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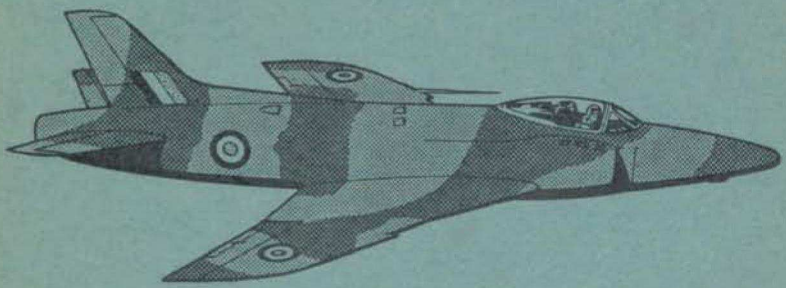
RESTRICTED

2nd Edition
April, 1959

A.P.4348E—P.N.

PILOT'S NOTES

SWIFT
F.R.5



Prepared by Direction
of the
Minister of Supply

W. Scott

Promulgated by Command
of the
Air Council

M. J. Dean.

RESTRICTED

NOTES TO USERS

These Notes are complementary to A.P. 129 (6th Edition) Flying, and it is assumed that all concerned have a thorough knowledge of the chapters of A.P.129 relevant to the operation of this type of aircraft. (See A.M.O. A293/55.) Additional copies may be obtained by the station publications officer by application on R.A.F. Form 294A, in quadruplicate, to Command Headquarters for onward transmission to A.P.F.S. (see A.P.113A). The number of this publication must be quoted in full—A.P.4348E–P.N. (2nd Edition).

Comments and suggestions should be forwarded to Officer Commanding, Handling Squadron, R.A.F., Boscombe Down, Wilts.

AMENDMENTS

Amendment lists will be issued as necessary and will be gummed for affixing to the inside front cover of these notes. Each amendment list will, where applicable, be accompanied by gummed slips for sticking in the appropriate places in the text. Each amendment list will give a list of all Special Flying Instructions and/or modifications which are covered thereby.

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

A.L. NO.	INITIALS	DATE	A.L. NO.	INITIALS	DATE
1	R.V.L	25/7/61	4		
2			5		
3			6		

LIST OF ASSOCIATED PUBLICATIONS

	A.P.
Aircraft operation and servicing under low temperature conditions	1441B
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Avon Mk. 114 aero engine	4321H & M
Cartridges, miscellaneous	1661F
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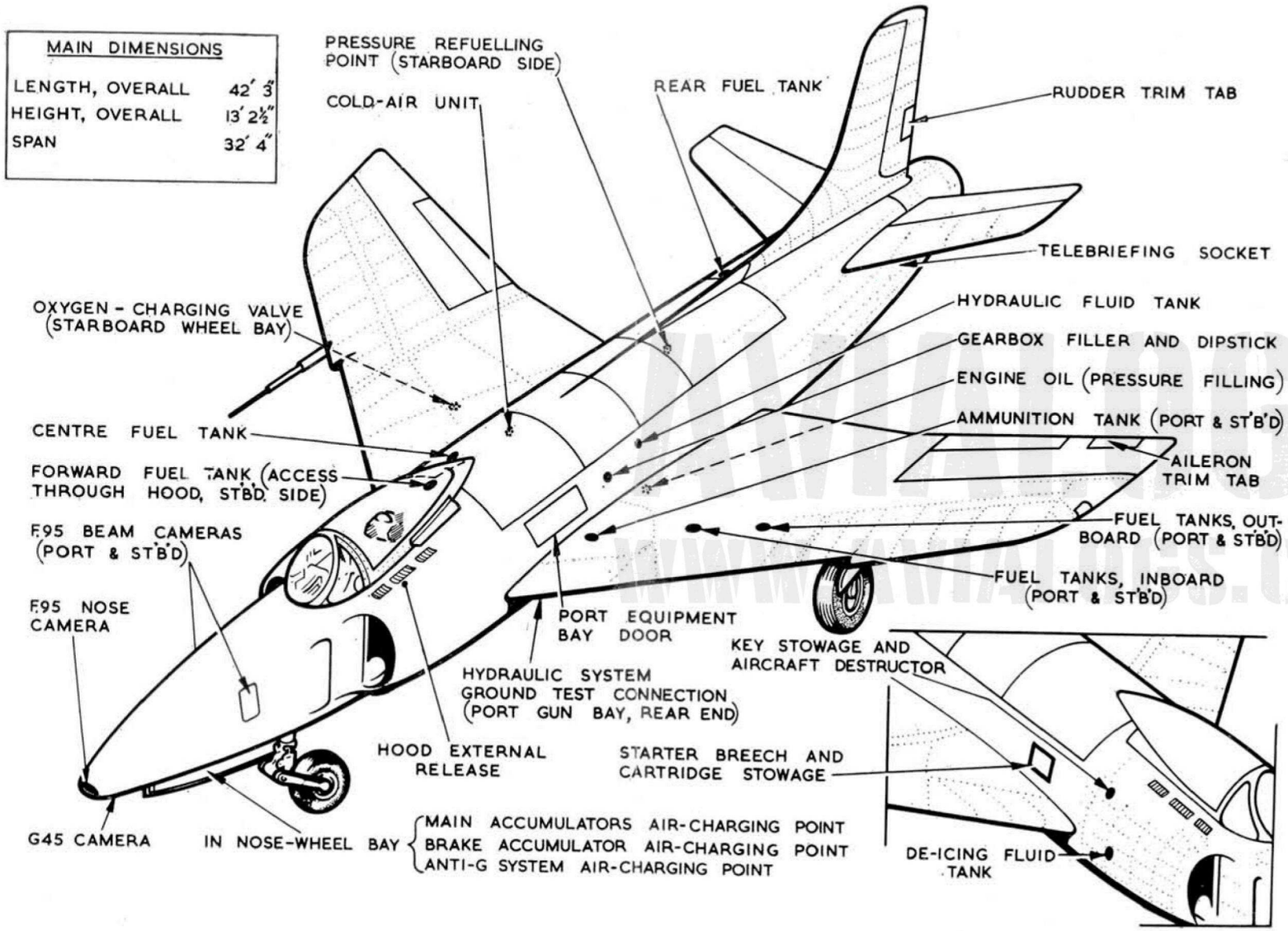


AIR MINISTRY
April, 1959

A.P.4348E—PN.
Pilot's Notes
Second Edition

SWIFT F.R.5

LIST OF CONTENTS

PART I

DESCRIPTIVE

NOTE.—Throughout this publication the following conventions apply:—

(a) Words in capital letters denote the actual markings on the controls concerned.

(b) Numbers quoted after items in the text refer to the illustrations in Part VII.

(c) Unless otherwise stated all airspeeds and mach numbers quoted are " Indicated."

1. Introduction

(a) The Swift F.R.5 is a single-seat, swept-wing fighter reconnaissance aircraft powered by a single Avon Mk. 114 axial-flow turbo-jet engine, with reheat. The engine develops 7,175 lb. (approx.) static thrust at sea level without reheat and 9,450 lb. (approx.) with reheat in use.

(b) The armament consists of two 30 mm. Aden guns and provision is made for the carriage of two beam oblique and one forward-facing oblique F.95 cameras. (See para. 51 (a).)

(c) The cockpit is pressurised and is equipped with a Mk. 2G fully automatic pilot-ejection seat. Access to the cockpit is via a special ladder supplied as ground equipment.

(d) Full-power ailerons and a power-assisted elevator are fitted, both with Manual reversion facilities.

FUEL SYSTEM

2. Fuel tanks and gauge

(a) Fuel is carried in five tanks, three in the fuselage and one in each wing. Incorporated in the centre fuselage tank

is a fuel recuperator, the contents of which are used only during inverted flight.

(b) A 220-gallon jettisonable belly tank is normally carried beneath the fuselage. The mechanical jettison handle (3) is on the port shelf.

(c) The tank capacities will vary slightly from aircraft to aircraft and according to whether the aircraft is pressure or open-line refuelled; the following should be taken as minimum capacities:—

	Gall.	*Wt. at 7.7 lb./gall.*
Front tank	112	862
Centre tank (excluding recuperator)	98	755
Rear tank	104	801
Wing tanks (2 × 96)	192	1,478
Total internal	506	3,896 lb.
Belly tank	220	1,694
Total all tanks	726	5,590 lb.

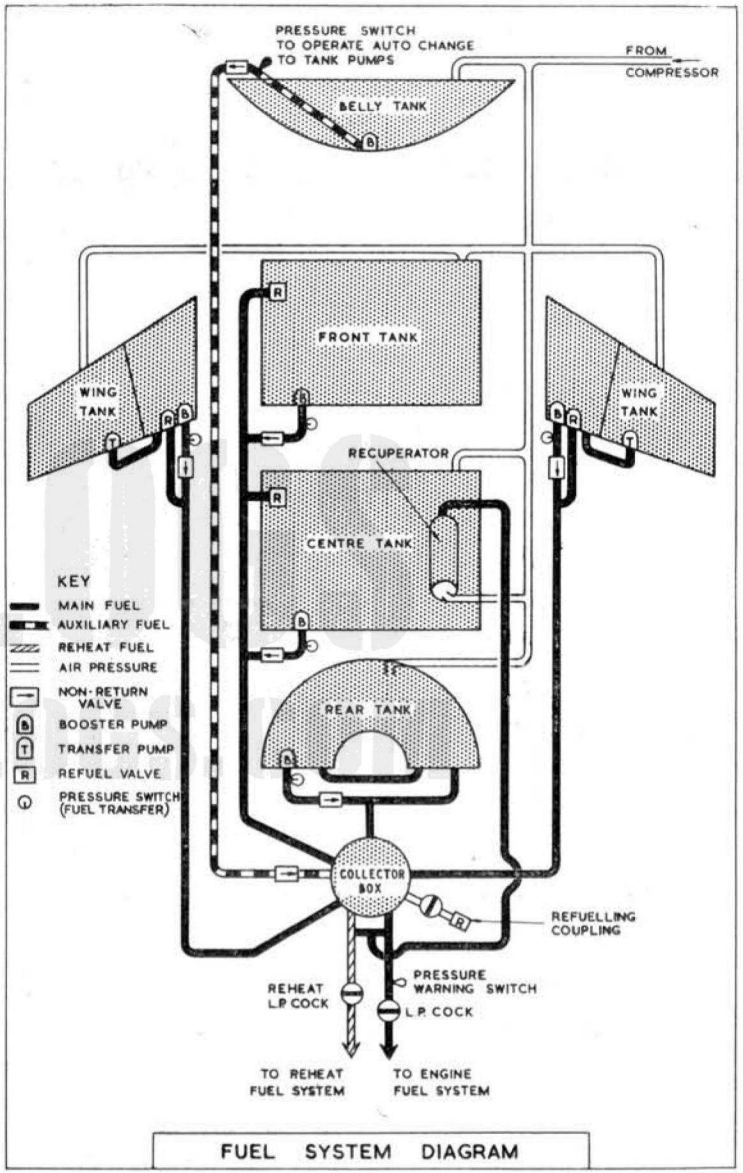
(d) A single contents gauge (60) on the starboard side of the instrument panel records the total contents, in pounds, of all internal tanks whenever electrical power is available.

3. Main fuel system

(a) Fuel from all tanks is fed under low pressure, by immersed booster-pumps, to a collector box and then to two pipe lines, one to the engine-driven H.P. fuel pumps and one to the reheat system through the reheat L.P. cock. (See paras. 5 and 12.)

(b) Fuel in the belly tank is automatically used first under normal conditions. When this tank is empty its booster-pump is automatically switched off by a float-operated switch and the internal tanks pumps are simultaneously switched on.

(c) For short periods of inverted flying, fuel is provided by the fuel recuperator in the centre tank. This is a flexible bag inside a cylindrical tank. When the aircraft is



FUEL SYSTEM DIAGRAM

inverted no pressure supply is available from the booster-pumps and the fuel from the recuperator is forced out by air pressure from the engine acting on the bag. When normal flight is resumed, the pressure from the booster-pumps is greater than the air pressure and the recuperator is automatically refilled.

(d) An air pressurising system tapped from the engine compressor, maintains a pressure of 3 lb./sq. in. in all tanks to prevent boiling and to assist in fuel transfer.

(e) A magnetic indicator (59) on the starboard instrument panel shows white if fuel delivery pressure from the collector box drops appreciably below normal.

(f) A panel of five magnetic indicators (58), one for each internal tank, is fitted beside the pressure indicator. Each indicator shows white only when fuel flow from its associated tank is below normal. A cancelling device ensures that the indicators do not show white when their associated tanks are empty. A magnetic indicator (63) below the starboard instrument panel shows white when fuel is not flowing from the belly tank.

4. **Fuel booster-pumps**

(a) Eight booster-pumps are fitted, one in each fuselage tank, two in each wing tank and one in the belly tank.

(b) Three switches control the booster-pumps. They are the FUEL MASTER ON/OFF switch (31), the two-position TAKE-OFF/NORMAL auto override switch (36) and the three-position AUTO-RETRIM switch at (61). Circuit breakers and test switches are in the starboard side of the equipment bay. Below generator cut-in speed the wing and rear tanks booster-pumps do not switch on.

(c) At all times when the engine is running, the fuel master switch should be ON and, unless manual fuel balancing is necessary, the balance switch should be at AUTO.

(d) When the belly tank is carried and the override switch is set to TAKE-OFF, the internal booster-pumps operate in the normal manner but the belly tank booster-pump is inoperative. When the switch is set to NORMAL, if the belly tank contains fuel and the fuel is transferring correctly, only the belly tank booster-pump remains in

operation. The other booster-pumps are inoperative until either a pressure switch (transfer rate below minimum) or a float switch (tank empty) operates to switch off the belly tank pump and to switch on the internal tanks pumps. Automatic balancing then commences.

NOTE.—When reheat is in use below 15,000 ft., with the switch at NORMAL all pumps are in operation. Above 15,000 ft. a barostat control switches off the internal pumps until the belly tank is empty.

