page 36)

(iii) Press the feathering pushbutton and hold it in only long enough to ensure that it stays in by itself; then release it so that it can spring out when feathering is complete.

(iv) Switch off the ignition when the propeller has stopped (or nearly stopped) rotating, and turn off the engine master cock if not already done so.

NOTE.—If an engine fails during take-off the sequence may be (iii), (ii), (iv).

A.L.1 Part IV Para. 53 (v) & 54

(v) Engine auxiliaries which will be affected by feathering:

Port outboard ..	Alternator for special radio, rear turret hydraulic pump.
Port inboard ..	Generator, main services hydraulic pump, compressor for Automatic Pilot and computor unit of Mk. XIV bombsight, No. 1 vacuum pump.
Starboard inboard	Generator, main services hydraulic pump, front turret hydraulic pump, Heywood compressor for pneumatic system, No. 2 vacuum pump.
Starboard outboard	Alternator for special radio, F.N.50 mid-upper turret hydraulic pump.

A.L.3 Part IV Para. 54

54. Unfeathering

NOTE.—(*a*) Do not unfeather at speeds above normal cruising speed to avoid the risk of overspeeding.

(*b*) Do not practice feathering and unfeathering if the outside air temperature is below −15°C.

(i) Put the ignition on, set the throttle as for starting and the propeller control fully down.

(ii) Check that the fuel booster pump of the tank in use is OFF, then press the feathering pushbutton. As the engine starts to turn, set the engine master cock to ON. Continue to hold the button in until r.p.m. reach 800-1000.

(ii) If the propeller does not return to normal constant-speed operation it must be refeathered and then unfeathered again, releasing the button at slightly higher r.p.m.

55. Damage by enemy action

(i) *Fires.*—If fire occurs in bomb bay, pilot should open bomb doors, jettison bombs, and dive.

(ii) *Flight engineer's checks:*

Check fuel contents gauges. Should any abnormal consumptions be shown on the tank the aircraft is running on, or should any of the other tanks show a loss of fuel, proceed as follows:

(*a*) Cross-feed cock ON.

(*b*) Run all engines on the damaged tank, and switch on its booster pump. The fuel selector for the tanks on the other side of the aircraft should be off.

(*c*) When contents of damaged tank fall to 20 gallons, turn on fuel selector for the corresponding tank on the other side of the aircraft and turn OFF cross-feed valve.

(*d*) Watch fuel pressure warning lights or fuel pressure gauge and change over to other tank as soon as pressure drops; switch off booster pump in empty tank.

A.L.1 Part IV Para. 56

56. Undercarriage emergency operation

If the hydraulic system fails, the undercarriage can be lowered by compressed air from a special bottle or bottles, irrespective of the position of the undercarriage lever.

NOTE.—The flap selector should be neutral before using the undercarriage emergency air system.

On early aircraft the control is just aft of the front spar, but on later aircraft the knob (80) for working the air system is just forward of the flight engineer's panel. The undercarriage cannot be raised again by this method. Although the undercarriage will lower by this method irrespective of the position of the normal undercarriage selector, the undercarriage lever *must* be selected DOWN for landing before operating the emergency air system, and left in the down position after landing, except in cases where the undercarriage selector cannot be moved through mechanical defect. Otherwise any leakage of air pressure may cause the undercarriage locks to be released and the undercarriage to collapse.

57. **Flaps emergency operation**

After lowering the undercarriage by turning on the emergency air cock, the flaps may be lowered by operating the flaps control, which admits the air pressure to the flaps system. The flaps can be raised again, but there may not be sufficient air pressure to lower the flaps a second time; furthermore it may cause the header tank to burst. If it is absolutely necessary to raise the flaps by emergency method extreme care must be taken to raise them slowly by stages. If the flaps are lowered by the emergency method before landing, flaps must be left down after landing, owing to the likelihood of bursting the header tank.

A.L.1 Part IV Paras. 58, 59 & 60

58. **Bomb door emergency operation**

This system has been deleted.

59. **Bomb jettisoning**

(i) Open bomb doors and check visually that both are fully open. *See* para. 19.

(ii) Then jettison containers first by switch (15) on right of instrument panel.

(iii) Jettison bombs by handle (16) beside container jettison switch.

(iv) Close bomb doors.

60. **Fuel jettisoning**

NOTE.—(*a*) Only the contents of No. 1 tanks can be jettisoned.

(*b*) Jettisoning should not be attempted if the hydraulic accumulator pressure cannot be built up to at least 650 lb./sq.in. (*see* para. 26A).

A.L.1 Part IV Para. 60 (contd.)

(i) Reduce speed to 150 m.p.h. I.A.S. and lower flaps 15°.

(ii) Lift and turn jettison control on left of pilot's seat. Return control after jettisoning.

(iii) The jettison valve should be closed while there is still about 100 gallons remaining in each tank; if the jettison valve is left open, all the fuel will be jettisoned less approximately 70 gallons, but the last 30 gallons of jettisonable fuel runs out slowly and is inclined to get splashed over the fuselage. The jettison valve may be closed at any time during jettisoning.

Approximate weight of jettisonable fuel, leaving 100 gallons in each tank, is 6,900 lb.

A.L.2 Part IV Paras. 61, 62

61. **Parachute exits**

(i) Hatch in floor of nose should be used by all members of the crew if time is available; originally it was released by a handle in the centre, lifted inwards and jettisoned, but when Mod. 1336 is incorporated the hatch is enlarged and is opened by a handle at the port side. It opens inwards and is secured by a clip which holds the hatch up on the starboard side. It can also be opened from outside the aircraft.

62. **Crash exits**

(i) On Lancaster I, III and X three push-out panels are fitted in the roof (one above the pilot, one just forward of the rear spar, and one forward of the mid-upper turret) except when Mod. 977 (which moves the mid-upper turret forward) is incorporated, in which case the third panel is deleted.

(ii) On Lancaster VII there are two push-out panels in the roof, one above the pilot and one just forward of the rear spar.

63. **Dinghy and ditching**

(i) A type J dinghy stowed in the starboard wing may be released and inflated:

(*a*) from inside by pulling the release cord running along the fuselage roof aft of the rear spar;

(*b*) from outside by pulling the loop on the starboard side, rear of the tail plane leading edge.

(*c*) automatically by an immersion switch.

(ii) The flaps should be owered 30° for ditching, but if the flaps will not lower by the hydraulic system, do not attempt to lower them by the compressed air system, as this will also cause the undercarriage to lower (*see* paras. 56 and 57).

A.L.2 Part IV Paras. 64 to 68

64. **Engine fire-extinguishers**

Each engine is provided with a fire-extinguisher system.

When Mod. 1221 is incorporated four fire-warning lights (one for each engine) on the instrument panel indicate if there is fire in an engine and the pilot is thus warned to stop the engine, feather the propeller and then press the appropriate fire extinguisher button (22).

When Mods. 1067 and 1314 are incorporated the fire warning lights are mounted on the respective propeller pushbuttons (19), and if a fire warning light comes on, pressing the feathering button also operates the fire extinguisher system. The pilot should, however, press the fire extinguisher button as well (see A.P. 2095). If the warning light is not on, pressing the feathering pushbutton will not operate the extinguisher.

The fire extinguishers are also operated automatically by a crash switch.

65. **Hand fire extinguishers**

One on the right side of air bomber's compartment.
One on the left side of pilot's seat.
One on the right side forward of the front spar.
One on the right side aft of mid-upper turret.
One at the left side of the rear turret.

66. **Signal pistol**

This is stowed on top of the front spar; the firing position is in the roof forward of the stowed position.

67. **Signal cartridge stowage.**—Starboard side of fuselage just forward of front spar.

68. **Parachute stowages**

One on the roof of the fuselage forward of mid-upper turret.
One forward of tail turret.

69. **Static line for parachuting wounded men**

(i) If possible, fly aircraft at 130 m.p.h. I.A.S. with 15° flap.
(ii) Assist casualty to air bomber's compartment and place him feet first facing aft.
(iii) Check casualty's parachute harness, fit parachute, remove helmet.

(iv) Remove static line from stowage which is situated on starboard side of front exit. Care should be taken that the threads keeping the static line folded up are not broken. Take snap hook at end of static line and attach to parachute as follows.
(v) Pass the safety becket on the static line through the double 8 cord loop, then pass the small snap hook through the safety becket.
(vi) Snap the hook down on to the rip-cord handle. Insert safety pin to lock the shroud of the snap hook.
(vii) Stow the slack of the static line between the becket and the snap hook under the adjacent pack elastic to prevent this slack length getting caught up on anything and thus pulling the rip-cord too soon.
(viii) Open and jettison front hatch.
(ix) Slide the man through the exit feet first facing aft. Care must be taken to keep his hands to his sides. Do not hold on to the static line by hand.

70. **Emergency packs.**—On starboard side at rest station.

71. **Projectible kite container.**—Along port side at rest station.

72. **Crash axes**

One on port side of fuselage aft of main entrance door.
One on starboard wall in front of rear spar.

73. **Incendiary bombs.**—Two are provided on front face of front spar for destruction of aircraft.

74. **First-aid equipment.**—Starboard side of fuselage aft of main entrance door.

PART V

SUPPLEMENTARY NOTES FOR FLIGHT ENGINEER

75. **Oil system.**—A self-sealing oil tank is fitted in each nacelle; the normal capacity is 37½ gallons with 4½ gallons air space. A stack pipe in each tank retains 2–3 gallons for feathering the propeller. Normal high-pressure oil feeds the propeller constant speed unit.

Under cruising conditions, it is recommended that the oil temperature should not exceed 60°C., but up to 90°C. may be used without damage to the engine. The oil consumption should be between 8 and 16 pints per hour.

A.L.1 Part V Paras. 76 & 77

76. **Coolant system**

A horse-shoe type header tank, filled with 30% Glycol and 70% distilled water, is mounted over the reduction gear of each engine. On the ground with engine running a small coolant discharge is normal, but not in flight.

From B block on each inboard engine coolant is led to the cabin heating radiator, through which the flow of air is regulated by controls either side of the fuselage at the wireless operator's station.

On later aircraft there are two radiators, one for the forward cabins regulated by a control forward of the front spar on the starboard side, and one for the rear part of the aircraft regulated by a control aft of the rear spar on the starboard side.

77. **Hydraulic systems**

The accumulator, supplied by two pumps, has an air charging valve and a pressure gauge which should read 220 lb./sq.in. when there is no pressure in the system.

A.L.1 Part V Para. 77 (contd.)

Misleading pressure gauge readings will occur if the accumulator air pressure is incorrect. The gauge should read between 800–900 lb./sq.in. under working pressure when the cut-out operates, isolating the pumps. The accumulator then provides the initial pressure to operate the various systems. When the pressure falls between 220–300 lb./sq.in. the pumps will automatically be cut in to operate the system and build up accumulator pressure again.

Fuel jettison.—When the fuel jettison control is operated an air inlet valve is opened in the top of each No. 1 tank, and at the same time a valve is opened at the bottom of each tank, breaking a small washer and releasing a spring-loaded stocking. Do not jettison below 100 gallons (*see* para. 60).

The valves may be closed at any point, but the stocking will not be retracted. When repacking, ensure that the stocking is dry and serviceable. Reseat the inlet and outlet valves. Before fitting one of the spare shear washers carried in the housing, the spindle must pass centrally through the jettison valve.

A.L.2 Part V Para. 78

78. **Pneumatic system**

The pressure (normally 300-320 lb./sq. in.) is controlled by a pressure regulating valve, which recommences charging when the pressure drops to 270-280 lb./sq. in. If the pressure drops to 130 lb./sq. in. or below, a pressure-maintaining valve closes, rendering the entire pneumatic system, with the exception of the brakes, out of operation. Therefore M supercharger ratio will be engaged, and the idle cut-off and radiator flaps will be inoperative. If pressure cannot be built up, to stop Merlin 28, 38 or 224 engines, throttle down to minimum r.p.m. and close the master fuel cocks. This will drain the carburettor, which should be carefully primed to expel all the air from the fuel chambers before re-starting (see para. 42 (vi)).

When Mod. ~~1196~~ 1145 (incorporating the "Lincoln" type undercarriage) has been fitted, the air supply pressure is increased to 450 lb./sq. in., the pressure regulating valve permits re-charging when the pressure drops to 390-410 lb./sq. in., and the pressure-maintaining valve closes when pressure drops to 150 lb./sq. in.

79. **Electrical system**

Four accumulators, connected in series parallel, giving a capacity of 80 ampere hours at 24 volts, are charged by two generators. Two ammeters on the main electrical control panel indicate the total generator output to services and battery charging. On the same panel a voltmeter indicates the state of the accumulators, reading 28–29 volts in flight under normal conditions and over 24 on the ground with engines stopped. On Lancasters I and III, spare fuses and a fuse location table are inside the hinged door. The main generator fuses are at the top inside the main control panel. Spare fuses are carried in the lid of the fuse box.

The switches below are for ground fault tracing and must be left on and not touched in flight.

On the front of the panel are two earth warning lights, a resin light switch (locked to prevent its movement) and the air bomber's station light switch of which the push button is for use on the ground in conjunction with the earth warning lights.

On Lancaster X, overload switches are fitted in the heavier circuits and flick off if the current becomes too great. Allow five or ten minutes for the service to cool down and turn the switch on.

80. **Undercarriage failure**

Should the red warning lights remain steady or the green lights not appear when the undercarriage is selected down, operate the warning light changeover switch. If this is ineffective select undercarriage up and return the selector down. If this is still ineffective check the accumulator pressure gauge reading. Should it be 300 lb./sq.in. there is probably no pressure in the system. Select the undercarriage up and down again. The pressure may drop between 200 and 300 lb./sq.in. then rise between 850 and 900 lb./sq.in. when the cut-out operates. If about 800 lb./sq.in. is indicated and the undercarriage appears to be down visually the indicator is probably faulty. If there is still some doubt use the emergency air

pressure to make certain the undercarriage is down, turning the cock off when the operation is complete. This conserves the air pressure for further use; if it is necessary to use the flaps emergency system the method of operation is described in para. 57.

