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AIR PUBLICATION 1565B
Pilots Notes

PILOT'S NOTES

SPITFIRE IIA and IIB AEROPLANES
MERLIN XII ENGINE

Prepared by direction of the
Minister of Aircraft Production

A. Rowlands

Promulgated by order of the Air Council.

[signature]

AIR MINISTRY.

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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 air-screw 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 under carriage units and a non-retractable tail wheel unit. The under-carriage 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 out-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. 33C/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 G.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 (55) 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. Map 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

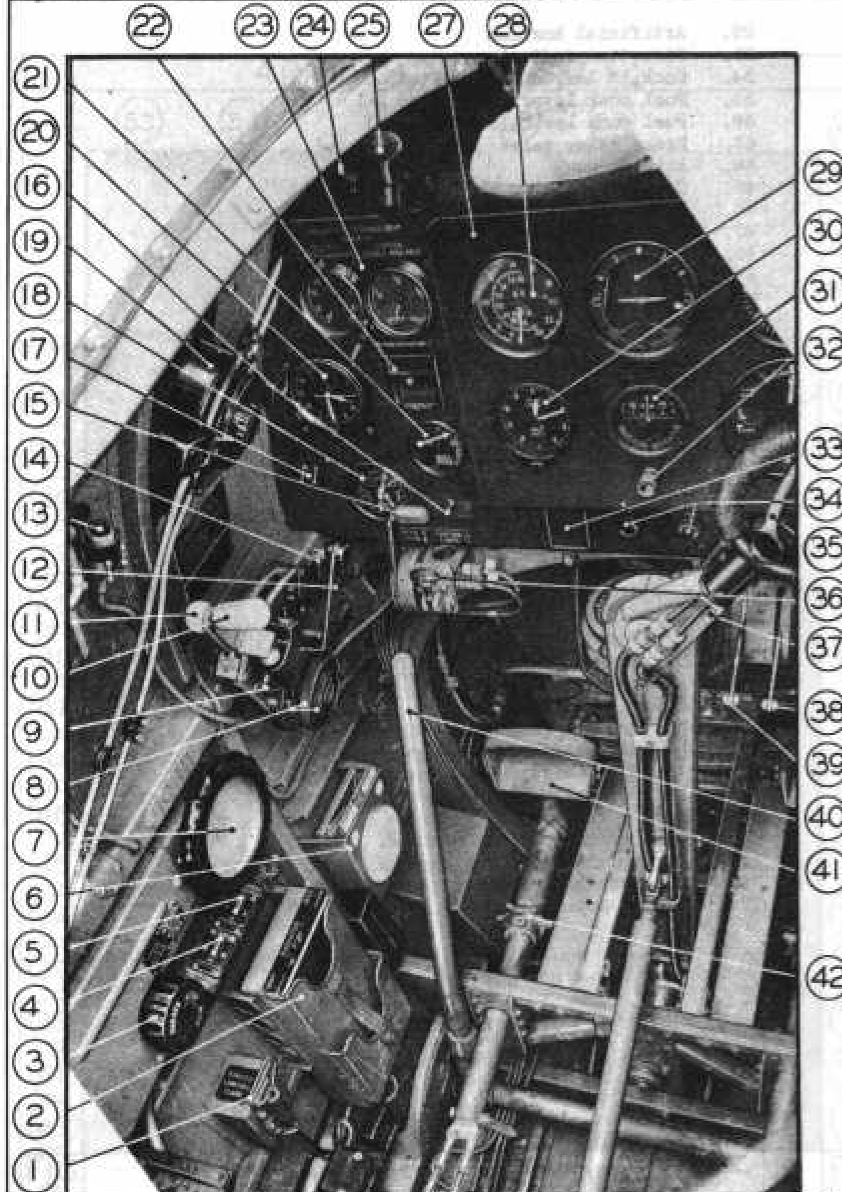

FIG. 1 PORT SIDE OF COCKPIT FIG. 1

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

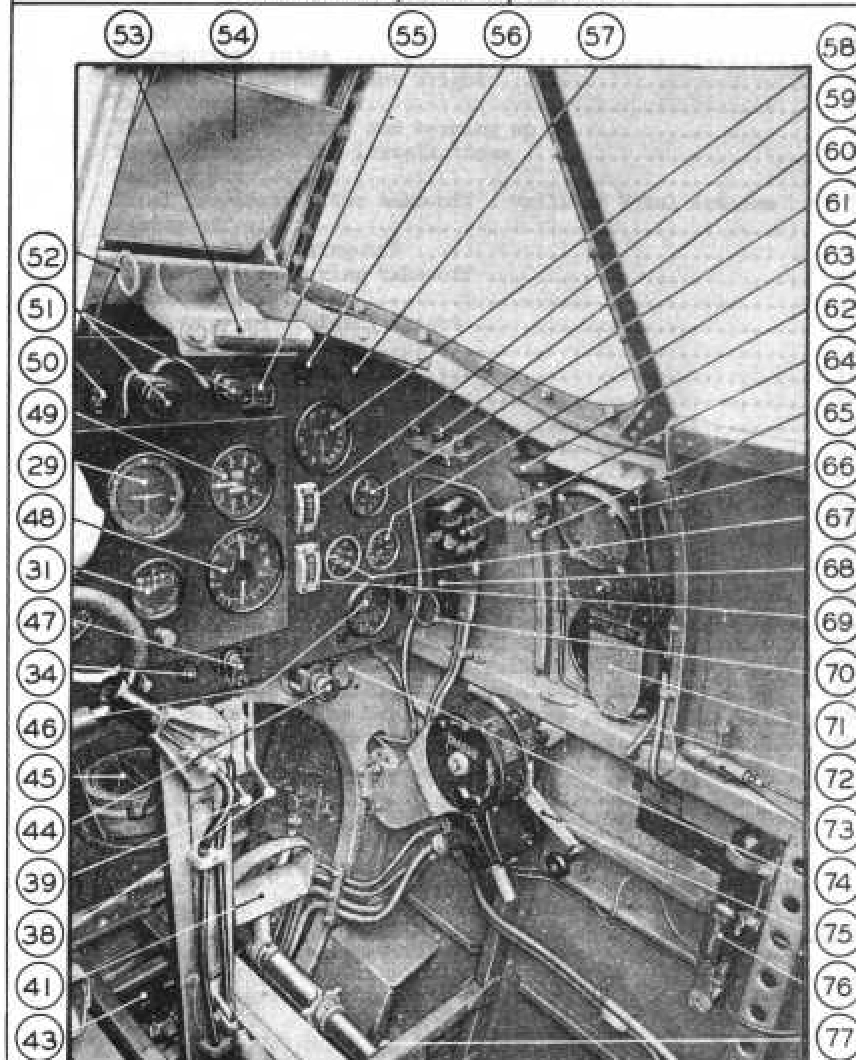

FIG. 2 STARBOARD SIDE OF COCKPIT FIG. 2