(e) (i) When automatic fuel balancing is in operation, the fuel in the front and centre tank group is kept in balance with that of the rear and wing tank group, in order to keep the C.G. within reasonable limits. To achieve this balancing, a relay, working with the fuel contents amplifiers, varies the speed of operation, and thus the output, of the booster-pumps.

(ii) Two magnetic indicators (at 61) are alongside the AUTO-RETRIM switch, and provide nose or tail-heavy indications. The appropriate indicator shows white when such a state occurs and remains so until correct balance is again achieved.

(iii) If the automatic balancing system fails, it can be overriden by setting the retrim switch in the direction of the white indication to RETRIM as required. This causes an alternative feed to the booster-pump speed relays to be obtained.

5. **L.P. fuel cock controls**

(a) The engine L.P. cock (27) on the port shelf controls the flow of fuel from the collector box to the engine-driven H.P. pumps and throttle. It is moved forward to on and should never be used to stop the engine except in an emergency. This cock cannot be set to off without moving the reheat L.P. cock to off.

(b) The reheat L.P. cock (28) controls the flow of fuel to the reheat H.P. pump. The cock should normally be ON but may be set to off without affecting the normal engine fuel supply (see para. 11).

(c) Both L.P. cocks must be off before pressure refuelling is possible.

ENGINE CONTROLS

6. Avon 114 engine

(a) *General*

The engine is a 12-stage axial-flow gas turbine developing 7,175 lb. static thrust at sea level without reheat and 9,450 lb. with reheat. The main engine systems include:—

A cartridge starting system. (See para. 7.)

Relighting facilities. (See para. 8.)

A high pressure fuel and reheat system. (See paras. 10–12.)

Variable swirl vanes and air-bleed valves. (See para. 14.)

Self-contained oil system.

(b) *H.P. fuel pumps*

Two engine-driven pumps are housed in a single casing but separated from each other. A single overspeed governor controls the maximum speed of both pumps, and a single servo control system connects both pumps to the B.P.C. and A.C.U.

Page 12 Para. 6 (c) A.L.1

(c) *H.P. pump isolating valve*

(i) The isolating valve, introduced by mod. 526, is intended as a means of restoring power in flight in the event of a failure of the H.P. pumps servo system causing a sudden loss of power. (See para. 86 (a).)

(ii) The valve is controlled by an ON/OFF switch on the port instrument panel, below the triple pressure gauge. When the switch is set ON one H.P. pump is cut off from the servo system, which continues to control only the other H.P. pump. The isolated pump moves to full stroke and is controlled only by its overspeed governor.

(d) *H.P. fuel cock control*

(i) The H.P. fuel cock lever (2) on the port shelf controls the fuel flow to the pressurising valve and burners. It should be moved down (off) to stop the engine. A catch on the control holds it in the open position.

(ii) A relight pushbutton is on the inboard side of the H.P. cock lever.

(e) *Oil system*

Oil is carried in the engine sump, the capacity of which is 17 pints. One pressure and four scavenge pumps maintain a continuous circulation through a cooler and filter to the engine bearings and gears. An oil pressure gauge is on the starboard side of the instrument panel.

7. Engine starting system

(a) Starting is by a triple-breech turbo-starter, using one cartridge for each start.

(b) (i) The STARTER MASTER switch (33) completes the circuit to the STARTER button (see para. 17 (a)). When the starter button is pressed, with the IGNITION switch (32) on, the circuit to the igniter plugs is completed. Both the master and ignition switches should be on for starting and at all times when the engine is running.

(ii) When Mod. 571 is incorporated a circuit breaker is introduced into the ignition circuit and is fitted aft of the L.P. cocks. It must be closed for starting and at all times when the engine is running.

(c) When the guarded STARTER button (65) is pressed it is held in the depressed position by a solenoid and the automatic starting cycle is then initiated, the cartridge firing over a period of 2–3 seconds. The engine should accelerate up to normal idling r.p.m. of 2,750 ± 100 in approximately 30 seconds.

8. Relighting pushbutton

The igniter plugs are used to relight the engine in flight, by pressing the relight button on the inboard side of the H.P. cock with the ignition switch on.

9. Throttle control

(a) The throttle lever (21) moves in a quadrant which incorporates a reheat gate forward of the normal full throttle position.

(b) Incorporated in the throttle handle is the GGS manual ranging twist-grip, together with the flaps inching switch and press-to-transmit button.

10. **Reheat system**

(a) The purpose of the system is to augment engine thrust by burning injected fuel in the jet-pipe. The temperature of the exhaust gases and hence their efflux speed from the jet-pipe nozzle is thereby increased, giving added thrust.

(b) When reheat is selected (see para. 12), the reheat igniter is energised for about 30 seconds and simultaneously causes solenoids to open two cocks. One cock permits fuel from the engine H.P. system to flow to a reheat pilot burner where it is lit by the igniter; the other cock allows air from the engine compressor to start up the reheat pump. As fuel pressure from the reheat pump builds up a pressure switch energises a solenoid to open the reheat H.P. fuel cock allowing fuel to pass to the main reheat burner where it is ignited by the pilot burner flame.

(c) The pressure switch also energises a second solenoid on the jet-pipe nozzle control valve. Air from the compressor then operates four ram jacks which open the jet pipe " eyelids " thereby increasing the final nozzle area.

(d) After about 30 seconds a time switch operates to cut off current to the reheat igniter.

(e) With reheat in use, total fuel consumption at all altitudes is about 2½ times that of normal full throttle conditions. The increase in sea level static thrust is about 30%. In flight the thrust increase is about 50%, increasing to about 60% at 40,000 ft. The total effect is to increase specific fuel consumption by about 70%.

11. **Reheat controls and indicators**

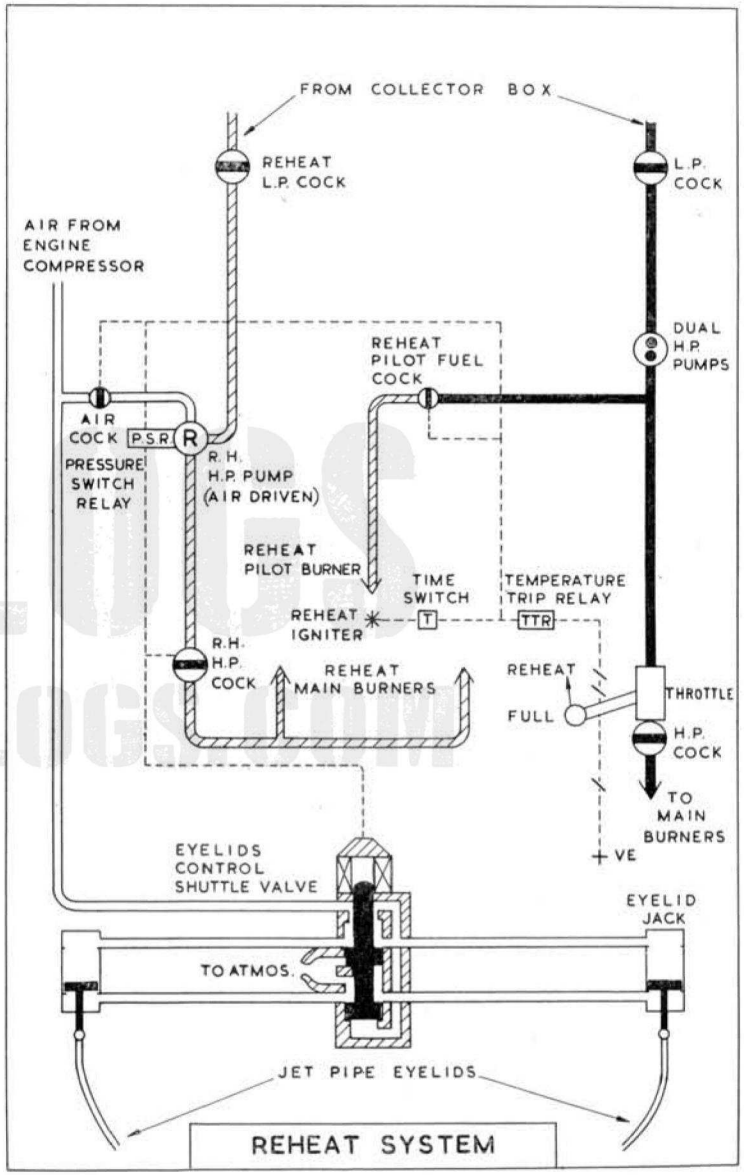
(a) *Controls*

These consist of:—

(i) The reheat L.P. cock (28) which controls the flow of fuel to the reheat pump.

(ii) A REHEAT SHUT-OFF SWITCH (47) which acts as a master switch and which must be at NORMAL at all times when reheat is in use. Reheat cannot be brought into use with the switch in the SHUT-OFF position.

(iii) The throttle lever which, when moved into the reheat gate, closes a second switch to complete the reheat electrical circuit.



(b) *Indicators*

These consist of:—

(i) A jet-pipe eyelid magnetic indicator (43) which shows black if the eyelids are in the correct position for the particular running condition selected and white while the eyelids are changing position, or if they are in the wrong position.

(ii) An amber warning light (48) which comes on if the temperature in the space between the jet pipe and its outer casing in zone 3 exceeds 300 ± 30°C. (See para. 13.)

(iii) An AIR EXTRACT magnetic indicator (49) which shows white if a breakdown occurs in the air extraction system for the space between the jet pipe outer casing and the fuselage skin in zone 4 (see para. 13). It also shows white momentarily when selecting undercarriage up or down.

12. **Operation of the reheat system (see para. 62)**

(a) Reheat is selected by moving the throttle into the reheat gate with the shut-off switch at NORMAL, and the reheat L.P. cock open. Light-up should occur within 2–5 seconds of selection, depending on altitude. During this period and for 2–3 seconds after light-up the jet-pipe " eyelids " position indicator will show white.

(b) The throttle position at which the throttle-operated reheat switch is closed is always the same, but minimum r.p.m. obtainable, once reheat has been engaged, vary from about 7,300 at sea level to 7,800 at 45,000 ft. R.p.m. with reheat in use may be varied by throttle movement but should not be allowed to fall below 7,600.

(c) Reheat is cancelled by pulling the throttle out of the reheat gate and throttling back. At the lower altitudes to avoid falling below 7,600 r.p.m. it will be necessary to cancel reheat by pulling the throttle out of the gate and then operating the shut-off switch.

(d) Reheat can be cancelled by operating the shut-off switch *without* pulling the throttle out of the gate, but should the switch be set back to NORMAL with the throttle still in the gate, the reheat will relight.

(e) A reheat top temperature limiter automatically cancels reheat and closes the eyelids if the j.p.t. exceeds 728° ± 10°C. In this event the nozzle position indicator *shows white* until the throttle is pulled out of the gate. When mod 739 is embodied a NORMAL/OVERRIDE switch is fitted to the port side of the instrument panel. When the switch is set to NORMAL the limiter is in operation; when set to OVERRIDE the limiter is inoperative. This position should be selected at take-off.

13. **Fire-extinguishers and fuselage ventilation**

(a) Two independent fire-extinguisher systems are fitted and may be operated by combined warning light/press switches (45) (46) on the port quarter panel. The outboard warning light/press switch is for zones 1 and 2, which are the compressor and flame tube zones respectively; the inboard switch is for zone 4, which is the rear fuselage. The bulbs may be tested by pulling the switches out.

(b) Zone 3 comprises the turbine and exhaust cone regions of the engine, also the interspace between the inner and outer jet-pipe skins, via which the ventilating air for this zone is exhausted. This zone is fire-protected by stainless steel but should high temperatures occur due to a gas leak or a break-down in ventilation the HOT GAS amber warning light (48) will come on.

(c) All three warning lights are controlled by resetting flame switches, *i.e.*, indication that a dangerous condition no longer exists is given by the warning light going out when the circuit is broken as the flame switches cool.

(d) The crash-operated inertia switch automatically discharges the contents of both bottles in the event of a crash, irrespective of the position of the battery isolating switch.

(e) To assist in cooling zone 4 on the ground, air from the seventh stage of the engine compressor is blown through the zone 4 extractor. The valve controlling this air is operated by the undercarriage selector and the position of the valve is shown by the magnetic indicator (49), on the port quarter panel, labelled AIR EXTRACT. The indicator will show white if the valve is in the wrong position relative to the selected undercarriage position. Overheating will occur if the indicator shows white on the ground.

14. **Variable incidence swirl vanes and air-bleed valves**

(a) The first row of stator blades in the engine compressor consists of variable incidence inlet swirl vanes which assist in imparting swirl to the incoming air. At r.p.m. below 6,200 the first stages of the compressor deliver more air than is acceptable to the later stages. To prevent instability of flow, *i.e.*, surge, the surplus air is bled off through air-bleed valves and the swirl vanes are held in the maximum swirl position. When the normal flight r.p.m. are reached, the air-bleed valves are closed and the swirl vanes move progressively to the minimum swirl position which occurs at 7,200 r.p.m.

(b) No noticeable change in r.p.m. or thrust occurs when the air-bleeds change over, nor do the swirl vanes have any noticeable effect on engine operation. However, until the swirl vanes reach the minimum swirl position at about 7,200 r.p.m. the compressor is not operating at maximum efficiency.

15. **Engine instruments and anti-icing control**

(a) The tachometer, jet pipe temperature gauge and oil pressure gauge are grouped on the starboard side of the instrument panel.

(b) *Anti-icing control*

NOTE.—Use of this system is at present prohibited.

The on/off switch (11) for the automatic anti-icing system is on the port wall. When set to on, hot air is bled from the engine and fed to the engine intakes. The system is intended only for icing prevention and is *not* intended for de-icing purposes.

ELECTRICAL SYSTEM

16. **D.C. supply**

(a) Two 6,000-watt engine-driven generators supply the whole of the electrical system and charge a single 24-volt aircraft battery. Two red lights (55), one for each generator, on the upper starboard coaming, come on when their respective generator is not supplying power. Generator cut-in speed is approximately 1,600 r.p.m.