81. **Gauges.**—The gauges on the engineer's panel in the Lancaster X are the four point type fitting into sockets and are therefore interchangeable.

PART VI

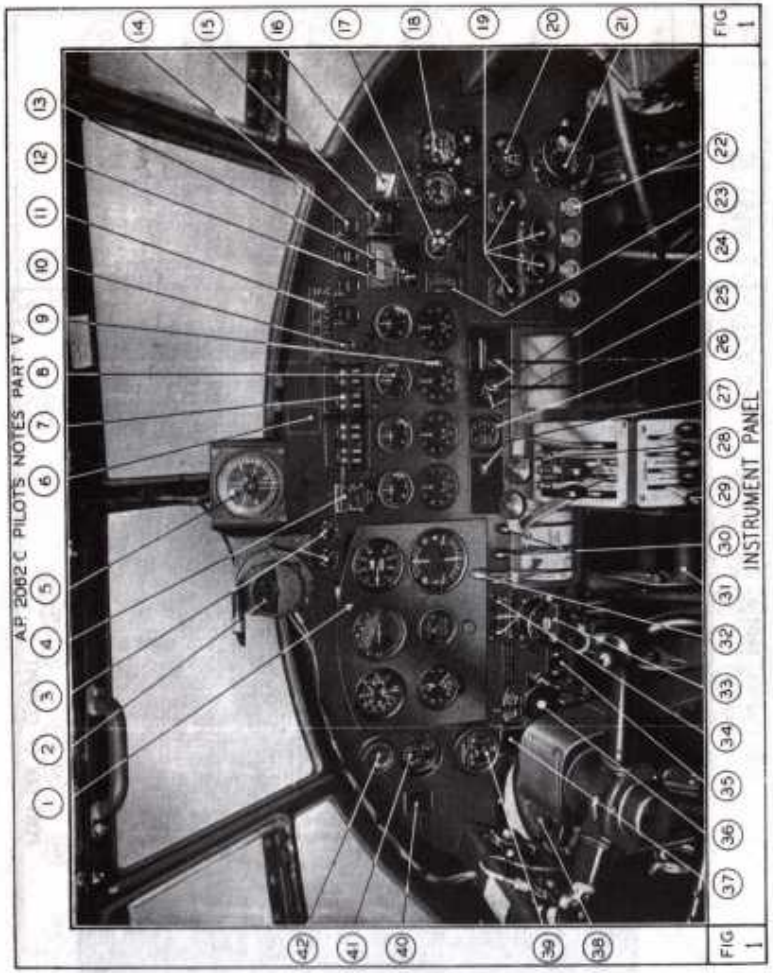
ILLUSTRATIONS AND LOCATION OF CONTROLS NOT ILLUSTRATED

LOCATION OF CONTROLS

Service	*Location*
Undercarriage warning horn test pushbutton	Behind pilot's seat.
Cross feed cock	On floor, just forward of the front spar.
Priming pump and cock (if fitted)	In each inboard nacelle
Air intake heat control	Left of pilot's seat.
Radiator shutter switches	On starboard cockpit wall.
Supercharger gear change lever (on early Lancaster I)	To right of starboard master engine cocks.
Ground/flight switch.	On starboard side aft of front spar.
Cockpit heat controls	One each side of the fuselage just forward of the front spar. Two adjustable louvres in fuselage nose.
Oxygen master valve	At forward end of oxygen crate
Camera pushbutton control	On starboard rail of cockpit.
Reconnaissance flare stowage	On either side of fuselage forward of flare chute.
Flame floats or sea markers stowage	On either side of fuselage adjacent to flare chute.

FUSES

Location	*Service*
(*a*) Inside junction box at forward end of bomb aimer's compartment	Bomb gear fuses.
(*b*) Pilot's auxiliary fuse panel	Oil and radiator thermometer fuses.
(*c*) Navigation panel	Radio fuses.
(*d*) Mid turret position	Mid-upper and underturret, call lights, and, on early aircraft beam approach fuses.
(*e*) Main electrical control panel	General services.



KEY TO *Fig. 1*

INSTRUMENT PANEL

1. Instrument flying panel.
2. D.F. Indicator.
3. Landing light switches.
4. Undercarriage lifejector switch.
5. D.R. compass repeater.
6. D.R. compass deviation card holder.
7. Ignition switches.
8. Boost gauges.
9. R.p.m. indicators.
10. Booster coil switch.
11. Slow-running cut-out switches.
12. I.F.F. detonator buttons.
13. I.F.F. switch.
14. Identification switches.
15. Bomb containers jettison button.
16. Bomb jettison control.
17. Vacuum change-over cock.
18. Oxygen regulator.
19. Feathering buttons.
20. Triple pressure gauge.
21. Signal cartridges (identification signals).
22. Fire extinguisher pushbuttons.
23. Suction gauge.
24. Starboard master engine cocks.
25. Supercharger gear change control panel.
26. Flaps position indicator.
27. Flaps jettison indicator switch.
28. Flaps switch.
29. Propeller speed control levers.
30. Port master engine cocks.
31. Rudder pedal.
32. Boost control cut-out.
33. Signalling switchbox (recognition lights).
34. Identification lights colour selector switch.
35. D.R. compass switches.
36. Auto controls steering lever.
37. P.4. compass deviation card holder.
38. P.4 compass.
39. Undercarriage position indicator.
40. A.S.I. correction card hold.
41. Beam approach indicator.
42. Watch holder.

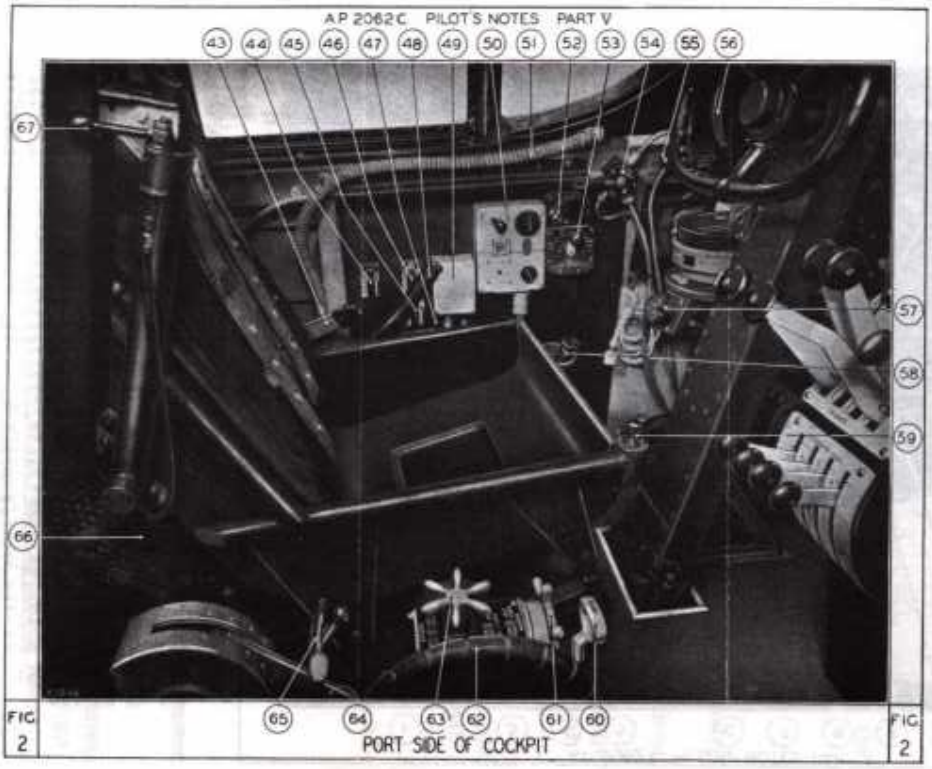


FIG. 2 PORT SIDE OF COCKPIT FIG. 2

KEY TO *Fig. 2*

PORT SIDE OF COCKPIT

43. Bomb doors control.
44. Navigation lights switch.
45. D switch.
46. Auto controls main switch.
47. Pushbutton unit for T.R. 1196.
48. Seat raising lever.
49. Mixer box.
50. Beam approach control unit.
51. Oxygen connection.
52. Pilot's call light.
53. Auto controls attitude control.
54. Auto controls cock.
55. Auto controls clutch.
56. Brake lever.
57. Auto controls pressure gauge.
58. Pilot's mic/tel socket.
59. Windscreen de-icing pump.
60. Flaps selector.
61. Aileron trimming tab control.
62. Elevator trimming tab control.
63. Rudder trimming tab control.
64. Undercarriage control lever.
65. Undercarriage control safety bolt.
66. Portable oxygen stowage.
67. Harness release lever.

KEY TO *Fig. 3*

FLIGHT ENGINEER'S PANEL
LANCASTERS I & III

68. Ammeter.
69. Oil pressure gauges.
70. Pressure-head heater switch.
71. Oil temperature gauges.
72. Coolant temperature gauges.
74. Fuel contents gauges.
75. Inspection lamp socket.
76. Fuel contents gauge switch.
77. Fuel tanks selector cocks.
78. Electric fuel booster pump switches.
79. Fuel pressure warning lights.
80. Emergency air control.
81. Oil dilution buttons.

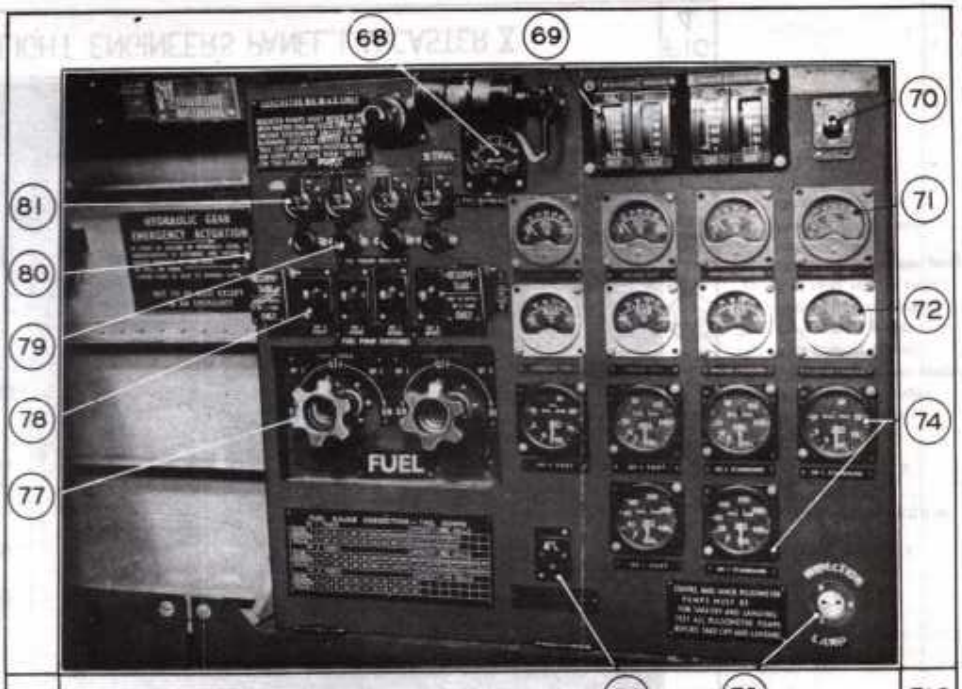


FIG 3 FLIGHT ENGINEER'S PANEL, LANCASTERS I AND III FIG 3

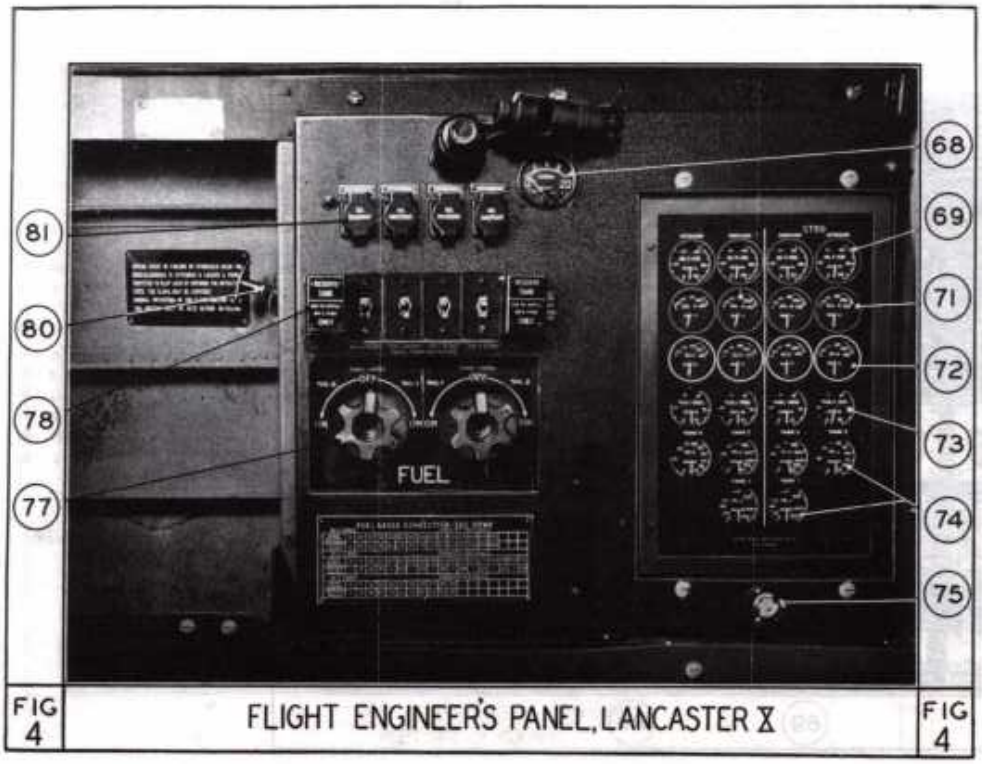


FIG 4 — FLIGHT ENGINEER'S PANEL, LANCASTER X — FIG 4

KEY TO *Fig. 4*

FLIGHT ENGINEER'S PANEL LANCASTER X

68. Ammeter.
69. Oil pressure gauges.
71. Oil temperature gauges.
72. Coolant temperature gauges.
73. Fuel pressure gauges.
74. Fuel contents gauges.
75. Inspection lamp socket.
77. Fuel tanks selector cocks.
78. Electric fuel booster pump switches.
80. Emergency air control.
81. Oil dilution buttons.