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 undcrcarriage 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.

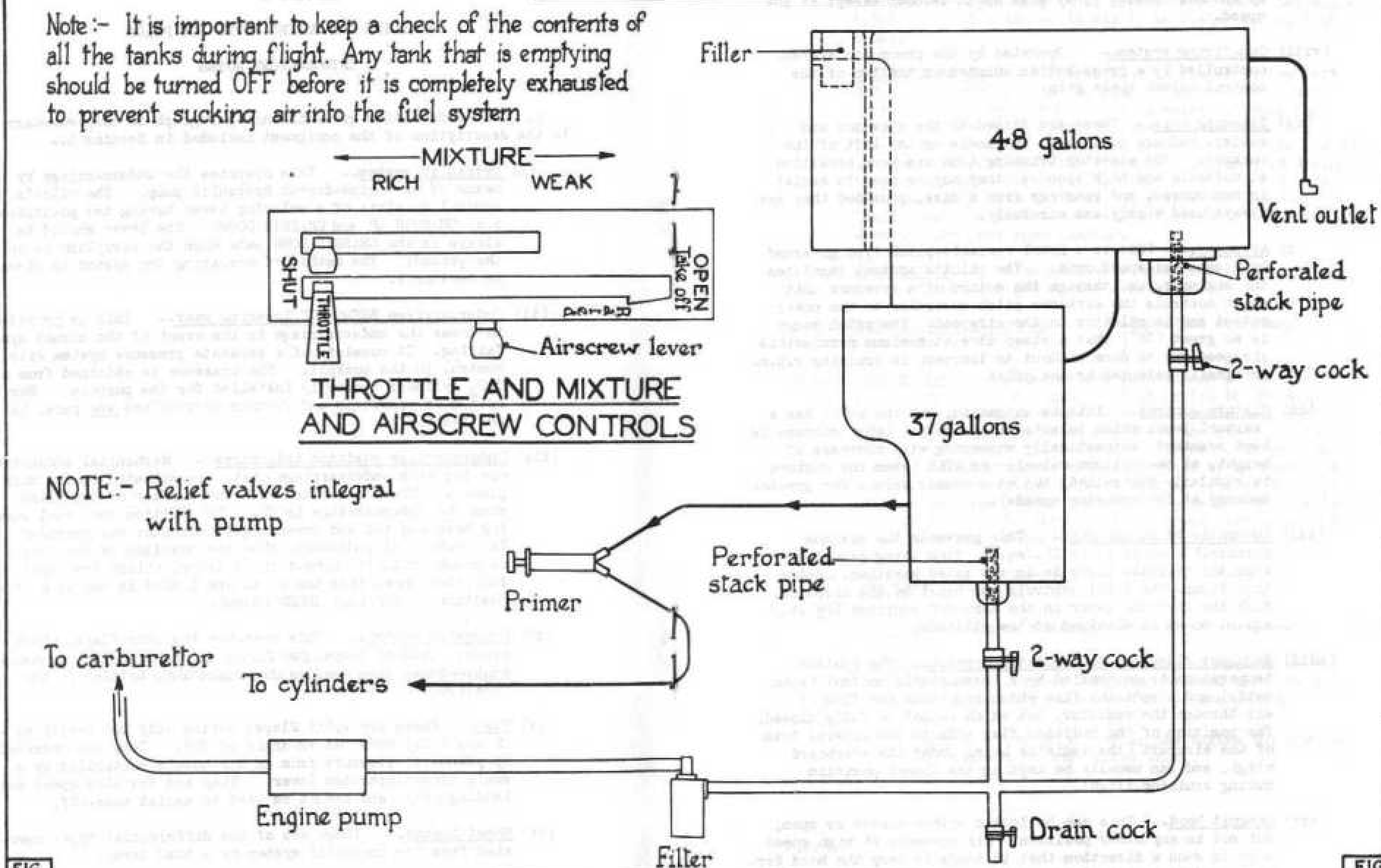

FIG. 1

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.

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(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 feel 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) Look 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.n. A.S.I.
30,000 ft.	-	125 m.p.h. A.S.I.
35,000 ft.	-	11C 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.

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(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

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.

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 - fully FINE (Lever fully forward)

and

(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 affectively, 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	8¼	m.p.h.
" 280	"	"	"	"	8¾	"
" 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 - 2,850 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 19,000 ft.

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