(b) Control of the battery is effected by a battery isolating switch (30) on the starter panel. If a crash occurs, an inertia switch de-energises the battery isolating relay and automatically isolates the battery and at the same time energises the generator field isolation relay which de-energises the field circuits of both generators. (See para. 13 (d).)

(c) The ground supply plug is on a recessed panel covered by a removable door under the port wing fillet. This supply point is for testing and servicing, but if an external ground battery is used for starting, the battery isolation switch should be set to ON before the ground supply is disconnected.

17. **A.C. supply (Pre-mod. 607)**

(a) A.C. for the Mk. 4F compass, the artificial horizon and reheat top temperature limiter is supplied by two inverters. No. 1 inverter, controlled by the starter master switch, normally supplies the flight instruments and top temperature limiter. No. 2 inverter, controlled by the ignition switch, acts as a standby to No. 1 inverter.

(b) If No. 1 inverter fails, automatic change-over to No. 2 inverter occurs.

(c) Circuit breakers for No. 1 and No. 2 inverter supplies are in the port and starboard sides of the nosewheel bay respectively, together with an indicator which shows white if inverter change-over has occurred during flight. None of these is accessible in flight.

(d) The A.C. supply for the guns is automatically supplied by a third inverter.

18. **A.C. supply (Post-mod. 607)**

(a) When mod. 607 is embodied, separate switches are provided for the inverters together with a change-over magnetic indicator (38). The magnetic indicator is situated on the port instrument panel, the FLIGHT INSTRUMENTS EARLY START switch adjacent to the starter button on the centre instrument panel and the INVERTER RESET switch on the starboard shelf aft of the D.M.E. control panel.

(b) Before starting, when the EARLY START switch is set ON, No. 2 inverter starts up and supplies A.C. The magnetic indicator shows white. When the engine is started, auto-changeover to No. 1 inverter occurs when engine r.p.m. are at ground idling; the magnetic indicator changes to black.

(c) If, during taxying, the magnetic indicator changes to white again it shows that auto-change back to No. 2 inverter has occurred. If this occurs the INVERTER RESET switch should be held momentarily to OFF, when a black indication should be restored. If the indicator remains white, it is an indication that No. 1 inverter has failed and No. 2 only will be operative.

(d) After take-off, when the nose-wheel door is retracted, an override relay ensures an alternative supply circuit so that, even if the EARLY START switch is inadvertently knocked OFF during flight, continuity of supply to No. 2 inverter will be available. If No. 1 inverter fails in flight, auto-changeover to No. 2 occurs and the magnetic indicator shows white.

(e) A No. 1 INVERTER GROUND TEST switch is located in the port side of the nosewheel bay and is for servicing purposes only.

19. **Warning indicators**

The following table lists the various warning lights and indicators in the cockpit:—

Service	Indication	Function
Fire warning	2 red lights (45) (46)	Give warning when temperature in engine bay or jet pipe zone exceeds 300 ± 30°C.
Hot gas warning	1 amber light (48)	Gives warning when temperature in zone 3 exceeds 300 ± 30°C.
Reheat nozzle position	1 white magnetic indicator (43)	Indicates nozzle position incorrect for throttle setting.
Air extraction failure	1 white magnetic indicator (49)	Indicates that air extraction valve is in wrong position relative to selected undercarriage position

Service	Indication	Function
Fuel balance warning	2 white magnetic indicators (61)	Give warning of " nose-heavy " or " tail-heavy " conditions when energized by out-of-trim coil in balance relay
Fuel pressure warning	1 white magnetic indicator (59)	Gives warning when the fuel pressure falls below a safe limit
Fuel flow failure warning	5 white magnetic indicators (58)	Each gives warning that transfer is unsatisfactory from its associated tank
Belly tank transfer warning	1 white magnetic indicator (63)	Indicates that fuel has ceased to flow from the belly tank
Generator warning	2 red lights (55)	Gives warning of electrical power failure from one of following causes:— (1) Cut-out not closed. (2) A fault in either generator, i.e. field circuit-breaker open or main fuse blown
Undercarriage position	3 red or green lights (42)	Indicate position of each u/c unit separately. No light—leg up and locked. Red light—leg unlocked and out of safety. Green light—leg down and locked.
Undercarriage	1 red light (centre light on position indicator) (42)	Gives warning when u/c is up and throttle less than quarter open
Power controls	2 green lights (35) (62)	Indicate associated control surfaces in Power.
Power controls warning	1 flashing red light (52)	Indicates when any control surface not correctly engaged in Power
Cockpit pressure warning	1 white light (53)	Gives warning that pressure differential is below minimum
F.95 cameras	3 green lights (one for each camera) (56)	Out—Shutters closed. Dim—Shutters open. Flashing—Cameras operating
Inverter changeover	1 magnetic indicator (38)	Indicates No. 2 inverter in use

HYDRAULIC SYSTEM

20. General

(a) Two engine-driven hydraulic pumps maintain a live-line pressure of 3,150 ± 150 lb./sq. in. for the normal operation of the:—

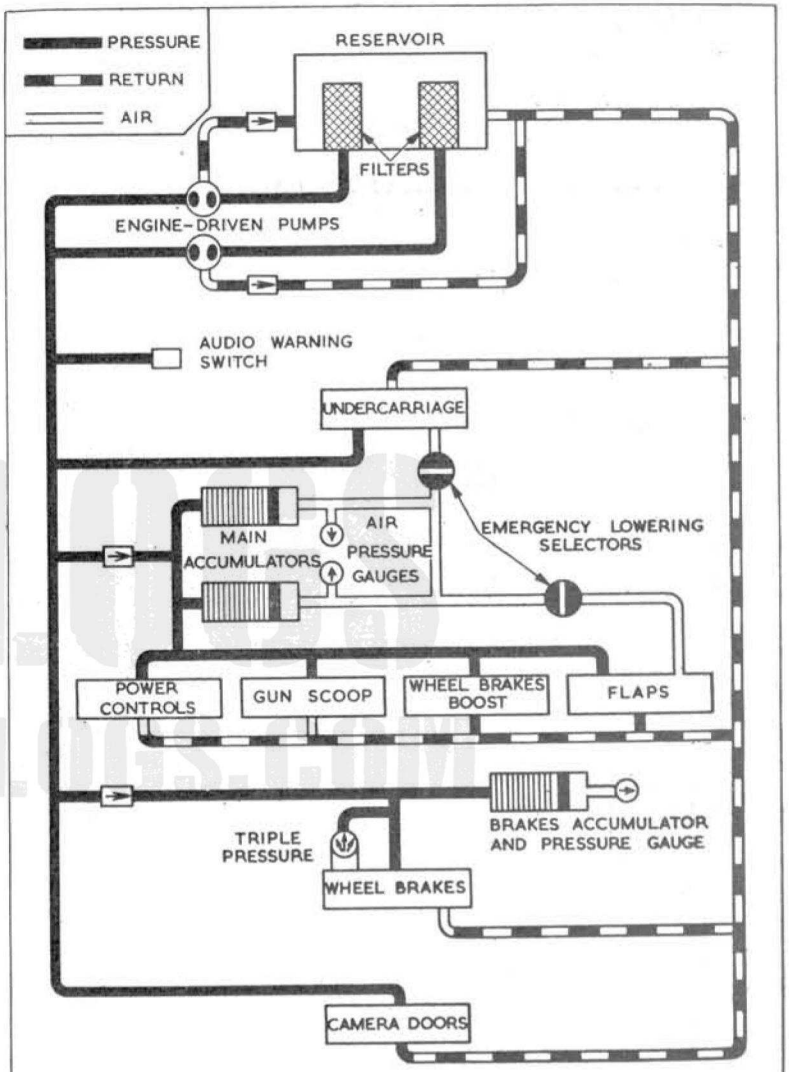
Undercarriage
Wheel brakes
Flaps
Gun-bay scavenging flap
Aileron and elevator hydroboosters
F.95 camera window shutters.

(b) Three hydraulic accumulators are fitted in the circuit to provide a reserve of power in emergency. The *hydraulic fluid* side of the two main accumulators is connected to the flaps, gun-bay scavenging flap, wheel brake override and elevator and aileron hydrobooster circuits. The *air pressure* side of the main accumulators is connected to the undercarriage and flaps emergency systems. The hydraulic fluid side of the third accumulator is connected to the wheel brake circuit.

(c) The main accumulators pressure gauges (9) (10) are on the cockpit port wall. They should both read 2,150 lb./sq. in. (air pressure) when the engine is not running and hydraulic pressure is exhausted. With the engine running, the pressure should build up to 3,150 ± 150 lb./sq. in. A third pressure gauge for the brakes accumulator is in the nosewheel bay. This accumulator is charged initially to an air pressure of 1,750 lb./sq. in.

(d) A triple pressure gauge (24) is on the port side of the instrument panel. It records the pressure available for braking and the pressure applied at each wheel brake. (See para. 25 (c).)

(e) An indication that failure of the live-line system has occurred is given by an intermittent audio-warning over the pilot's headset. Its purpose is to indicate immediately to the pilot that failure has occurred and that due to the limited accumulator capacity, the power controls hydroboosters will only be available for a limited period. The pilot will then be able to reduce speed if necessary before reverting to Manual control. Automatic reversion to Manual control will in any case occur when the accumu-



SIMPLIFIED HYDRAULIC SYSTEM

lators are exhausted. (See para. 30.) A TEST-ON-OFF switch (85) on the starboard console enables the warning to be switched off once indication has been given. The OFF position is wired and force will be necessary to push the switch to that position. With the weight of the aircraft on the undercarriage the warning system is inoperative. If the system is to be checked on the ground the switch should be set to TEST with the R/T on.

21. **Undercarriage control and position indicator**

(a) The undercarriage is operated hydraulically after electrical selection by either the UP or DOWN pushbutton (41) on the port side of the instrument panel.

(b) A standard indicator (42) is on the inboard side of the undercarriage selector buttons. The nosewheel light shows red if the throttle is less than quarter open when the undercarriage is up.

22. **Undercarriage emergency operation**

(a) If electric or hydraulic failure occurs, the undercarriage may be lowered irrespective of the position of the normal selector button by pressing the emergency pushbutton (5) on the port shelf. This releases the air trapped in the main hydraulic accumulators, which in turn releases the "up" locks and applies pneumatic pressure to the jack pistons of the undercarriage units.

(b) If it is required to retract the undercarriage on the ground, the "up" selector button should be rotated clockwise and then pressed. It must never be so used when the aircraft is airborne otherwise damage may be caused to the wings.

23. **Flaps/airbrakes control and position indicator**

(a) The split trailing edge flaps, which also act as airbrakes, are selected electrically and operated hydraulically. They may be selected down at any speed but the amount to which they will lower depends upon the air loads. If speed is increased with the flaps extended, the air loads will reduce the flap angle.

(b) Control of the flaps is by an inching switch on the throttle lever in conjunction with a limit setting switch (22) on the instrument panel. Rearward movement of the inching switch lowers the flaps, forward movement raises them. When the inching switch is released it returns to the central (off) position and flap movement is arrested.

(c) The limit setting switch may be set to either:—

(1) TAKE-OFF AND AIRBRAKES

or

(2) LANDING.

When set to (1) the limit to which the flaps may be lowered is 35°. When set to (2) the limit is increased to 50° (fully down).

(d) The use of flaps for airbraking is restricted to 35° to avoid slight directional snaking which might occur if larger flap angles were selected.

(e) A position indicator (23) is situated adjacent to the limit setting switch.

24. **Flaps/airbrakes emergency operation**

(a) If the live-line pressure fails, the flaps may be lowered, raised and re-lowered by the hydraulic pressure of the two main accumulators, after normal selection, providing no other hydraulically-operated system is used, *e.g.*, powered controls.

(b) If no hydraulic pressure is available the flaps may be lowered *fully down* only, irrespective of the position of the limit switch, by pressing the emergency button (4) on the port shelf.

25. **Wheel brakes control**

(a) The maxaret wheel brakes are operated hydraulically by means of a lever (71) on the control column and a differential relay controlled by the rudder pedals. When the brakes are applied, the maxaret units automatically prevent the wheels locking irrespective of the rate of deceleration and type of landing surface in use. For maximum braking the brakes should be applied fully and the maxaret units allowed to vary the pressure as necessary. Normally the maxaret units should not be

allowed to operate (indicated by violent oscillation of the triple pressure gauge needles) as this leads to excessive brake wear.

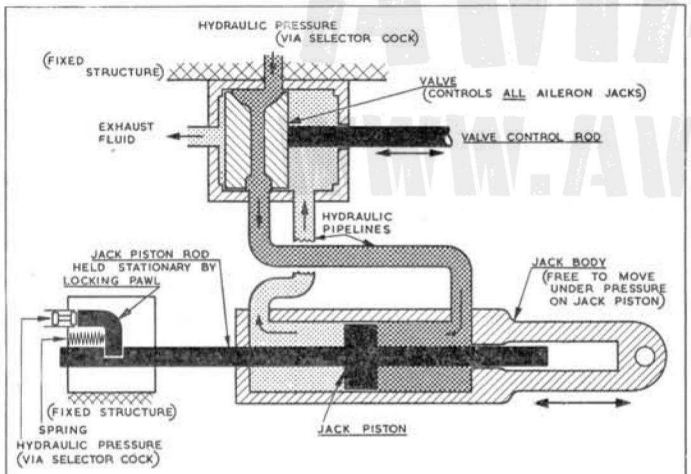
(b) The available hydraulic pressure (3,150 ± 150 lb./sq. in.) is shown on the triple pressure gauge (24) together with the pressure at each wheel brake (1,750 lb./sq. in. max.).

(c) When the boost switch (39) on the instrument panel is placed up to ON the entire hydraulic pressure is made available at the wheel brakes, the operation by-passing the differential relay valve and reducing valve. The pressure at each wheel will not in this case be shown on the triple pressure gauge. Use of this control enables full reheat power to be used without brakes slipping.