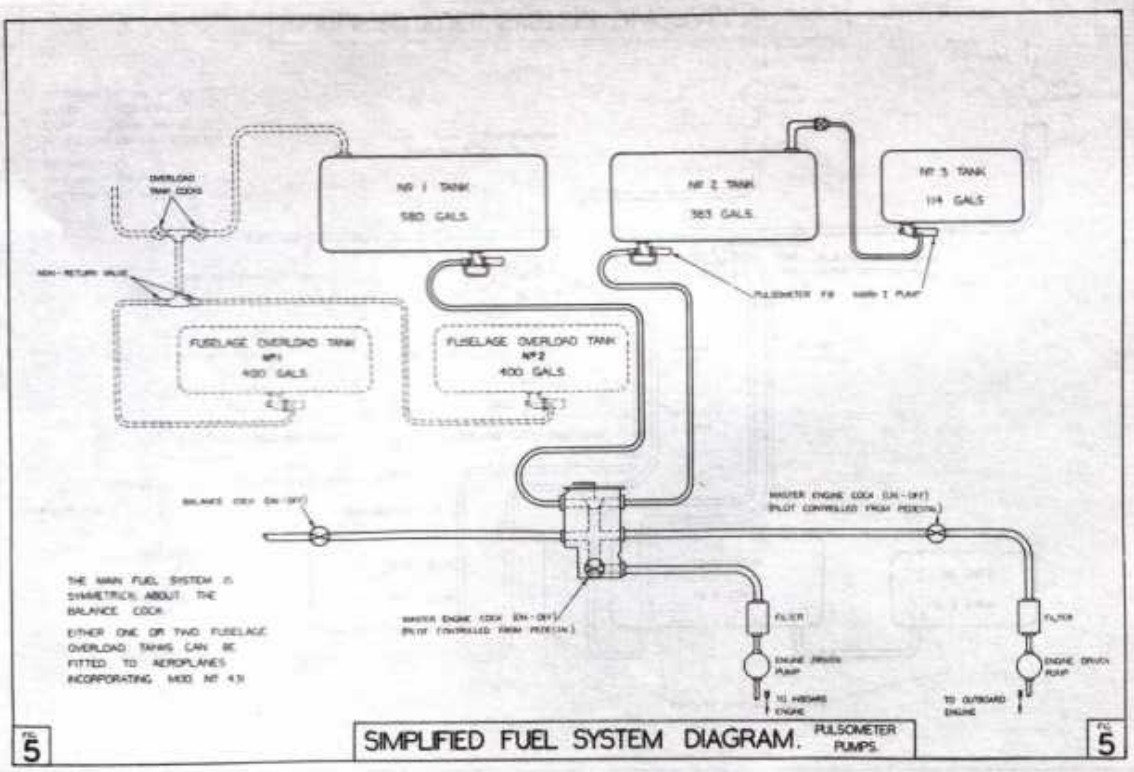


FIG 5 — SIMPLIFIED FUEL SYSTEM DIAGRAM. PULSOMETER PUMPS. — FIG 5

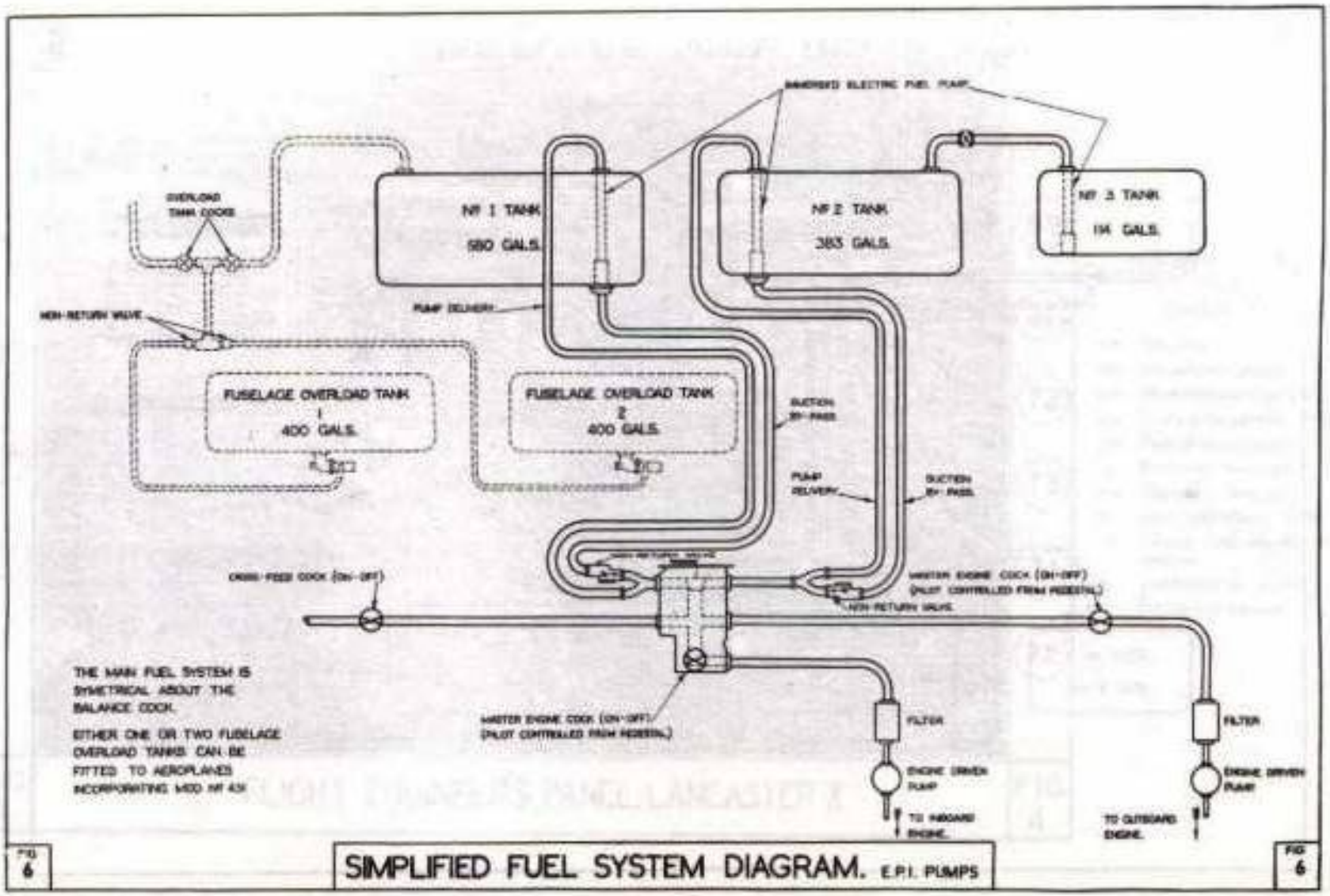


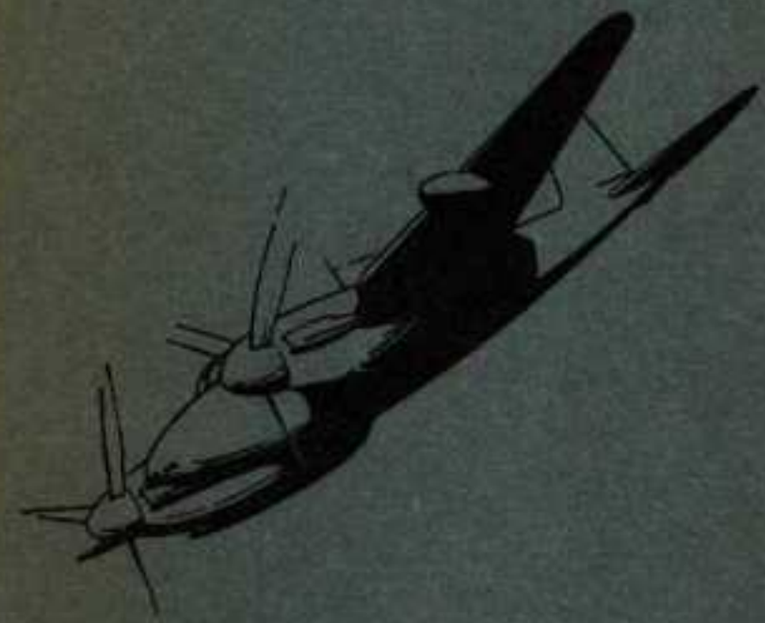
FIG 6

SIMPLIFIED FUEL SYSTEM DIAGRAM. E.P.I. PUMPS

FIG 6

SAPPHIRE PRODUCTIONS, 5 HILLTOP CLOSE, LOUGHTON, ESSEX
ENGLAND

PILOT'S NOTES
OR
MOSQUITO FB. 6



PREPARED BY DIRECTION OF THE MINISTER OF SUPPLY

A. C. Poulett.

PROMULGATED BY ORDER OF THE AIR COUNCIL

J. H. Barnes.

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, 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.

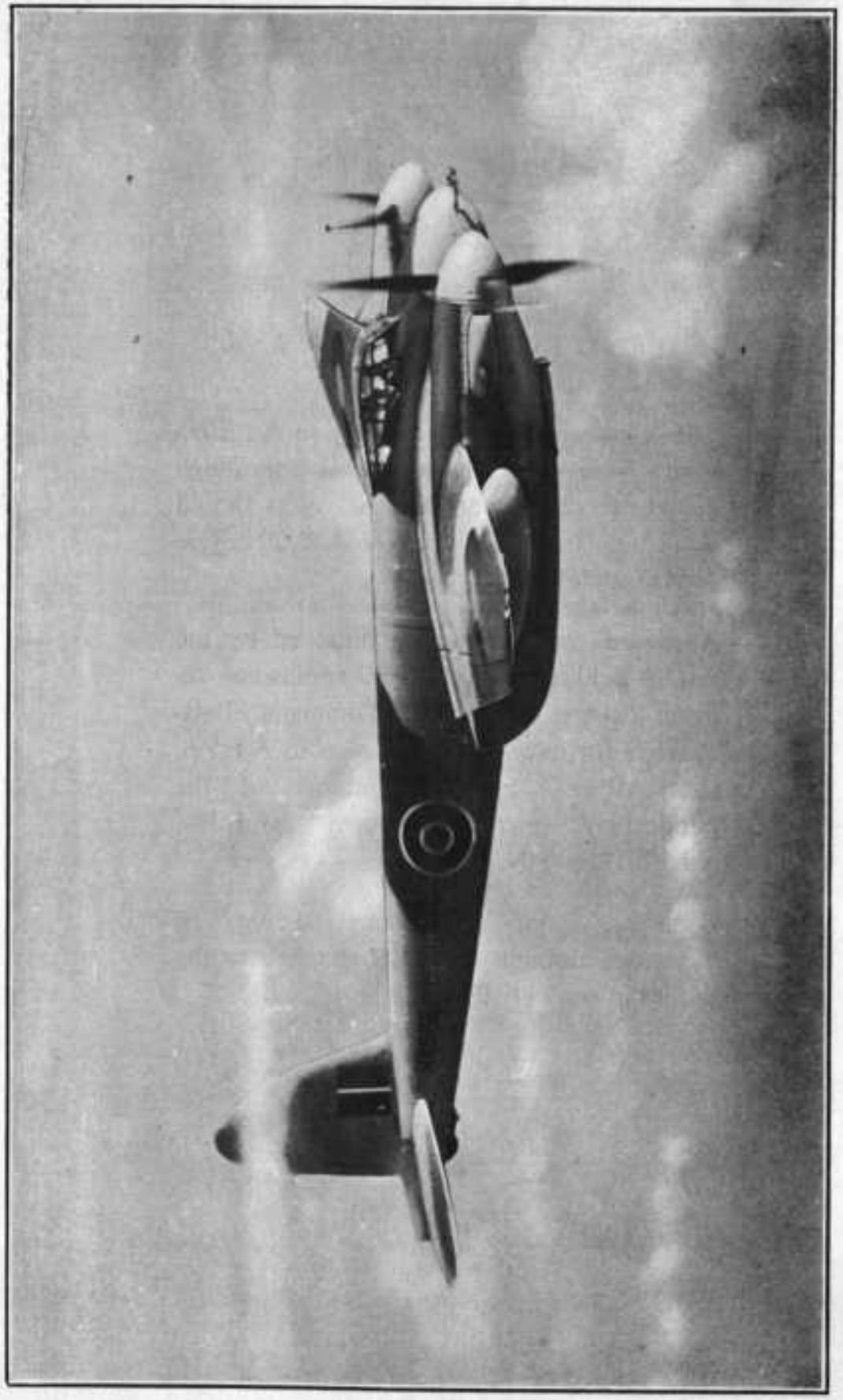
A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
1	Dmly.	6.6.51	7		
2			8		
3			9		
4			10		
5			11		
6			12		

NOTES TO USERS

THESE notes are complementary to A.P.2095 Pilot's Notes General and assume a thorough knowledge of its contents. All pilots should be in possession of a copy of A.P. 2095 (see A.M.O. A718/48).

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. (see A.P. 113). The number of the publication must be quoted in full—A.P. 2019E—P.N.

Comments and suggestions should be forwarded through the usual channels to the Air Ministry (TF 2).



MOSQUITO FB 6

AIR MINISTRY
January, 1950

Air Publication 2019E—P.N.
Pilot's Notes

MOSQUITO FB6

2nd Edition. This edition supersedes all previous issues.

LIST OF CONTENTS

PART IV—EMERGENCIES

MOSQUITO FB6

PILOT'S CHECK LIST

(Excluding Checks of Operational Equipment)

ITEM		CHECK
1.	Weight and balance.	Within permissible limits.
	External checks.	
	N.B.—Start at the entrance door and work clockwise around the aircraft.	
2.	Starboard radiator shutter.	Condition and position.
3.	No. 2 engine.	Security of cowlings. Condition of propeller and spinner. Oil and coolant - leaks.
4.	Starboard undercarriage.	U/C lock removed and stowed. U/C dust cap on. Extension of shock absorber legs. Condition of snow guard. Tyre for cuts and creep. Valve free. Brake leads secure. Chock in position.
5.	Starboard mainplane.	Leading edge. Under surface. Landing lamp retracted.
6.	Starboard navigation light.	Condition.
7.	Starboard identification lights.	Condition.
8.	Starboard aileron.	Condition. Trimmer. External control lock removed.
9.	Starboard flap.	Position
10.	Starboard mainplane.	Condition of upper surface. Tank covers secure.
11.	Fuselage (starboard side).	Condition.
12.	Rear hatch.	Door securely closed.
13.	Downward identification lights.	Condition.
14.	Tailwheel.	Extension of shock absorbers. Tyre for cuts and creep. Valve free.
15.	Fin.	Condition. Leading edge.
16.	Pressure head.	Cover removed.
17.	Starboard tailplane.	Condition. Leading edge.
18.	Starboard elevator.	Condition. Trimmer. External control lock removed.
19.	Rudder.	Condition. Trimmer. External control locks removed.
20.	Tail light.	Condition.
21.	Port elevator.	Condition. Trimmer. External control lock removed.
22.	Port tailplane.	Condition. Leading edge.
23.	Fuselage (port side).	Condition.
24.	External aerial.	Condition.

ITEM		CHECK
25.	Port mainplane.	Condition of upper surface. Tank covers secure.
26.	Port flap.	Position.
27.	Port aileron.	Condition. Trimmer. External control lock removed.
28.	Port identification lights.	Condition.
29.	Port navigation light.	Condition.
30.	Port mainplane.	Leading edge. Under surface. Landing lamp retracted.
31.	No. 1 engine.	Security of cowlings. Condition of propeller and spinner. Oil and coolant leaks.
32.	Port undercarriage.	U/C lock removed and stowed. U/C dust cap on. Extension of shock absorber legs Condition of snow guard. Tyre for cuts and creep. Valve free. Brake leads secure. Chock in position.
33.	Port radiator shutter.	Condition and position.
34.	Aircraft nose.	Condition. Panels secure.
35.	Fuselage (under surface).	Condition.
36.	Bomb doors.	Condition and position.
37.	Static vent.	Plug removed.
	Internal checks.	
38.	Internal control locks.	Removed and stowed.
39.	Manual dinghy release (if fitted).	In position.
40.	Crash axe.	Stowed.
41.	First-aid kit.	Stowed.
42.	Fire-extinguisher.	Stowed.
43.	Emergency hatch.	Lugs engaged. Handle in strap.
44.	Hydraulic pump handle.	In emergency socket.
45.	Undercarriage emergency selector.	UP.
46.	Fuel tank cocks.	As required.
47.	Fuel transfer cock.	Off.
48.	Slow running cut outs.	Off.
49.	Pressure venting cock.	On.
50.	Flying controls.	Full and correct movement.
51.	Master switch.	On.
	Cockpit checks.	
	N.B.—work from left to right and then down the centre.	
52.	Elevator trimmer.	Full and correct movement.
53.	Throttles friction adjuster.	Function.
54.	R.p.m. controls friction adjuster.	Function.

ITEM		CHECK
55.	Fuel pressure warning lights.	On.
56.	Compass light.	Operation.
57.	Boost control cut out (if fitted).	Off.
58.	Boost gauges.	Static reading.
59.	Magnetic compass.	Serviceability.
60.	Direction indicator	Cage.
61.	Landing lamps.	Operation. Retract.
62.	Air pressure.	Available pressure. Delivery to brakes.
63.	Undercarriage.	Selector neutral.
64.	Undercarriage indicator.	Operation.
65.	Flaps.	Pump down with handpump. Indicator functioning correctly. Pump up. Selector neutral. Stow handpump handle.
66.	Radiator shutters.	Closed.
67.	Air intakes control.	Filter in.
68.	Ignition switches.	Off.
69.	Feathering push-buttons.	Out.
70.	Rudder trimmer.	Full and correct movement.
71.	Aileron trimmer.	Full and correct movement.
72.	Voltmeter (if fitted).	Reading.
73.	Windscreen de-icer.	Operation.
74.	Generator warning light.	On.
75.	Navigation lights.	Operation.
76.	Identification lights.	Operation.
77.	U.V. cockpit lighting.	Operation.
78.	Fuel gauges.	Contents.
79.	Windscreen wiper.	As required.
80.	Immersed fuel pump.	Off.
81.	Entrance ladder.	Stowed.
82.	Intercom.	Adjust head set. Check with crew.
83.	Oxygen.	Delivery.
84.	Pilot's harness.	Adjust. Test lock.
85.	Entrance door.	Locked.
	Start and warm up the engines (see para. 37).	
86.	Radio.	Test. Check altimeter setting with control.
87.	Vacuum system.	Instruments operating.
88.	R.I. compass.	On.
89.	Direction indicator.	Set with magnetic compass. Compare with R.I. compass. Uncage.
90.	Bomb doors.	Shut.
	Exercise and test the engines (see para. 38).	
91.	Generator.	Charging.

ITEM		CHECK
92.	Pneumatic pressure.	Supply increasing to maximum.
	Checks before and during taxying.	
93.	Chocks.	Clear.
94.	Taxying.	As soon as possible test brakes. Direction indicator for accuracy. Artificial horizon for accuracy. R.I. compass for accuracy. Temperatures and pressures. Pressure head heater on if necessary.
	Checks before take-off.	
95.	Trim : Elevator Rudder Aileron.	1-1½ divisions nose heavy. Slightly right. Neutral.
96.	Air intakes control.	As required.
97.	R.p.m. control levers.	Maximum r.p.m. position.
98.	Fuel.	Contents. Correct tanks selected.
99.	Flaps.	Up or 15° down.
100.	Superchargers.	Mod.
101.	Radiator shutters.	Open.
102.	Direction indicator.	Synchronised with magnetic compass.
103.	Hatches.	All secure.
104.	Harness.	Tight and locked.
105.	Engines.	(Clear (if necessary).
	Checks before landing.	
106.	Pneumatic supply.	Pressure 200 lb./sq. in. (max.). Pressure at each wheel brake.
107.	Air intakes control (if fitted).	Filter in.
108.	Fuel.	Fullest tanks selected.
109.	Superchargers.	Mod.
	Reduce speed to 155 knots and check :—	
110.	Undercarriage.	Down and locked. Green lights on.
111.	R.p.m. control levers.	Set to give 2,850 r.p.m.
	Reduce speed to 130 knots.	
112.	Flaps.	As required.
	When the flaps are down, reselect the undercarriage down to ensure that it is positively locked.	
	Checks after landing.	
	When clear of the landing area :—	
113.	Flaps.	Up. Selector neutral.
114.	Radiator shutters.	Open.
115.	R.p.m. control levers.	Maximum r.p.m. position.
116.	Pressure head heater.	Off if necessary.
117.	Brake pressure.	Sufficient for taxying.
	On reaching dispersal.	
	Stop the engines (see para. 49).	
118.	Ignition switches.	Off.
119.	Radiator shutters.	Closed.

ITEM	CHECK
120. Electrical services.	All off.
121. Master switch.	Off.
122. Fuel cocks.	Off.
123. Direction indicator.	Caged.
124. Chocks.	In position.
125. Brakes.	Off.
126. Internal control locks.	In position.
After leaving the aircraft.	
127. Pressure head.	Cover on.
128. Undercarriage.	Locking caps on.

PART I
DESCRIPTIVE

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

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

(b) Unless otherwise stated, all speeds quoted are indicated airspeeds.

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

INTRODUCTION

The Mosquito FB Mark 6 is a fighter-bomber aircraft and is powered by two Merlin 23 or 25 engines, driving three-bladed, Hydromatic propellers. There is provision for the alternative carriage of a long-range tank, a bomb or depth charge, or for the simultaneous carriage of R.P. and a 100-gallon drop tank under each wing. An internal bomb load can also be carried.

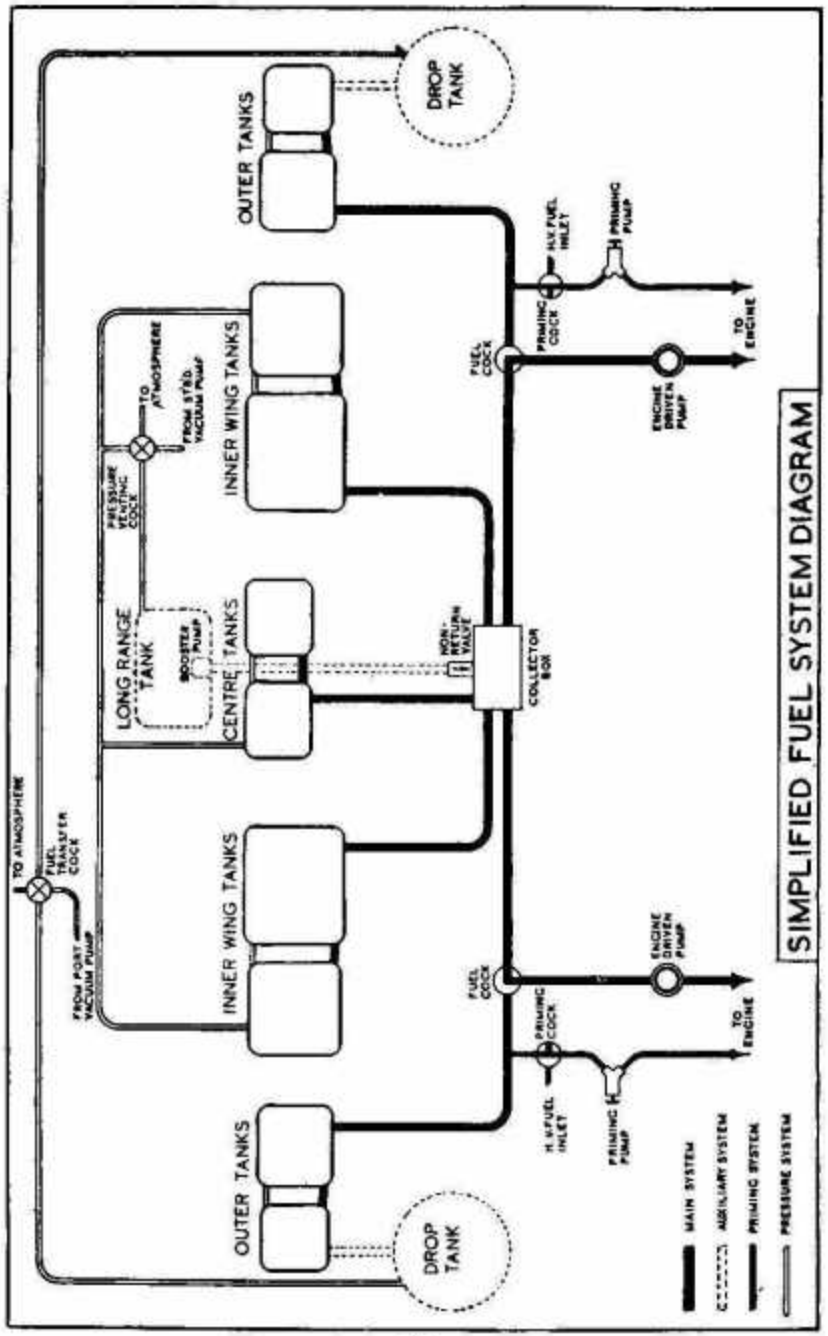
FUEL AND OIL SYSTEMS

1. Fuel tanks

Fuel is carried in four outer wing tanks, four inner wing tanks, and two centre tanks. In addition a fuselage (long-range) tank can be carried and a drop tank fitted under each wing.

The fuel capacities are as follows :—

MAIN SUPPLY	
Centre tanks	50 gallons
Inner wing tanks	286 gallons
OUTER TANKS	116 gallons
Total	452 gallons
Long-range tank	63 gallons
Wing drop tanks (2 × 100 gallons)	200 gallons
Total fuel capacity	715 gallons



The centre tanks and the inner wing tanks supply both engines through a fuel collector box when the fuel cocks, behind the pilot's seat, are set to MAIN SUPPLY. If a long-range tank is fitted this also supplies both engines through the fuel collector box with the fuel cocks at MAIN SUPPLY and the immersed fuel pump switch (65) on the electrical panel in the "ON" position. When the fuel cocks are set to OUTER TANKS the port outer wing tanks supply No. 1 engine only and the starboard outer wing tanks No. 2 engine only. Fuel is transferred from the wing drop tanks to the OUTER TANKS by air pressure from the port vacuum pump controlled by a transfer cock behind the pilot's seat. If the transfer is not automatic this cock is marked JETTISON TANKS FUEL TRANSFER ; in this case the outer tanks must be nearly emptied before transferring, or fuel will be lost by venting to atmosphere. If Mod. 613 is incorporated, the cock is marked ON FOR AUTO TRANSFER and it may be left on whilst using fuel from the outer tanks. Transfer will then be automatic until the wing drop tanks are empty when the gauge will show a fall in the contents of their respective outer tanks.

A premature fall, in the early part of a flight at altitude, will indicate an interruption of flow ; after an interval which will vary with atmospheric conditions, this will be cured and the fall in the fuel level will stop. The cock should be left ON during an interruption of flow, but must be turned OFF on completion of transfer.

2. **Fuel tank pressurising**

(i) The permanent tanks of the MAIN SUPPLY are provided with automatically regulated pressurising to reduce fuel vaporisation at high altitudes. When the PRESSURE VENTING cock, behind the pilot's seat is ON an aneroid operated valve so controls pressure from the starboard vacuum pump that whilst none is admitted at low altitudes, the amount is progressively increased as height is gained. When it is OFF, all tanks are vented to atmosphere at all altitudes.