POWERED FLYING CONTROLS AND VARIABLE INCIDENCE TAILPLANE

26. Flying controls—general

The ailerons and elevator are power-operated, the power being supplied by hydraulic oil under pressure from the

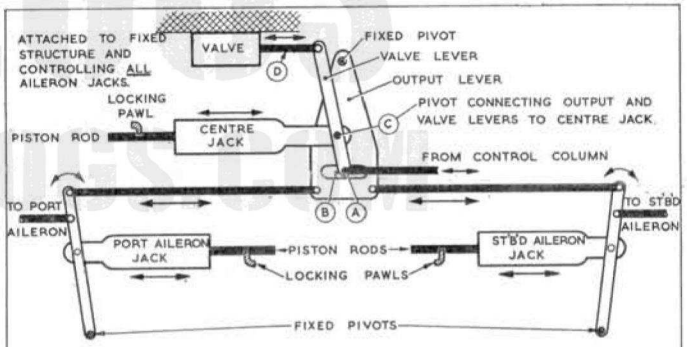


DETAIL OF AILERON BOOSTER JACK
(ELEVATOR JACK SIMILAR, EXCEPT VALVE IS ATTACHED TO JACK BODY)

aircraft hydraulic system, through two manual selector cocks under the control of the pilot. Four hydroboosters each consisting of a jack body and piston rod are fitted, three in the aileron circuit and one in the elevator circuit. Two hydraulic valves are provided, one controlling the three aileron boosters and the other controlling the elevator booster.

27. Aileron power circuit

In the aileron circuit the centre booster of the three operates an output lever which is connected to two aileron control rods. The other two boosters are situated, one adjacent to each control surface and connected through a linkage to the respective control rod. When hydraulic power is available, movement of the control column, through a linkage, opens the aileron control valve which admits pressure oil to one side of all three booster jack pistons and at the same time opens the other sides to return. All three booster piston rods are anchored to the aircraft structure by means of spring-

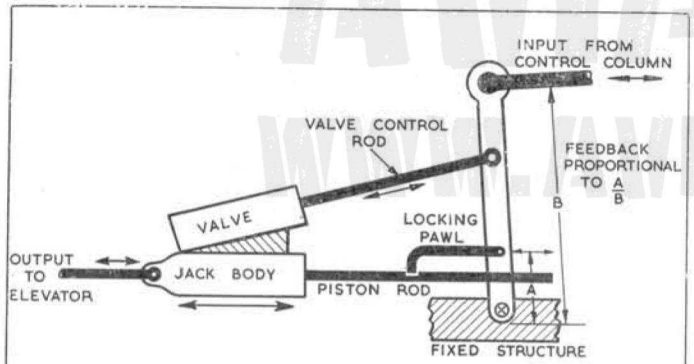


SIMPLIFIED AILERON POWER CIRCUIT

loaded hydraulically-operated pawls. When the pawls are in position and hydraulic pressure is fed from the valve to the jacks, the jack bodies move relative to the pistons and deflect the control surfaces and the output lever. When control column movement ceases, the centre booster closes the control valve which stops oil flowing to the boosters causing simultaneously in each a hydraulic lock which prohibits further movement of the jack bodies and control surfaces.

28. **Elevator power circuit**

In the elevator circuit the single booster operates in a similar manner to the aileron boosters, the main differences being that the control valve is attached to the booster jack body and the piston rod locking pawl is attached to the control circuit. (See para. 34.) The opening of the valve is achieved by a rod attached to the control column linkage and the closing of the valve is achieved after the valve control rod stops moving, by the further movement of the jack body, until the valve is completely closed, when the hydraulic lock occurs.



SIMPLIFIED ELEVATOR POWER CIRCUIT

29. **Ailerons and elevator in Manual**

(a) Manual operation of the controls may be selected deliberately by the controls in the cockpit (see para. 31) or will happen automatically if hydraulic failure occurs.

(b) Aileron control surface movement in Manual is achieved by the control column moving the output lever and thus the control rods.

(c) Elevator control surface movement in Manual is achieved by pushing the valve control rod against its stop and then pushing manually the valve and jack body to obtain elevator movement.

(d) The controls are heavy in Manual, but to avoid excessively high stick forces the locking pawls automatically disengage, under the pressure of their springs, to release the anchored jack piston rods, allowing them to slide freely with movement of the jack bodies.

30. **Hydraulic power reserve**

Two accumulators are fitted in the power controls circuits to provide a reserve of power if the main supply fails. This reserve may be sufficient for several cycles of aileron and elevator movement before the controls revert automatically to Manual. Even if no control movement is made, accumulator pressure will not be maintained for a long period due to seepage through the hydraulic components. Certain hydraulic pipe failures can cause immediate reversion to Manual.

31. **Controls and indicators**

(a) *Ailerons*

Hydraulic pressure to the aileron hydroboosters is selected by pushing in the AILeron POWER on/off selector (34) below the port side of the instrument panel. It is pulled out to select Power off.

(b) *Elevator*

A similar control (64) ELevator POWER on/off is fitted below the starboard side of the instrument panel for hydraulic selection to the elevator hydrobooster.

(c) *Power controls engagement warning*

(i) Two green lights (35) and (62) on the instrument panel near their respective selectors come on when their associated boosters are correctly engaged in Power.

(ii) A red warning light (52) in the centre of the instrument panel flashes if any one of the boosters is not correctly engaged in Power, once power has been selected.

(d) *Hydraulic failure warning*

An audio warning over the pilot's headset, providing the R/T is on, provides indication that the hydraulic system is losing pressure. It sounds when line pressure has fallen to below 2,150 lb./sq. in.

32. **Engaging powered controls**

(a) When Power is initially engaged on the ground it is possible that the locking pawls will not be opposite their slots in the piston rods. The hydraulic pressure acting on the pawls will cause them to clamp on the rods, giving a false lock, or anchorage, which will slip when moderate jack loads are imposed. Although the feel on the control column will be one of apparent Power, the red warning light will flash and full control column travel will not be obtainable.

(b) The pawls may be correctly engaged in their slots by exercising force on the stick in the direction of restricted travel to overcome the friction of the pawl clamping on the rod. Easier engagement is obtained with the aileron gear selector set to POWER. (See para. 33 (c).)

(c) In the air the pawls will normally engage immediately on selection, but should they fail to do so the instructions in (b) above should be carried out.

(d) When all pawls are correctly engaged the control column can be moved freely in all directions and will be felt to come up against positive stops at the extremes of its movements. The red light will go out and the green lights will then come on.

33. **Aileron feel and trim**

(a) On the ailerons, the piston rod is anchored to the aircraft structure, the air loads are resisted entirely by the hydraulic jack effort and no load is fed back to the control column. To provide control feel, a spring is fitted in the control circuit and gives an artificial stick force which is proportional to aileron deflection but not to airspeed. A small handwheel (72), mounted on the control column, is provided for adjustment to lateral trim when flying in Power.

(b) A trim tab is fitted on the port aileron for use in Manual only. It has no effect on lateral trim when the ailerons are in Power, but should it have been offset and Manual reversion takes place, its effect will be immediate. A trim control switch (6), which operates in the natural sense, is on the port shelf, aft of the throttle quadrant. The trim position indicator (17) is adjacent.

(c) When mod. 395 is embodied the control column/aileron gearing can be adjusted by means of a lever on the right of the control column. Two positions, POWER and MANUAL, can be selected. For the same stick movement aileron travel with MANUAL selected is approximately half of that obtained with POWER selected.

34. **Elevator feel and trim**

(a) On the elevator the piston rod is anchored to the control circuit itself, so that approximately 1/15th of the air loads on the control surface are fed back to the stick, and changes of air load on the elevator will be felt by the pilot as changes of stick force thus providing a measure of control feel.

(b) (i) The variable incidence tailplane is provided to trim out the changes of stick force with speed. After selecting by feel the required tailplane angle to give zero stick force for a given flight condition, the elevator is trailing with no air load imposed on it.

(ii) The tailplane is operated by two electric motors controlled normally by a spring-loaded three-position switch (69) on the control column handgrip. A speed control switch (8) on the port shelf is provided for FAST or SLOW operation. When set to FAST the tailplane is operated by both motors; when set to SLOW only one motor (the port) operates and tailplane movement is about the half the fast rate.

(iii) A DUPLICATE SLOW CONTROL switch (16) on the port shelf can be used to operate the tailplane

on the starboard motor only, regardless of the setting of the FAST/SLOW switch. When the duplicate switch is in use the control column switch is inoperative.

(iv) If any fault develops in the control column switch leading to a " runaway " tailplane, the switch may be isolated by means of the MAIN TRIM ISOLATION switch (15) on the port shelf and trimming achieved by means of the DUPLICATE SLOW CONTROL.

(v) A.T.P. INCIDENCE PRESELECTOR lever (29) inboard of the throttle, when set forward, permits operation of the tail within a +4° to —4° range. When set aft the negative limit is increased to —9°. The lever must only be moved to the —9° position when the tail is clear of the —4° limit stop. Conversely the lever must not be moved to the forward position when the tail is between —9° and —4°.

(vi) A tailplane incidence indicator (20), which is combined with the cockpit temperature indicator, is on the port shelf.

GENERAL EQUIPMENT AND CONTROLS

35. Flying controls locking gear

Detachable locks are provided for the internal locking of the flying controls. A stowage is provided at the aft end of the port wall. No external locks are provided.

36. Rudder pedals adjustment and rudder trimmer

(a) The rudder parallel-motion pedals are adjustable for leg reach by pulling up a handle (93) on the starboard shelf and allowing the pedals to move aft under the action of a spring, or forward by pushing against the spring. Releasing the handle holds the pedals in the desired position.

(b) The rudder trim tab is operated electrically by a switch (1) on the port shelf aft of the throttle quadrant. The switch works in the natural sense.

(c) The trim position indicator (17), which is combined with the aileron trim position indicator, is on the port shelf.

37. Hood operation

(a) The hood is opened or closed electrically by means of a three-position OPEN-off-SHUT switch (18) under the port coaming, provided that the clutch is engaged. The clutch is operated by a knob (86) on the starboard coaming; when this control is set to FREE the hood can be moved by hand.

(b) The hood seal is inflated automatically when the hood is fully closed with the switch at OFF or SHUT, provided that the clutch control is set to ENGAGED.

38. Hood jettisoning

(a) The hood may be jettisoned by pulling the control handle (40) on the port coaming panel. This action also operates a micro-switch which if electrical power is available, automatically lowers the gunsight. The hood will not jettison cleanly unless it is fully closed, and the three-position switch is in the off position.

(b) An indicator on the port wall shows that the jettison mechanism is locked. The line on the pointer must be *exactly* in line with that on the perspex to be indicating safe. 1/20 in. from this position is unsafe.

(c) An external jettison control is on the port side of the fuselage. When pulled it releases the hood thereby enabling it to be lifted clear manually.

39. Cockpit pressurisation and heating

(a) Control of cockpit pressure is by means of a master ON/OFF switch (13) and control of temperature is by means of the spring-loaded selector switch (14), both on the port wall. A temperature indicator (19) on the port shelf registers whenever the master switch is ON and electrical power is available.

(b) When the master switch is ON, air is bled from the engine compressor and fed to three entry points in the cockpit. One at the extreme rear end of the port shelf can be blanked off at will; the same feed line supplies air to a small louvre (44) on the port side of the instrument panel. The quantity of air entering the cockpit via this louvre will depend on whether the inlet port is blanked off or not. The third entry point is a larger louvre (78) on the starboard wall, above the oxygen regulator.

(c) The cockpit pressure control valve limits the pressure differential to 3½ lb./sq. in. at 27,000 ft. and above. If the pressure differential falls below a predetermined minimum, a warning light (53) on the instrument panel comes on. Should the differential fall still further so that the cockpit altitude reaches 42,000 ft. ±250, a warning horn sounds. The horn may be silenced by setting a guarded switch (76) on the starboard wall to OFF. An altimeter (68) which shows the equivalent cockpit altitude is on the starboard shelf.

(d) A manually operated vent (7) on the port wall admits air at atmospheric pressure, and may be opened when the pressurisation system is OFF or to release pressure in an emergency.

(e) The hood seal and the cartridge starter access door seal are inflated by air direct from the engine compressor.

40. **Hood and windscreen de-misting**

(a) Hot air for de-misting the windscreen interspace is fed direct from the engine compressor.

(b) Hot air supply to the windscreen and hood gallery pipes is controlled by a DEMIST switch (12) on the port wall. The air supplied is very hot at high power and low altitude and in these circumstances should only be used if mist has already formed. It should be used at high altitude and, to reduce the possibility of mist forming, it should be left on for the descent.

41. **Windscreen de-icing system**

The system is operated by compressed air from the cockpit air system, passing into the storage tank and forcing fluid from the tank onto the windscreen via a spray tube. The system is controlled by an ON/OFF cock (88) on the starboard shelf.

42. **Anti-G suit system**

(a) Air under pressure is stored in an air bottle and is controlled by an ON/OFF cock (92) on the starboard shelf. When the cock is ON, and G in excess of approximately 1½ is applied, a spring-loaded valve operates and allows air at low pressure to pass to and inflate the anti-G suit. The amount of inflation will depend on the amount of G applied.

(b) The system may be tested, with the cock ON, by pressing the TEST button on the starboard bulkhead.

(c) An air pressure gauge, in the nosewheel bay, shows the pressure in the system (1,800 lb./sq. in. max.).

43. **Ejection seat Mk. 2G**

(a) A Mk. 2G pilot ejection seat is fitted incorporating a type ZF harness, headrest, footrests, parachute container and a seat well for the dinghy and emergency oxygen supply. An 80 ft./sec. ejection gun is fitted.

(b) The height may be adjusted by a lever on the starboard side of the seat; the harness release is also on the starboard side.

(c) The ejection gun is fired by pulling the handle above the headrest. When Martin Baker Mod. 309 is embodied a secondary firing handle is fitted to the forward edge of the seat pan and is intended for use when ejecting in positive G conditions. When either firing handle is pulled the ejection gun is fired and ejection follows.

(d) All leads incorporate quick releases which are automatically broken on ejection.