(ii) When Mod. 443 is incorporated the pressure venting cock is usually wired in the ON position because the pressurising is then extended to the long-range tank. When this modification has not been incorporated it is advisable to turn the cock OFF whilst actually using the long-range

tank because the immersed fuel pump might not be able to overcome pressurising in the fuel collector box sufficiently to ensure a supply of fuel from the long-range tank.

(iii) Pressurising impairs the self-sealing properties of the tanks and should be turned OFF in emergency. If the cock is locked ON the locking wire can easily be broken.

3. Immersed fuel pump

When the long-range tank is fitted an immersed fuel booster pump is provided to feed the fuel to the engine via the collector box. A fuel pressure warning light (21) on the starboard side of the front cockpit coaming, indicates when the long-range tank is nearly empty; the immersed fuel pump switch must then be turned to OFF.

4. Fuel contents gauges

Three gauges (71, 72, 73) are positioned on the electrical panel. They will indicate as follows when the electrical services switch (20), linked with the ignition switches, is on.

The aft gauge (71) ...	the outer wing tanks
The centre gauge (72)...	the centre tanks and long-range tank when fitted
The forward gauge (73)	the inner wing tanks

5. Fuel pressure warning lights

Two fuel pressure warning lights (5) are fitted on the left-hand side of the instrument panel. They light when the pressure drops to 3 lb./sq. in. (These lights will be deleted by Mod. 1243.)

6. Priming system

A priming pump is fitted in each engine nacelle and is accessible through a hinged flap on the starboard side. Priming cocks are fitted in each nacelle, and allow fuel to be drawn either from the outer tanks, or from an external supply of high-volatility fuel for cold weather starting.

7 Oil and coolant systems

(i) Oil is supplied from two self-sealing tanks of 15 gallons oil capacity and 2½ gallons air space; one in each engine nacelle.

(ii) There are no separate oil cooler controls. Electro-pneumatically operated radiator shutters are fitted at the rear of the combined engine coolant radiator and oil cooler, inboard of each engine. Airflow through the radiator ducts is controlled by these shutters which are operated by two-way switches (15) marked RAD. FLAP-CLOSED (up)—OPEN (down). Thermostatic and viscosity valves in both coolant and oil cooler systems respectively, ensure rapid "warming up" to pre-determined temperatures.

MAIN SERVICES

8. Hydraulic system

(i) Two engine-driven pumps, one on each engine, supply hydraulic pressure for the operation of the :—

Undercarriage and tailwheel
Flaps
Bomb doors.

The system will function on one pump, but only at a reduced rate.

(ii) A handpump for operating all the services through the normal system, when the engine pumps are not running is mounted in a socket (55) beneath the pilot's seat. The detachable handle is stowed on the cockpit door. The approximate time to lower the undercarriage by hand-pump is four minutes.

(iii) The handpump may also be used to operate the separate emergency undercarriage lowering system, when the emergency selector valve, marked PUSH FOR EMERGENCY, on the right of the pilot's seat is pushed down.

9. Pneumatic system

(i) An air compressor on No. 1 engine charges an air bottle for the operation of the brakes and guns, and the electro-pneumatic rams for :—

Radiator shutters
Automatic supercharger gear change
Carburettor air-intake filter control.

(ii) The available pressure is shown on the pneumatic system and brakes triple pressure gauge (36) and should record 200 lb./sq. in. in flight. All services except the brakes are cut off by a pressure maintaining valve if the supply falls below 150 lb./sq. in.

(iii) Two vacuum pumps, one driven by each engine, together operate the flight instruments. If either pump should fail it is automatically isolated from the suction system. Each pump can be proved on the ground by alternatively starting the port and starboard engine first and checking that the artificial horizon erects properly.

10. Electrical system

A generator on No. 2 engine charges a battery which supplies electrical power at 24 volts for :—

Automatic superchargers
Air intake filters
Radiator shutters
Guns
Radio (Gee 11, G.P. H.F. communication set, V.H.F., I.F.F.)
Instrument and cockpit lighting
Air recognition, identification, navigation lights and landing lamp.
Engine starters and booster coils
Immersed fuel pump
Feathering pump motors
Undercarriage warning lights and horn
Oil dilution valves
Fuel pressure warning lights
Fire-extinguishers
Windscreen wiper
Pressure-head heater
Cine-camera
Reflector gunsight
Bomb selection, fuzing and release gear
R.P. release.

A warning light (60) on the electrical panel shows when the generator is not delivering current. On the ground with the engine stopped, the light will be on so long as the

aircraft battery is connected. The current consumed is negligible.
A ground starter battery socket is provided on the port side of rear fuselage.

AIRCRAFT CONTROLS

11. Flying controls

The flying controls are conventional and the rudder pedals are adjustable for reach.

12. Flying controls locking gear

The rudder pedals are locked by a spool which fits between them and is secured by a wing nut. The spool is connected to the control column locking tube by a cable so that one cannot be removed without the other. Controls are locked in the neutral position. The gear is stowed in the fuselage opposite the rear hatch. It should be ensured that the locking pins are attached to the gear.

13. Trimming tab controls

The elevator trimming tab control is on the left of the pilot's seat ; the indicator (42) is on the cockpit port wall. The rudder trimming tab control and indicator (19) are mounted on the front cockpit coaming.
The aileron trimming tab control and indicator are mounted on the lower right-hand side of the instrument panel. All trimming tab controls work in the natural sense.

14. Undercarriage

(i) The undercarriage selector lever (32) has a safety catch which must be released before UP can be selected. The selector should always be moved smartly to the UP or DOWN positions, as it may become locked if it is moved slowly.

(ii) The selector should return automatically to neutral when the UP or DOWN operation is completed. If the lever does not return when it is certain that the operation is complete, it should be returned by hand. If the lever re-

turns prematurely, and the undercarriage indicator shows that the wheels are not locked UP or DOWN, the selector lever should be held UP or DOWN for not more than 5 seconds. This will occur only when the system is not properly adjusted.

(iii) In cold weather before landing, the system should be exercised a few times by alternatively selecting UP or DOWN; owing to the hydraulic oil congealing, when the undercarriage selector is put DOWN the main wheels may come down and the selector return to neutral before hydraulic pressure reaches the tailwheel jack.

(iv) It is not desirable to hold the selector DOWN for longer than 5 seconds as this subjects the lines to high pressures.

15. Undercarriage position indicator

(i) The undercarriage position indicator (38) operates when the electrical services switch is on.

(ii) The indicator lights are fitted with dimmer screens for night flying. Indications are:—

Main wheels locked up	No lights
Main wheels locked up but throttles less than ¼ open	2 red lights
Main wheels between UP and DOWN	2 red lights
Main wheels locked down	2 green lights

When the main wheels are lowered, the red lights do not go out until the down locks are engaged.

(iii) There is no tailwheel indicator.

16. The undercarriage warning horn

The undercarriage warning horn sounds when the main wheels are not locked down and the throttles are less than ¼ open.

17. Undercarriage ground locking

(i) Ground locking caps are stowed in a bag on the rear bulkhead of each nacelle, and should be fitted after landing in place of the dust caps which cover the end of the locking latches.

(ii) If the aircraft is taken off with the locking caps on, and an attempt is made to retract the undercarriage, the tailwheel only will retract; therefore, the undercarriage

selector lever should be moved to the DOWN position, allowed to return to neutral and then held down for 5 seconds before landing to ensure that the tailwheel is down.

18. Flaps control and indicator

Operation of the flaps is controlled by the lever (29) marked F to the right of the undercarriage selector lever. A safety catch must be pushed to the right before flaps DOWN can be selected. The selector lever should return automatically to neutral on completion of a full operation. Any flap angle up to 45° can be obtained by returning the lever to neutral when the desired angle is reached according to the position indicator (37). The maximum flap angle is 45° although the gauge is marked up to 70°.

19. Wheel brakes

The brakes control lever (46) and parking catch are on the control column. Differential braking is afforded by means of a relay valve connected to the rudder pedals. The pressure at each brake should be between 80 to 100 lb./sq. in.

ENGINE CONTROLS

A.L.1 Para. 20

20. Throttle controls

The black friction nut is for the throttles the (larger) white one for the propeller levers. Normally the throttles can be pushed forward to the stops only. When the small catches on the levers are squeezed the throttles can be pushed fully forward. Merlin 25 engines give +12 lb./sq. in. boost at the stops and +18 lb./sq. in. when fully forward; there is no cut-out. Merlin 23 engines may still be fitted. They give +9 lb./sq. in. at the stops and +12 lb./sq. in. at the fully forward position. If the boost control cut-out is pulled, +14 lb./sq. in. will be obtained in low gear.
De-rated engines of either mark give +9 lb./sq. in. boost at the stops and +12 lb./sq. in. at the fully forward position, and do not have a cut-out.

21. Mixture and slow running cut-out controls

(i) S.U. carburettors are fitted and mixture is automatically controlled by the boost pressure; an economical mixture is obtained when this is less than +7 lb./sq. in.

(ii) Spring loaded slow running cut-out controls, mounted above the fuel cock controls should be pulled out to stop the engines, after which they should be released smartly.

22. Propeller controls

The r.p.m. control levers (49) which vary the governed pitch from 3,000-1,800 r.p.m. are fitted on the side of the engine controls box. The feathering pushbuttons (25) are on the right-hand front panel. The friction control lever (50) is the larger white knob on the engine controls box.

23. Superchargers control

When the superchargers gear change switch (51) is set to MOD, the superchargers will remain in low gear at all altitudes. When this switch is set to AUTO the electro-pneumatic rams are controlled by an aneroid, and will automatically engage high gear when climbing, at approximately the following heights:

Merlin 23—8,750 ft.
Merlin 25—7,000 ft.

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These heights are the correct supercharger gear change heights only when using maximum power (operational necessity). When using low power settings, the selection of high gear should be carried out by switching to AUTO as recommended in para. 41. When descending in AUTO, low gear will be engaged at slightly lower altitudes than those quoted above.

Failure of the electrical or pneumatic system will cause the superchargers to remain in, or return to, low gear.

24. Radiator shutters

The radiator shutters are controlled by two switches (15) which operate electro-pneumatic rams. It is not possible to set the shutters at intermediate positions between fully open and shut.

25. Carburettor air-intake filters

Air-intake filters are provided. They are controlled by a switch (16) beside the radiator shutter switches, or when Mod. 862 is incorporated by two pushbuttons fitted below the coaming on the right-hand side of the instrument panel when the filters are controlled manually by a *projecting* pushbutton marked FILTER OUT and a *flush* pushbutton marked FILTER IN. The relay control is interconected with the undercarriage so that when the undercarriage is down the filter is automatically brought into operation irrespective of the position of the push-

buttons, unless the FILTER OUT pushbutton is kept pressed. After take-off and well clear of the dust-laden zone the projecting pushbutton should be pressed in for FILTER OUT.

If required FILTER IN may be selected at any time during flight, though normally FILTER OUT should be used.

OPERATIONAL CONTROLS

26. Bomb doors

The bomb doors selector lever (34) marked B on the left of the undercarriage selector lever, should return automatically to neutral on completion of a full operation. A warning light (26) on the bomb control panel indicates when the bomb doors are fully open.

27. Bomb selection, fusing and release

(i) The panel on the right-hand side of the instrument panel provides the switching arrangements for the fuselage bomb, wing bombs and wing drop tanks. The switch (28) at the top marked BUTTON CHANGEOVER CAMERA and BOMBS or TANKS permits the push-button (45) on the control column to be used for operating either the cine-camera or the bomb release. The bombs cannot be selected or fused until the BUTTON CHANGEOVER has been moved to BOMBS or TANKS.

For emergency bomb release see para. 61.

28. Cine-camera operation

The cine-camera master switch (61) must be ON and the button changeover switch set to CAMERA before the camera can be operated by the release button or by pressing either of the gun-firing triggers.

29. R.P. and gun controls

(i) Before the guns can be fired the gun master switch (33) must be set to FIRE.

The 20 mm. guns are fired by a forefinger operated trigger, the machine guns by a thumb-operated trigger (44)

both on the control column. The gun heating control is on the right of the observer's seat. Minimum pneumatic pressure required for operation is 200 lb./sq. in.

(ii) The R.P. PAIRS—SALVO switch is mounted adjacent to the gunsight and should be switched to the required position before the MASTER SWITCH is turned ON. The MASTER SWITCH is on the R.P. Auto-selector unit, which is mounted on the cockpit port wall aft of the engine controls box. The firing pushbutton is mounted on No. 2 engine throttle lever.

COCKPIT EQUIPMENT

30. Oxygen

A Mk. 11B oxygen regulator (35) is fitted together with a flow selector switch and indicator.

31. Heating

The cockpit heat control is behind the pilot's seat, and is rotated forward to permit hot air from the port coolant radiator to enter the cockpit.

32. Cooling

There are two adjustable ventilators (24) by means of which cool air can be admitted to the cockpit.

33. Windscreen wiper and de-icer

The windscreen wiper should not be used on a dry screen, it may injure the surface. When not in use make sure that the rheostat (78) is turned fully off, otherwise, current may be wasted.
A windscreen de-icer pump is mounted beneath the aileron trimming tab control.

34. Lighting

Three floodlights with adjacent rheostats, light the instrument panel and compass.
They are controlled by separate dimmer switches.
There is a cockpit roof light, and provision is also made for UV/red and emergency lighting.

35. Night flying screens

The generator (60) and fuel pressure (5) warning lights are fitted with dimmer screens. When flying by day, these screens must be opened ; otherwise, indications will not be noticed.

PART II
HANDLING

36. Management of the fuel system

(i) Start the engines on the outer tanks, warm up on the main tanks, taxy and take-off on the fullest tanks.

(ii) Use of the outer tanks.

(a) Do not rely on outer tanks when flying at low altitudes; their capacity is small and the gauges diminish in accuracy as the fuel level falls.

(b) The outer tanks are pressurised only when transfer of fuel is taking place from the wing drop tanks. When wing drop tanks are not used vaporisation may cause engine cutting at high altitudes particularly in tropical climates.
Interruptions of flow are most likely to take place in the early part of a flight at high altitude. When at dispersal every effort should be made to shield the aircraft from the direct rays of the sun, as the fuel should be kept as cool as possible.