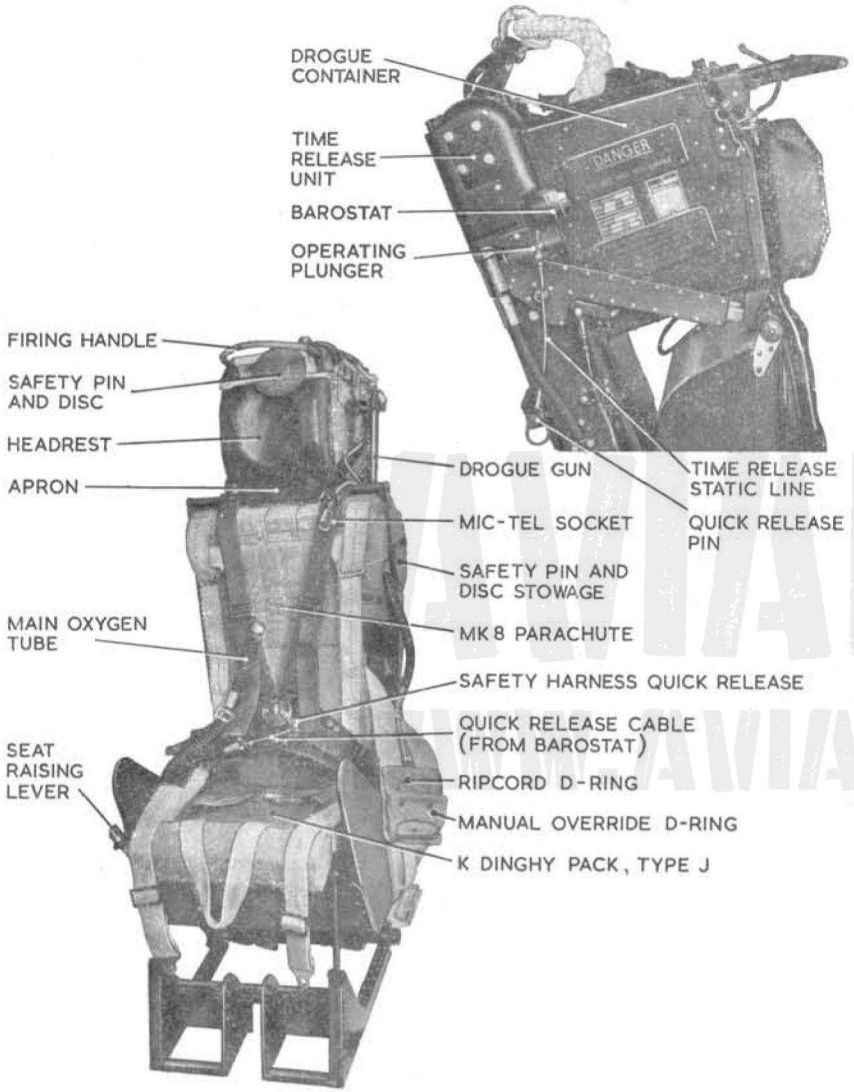
(e) After ejection, at heights of 10,000 ft. and below, a barostat causes an automatic cycle to commence. After 3 seconds the safety harness is released as are the face screen, firing handle and headrest pad. An apron attached to the seat drogue then pitches the pilot head first out of the seat, at the same time opening his parachute.

(f) A manual override D-ring is fitted over the ripcord D-ring and should be operated to isolate the automatic device if the system has failed.

(g) *Leg restraining cords*

(i) When Martin Baker Mod. 308 is embodied, leg restraining cords are fitted in lieu of footrests. The thigh guards are retained.

(ii) The leg restraining cords ensure that the occupant's legs are drawn back automatically and restrained close to the seat pan during ejection, thus providing leg clearance and preventing the legs being blown



EJECTION SEAT MK 2G

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A.L.1

apart after ejection. The restraining cords pass through snubbing units at the front of the seat pan. These units allow the cords to pass freely *down* through the unit, but prevent them passing *upwards*. A release button is provided under each snubbing unit to allow the occupant to adjust the cords to give comfortable leg movement in the aircraft.

(h) The following ejection seat modifications alter the basic seat and affect its operation as below:—

E.S. Mod.	Title	Effect
247	80 f.p.s. ejection gun	All four together give the seat a ground level ejection capability in flight parallel to the ground at speeds above 90 knots. The G stop prevents the parachute opening if the speed at ejection is too high for safe deployment.
293	22-in pilot drogue	
387	Solid drogue gun piston	
491	1¼ sec. time delay and G stop	

If any of the above mods are not embodied, the minimum height/airspeed combination for safe ejection in level flight is 200 feet/120 knots. A label on the port side of the drogue gun container below the danger warning plate states either "GROUND LEVEL" or "200 FEET".

44. Oxygen system

(a) Oxygen is carried in a Mk. 5D cylinder in the starboard wing. (Mod. 682 introduces a second cylinder.) A Mk. 17 or 17B demand regulator controls the supply to the pilot.

(b) A contents gauge (67) is aft of the regulator (66) on the forward end of the starboard shelf. The regulator consists of an ON/OFF valve which controls the flow of oxygen, an air inlet NORMAL–100% OXYGEN switch, an emergency three-position switch and a combined flow and blinker unit.

(c) When the ON/OFF valve is on and the inlet switch is at NORMAL, an air/oxygen mixture is fed to the pilot's mask, up to a height at which 100% oxygen is automatically delivered. When the inlet switch is at 100% OXYGEN no air is added, irrespective of the height. This position should normally be selected. The emergency switch when moved to either right or left admits oxygen under greater pressure. Normally it should be central, but in the event of loss of cabin pressure should be offset.

(d) The mask may be tested before flight by firmly pressing in the EMERGENCY switch, when in the central position. Oxygen is then supplied under pressure, the firmer the switch is pressed the greater the pressure (up to 5 times that obtained with the switch in either side position). The mask can then be adjusted until no leaks are apparent.

(e) *Emergency system*

A manual control (94) on the starboard shelf operates the emergency oxygen bottle in the seat well, providing the safety pin on the bottle is withdrawn.

45. **Flight instruments**

(a) The turn and slip indicator is operated by D.C. whenever electrical supply is available. If electrical supply is lacking the word OFF appears in the face of the instrument. When Mod. 599 is embodied a TURN & SLIP NORMAL-EMERG switch on the instrument panel provides a separate emergency d.c. supply when set to EMERG.

(b) The Mk. 4 artificial horizon is operated by A.C. (see para. 17 or 18)). A power failure indicator shows the word OFF when electrical supply is lacking. If the fast erection button (51) is used before flight to erect the horizon it must not be kept depressed after satisfactory erection is achieved. In flight the button should only be used in unaccelerated level flight.

(c) The Mk. 4F compass is also operated by A.C. (see para. 17 or 18)).

(d) The accelerometer indicates all normal accelerations imposed on the aircraft by means of three concentrically mounted pointers. One pointer indicates instantaneous G, the other two register the maximum positive and negative G readings respectively until re-set.

(e) The heater element in the pressure head is controlled by a switch (37) on the port side of the instrument panel.

46. **Internal and external lighting**

(a) *Cockpit lamps*

The lamps are controlled by five on-off dimmer switches (80) (87) on the starboard wall.

(b) *Emergency lamp*

The emergency lamp, powered by a separate battery, is controlled by an on/off switch (77) on the switch panel on the starboard wall.

(c) *External lighting*

Navigation lights only are fitted, which are controlled by a BRIGHT-OFF-DIM switch (79) on the switch panel.

OPERATIONAL CONTROLS

47. **Gyro gunsight Mk. 5A**

(a) The G.G.S. is housed in a retractable mounting above the instrument panel. Retraction is controlled by an electric motor in circuit with the G.G.S. ON/OFF switch above the coaming on the left of the sight. Ranging is effected by rotating the throttle twist-grip.

(b) Altitude and ballistics units automatically compensate for the time of flight and gravity drop of the particular ammunition in use. The altitude unit is fully automatic but the ballistics unit must be preset before flight.

(c) The selector dimmer control (54) contains a dimmer switch and a five-position selector switch.

(d) Emergency manual lowering is effected by striking the knob (50) on the left of the sight.

48. **V.H.F.-TR. 1985/86 with telebriefing—ARI. 18064**

(a) The two 10-channel V.H.F. controllers (25) with an adjacent change-over switch (26) are at the bottom of the port instrument panel. A press-to-transmit switch is in the end of the throttle lever handle. The sets are stowed in the starboard equipment bay. The TR. 1985 aerial is mounted on top of the fuselage and the TR. 1986 aerial is below the fuselage.

(b) The telebriefing land-line connection is at the aft end of the fuselage port side. When the plug is connected the V.H.F. circuit is de-energised and a red warning light (90) on the starboard shelf indicates that telebriefing is in use. The pilot's press-to-speak switch is adjacent.

49. **D.M.E. (Rebecca MK. 7) ARI.5849**

(a) The control unit (89) is on the starboard shelf. A range and heading meter (57), which indicates range and left/right heading from the homing beacon, is on the starboard instrument panel.

(b) Three suppressed receiver aerials are fitted, one in each wing leading edge and one in the rear fuselage undersurface. A suppressed transmitter aerial is also inside the rear fuselage undersurface.

50. **Gun firing**

(a) The gun firing switch is on the forward face of the control column handgrip. The circuit is automatically isolated when the undercarriage is locked down. A butt test switch is in the starboard wheel bay and provides an override for the automatic isolation of the gun firing circuit.

(b) When the guns are fired, an electrically-operated selector is energised allowing hydraulic fluid to open the gun bay scavenging flap. This causes air to clear the gases from the link and empty case chutes. When the trigger is released the scoop closes and the air flow is cut off.

51. **F.95 cameras**

(a) Three oblique cameras may be carried, one in the nose of the aircraft and one in each side of the nose. When Mod. 499 is incorporated, alternative facilities for vertical photography are provided for the nose camera only. The windows of all three cameras are protected by hydraulically-operated shutters.

(b) The following controls are fitted:—

(i) Heater ON/OFF switch (83).

(ii) F.95-G.45 SELECTOR switch (84).

(iii) An IRIS SETTING switch (82).

(iv) A camera WINDOW OPEN-OFF-SHUT switch (73) controls the opening and closing of the protective shutters. The shutters will open automatically with the switch in the OFF position when the camera button is pressed, but can only be closed by use of the selector switch. The shutters will also open automatically when the engine is stopped and shut when it starts. There is no method, other than starting the engine, of opening the shutters on the ground if the switch is set to SHUT when the engine is shut down.

(v) Footage indicators (81) with resetting controls. Provision is made here for a fourth indicator for a downward facing camera (at present not fitted).

NOTE.—Items (i) to (v) are on the switch panel on the starboard wall.

(vi) Individual 4FPS-OFF-8FPS selector and speed control switches together with green indicator lights (56) on the starboard quarter panel. The lights glow dimly when the shutters are open and flash when the cameras are in operation.

(vii) The cameras are operated by the button (70) on the left-hand side of the control column hand grip. They will also be set in operation if the F.95/G.45 selector switch is set to F.95 and the gun firing button is pressed.

52. **G.45 and recorder cameras**

In addition to the F.95-G.45 selector switch (84), a G.45 MASTER switch (75) and a CLOUDY/SUNNY switch (74) are fitted. The MASTER switch must be ON and the selector switch must be at G.45 before the camera will operate. Operation is by means of the camera button (70), or when the gun firing button is pressed.

EMERGENCY EQUIPMENT

53. **Crowbar**

This is clipped to the aft end of the cockpit port wall.

54. **Survival equipment**

This may be stowed in the starboard ammunition tank.

55. **First-aid equipment**

This is stowed in the starboard ammunition tank. Access to the ammunition tanks is via the ammunition tank doors which are unlocked by a key stowed in the aircraft destructor stowage.

56. **Aircraft destructor**

A quick release panel, with hand-operated latches, gives access to the aircraft destructor, stowed in the starboard side of the fuselage level with the cockpit.

57. **E.2 compass**

This is attached to the starboard side of the windscreen arch.

PART II

LIMITATIONS

NOTE.—The limitations herein are mandatory are ~~are~~ not to be exceeded. The contents of Parts III, IV and V are mainly advisory, but instructions containing the word " must " are to be regarded as mandatory.

58. **Engine limitations—Avon Mk. 114**

Condition	Time Limit	R.p.m.	Max. J.P.T. °C.
Take-off and Operational Necessity (with or without reheat)	10 mins. combined	7,900 ± 50	700°
Intermediate	30 mins.	7,800	685°
Max. Continuous	Unrestricted	7,550	645°
Ground Idling	Unrestricted	2,750 ± 100	550°

Oil pressures

At 7,550 r.p.m. and above:—15 lb./sq. in. (min.)
20 lb./sq. in. (normal)

Negative G

The application of negative G is limited to 15 seconds at all altitudes. With reheat in use below 30,000 ft. this limit is reduced to 7 seconds.

59. **Flying limitations**

(a) Intentional spinning is prohibited. If an inadvertent spin occurs above 15,000 ft. the aircraft is to be abandoned if recovery has not been assured by 10,000 ft. If the spin occurs below 15,000 ft. the aircraft is to be abandoned immediately.

(b) *Maximum speeds*

Clean aircraft	600 knots. No mach limit but see para. 75.
With belly tank:—	
Below 10,000 ft.	585 knots or 0.92M.
Above 10,000 ft.	585 knots, no mach limit.
Flying in Manual (with or without belly tank)	500 knots or 0.90M.
Undercarriage operation and flight with u/c lowered	250 knots.
Belly tank jettisoning	550 knots (180 knots min.).

(c) *G limitations*

Clean, or with empty belly tank ..	7.5G
With full belly tank	6.5G

(d) *Weight limitations*

Take-off	21,500 lb.
All permitted forms of flying	19,500 lb.
Normal landing	17,000 lb.

NOTE.—For landing at higher weights, special care is necessary as full strength factors are not achieved.

(e) *Gun firing*

Gun firing is permitted subject to the following limitations:—

Max. Height	20,000 ft.
Max. Speed	540 knots or 0.95M
Min. Speed	250 knots up to 10,000 ft., then 300 knots.
Burst length	3 secs. max. (no limit below 10,000 ft. and above 350 knots).

Below 300 knots guns must be fired in straight and level flight. Above 300 knots they may be fired in manoeuvres up to the onset of buffet.

(f) *Temporary restrictions*

Pending trials, or the completion of trials, the following limitations should be adhered to:—

(i) *Engine anti-icing*
Use of the system is prohibited.

(ii) *Pressurisation, heating and cooling*
To allow sufficient time to clear any possible misting after prolonged flight at high altitude, it is advisable to keep a reserve of fuel sufficient for 5 minutes' high-speed low-level flight.

PART III

MANAGEMENT OF SYSTEMS AND USE OF EQUIPMENT

60. Management of the fuel system

(a) The L.P. and H.P. cocks and fuel master switch must be on for starting and at all times when the engine is running.

(b) Set the retrim switch to AUTO and the override switch to NORMAL, to ensure all fuel is fed automatically and in the correct sequence, the belly tank (when fitted) being used first.

(c) For take-off, with the belly tank fitted, set the override switch to TAKE-OFF. This allows fuel to be fed from the rear internal tank first thus ensuring that the C.G. remains within limits for the whole trip. Once comfortably airborne the switch should be returned to NORMAL.

(d) If the automatic balancing system fails, and a nose or tail heavy indication is given, trim can be restored by operating the retrim switch in the direction of the white indicator until it returns to black. When less than 1,000 lb. of fuel remain, any out-of-trim indications may be safely ignored, unless the aircraft appears to be abnormally nose or tail-heavy. Lateral out of balance may occur due to unequal feeding, but, unless this is due to a booster-pump failure, balance will be restored as the wing tanks empty.

(e) If a booster-pump fails, the appropriate magnetic indicator will show white and the fuel from this tank should be considered unusable.

(f) If the fuel pressure indicator shows white (fuel pressure low) when the belly tank is being used, switch the override switch to TAKE-OFF immediately.

(g) *Total booster-pump failure*

(i) If total booster-pump failure occurs set the TAKE-OFF/NORMAL override switch to TAKE-OFF. If this does not rectify the failure close the throttle at once and descend to 18,000 feet or below. Up to 7,000 r.p.m. may then be used but the aircraft should be landed as soon as practicable. Reheat must *not* be used.

NOTE.—If absolute range is essential the height limitation may be increased to 23,000 ft. but a ground run of the engine must subsequently be carried out to check for leaks in the H.P. fuel system caused by H.P. pump cavitation.

(ii) If total booster-pump failure occurs when the internal tanks are in use, all booster-pump indicators will change from black to white and the low pressure indicator will show white.

(iii) If total booster-pump failure occurs when the belly tank is in use, the belly tank indicator will change to white, the internal tanks indicators will remain white and the low-pressure indicator will change to white.

(iv) If the internal tanks pumps fail to come into operation when the belly tank is empty as a result of a sticking change-over relay, the effect will be the same as total booster-pump failure and is more probable. The indications will be the same as in (iii).

61. Engine handling

(a) The acceleration control unit (A.C.U.) ensures optimum acceleration under normal flight conditions at low altitude but becomes progressively less effective with increase in height. Except in cases of necessity throttle movements should be smooth and progressive. Damage to the engine may result if the throttle is closed too rapidly at high I.A.S.

(b) When the compressor is hot the engine will not accelerate from low r.p.m. (below about 3,500). These conditions can only be reached if the throttle is closed after a period

at high or moderate power at low speed (*e.g.*, the approach to land). At high speed this will not occur as the r.p.m. will not fall low enough until the speed has dropped off by which time the compressor will have cooled. It may be found, particularly in hot weather, that the engine will not accelerate when the throttle is opened to taxy away at the end of the landing run. In this case the throttle should be closed and opened again to assist the engine to pick up but careful watch must be kept on j.p.t.

WARNING.—Except in cases of extreme emergency no attempt should be made to overshoot once the throttle has been fully closed for landing.

(c) When temperatures at high altitude are below normal a combination of high r.p.m. and low forward speed can produce a compressor stall which is accompanied by one or more loud bangs. With the compressor in a stalled condition the engine will idle at lower r.p.m. than is normal at high altitude and a slight buzzing noise may be discernible; in this condition the engine will not accelerate when the throttle is opened. If this occurs the throttle should be closed at once to prevent excessive j.p.t. and speed increased until the compressor unstalls and buzzing ceases. Up to 8,000 ft. may be lost before the compressor will unstall and it should not be assumed that a flame-out has occurred unless the r.p.m. are substantially below 3,000. If flame-out has occurred the H.P. cock should be closed and all unnecessary electrical services switched off. (See para. 86.)

(d) With reheat on, any form of compressor stall is unlikely to occur but if it does the reheat will cancel automatically and the throttle should be closed.

62. **Management of the reheat system**

(a) To operate the reheat, check that the shut-off switch is at NORMAL and open the throttle to the reheat gate. Check that the j.p.t. exceeds 600°C. at 7,900 ± 50 r.p.m. and then push the throttle through the gate. The reheat will light after about three seconds.

(b) When the reheat lights up momentary fluctuation of r.p.m. occurs but should damp out quickly. If, when reheat is on at high altitude, a fluctuation of r.p.m.

accompanied by a sympathetic thrust variation sets in, it is due to malfunctioning of the reheat controller. If the fluctuation becomes large (more than 100 r.p.m.) reheat should be cancelled.

(c) Reheat light-up at heights above 25,000 ft. is not 100% certain.

(d) To cancel reheat pull the throttle out of the gate and throttle back. However, at lower altitudes it will be necessary to pull the throttle out of the gate and then operate the REHEAT SHUT-OFF switch in order to prevent r.p.m. falling below 7,600. If the shut-off switch has been used to cancel reheat it must afterwards be returned to NORMAL, so that reheat will be available when next required.

(e) The nozzle position indicator shows white only when the nozzle eyelids are in the incorrect position for the running condition selected. It shows white therefore momentarily, whilst the eyelids are changing position when reheat is selected or cancelled.

(f) *Failure of the reheat system*

(i) If the eyelids fail to open after light-up occurs, pressure will build up in the jet pipe and will automatically cut off the reheat fuel. Reheat should then be cancelled by use of the shut-off switch. If there is any delay in cancelling, the reheat will light intermittently as pressure rises and falls. The indicator will remain white from the time the throttle is put through the gate until reheat is cancelled.

(ii) If the eyelids fail to open *fully* after light-up occurs, but back pressure is insufficient to operate the automatic cut-off, then the reheat will continue to burn. If the indicator does not go black after a maximum of *five* seconds after light-up then the reheat should be cancelled by use of the shut-off switch. Delay in cancelling will cause the amber hot gas warning light to come on. The indicator will behave as in (i) above.

(iii) If the reheat fails to light up or flames out, the eyelids will remain open, or partially open, causing a large drop in thrust and j.p.t. until reheat is cancelled; the eyelids will then close. The indicator will be unreliable until the reheat has been cancelled.

(iv) If the eyelids remain open after the cancellation of reheat, a large drop in thrust and j.p.t. will be apparent and the indicator will remain white.

(v) If the amber hot gas warning light comes on, reheat should be cancelled if in use.

63. Cockpit temperature control and demisting air

(a) When the indicator is set at the junction of the medium (green) and cold (blue) sectors, cockpit air temperature will be comfortable for the initial climb. When a change in temperature is required the indicator should not be moved more than one division as there is a delay in the temperature change and the control is very sensitive.

(b) With high power settings at low altitude the demisting air is very hot; it should therefore only be switched on if misting occurs. In order to prevent mist and ice formation at high altitude, however, the air should be switched on and left on until descent is complete.

64. Use of ejection seat equipment

WARNING.—1. The pilot must ensure that each safety pin is removed and stowed before flight. He must also ensure, before leaving the cockpit after flight, that each handle is locked against the possibility of accidental withdrawal on the ground by passing the appropriate safety strap through its associated handle and securing it with its spring safety pin. All personnel must ensure that both firing handles are locked before entering the cockpit.

2. If it is necessary to leave the aircraft in an emergency on the ground, special care must be taken not to foul the secondary firing handle (on the seat pan) if its safety strap and pin are not in position.

The safety of the pilot on ejection depends primarily on the correct use of his equipment. The following drill should therefore be followed carefully when preparing for flight.

(a) Adjust the height of the seat.

(b) When seated, connect the dinghy lanyard to the life-saving waistcoat, ensuring that the quick release is below the parachute waist-belt. Secure the parachute harness.

(c) Fasten the safety harness lap-straps and then, if fitted, secure the leg restraining cords as follows:—

(i) Secure the leg straps below the knees with the D-rings to the rear.

(ii) Pass the left nylon cord through the right-leg D-ring under the safety harness lap straps and insert the right shoulder harness eyepiece through the loop on the cord. Secure the shoulder harness in the quick-release box.

(iii) Repeat for the other cord, passing the right cord through the left-leg D-ring and attach the loop to the left shoulder harness. Secure the harness.

(d) Connect the main oxygen and emergency oxygen supply tubes to the oxygen mask tube and the locating chain to the life-saving waistcoat. To prevent possible entanglement, ensure that the emergency oxygen tube is connected under the seat safety harness but above the parachute harness.

(e) Connect the mic./tel. lead.

(f) Check that the firing handle can be reached with both hands together.

(g) Have the ejection seat safety pins removed and stowed.

PART IV

HANDLING

STARTING, TAXYING AND TAKE-OFF

65. External checks

Start at the port intake and check the aircraft for obvious signs of damage, also:—

Intakes and boundary layer bleeds	Covers removed. Intakes clean. Swirl vanes undamaged.
Nose wheel bay	Brake accumulator gauge 1,750 lb./sq. in. Anti-G gauge between 500 and 1,800 lb./sq. in. Caps secure on air charging connections.
Gun, ammunition and access panels and fuel filler caps	Secure.
Main wheel bays	Hydraulic lines for chafing. Door sequence valve for position and freedom of movement. Butt test switch OFF and nosewheel retraction switch OFF and locking bolt in position in starboard wheel bay.
Wheels	Tyres, brake lines and oleo extension. Maxaret units for correct engagement.
Pressure head	Cover removed and tube straight.

Rear fire access panels	Open.
Jet pipe	Condition. Nozzle eyelids open.
Ailerons	Manual trimming tab neutral. No cracks or pulled rivets.
Wing fillets	No cracks or pulled rivets.
Control locks	Removed from undercarriage and flying controls.

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66. Cockpit checks

(a) *Comfort*

Throttle guard	Stowed
Dinghy connections	Connect to life-saving waistcoat.
Parachute harness	Fasten and adjust.
Safety harness	Fasten and adjust.
Anti-G tube	Connect, ensuring aircraft part not entangled in safety harness.
Oxygen supply	Connect.
Seat and rudder pedals	Adjust.

NOTE.—Check R/T lead plugged in. Ejection seat safety pin removed and stowed.

(b) *Left to right checks*

Crowbar	Stowed
Hydraulic accumulator pressure	2,150 lb./sq. in.
Cockpit air vent	Closed.
Cockpit air inlet cover	As required.
Belly tank jettison lever	Down and locked.
High pressure cock	Off.
Undercarriage and flap emergency selectors	Out.
Cockpit pressure, demist and anti-icing switches	OFF.
Hood indicator	Exactly in line.
Hood motor switch	OFF.
Reheat top temperature control	OVERRIDE.
Throttle	Closed.

Ignition circuit breaker	Closed.
Low pressure cocks	On.
Tailplane incidence selector	Forward.
V.H.F.	OFF, selector switch as required.
Aileron and elevator power control selectors	Forward (Power on).
H.P. pump isolating valve switch	OFF.
Brake gauge	Pressures.
Fuel auto/override switch	NORMAL.
Pressure head heater switch	OFF.
Inverter changeover indicator	Black.
Flaps selector switch	TAKE-OFF and AIR-BRAKES.
Brake boost switch	OFF.
Undercarriage selector	DOWN.
Hood jettison handle	In.
Nozzle eyelids indicator	Black.
Fire warning lights	Out and test.
Reheat shut-off switch	NORMAL.
Hot gas warning light	Out.
Air extract indicator	White.
Accelerometer	Set to zero.
Blind flying panel	Set altimeter.
Starter panel switches	OFF.
Cockpit pressure warning light	Out.
Generator warning lights	Out.
Fuel flow indicators	Black.
Fuel pressure indicator	Black.
Belly tank indicator	Black.
Fuel balance indicators	Black and switch to AUTO.
Cockpit lighting	As required.
Oxygen	100%, test, contents.
Cockpit pressure warning switch.	ON.
Camera shutter switch	OFF.
Emergency oxygen selector	In.
Anti-G selector	ON.
D.M.E.	OFF.
De-icing cock	OFF.
Hood clutch	ENGAGED.
Parking brake	Apply.

67. **Checks before starting** (Mod. 607 not incorporated)

Battery isolation switch	ON. Air extract indicator, black. Nozzle eyelids, fuel flow, fuel pressure and belly tank indicators, white. Generator warning lights on. Power controls unsafe red light flashing. Undercarriage position indicator 3 greens and alternative bulbs serviceable. Turn and slip indicator functioning.
Fuel master switch	ON. (a) *Fuel in belly tank* Belly tank indicator, black. Fuel pressure indicator, black. (b) *No fuel in belly tank* Centre and forward tanks fuel flow indicators, black. Fuel pressure indicator, black.
Ignition switch	ON. No. 2 inverter starts up. Artificial horizon erect and Mk. 4F compass functioning.
Starter master switch	ON. No. 1 inverter takes over from No. 2.
High pressure cock	Locked on.
Relight button	Test. If serviceable an irregular clicking sound is heard.

68. **Checks before starting** (Mod. 607 incorporated)

Battery isolation switch	ON. Power controls unsafe red light flashing. Air extract indicator, black. Nozzle eyelids, fuel flow, fuel pressure and belly tank indicators, white. Generator warning lights on. Undercarriage position indicator 3 greens and alternate bulbs serviceable. Turn and slip indicator functioning.
Fuel master switch	ON. (a) *Fuel in belly tank* Belly tank indicator, black. Fuel pressure indicator, black. (b) *No fuel in belly tank* Centre and forward tanks fuel flow indicators, black. Fuel pressure indicator, black.
Flight instruments early start switch	ON. No. 2 inverter starts up. Artificial horizon and compass erect. Inverter changeover indicator, white.
Starter master and ignition switches	ON.
High pressure cock	Locked on.
Relight button	Test. If serviceable an irregular clicking sound is heard.