(c) Engine cutting may occur during evasive action, at high power at altitude, and whenever the tanks are less than half full.

(d) It is not possible to cross-feed from the outer tanks should one engine fail and they should therefore be used first. When they are nearly empty, change to the main supply.

(iii) Use of the wing drop tanks

(a) The contents of both wing drop tanks are transferred by pressure from the exhaust side of the port vacuum pump. Failure of this pump will be masked by the automatic isolation valve, unless failure of No. 1 engine makes it obvious. Failure of this pump will only be revealed by the non-transfer of the contents of the wing drop tanks when transfer is selected.

(b) The contents of the wing drop tanks should be transferred as early as possible to avoid loss of fuel if they should have to be jettisoned. In the event of

FINAL CHECKS FOR TAKE-OFF

TRIM	ELEV. ...	NOSE HEAVY AS REQUIRED
	RUD. ...	SLIGHTLY RIGHT
	AIL. ...	NEUTRAL
PROPS.	...	MAX. RPM.
FUEL	...	COCKS FULLY ON
FLAPS	...	UP OR 15°
RADIATORS	...	OPEN

FINAL CHECKS FOR LANDING

FUEL	...	CHECK TANKS
RADIATORS	...	OPEN
BRAKES	...	OFF
		CHECK PRESSURES
WHEELS	...	DOWN AND LOCKED
PROPS.	...	2,850 RPM ON FINAL
FLAPS	...	FULL ON FINAL

failure of the port vacuum pump, fuel cannot be transferred, nor can it be cross-fed, in the event of engine failure ; therefore, as soon after take-off as convenient turn on the transfer cock. When the wing drop tanks have been emptied, shown by a fall in the contents of the outer tanks, turn off the transfer cock.

Continue on the outer tanks until they are empty, then change to main supply.

(c) If automatic transfer is not provided, sufficient fuel must be used from the outer tanks before attempting to transfer, or fuel may be lost through the atmospheric vents. To transfer fuel, change to main supply and turn on the transfer cock. When the outer tanks are full, turn off the transfer cock and revert to outer tanks. Repeat the sequence until the wing drop tanks are empty.

(iv) *Use of the long-range tank*

Select main supply and turn on the immersed fuel pump. As soon as the warning light comes on the immersed fuel pump should be switched off.

37. Starting and warming up the engines

(i) After carrying out the external, internal and cockpit checks laid down in the Check List, confirm :—

Main fuel cocks	...	Outer tanks
Throttles ...	...	½ in. open
R.p.m. control levers ...		Maximum r.p.m. position
Superchargers ...	...	Mod. (low gear)
Radiator shutters	...	CLOSED
Pressure venting cock...		ON
Fuel transfer cock	...	OFF
Immersed fuel pump switch		OFF
Bomb doors ...	...	Shut, selector neutral

(ii) If the engines are to be started from an external source, have a ground starter battery plugged in, and then for each engine in turn :—

(iii) The ground crew should work the priming pump until fuel reaches the priming nozzles ; this can be judged by a sudden increase in resistance.

(iv) Switch on the ignition and press the starter and booster-coil pushbuttons. Turning periods must not exceed 20

seconds with 30 second intervals.

(v) The ground crew should work the priming pump as rapidly and vigorously as possible while the engine is being turned.

(vi) At air temperatures below freezing it will probably be necessary to continue priming after the engine has fired and until it picks up on the carburettor.

(vii) As soon as the engine is running satisfactorily, release the starter and booster-coil pushbuttons and instruct the ground crew to screw down the priming pump and remove the ground starter battery if used.

(viii) After the oil pressure has become steady, open the throttle slowly and warm up at 1,200 r.p.m.

(ix) While warming up, items (86) to (90) of the Check List should be carried out.

NOTE.—(a) It is recommended that the engines be started in a different order each time so that the vacuum pumps can be checked for correct functioning.

(b) When the starboard engine is opened up, check that the generator is charging. The warning light should be out.

38. Exercising and testing

(i) Warm up to 15°C. oil temperature and 40°C. coolant temperature, and then for each engine in turn :—

(ii) At warming up r.p.m. test each magneto as a precautionary check. and open the radiator shutters

(iii) Open up to the static boost reading (zero under standard atmosphere conditions) and check the operation of the supercharger by setting the switch to AUTO and having the ground crew press the test pushbutton in each engine nacelle. R.p.m. should drop slightly and boost should rise when the change to high gear is made.

(iv) At the same boost, exercise and check the operation of the constant speed unit by moving the r.p.m. control lever over the whole range at least twice. Return the control lever to the maximum r.p.m. position, then check that the r.p.m. are within 50 of those normally obtained.

(v) At the same boost test each magneto. If the single ignition drop exceeds 150 r.p.m. but there is no undue vibration,

a full power check should be carried out; if there is marked vibration the engine should be stopped and the cause investigated. The full power check may also be carried out after repair, inspection other than daily, when the ignition drop at zero boost exceeds 150 r.p.m. or at the discretion of the pilot. If the checks at the static boost are satisfactory no useful purpose will be served by a full power check.

(vi) The full power check should be carried out as follows :— Open the throttle fully and check the take-off boost and r.p.m. Throttle back until a drop in r.p.m. is apparent and test each magneto. If the single ignition drop exceeds 150 r.p.m. the aircraft should not be flown.

(vii) After completing the checks either at the static boost reading or at full power, steadily move the throttle to the fully closed position and check the minimum idling r.p.m. Then open up to 1,200 r.p.m.

39. Taxying

Carry out items (93) and (94) in the Pilot's Check List.

40. Take-off

(i) Carry out items (95) to (105) in the Pilot's Check List.

(ii) Taxy forward a few yards to straighten the tailwheel.

(iii) Open the throttles slowly, checking any tendency to swing by coarse use of the rudder and by differential throttle movement. There is little tendency to swing if the engines are kept synchronised.
The travel of the throttle levers is very short for the power obtained.
Coarse use of the throttles will aggravate any tendency to swing.

(iv) When comfortably airborne, brake the wheels and raise the undercarriage, check that the undercarriage locks up; if it does not hold the selector lever up for five seconds.

(v) Safety speed at a weight of approximately 17,000 lb. flaps up or 15° down at +9 lb./sq. in. boost is 155 knots. At +18 lb./sq. in. boost it is 170 knots. These speeds however, may vary considerably with individual aircraft.

(vi) Before raising the flaps, if used, trim the aircraft slightly tail heavy.

41. Climbing

(i) The speed for maximum rate of climb is 150 knots.

(ii) Climb in low gear at 2,850 r.p.m. and +9 lb./sq. in. boost. When the maximum obtainable boost has fallen to +7 lb./sq. in., change to AUTO. Above 18,000 ft. decrease the airspeed by 2 knots per 1,000 ft.

(iii) When climbing for maximum range, climb in low gear at 2,650 r.p.m. and +7 lb./sq. in. boost, using the airspeeds recommended above. When the maximum obtainable boost has fallen to +4 lb./sq. in. set the supercharger gear change switch to AUTO and re-adjust the throttles. Above 18,000 ft. increase power to +9 lb./sq. in. and 2,850 r.p.m. and reduce airspeed as recommended. Although less fuel is used to reach a given altitude by climbing at high power the total fuel used and the time taken on the subsequent cruise is the same, whether the aircraft is climbed at 2,650 r.p.m. and +7 lb./sq. in. boost or 2,850 r.p.m. and +9 lb./sq. in. boost.

(iv) When climbing with a boost setting of less than +9 lb./sq. in. the automatic boost control cannot open the throttle valves fully and the boost will begin to fall off before full throttle height is reached; the throttle levers should be progressively advanced to the gate to maintain the desired boost.

(v) For operational necessity at any altitude, select AUTO and 3,000 r.p.m. and move the throttles fully forward (see para. 20).

42. General flying

(i) *Stability*
Stability about all axes is satisfactory, but with the C.G. aft longitudinal stability deteriorates on the climb.

(ii) *Changes of trim*

Undercarriage up ...	Slightly nose up
Undercarriage down ...	Nose down
Flaps up	Strongly nose down
Flaps down	Nose up
Radiator shutters open	Nose up
Radiator shutters closed	Nose down
Bomb doors open ...	Nose up slightly
Bomb doors closed ...	Nose down slightly

(iii) *Controls*
The controls are light and effective and manœuvrability is good. The rudder should not be used violently at high

speeds. When two-tier R.P. or rails are carried, aileron control is poor at low speeds, i.e., during take-off and approach to land.

(iv) *Flying at reduced airspeeds*
Speed should be reduced to 175 knots, flaps lowered 15° and the r.p.m. controls set to give 2,650 r.p.m. Speed may then be reduced to 130 knots.

43. Stalling

(i) The approximate stalling speeds in knots are as follows:—

	18,000 lb.
Power off	
Undercarriage and flaps up	105
Undercarriage and flaps down	95–100
Power on under typical approach conditions	90–95

(ii) Warning of the approach of the stall is given by pronounced buffeting of the control surfaces, the onset of which can be felt some 10 knots before the stall itself. At the stall the aircraft pitches, the A.S.I. fluctuates and the nose drops gently. There is little tendency for the wing to drop unless the control column is held back.
Recovery is easy and normal in all cases.

44. Cruising

(i) For any required airspeed, the maximum weak mixture boost (+7 lb./sq. in.) together with the lowest practicable r.p.m. provide the most economical conditions.

A.L.1 Para. 44 (ii) | (ii) When cruising at low r.p.m. the engines should be cleared every 30 mins. at +12 lb./sq. in. boost and 2,850 r.p.m. for 30 secs.

(iii) At any height the speed for maximum range is 170 knots at a weight of 17,000 lb. but below 10,000 ft. this speed can only be obtained at an uneconomical boost setting, even when using minimum r.p.m. Speed should therefore be increased to approximately 200 knots.

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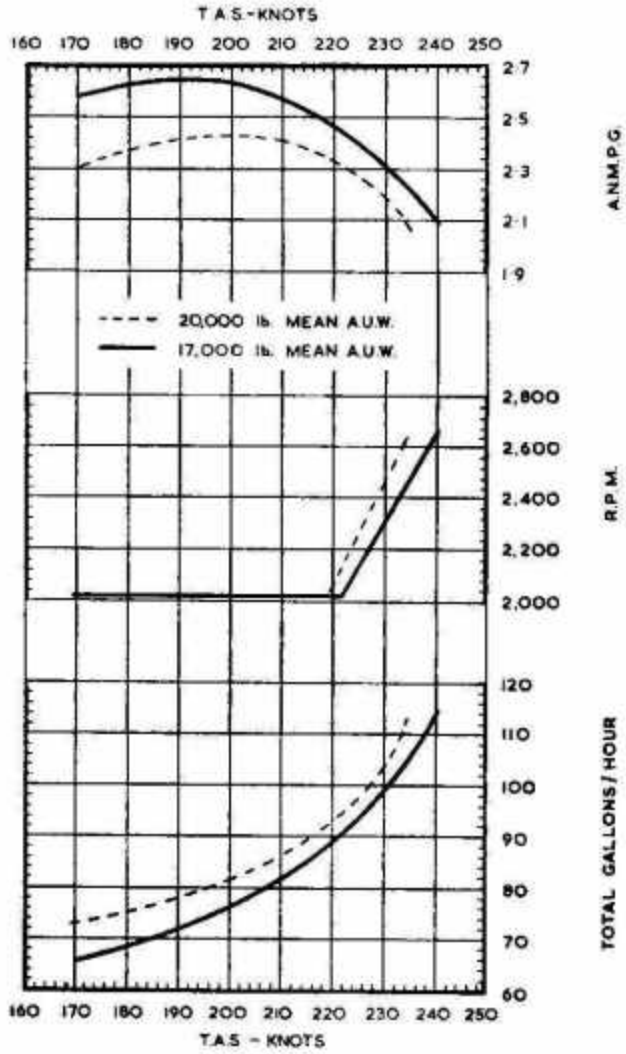
(iv) Fly with the supercharger gear change switch in the MOD position, unless the recommended airspeed cannot be obtained without exceeding 2,650 r.p.m., when high gear should be engaged by switching to AUTO.

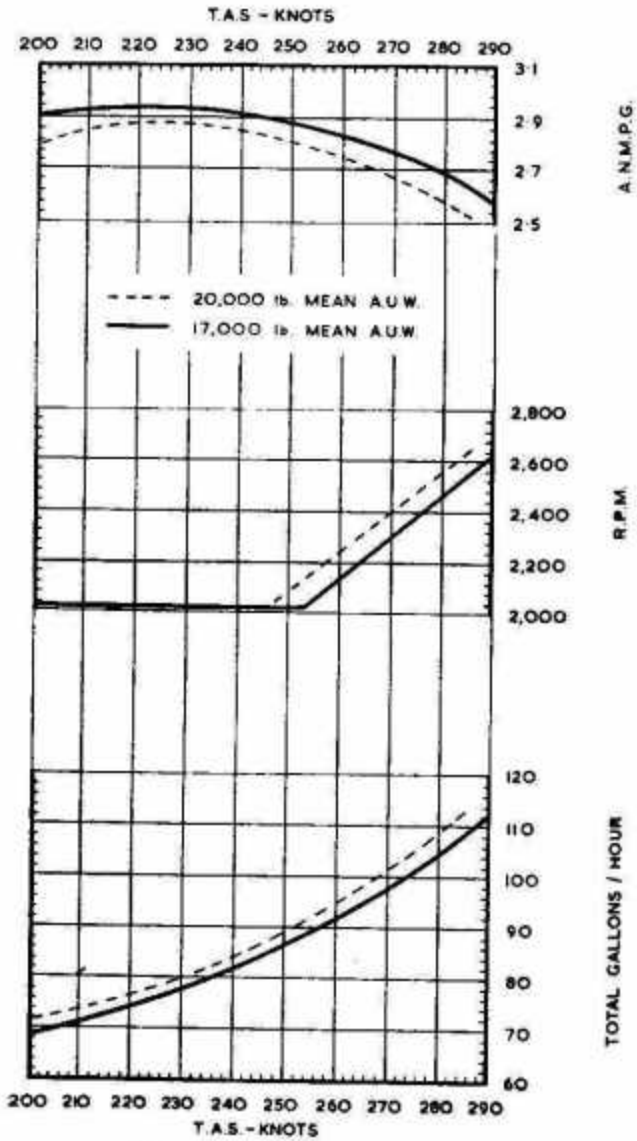
45. Flight planning charts

The recommended cruising speeds ANMPG and GPH curves for a mean weight of 17,000 lb. and 20,000 lb. at sea level, 10,000 ft. and 20,000 ft. in low gear and at 25,000 ft. in high gear are on pages 30 to 33.