69. **Starting the engine**

(a) With the H.P. cock fully on, press the starter button and check that it remains in.

(b) The starter cartridge fires over a period of 2–3 seconds during which time the engine speed should rise to approximately 1,450 r.p.m. and light-up occur. The engine should accelerate to the idling r.p.m., 2,750 ± 100 in approximately 30 seconds.

(c) As r.p.m. reach 1,600 check that the generator warning lights go out and that the remaining internal tanks flow indicators change to black, if no fuel in the belly tank. If Mod. 607 is fitted check that the inverter changeover indicator changes from white to black.

(d) *Failure to start*

(i) If the cartridge does not fire, close the H.P. cock immediately. It must not be assumed that the breech is empty and the time switch should be allowed to run out (30 seconds) before attempting a further start. If the second and third cartridges fail to fire, have the defect investigated.

(ii) If the cartridge fires, but the engine fails to light up, close the H.P. cock without delay. If it is suspected that an excess of fuel has collected in the engine, a second cartridge should be fired with the ignition switch and the H.P. cock off. This procedure entails a 30-second delay whilst the time switch runs out. A third attempt may be made after an interval of at least 30 seconds as controlled by the time switch.

(iii) If, due to a circuit fault, the starter button does not hold in, irrespective of whether a cartridge is fired or not, a period of at least 30 seconds must elapse before the button is again pressed.

(iv) If the pressure relief valve sticks open, as indicated by intermittent clouds of black or yellow smoke from the starter exhaust without r.p.m. indication, wait at least until the time switch runs out (30 seconds) and then fire a second cartridge.

(v) The run of the time switch must not be shortened by the use of the master switch, otherwise over-speeding of the starter may occur in some circumstances. A period of at least 10 minutes must elapse between firing a cartridge and reloading the breech.

70. **Checks after starting**

Fire warning lights	Out.
Idling r.p.m.	2,750 ± 100.
J.p.t.	550°C. Max.
Oil pressure	Registering.
Power controls	Full control column movement. Two green lights. No flashing red.
Hydraulic pressure	3,150 ± 150 lb./sq. in.
Trimmers	Function and set to neutral (see NOTE).
Throttle to 4,000 r.p.m.	Nozzle eyelids indicator, black. Close throttle.
Flaps	Operation and note fall and rise in accumulator pressure. Flaps up.
V.H.F.	Select frequencies required.
Brake pressure	1,750 lb./sq. in. Max. to each wheel.
	3,150 ± 150 lb./sq. in. supply.
Artificial horizon and compass	A/H erected. Synchronise Mk. 4F compass and check E2.
Fuel contents	Sufficient.
Fuel balance indicators	Normally black.
Oxygen flow indicator	Operating.
Hydraulic audio warning	Test on both radios and leave ON.
D.M.E.	STAND-BY.

NOTE.—*Trimmers.* Check aileron and rudder trimmers fully and return to neutral, then check elevator trim as follows:—

(a) Trim nose-down using control column switch with the FAST/SLOW selector at FAST; release switch.

(b) Trim nose-up using duplicate slow switch and at the same time check that the control column switch is inoperative.

(c) FAST/SLOW switch to SLOW and trim to neutral with control column switch.

(d) FAST/SLOW switch to FAST.

(e) Isolate main trim. Check control column switch is inoperative. Return main trim switch to NORMAL.

71. **Taxying**

Taxy forward and check for equal braking effect. Taxying is easy and the characteristics are those of a normal nosewheel undercarriage jet aircraft.

72. **Checks before take-off**

Trims	All neutral.
Airbrake	Switch at TAKE-OFF and select out.
Fuel	High and low pressure cocks on.
	Reheat top temperature control—OVERRIDE.
	Fuel auto-override switch—TAKE OFF (NORMAL if no fuel in belly tank).
	Reheat shut-off switch—NORMAL.
	Fuel master switch—ON.
	Fuel flow and pressure indicators, black.
	Contents sufficient.
	Balance switch to AUTO.
	Belly tank indicator white.
Flaps	No creep from take-off position.
Instruments	Check all.
	Pressure head heater switch—ON.
Oxygen	100%, blinking, contents, connections.
Harness	Tight and locked.

Hood	Closed, switch at OFF, pointer safe, clutch engaged.
Hydraulics	Flying controls, free and correct movement—2 green lights—no flashing red light. 3,150 ± 150 lb./sq. in. on 3 gauges.

73. **Take-off**

(a) Align the aircraft on the runway, check:—

Wheel brakes	On.
Throttle to 7,000 r.p.m. (min.)	Brakes holding.
Brake boost	On.
Parking brake	Release.
Full power dry	J.p.t. 600°C. min., 680°C. max. R.p.m. 7,900 ± 50.
Throttle through the gate	Reheat nozzle eyelids indicator, white.
When reheat in	Nozzle eyelids indicator, black in 5 secs. J.p.t. 600°C. min., 680°C. max.
Brake boost	Off.

(b) The aircraft accelerates rapidly with no tendency to swing, the rudder becoming effective at 60 to 70 knots: until this speed is reached directional corrections should be made on the brakes.

WARNING.—There is a high degree of elevator boosting (15 : 1) and care should be taken to avoid over-controlling during take-off.

(c) The elevator becomes effective suddenly at just over 110–115 knots and a slight backward pressure will raise the nosewheel at 115–120 knots. The aircraft should be flown off at 145 to 150 knots (155 to 160 knots with full belly tank), and should not be pulled off the ground.

(d) *After take-off checks*

Brakes	On until undercarriage retracted.
Undercarriage	Up (note audio warning pre-Mod. 856).
Flaps	Up when undercarriage lights out and audio warning ceased.
Throttle	From reheat gate to full power dry.

Cancel reheat at 250 knots by operating reheat shut-off switch and returning to NORMAL. Return fuel AUTO/OVERRIDE switch to NORMAL. Switch reheat top temperature control to NORMAL. Switch on pressurisation and select required temperature.

HANDLING IN FLIGHT

74. **Climbing**

(a) The recommended climbing speeds are given below. Nothing is gained by holding the aircraft down; speed should be allowed to increase to the recommended figure as 5,000 ft. is reached. At high altitude it is particularly important to maintain the correct climbing speed. If speed is reduced the rate of climb will fall off rapidly and it will take a long time to regain speed without losing height.

Height (ft.)	*Reheat off*	*Reheat on*
5,000	400 kts.	0.81M
10,000	400 kts.	0.83M
15,000	400 kts.	0.84M
20,000	0.8M	0.85M
25,000	0.83M	0.85M
30,000	0.85M	0.86M
35,000	0.85M	0.86M
40,000	0.84M	0.86M
45,000	0.83M	0.86M

(b) For maximum range, reheat should not be used on the climb and to avoid exceeding the engine limitations it is recommended that 7,800 r.p.m. be used up to 20,000 ft.

and full power thereafter. At full power no throttle adjustments should be required but at lower r.p.m. it may be necessary to throttle back as height is gained to maintain the selected r.p.m.

75. **General flying**

(a) *Longitudinal stability and control*

(i) *Stability*

The aircraft is statically stable throughout the speed range up to about 0.86M, when a nose-down trim change sets in. The trim change continues up to about 0.91M, when little further trim change occurs up to about 0.955M (which is sonic speed). At this speed a slight nose-up trim change occurs and above this speed the aircraft is stable. The trim changes can be held on the elevator but the aircraft should normally be kept trimmed on the V.I. tailplane. For high mach number and low and medium indicated airspeed flying, it is recommended that the tailplane be operated with the speed control in FAST. For flying at high indicated airspeeds the control should be set to SLOW otherwise this control will be over-sensitive.

(ii) *Elevator control*

At low and medium speeds the elevator is very light. It becomes heavier as speed is increased up to about 0.88M when it begins to heavy-up more rapidly. As the aircraft becomes supersonic a slight kick may be felt on the elevator and the stick may move back slightly without affecting the flight path of the aircraft. Above this speed the elevator is heavy and its effectiveness is reduced, the G available from the trimmed value being about 1.25 (*i.e.*, an accelerometer reading of 2.25 when trimmed at 1G) when applying a maximum stick force. Under these conditions it is recommended that the V.I. tail be used to assist the elevator and when this is done longitudinal control is entirely adequate. It must be realised, however, that if the tail is used to assist manoeuvring at mach numbers between about 0.88 and 0.95 a strong push force will develop if speed falls off.

(b) *Lateral control*

(i) The ailerons are light and powerful. At speeds below 300 knots use of full aileron causes slight yaw in the opposite direction to that in which aileron is applied and this should be counteracted with rudder. When the belly tank is fitted this characteristic is more marked and is present up to about 350 knots.

(ii) Up to about 0.935M, when wing heavying may occur, the ailerons give a high rate of roll; at this speed and up to about 0.945M the rate of roll is reduced but increases again at higher mach numbers. With the belly tank fitted the wing drop is more severe and may require up to 3/4 aileron to hold. For this reason the limitation of 0.92 below 10,000 ft. must not be exceeded.

WARNING.—If the wing drop mach number is reached below 5,000 ft., particularly in bumpy air or when pulling G, the aileron boosters will stall and limit the amount of aileron available. If this occurs speed must be reduced.

(c) *Directional control*

(i) The rudder is light and effective at low speed but becomes progressively heavier as speed is increased.

(ii) At speeds below 250 knots, if rudder is applied beyond two-thirds travel, there is a gradual lightening off of foot load. This is more pronounced with the undercarriage down, particularly when right-rudder is applied, this being due to the effect of the nose-wheel door.

(iii) As the aircraft becomes supersonic a slight change in rudder angle may be felt but this does not affect directional trim.

(iv) The rudder tab loses effectiveness above 0.9M and excessive amounts should not be applied owing to the foot force which will develop as speed is reduced.

(d) *Airbrakes*

The flaps may be used as airbrakes at any speed or mach number. Up to about 0.9M there is very little trim change, but at higher mach numbers a nose-down trim change occurs; this can be held on the elevator.

(e) *Changes of trim*

Undercarriage DOWN	Negligible fore and aft. Yaw to starboard.
Flaps/Airbrakes	Negligible up to 0.94M above which nose-down change occurs.

(f) *Flying at reduced airspeed*

(i) Fly at 180 to 200 knots, using the flaps as required.

(ii) The hood may be opened if necessary but an uncomfortable drumming roar is caused when fully open. The maximum speed for opening the hood is 240 knots.

(g) *Flying in turbulence*

The recommended speeds for flight in turbulent conditions are as follows:—

Level flight, or climbing	300 knots/0.79M
Descending, airbrakes out	270 knots/0.79M

76. **Practice flying in Manual control**

NOTE.—If, after practice flying in Manual, it is not possible to re-engage Power correctly (indicated by the red light flashing) select Power off. If subsequent attempts to re-engage Power are unavailing the remainder of the flight and the landing must be carried out in Manual.

(a) *Ailerons*

(i) Before selecting aileron power OFF in flight, check that the aileron trim is neutral and the speed is below 250 knots or 0·8M and above 5,000 feet. If the aileron has been changed, or any adjustments made which may affect lateral trim, check the aircraft in Manual by selecting Manual below 200 knots and above 10,000 feet. Trim the aircraft for straight and level flight at 360 knots.

(ii) The stick forces are high and there is a small amount of backlash, but the aircraft may be flown to 0·9M, and 500 knots without undue difficulty.

(iii) Aileron Power can be reselected at any speed and engagement is instantaneous on reselection, provided that the control column is in approximately the same position as that at which Manual was selected. When mod 395 is embodied it is important that the Power/Manual lever is set to POWER before reselecting aileron Power.

(b) *Elevator*

The elevator may be selected off and re-engaged in flight without difficulty. The stick forces in Manual are high, but these can readily be trimmed out on the variable incidence tailplane.

(c) *Landing*

(i) Practice Manual landings should not be carried out in very gusty and/or crosswind conditions. A circuit and landing in Manual, elevator and/or ailerons, presents no special difficulties once the difference in feel is appreciated. It is recommended that a wider circuit is made but otherwise a normal approach.

(ii) In an emergency, when landing in Manual in very gusty or crosswind conditions, special care is needed to allow for backlash in the controls and in these circumstances consideration should be given to jettisoning the belly tank, if fitted.

77. **Stalling**

NOTE.—Deliberate low speed stalling is not to be carried out beyond the buffet stage nor is it to be carried out below 20,000 feet. Information regarding behaviour beyond the buffet stage is included below to assist pilots who inadvertently enter the fully-stalled condition.

(a) *Speeds*

The minimum speed which can be reached depends upon the way in which the controls are handled and in particular upon the small amounts of G which may be applied while reducing speed. The speeds and characteristics described are typical for an aircraft with wheels and

flaps down, carrying full ammunition and with half fuel remaining but without a belly tank fitted.

Speed (knots)	*Remarks*
200 to 150	Progressively increasing left rudder trim is required to counteract the effect of the nosewheel door.
150 to 140	Slight directional wandering which should be corrected with rudder before the associated roll is counteracted with aileron. Slight buffet.
135 to 120	Increase of buffet to a high intensity, increase in rate of sink.
115	Very high rate of sink now present and possible wing drop. If this stage is reached recovery action must be taken immediately.

NOTE.—These speeds increase by about 5 knots when a drop tank is fitted.

(b) Coarse use of the ailerons may produce marked yaw in the opposite direction to that in which aileron is applied. This is not so likely to occur when the aircraft is being " pushed out " of the stall, i.e. when G is below 1, but whenever it occurs the aileron should be centralised and the wing picked up with rudder.

78. **G-stalling**

(a) Below 0.85M the aircraft is stable at the G-stall, marked by buffeting which increases to strong, before the stage is reached where further application of elevator does not increase the G. In this condition coarse use of the aileron causes the aircraft to yaw.