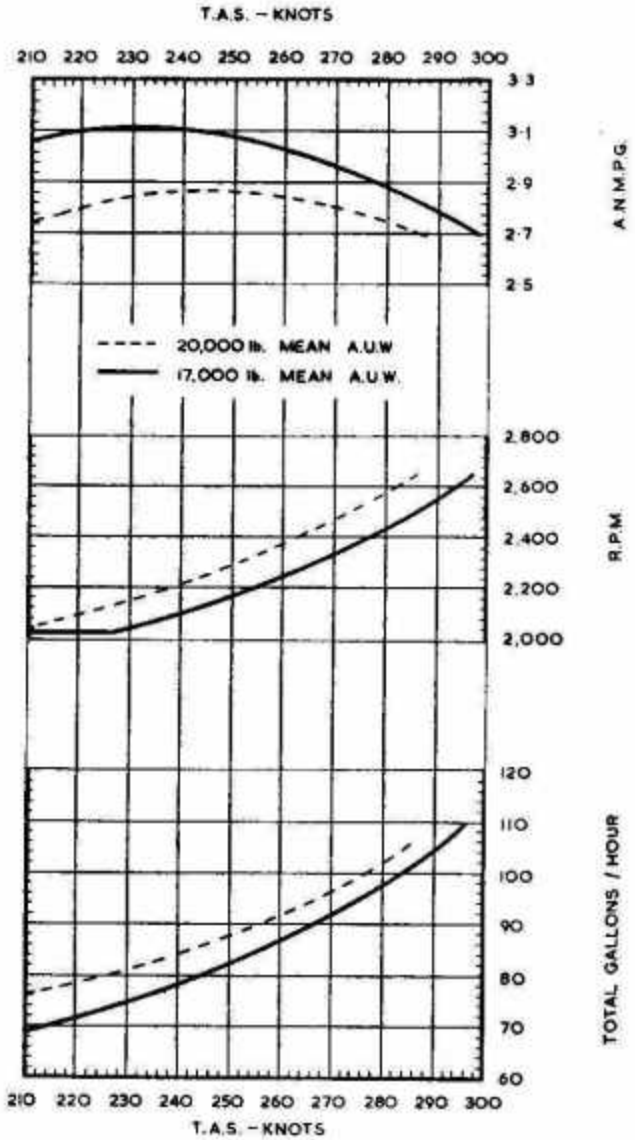
FLIGHT PLANNING CHARTS.



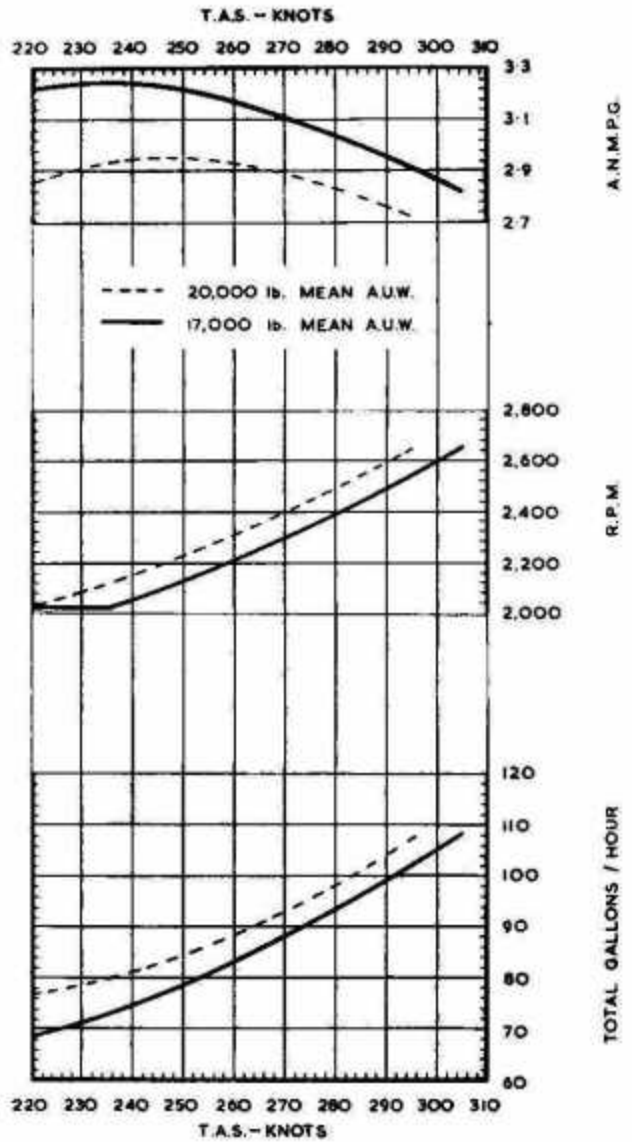
SEA LEVEL LOWGEAR



10,000 FT. LOWGEAR



20,000 FT. LOWGEAR



25,000 FT. HIGHGEAR

46. Position error corrections

The position error corrections are negligible and may be disregarded.

47. Approach and landing

(i) Carry out items 106 to 112 in the Pilot's Check List.

(ii) From 17,000 lb. to 18,000 lb. the following final approach speeds are recommended :—

	Flaps down
Engine assisted	100-105 knots

At full load this speed should be increased by about 5 knots.

(iii) With the undercarriage and flaps down the rate of descent is very high. If undershooting, corrective action entails the use of more power than might be expected.

(iv) After landing and when clear of the runway carry out items 113 to 117 in the Pilot's Check List.

48. Mislanding and going round again

The aircraft will climb satisfactorily at approximately 120 knots with flaps and undercarriage down at climbing power.

(i) Open the throttles to +9 lb./sq. in. boost.

(ii) Raise the undercarriage and while it is retracting raise the flaps to 15°, and re-trim.

(iii) At a safe height and speed retract the flaps fully and retrim.

49. Stopping the engines

(i) If the serviceability of the engine is in doubt, such items of the run-up given in para. 38 as may be necessary should be carried out. In all cases, however, the engines should be idled at 1,000 r.p.m. for a short period and during this period if no other check of the ignition has been made the magnetos should be tested for a dead cut.

(ii) To stop the engines the slow-running cut-outs should be pulled out until the engines have stopped, after which they should be released smartly.

(iii) After the engines have stopped, carry out items 118 to 128 in the Pilot's Check List.

50. Oil dilution

(i) Adjust the oil level in the tanks to 12½ gallons.

(ii) To ensure a cold start at the following temperatures the oil should be diluted for the times quoted below :

Between −10°C. and −15°C.	1 minute
Between −15°C. and −26°C.	2 minutes

(iii) During the next start after 2 minutes' dilution the minimum partial boiling-off period at 2,000 r.p.m. is 10 minutes. After 1 minute dilution no special partial boiling-off precautions are necessary.

PART III
LIMITATIONS

51. Engine data Merlin 23 and 25

The principal engine limitations are as follows :—

Merlin 25

	Supercharger gear	R.p.m.	Boost lb./sq. in.	Temp. °C. Coolant	Oil
MAX. TAKE-OFF	Low	3,000	+18*		
INTERMEDIATE 1 HR. LIMIT	Low / High	2,850	+ 9	125	90
MAXIMUM CONTINUOUS	Low / High	2,650	+ 7	105(115)†	90
OPERATIONAL NECESSITY 5 MINS. LIMIT	Low / High	3,000	+18*	135	105

*May not be used at r.p.m. below 2,850.

†The temperature shown in brackets may be used if necessary for short periods only.

NOTE.—In some aircraft Merlin 23 engines will still be installed. The difference as regards operational limitations from those for the Merlin 25 quoted above are as follows :—

MAX. TAKE-OFF ... ... + 14 lb./sq. in.

OPERATIONAL NECESSITY 5 MINS. LIMIT — L / H — 3,000 r.p.m. — + 14 lb./sq. in.* / + 16 lb./sq. in.*

* Obtainable by use of the boost control cut-out.

Merlin 23 and 25

OIL PRESSURE

MINIMUM IN FLIGHT ... ... 30 lb./sq. in.

MINIMUM TEMPERATURE FOR TAKE-OFF

OIL +15°C.

COOLANT +40°C.

52. Flying limitations

(i) Deliberate spinning is prohibited and an incipient spin should be checked by immediate recovery action.

Although aerobatics are permitted at weights below 19,100 lb. without bomb load, underwing stores or wing drop tanks, they are not recommended owing to the possibility of damaging the special equipment.

(ii) The controls are light and effective and care should be taken to avoid excessive accelerations in turns and recovery from dives. At high speeds violent use of the rudder and large angles of yaw must be avoided.

(iii) *Maximum weights*

Take-off and gentle manœuvres	20,500 lb.
All forms of flying	19,000 lb.
Landing	20,500 lb.

(iv) *Maximum speeds in knots are :*

(a) Without underwing stores or with 2 × 250 or 500 lb. G.P. bombs with standard wing bomb fairings.

(b) With 2 × 100 gal. wing drop tanks.

(c) With underwing R.P. or depth charges.

(d) With underwing stores.

	(a)	(b)	(c)	(d)
Sea level to 10,000 ft.	370	330	350	305
10,000 ft. to 15,000 ft. ...	350	330	350	305
15,000 ft. to 20,000 ft. ...	320	320	320	305
20,000 ft. to 25,000 ft. ...	295	295	295	295
25,000 ft. to 30,000 ft. ...	260	260	260	260
30,000 ft. to 35,000 ft. ...	235	235	235	235

Bomb doors open	305
Undercarriage down	155
Flaps not more than 25° down	175
Flaps fully down	130

(v) (a) Firing of RP is prohibited whilst carrying drop tanks and until at least one minute after they have been jettisoned.

(b) Wing drop tanks should only be jettisoned in level flight without yaw, at speeds between 175 and 260 knots.

PART IV
EMERGENCIES

53. Feathering

(i) Close the throttle.

(ii) Hold the pushbutton in only long enough to ensure that it stays in by itself, then release it so that it can spring out when the feathering is complete. If it does not spring out, it must be pulled out.

(iii) Turn off the fuel cock.

(iv) When the engine has stopped, or nearly stopped, switch off the ignition and close the radiator shutter.

54. Unfeathering

(i) Set the throttle slightly open and the r.p.m. control lever fully back, and then switch on the ignition.

(ii) Hold the pushbutton in until r.p.m. rise to 800-1,000 and ensure that it springs out fully.

(iii) Turn on the fuel.

(iv) If the propeller does not return to normal constant-speed operation it must be feathered and unfeathered again, releasing the pushbutton at slightly higher r.p.m.

(v) It is advisable to unfeather at speeds below 175 knots to avoid risk of engine overspeeding.

(vi) Idle the engine at approximately 1,800 r.p.m. until the temperatures reach the minimum for opening up.

55. Engine failure during take-off

(i) The handling characteristics of individual aircraft differ considerably according to age and load. Except in cases where it is known to be less ; at approximately 17,000 lb., safety speed should be assumed to be 155 knots at +9 lb./sq. in. boost and, if the engines have not been de-rated 170 knots at +18 lb./sq. in. boost.

(ii) If safety speed has been attained, the aircraft will climb away on one engine at climbing power at about 135-140 knots provided that :—

(a) The propeller of the failed engine is feathered and the radiator shutter closed.

(b) The flaps are fully up.

(iii) The drag of a windmilling propeller is very high and unless feathering action is taken immediately, control can only be maintained at the expense of a rapid loss in height.

(iv) The aircraft accelerates slowly to the safety speed at +18 lb./sq. in. boost. If high power is used for take-off, it is recommended that climbing power is used as soon after take-off as is possible.

56. Engine failure in flight

(i) Close the throttle and feather the propeller of the failed engine.

(ii) Open the radiator shutter and keep a careful watch on the temperature of the live engine.

(iii) At full load, height can be maintained on either engine up to 12,000 ft. using climbing power at about 150 knots.

57. Single-engine landing

(i) While manœuvring with the flaps and undercarriage up, a speed of 140-150 knots should be maintained ;

(ii) A normal circuit can safely be made irrespective of which engine has failed. The checks before landing should be carried out as for a normal landing, but it should be remembered that the undercarriage will take longer to lower on one engine—approximately 30 seconds at 2,850 r.p.m. —and, owing to its high drag, height will be lost once it has started to lower.

(iii) When across wind, flaps may be lowered 15° and the live engine used carefully to regulate the rate of descent. Speed should not be allowed to fall below 135 knots until it is clear that the airfield is within easy reach ; flaps may then be lowered further as required and power and speed reduced as height is lost, aiming to cross the airfield boundary at the speeds quoted for an engine assisted landing.

58. Going round again on one engine

Going round again is only possible if the decision is made while ample height remains and before more than 15° of flap is lowered. The height is required in order to maintain the speed above the critical speed, for the high power necessary, while the undercarriage and flaps are retracting. When the decision to go round again has been made :—

(i) Ensure that the speed is not less than 135 knots, and then increase power on the live engine to +9 lb./sq. in. boost and 2,850 r.p.m.

(ii) Raise the undercarriage.

(iii) Increase speed to 140-150 knots.

(iv) Raise the flaps and re-trim.

(v) If the engines are not de-rated, power higher than +9 lb./sq. in. should only be applied carefully and within the limits of rudder control.

59. **Undercarriage and flaps emergency operation**

(i) If the undercarriage has lowered but not locked down:

(a) Re-select DOWN, check that the selector lever returns to neutral, and check the position of the undercarriage by the indicator and warning horn.

(b) If the undercarriage is still not locked down, but the selector lever springs back to neutral, this indicates functioning of the hydraulic pumps, but no positive operation of the undercarriage down locks.
Leave the selector in the neutral position until the flaps have been lowered, then take every opportunity of holding the undercarriage selector in the DOWN position. After landing hold the selector in the DOWN position until the units can be locked by the ground crew.
Until this has been done, avoid raising the flaps, taxying, turning or using the brakes.

(ii) If the indicator fails to show that the undercarriage is locked down, and the selector lever does not spring back to neutral:

(a) Return the selector lever to neutral and push the emergency knob down. Operate the handpump until the indicator shows that the wheels are locked down, or until considerable resistance is felt for several strokes. This, however, will not lower the tailwheel.

(b) Return the emergency knob to the UP position. Put the flap selector lever DOWN and handpump until the flaps are 15° down. Then return the selector lever to neutral.

(c) Select undercarriage DOWN, and use the handpump in an attempt to lower the tailwheel. Increased resistance to the handpump indicates when the operation is complete.

(d) Lower the flaps fully, or as required, using the handpump. Return the flaps selector lever to neutral.

(e) If the main wheels fail to lock down, or to remain locked down, push the emergency knob down again and maintain pressure on the undercarriage by using the handpump during the landing (see sub para. (i) (b)).

60. **Flapless landing**

The approach with flaps up is very flat, and difficulty may be experienced in maintaining a steady airspeed. At the maximum landing weight the final approach should be made at 115 knots. At light loads, this speed may be reduced by 5 knots. The touchdown is straightforward and the landing run, although lengthened, does not become excessive.

61. **Bombs, R.P. and wing drop tank jettisoning**

(i) *Bombs and wing drop tanks*

(a) Select bomb doors DOWN.

(b) Check doors open with warning light.

(c) Jettison small bomb containers by pressing the button (27).

(d) Select all bombs, and press the release button (45) on the control column; this will release the fuselage bombs unfused, and the wing bombs or wing drop tanks.

A.L.1 Para. 61 (ii)

(ii) *R.P.*

Rocket projectiles cannot be jettisoned except by firing as stated in para. 29 (ii).

62. **Fire-extinguishers**

The engine fire-extinguisher buttons (70) are on the electrical panel on the cockpit starboard wall. They

operate automatically in the event of a crash. A hand fire-extinguisher is provided to the right of the pilot's seat. Mod. 1145 introduces a fire warning light which is positioned in the centre of each feathering pushbutton. When this light glows red it indicates an outbreak of fire at the appropriate engine.
A semi-automatic fire-extinguisher system will be introduced under Mod. 1398.

63. **Parachute exit**

Exit should be made through the entrance door, which must first be jettisoned by pulling the handle (80) and kicking out. Do not touch the normal handle. If possible feather the starboard propeller before leaving the aircraft.

64. **Crash exit**

Through the roof panel—pull down the red lever in front of the panel and push out.

65. **Ditching**

(i) The aircraft may be successfully ditched but, whenever possible, it should be abandoned by parachute.

(ii) When ditching, jettison the roof panel but keep the entrance door closed.

(iii) Lower the flaps 15°

(iv) The harness should be tight and locked.

(v) Ditching should be along the swell or into wind if the swell is not steep.

(vi) If power is available it should be used to reduce speed of touchdown as far as possible.

66. **Crash landing**

Cases have occurred of paddle-bladed propellers, when under power, breaking on impact, when the port propeller is liable to cause injury to the pilot's legs. The engines should, therefore, be throttled fully back before touching down.

67. **IFF**

The demolition switches (69) for the IFF are on the electrical panel aft of the master switch (68).

68. **Signal pistol**

A signal pistol is mounted in the centre of the cockpit roof above the pilot's head. A stowage for ten cartridges is provided under the observer's seat.

69. **Emergency equipment**

(i) *Desert equipment*

Desert equipment is stowed in the rear fuselage and is accessible through the rear hatch.

(ii) *Dinghy*

An L type dinghy with an emergency pack is stowed in the fuselage above the centre section. The dinghy is inflated automatically by an immersion switch, or manually by pulling the release cable in the roof behind the pilot's head.

(iii) *Crash axe*

This is stowed at the back of the pilot's seat.

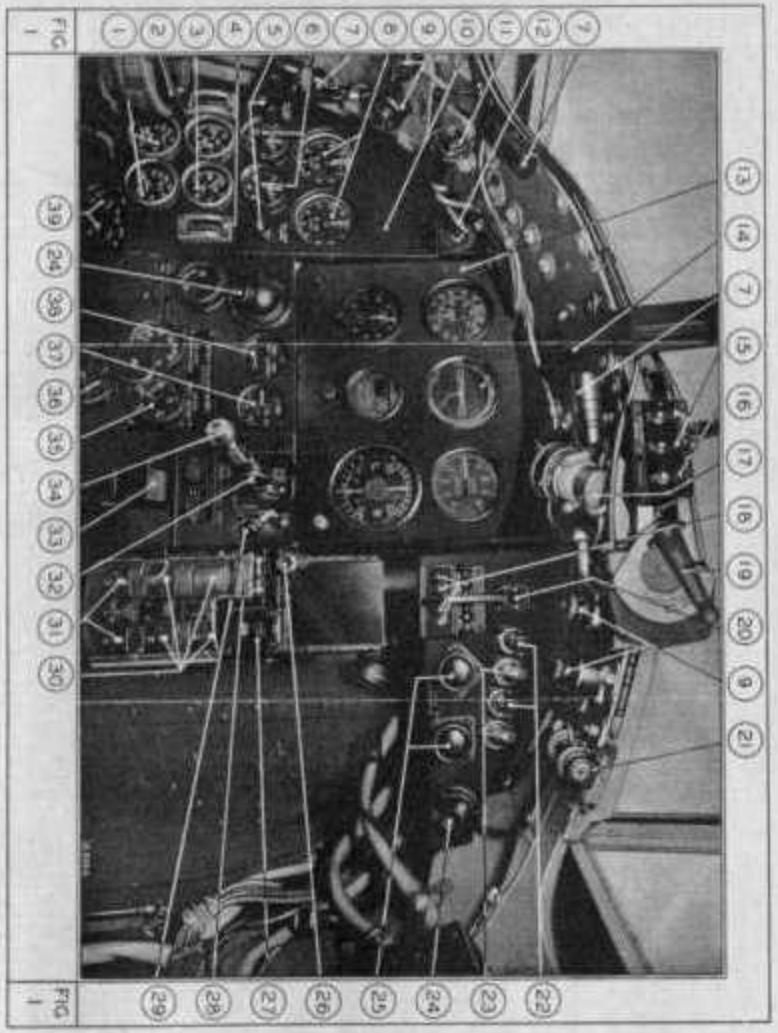
(iv) *First-aid outfit*

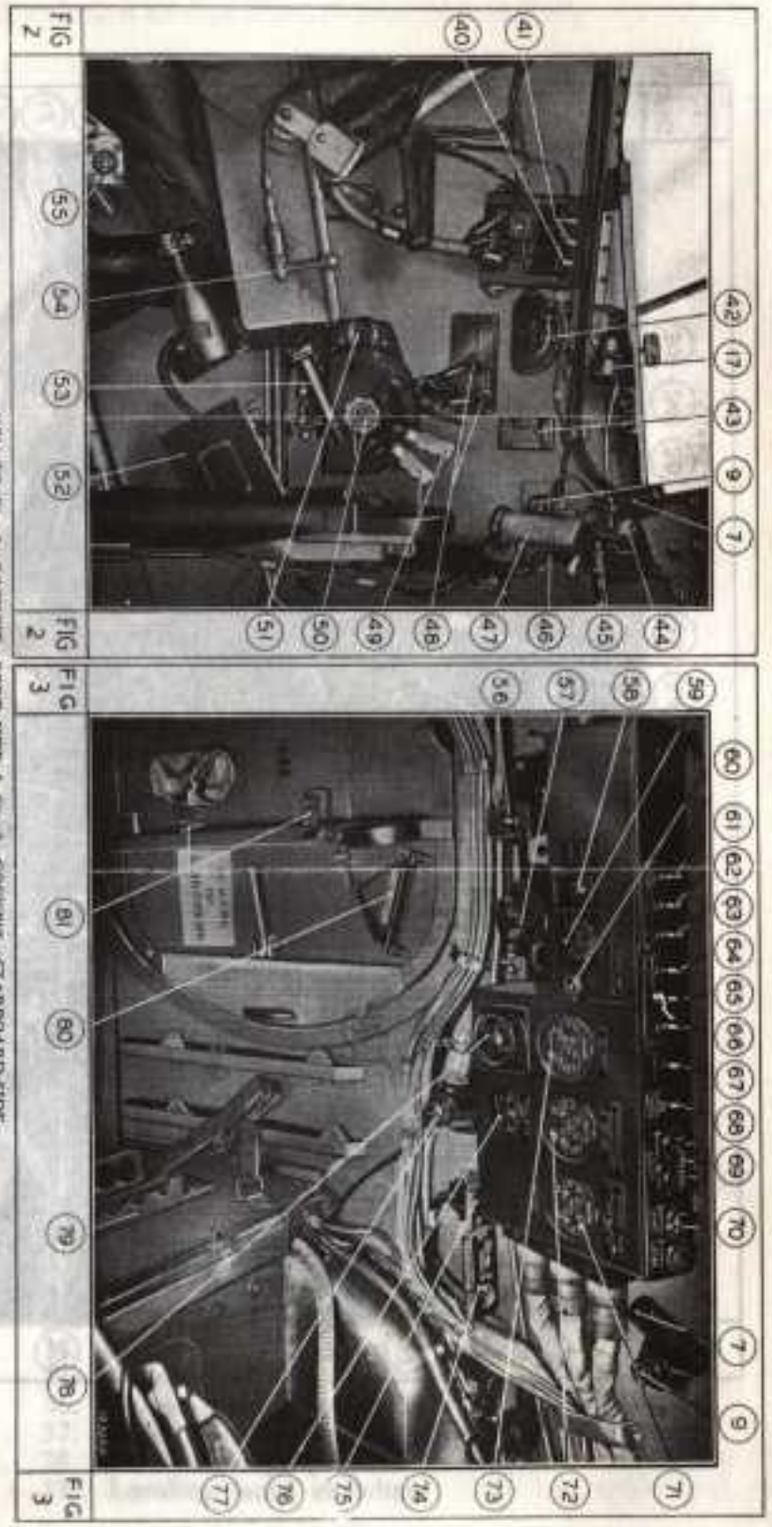
This is stowed under the pilot's seat.

KEY TO *Fig.* 1

COCKPIT—CENTRE

1. Coolant temperature gauges.
2. Compass.
3. Oil temperature gauges.
4. Oil pressure gauges.
5. Fuel pressure warning lights (see para. 5).
6. Boost pressure gauges.
7. Floodlights.
8. R.p.m. indicators.
9. Floodlight rheostats.
10. Stowage for R.I. compass repeater.
11. Exciter button for U.V. lighting.
12. Boost control cut-out (see para. 20).
13. Instrument flying panel.
14. Gunsight bracket.
15. Radiator shutter switches.
16. Air-intake filter switch.
17. Ultra violet lamp.
18. Magneto switches.
19. Rudder trimming tab and indicator.
20. Electrical services switch.
21. Immersed pump warning light.
22. Engine starter switches.
23. Booster-coil switches.
24. Ventilators.
25. Feathering buttons.
26. Bomb doors warning light.
27. Bomb containers and wing drop tanks jettison button.
28. Bombs or tanks/camera change-over switch.
29. Flaps selector lever.
30. Bomb selector switches.
31. Bomb fusing switches.
32. Undercarriage selector.
33. Gun master switch.
34. Bomb doors selector.
35. Oxygen regulator.
36. Triple pressure gauge.
37. Flaps position indicator.
38. Undercarriage position indicator.
39. Landing lamp switches.





KEY TO *Fig.* 2—COCKPIT—PORT SIDE & *Fig.* 3—COCKPIT—STARBOARD SIDE.

40. Beam approach switch.
41. R.I. compass switches.
42. Elevator trimming tab indicator.
43. Engine limitation data plate.
44. Gun firing control.
45. Bomb release button.
46. Wheel brakes control lever.
47. Control column.
48. Throttle levers.
49. R.p.m. control levers.
50. Friction controls.
51. Supercharger gear change switch.
52. V.H.F. controller.
53. Seat height-adjusting lever.
54. Harness release lever.
55. Socket for hydraulic handpump.
56. Air navigation lights switch.
57. Identification lights switch, box and key.
58. Identification lights colour selector switch.
59. Voltmeter.
60. Generator warning light.
61. Circuit-breaker master switch.
62. Navigation lights switch.
63. U.V. lights switch.
64. Pressure-head heater switch.
65. Instrument flood lighting switch.
66. Reflector gunsight switch.
67. Navigation head lamp switch.
68. I.F.F. master switch.
69. I.F.F. Interrogator pushbuttons.
70. Fire-extinguisher switches.
71. Fuel contents gauges—outer wing tanks.
72. Fuel contents gauges—centre tanks and long-range tank refuel switch.
73. Fuel contents gauges—inner wing tanks.
74. Switch and warning lights for transmitter type F.
75. Master switches for R1155 and T.R.1143.
76. Outside air temperature gauge.
77. Ventilation control.
78. Windscreen wiper rheostat.
79. Stowage for signal cartridges.
80. Emergency door release handle.
81. Stowage for hydraulic handpump handle.

AIR MINISTRY
November, 1950

Amendment List No. 1
to A.P. 2019E—P.N.

MOSQUITO FB.6

The 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 Pilot's Notes.

PART	PARA	AMENDMENT
I	20	*Amend* by gummed slip herewith.
I	23	*Amend* last seven lines by gummed slip herewith.
II	38 (ii)	*Add* " and open the radiator shutters."
II	44 (ii)	*Amend* by gummed slip herewith.
II	44 (iii)	Line 2. *Substitute* " 10,000 " for " 5,000."
IV	61 (n)	*Amend* by gummed slip herewith.

Affix this Amendment List to inside back cover of Notes.