(b) Between 0.85M and 0.95M the stick force lightens off as G is increased above the value at which buffet sets in. Further increase of G results in a mild pitch-up which requires a rapid forward movement of the stick to check. In order to avoid the possibility of exceeding the airframe limitations, G should not be increased beyond the initial buffet stage at speeds above 0.85M at heights below 25,000 ft.

79. **Aerobatics**

The following are the recommended minimum speeds, in knots, for aerobatics until experienced is gained:—

Roll (full aileron)	350
Loop	460
Roll off	480
Vertical roll	520

80. **Spinning**

(a) Intentional spinning is prohibited. The aircraft must be abandoned if a spin occurs below 15,000 ft. or if a spin which has developed above this height has not been stopped by 10,000 ft.

(b) The aircraft is not prone to spin off a stall, either in level or turning flight.

(c) As a result of tests the following actions are recommended in the event of a spin developing:—

(i) Apply full opposite rudder and ease the stick forward taking care to ensure that the ailerons are central. If in doubt release the handgrip and allow the feel spring to centre the ailerons.

(ii) If the undercarriage and flaps are down they should be retracted immediately.

(iii) Maintain full rudder until all rotation has ceased. Centralise the controls quickly when the spin stops.

(iv) If the aircraft stops in a steep nose-down attitude, extending the airbrakes will enable a tighter pull-out to be made.

(v) If the aircraft is beyond the vertical when the spin stops, less height will be lost if it is half rolled before pulling out, but the ailerons must be used very gently.

(d) Flight tests with a ventral drop tank have not been made, but evidence from model tests shows that the tank does not affect a spin recovery and jettisoning the tank during the spin may cause damage to the wing. The tank should not therefore be jettisoned.

NOTE.—1. The normal characteristics are a slow rate of spin with considerable oscillation in pitch,

the nose dropping steeply down and rising almost to the horizon once in each turn. Recovery action is effective at once when taken with the nose down. A moderate force is required to apply opposite rudder and a light force to hold the stick forward.

2. Some spins vary from Note 1 as regards recovery characteristics and are as follows:— A very light force is required to apply the opposite rudder and a marked degree of sideslip may be felt. This is usually followed by a sudden increase in the rate of spin which may continue with the aircraft pointing steeply down for a further 1 or 1½ turns before stopping.
3. Height loss will vary considerably but the average height involved in making one turn of a spin and recovery to level flight is about 9,000 feet.

CIRCUIT PROCEDURE AND LANDING

81. Circuit procedure

NOTE.—460 lb. of fuel should be allowed for the circuit and landing.

(a) Reduce speed to below 250 knots with the airbrakes, then open the throttle to give 6,500 to 7,000 r.p.m. Lower the undercarriage and trim out the resultant foot loads. (See para. 75 (c) (ii)). A comfortable speed for the downwind leg is 200 to 220 knots.

(b) *Checks before landing*

(i) Airbrakes	Out
Undercarriage	Down below 250 knots— 3 green lights. Trim out yaw.
Fuel	Contents.
Flaps	Limit switch to LANDING.
Harness	Tight and locked

Brakes	Operate on/off, check pressures, check lever fully off, pressure at each wheel exhausted and brake boost OFF.

Switch off pressurization before joining circuit.

(ii) *Final checks*

Undercarriage position indicator	3 green lights
Flaps	As required

(c) *Approach*

(i) Turn on finals at 180–200 knots, then lower full flap. At maximum overload landing weight in turbulent conditions a speed as high as 200 knots for the turn will be found to be more comfortable. Steep and/or turning approaches are not recommended.

(ii) To ensure quick engine response, r.p.m. should be maintained above 5,500.

(iii) The recommended minimum speeds at which to cross the runway threshold are:—

At normal landing weight (No ammunition and 800 lb. or less fuel)	140
At maximum normal landing weight. (Full ammunition 1,900 lb. fuel)	145–150
At maximum overload landing weight (Full fuel and ammunition)	160

(d) *Landing*

(i) From the speeds quoted a roundout and landing in the normal manner can be made, but elevator movements should be gentle to avoid G-stalling the aircraft. If the aircraft is stalled on to the runway a wing drop is unlikely but a slight yaw may occur which should be corrected with rudder.

(ii) The shortest landing run is obtained by putting the nosewheel on to the runway as soon as possible after touchdown and applying the brakes. Once the brakes are applied the stick should be pulled to the fully back position and the V.I. tail set to —9°,

thus bringing the weight on to the main wheels, and giving maximum braking effect. However when sufficient runway is available and/or the wind is strong (above 15 knots) brake wear can be reduced by holding the nosewheel off until it falls at 90 knots. An excessive nose-up attitude should be avoided otherwise the tail cone may strike the ground.

(iii) The maxaret units prevent the wheels locking when excessive brake is applied but unless the shortest possible run is required more gentle use of the brakes is recommended. When the runway is slippery a greater distance is needed to stop and braking should be started as early as possible. If difficulty is experienced in keeping straight release the brakes momentarily.

(iv) The aircraft must be firmly on the ground before the brakes are applied as the maxaret units do not operate until the wheels are revolving. As a safeguard against locking the wheels during a bounce the maxaret units do not cut out until 4 seconds have elapsed.

(v) For crosswind landings the "crab" technique is recommended. There is no difficulty in straightening the aircraft before touchdown but some aileron movement is required to counteract the roll resulting from the yaw.

NOTE.—New brake pads require bedding in before they work efficiently. When these have been fitted the aircraft should be taxied up to 60–70 knots and stopped with *gentle* brake application. A definite pause, with the brakes off, should be made between runs to allow the brakes to cool. Following this procedure two landings should then be made, using the full runway length and with gentle brake application.

82. **Instrument approach**

(a) *Maximum rate descents*

For maximum rate of descent use 6,500 r.p.m. and 0.80M until the airspeed reaches 400 knots.

(b) *Instrument approach*

The following are the recommended speeds and approximate power settings with the undercarriage down:—

	R.P.M.	FLAPS	AIRSPEED (knots)
Downwind	7,200	Take-off	200
Base leg	7,200	Take-off	200
Glide path	6,800	Full	170

83. **Going round again**

WARNING.—Except in cases of extreme emergency no attempt should be made to overshoot once the throttle has been fully closed for landing, as the engine cannot be relied upon to accelerate from low r.p.m. when the compressor is hot (see para. 61 (b)).

Open the throttle smoothly to the power required and raise the undercarriage. When the wheels have locked up raise the flaps.

84. **Checks after landing**

Brake pressure	Sufficient to taxy.
Flaps	In, return limit switch to TAKE-OFF.
Pressure head heater switch	OFF.
Camera shutters	OPEN.

Open hood and set switch to OFF as required.

85. **Stopping the engine**

Radios and D.M.E.	OFF.
High pressure cock	OFF.
Starting panel switches	All OFF.
Hood	Clutch FREE.
Anti-G system	OFF.

When the engine has stopped turning:—

Low pressure cocks	Off.
Ejection seat	Safe.

PART V

EMERGENCY HANDLING

86. Engine failure and relighting in flight

(a) *Sudden drop in engine speed*

NOTE.—This procedure only applies if the H.P. pump isolating valve and switch are fitted (by ~~engine~~ mod. ~~action~~ 5826).

(i) If a sudden inexplicable drop in engine speed occurs, which cannot be identified as engine surge (see para. 61 (c)), proceed as follows:—

(ii) *Above* 20,000 *ft.* Close the throttle fully and descend: check engine response to throttle movement during the descent.

(iii) *Below* 20,000 *ft.* If the engine fails to respond to normal throttle movement, close the throttle fully and set the H.P. pump isolating switch ON. If the engine still fails to respond to throttle movement, leave the switch at ON and carry out relight action. Once the switch has been set ON it must be left there for the remainder of the flight; with it thus set the A.C.U. is ineffective and all throttle movements must be made with care.

(b) *Flame-out*

(i) If a flame-out occurs when the engine is at or above cruising power, a relight may be attempted immediately, while r.p.m. are decreasing, by pressing the relight button with the H.P. cock open and the throttle at its set position. A successful relight will be indicated by the r.p.m. stabilizing and then commencing to rise; the likelihood of a successful relight is increased if the height and airspeed are below the permitted maxima for relighting.

(ii) If no relight occurs within 10 seconds, release the relight button and proceed as follows:—

H.P. cock	OFF.
Throttle	Closed.
Engine L.P. cock	Leave on.
Reheat L.P. cock	Closed.
All non-essential electrics	OFF (see para. 99 (b)).
If below 35,000 ft.	Relight at once.
If above 35,000 ft.	Switch off the booster pumps, descend to 35,000 ft. and carry out the relight drill.

(iii) If above 35,000 ft. the decision either to descend quickly or glide at 200 knots will depend on the prevailing circumstances, *e.g.*, weather conditions, distance to travel, etc. The following should be borne in mind.

1. The likelihood of obtaining a relight increases with decrease in altitude.
2. At best gliding speed the aircraft will cover approximately 2 miles per 1,000 ft.
3. With normal services running, the battery cannot be relied on for more than approx. 5 minutes. All non-essential services, including booster pumps, should therefore be switched off to conserve battery power.
4. Descending rapidly at a speed above 200 knots will increase windmilling r.p.m. Consequently hydraulic pressure will be higher and the generators may continue to supply power.

(c) *Relighting*

NOTE.—This drill applies irrespective of the position of the jet pipe eyelids. Relights are obtained more easily at lower altitudes and with lower airspeeds. Every precaution should be taken to ensure success at the first attempt due to the loads on the battery. If the engine and its fuel system are serviceable and the drill is followed correctly, a relight should occur at the first attempt.

(i) Check and/or set:—

Maximum altitude	35,000 ft.
Maximum airspeed	200 knots above 25,000 ft. 0.80M below 25,000 ft.
All non-essential electrics	OFF (see para. 99 (b)).
Throttle	Closed.
Battery master switch	ON.
Ignition switch	ON.
Ignition circuit breaker	Closed.
Starter master switch	ON.
Fuel master switch	ON.
Fuel override switch	TAKE-OFF.
Reheat L.P. cock	Closed.

(ii) Press the relight button and at the same time open the H.P. cock fully, keeping the relight button pressed until the engine lights up and r.p.m. rise by about 200. R.p.m. should commence to rise almost immediately. When the r.p.m. rise to idling, increase power carefully.

(iii) If no relight occurs within 30 seconds, release the relight button, close the H.P. cock, switch off the booster-pumps. Allow if possible, 30 seconds for the engine to dry out before the next attempt.

(d) *Emergency relighting*

(i) In circumstances where the engine cannot be relit by use of the above drill, *provided that the pilot is reasonably certain that the fault lies in the relight button circuit* it may be possible to obtain a light-up using the starter pushbutton in the following way:—

(ii) To ensure that a live cartridge is not fired, the spent cartridge with which the engine was ground-started should first be mechanically reindexed. To do this, set the starter master switch OFF and then press the starter pushbutton fully in twice, pausing for an instant between each operation to allow the button to spring fully out.

(iii) Check and/or set:—

Maximum altitude	15,000 ft.
Maximum airspeed	0.80M.
All non-essential electrics	OFF (See para. 99(b)).
Throttle	Closed.
Battery master switch	ON.
Booster-pumps	ON.
Starter master switch	ON.
Ignition switch	ON.
Ignition circuit breaker	Closed.

(iv) Press the starter pushbutton again and then open the H.P. cock fully. The igniters will then function but if the reindexing drill has been correctly carried out a cartridge will not be fired. If no relight occurs within 30 seconds, set the H.P. cock OFF when the starter button comes out. The spent cartridge must be reindexed as in (ii) above before any further attempt is made.

WARNING.—If for any reason the reindexing drill has not been correctly carried out and a live cartridge is indexed when the starter button is finally pressed, it is probable that damage will be caused to the starter and to the aircraft. This probability may be lessened to some extent if the engine windmilling speed is low and positive G is not applied at the time of operating the pushbutton.

(e) *Engine seizure*

If flame extinction occurs due to mechanical failure of the engine, take the following immediate action:—

H.P. cock	OFF.
L.P. cock	OFF.
V.I. tailplane	—1°.

All non-essential electrics OFF. Do not attempt relight. (see paras. 92, 94 and 99).

87. **Action in the event of fire**

(a) Should a fire occur in the engine, indicated by either of the fire warning lights coming on, close the throttle immediately. If the warning light goes out, land as soon as possible, keeping power to a minimum.

(b) If the warning light does not go out, take the following immediate action:—

H.P. cock	OFF.
L.P. cocks	OFF.
Fuel master switch	OFF.

Reduce airspeed to as low as practicable and press the fire-extinguisher button in which the warning light has appeared.

(c) If the fire persists, indicated by either light remaining on, the aircraft should be abandoned.

(d) If the fire is extinguished, the warning light should go out when the flame switches cool. If there are still obvious indications of a fire even though the warning light has gone out, the aircraft should be abandoned.

(e) Any further attempt to relight the engine may result in a further outbreak of fire which will be uncontrollable, since the extinguishers cannot be used again.

88. **Action in the event of hot gas warning**

(a) If reheat is on, it should be cancelled and speed reduced below 0.92M.

(b) When the reheat is off, a hot gas warning is unlikely, but it is possible in the event of incorrect nozzle position. If this occurs the light will go out when the nozzles close properly.

(c) If the nozzle eyelids fail to open fully when reheat is selected the magnetic indicator will remain white; if the cancelling of reheat is then unduly delayed the hot gas warning light will come on. If this occurs before take-off, the take-off should be abandoned.

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89. **Abandoning the aircraft**

NOTE.—With the G stop (and companion mods) fitted the seat has a ground level ejection capability provided that the aircraft is parallel to the ground and speed is above 90 knots. If in a nose down attitude more than the minimum altitude will be required. Without the G stop fitted, the minimum height for safe ejection is 200 feet.

(a) Reduce speed to 250 knots, the recommended speed for a premeditated ejection.

(b) Jettison the hood and retract the GGS. The GGS should lower automatically, if electrical power is available, when the jettison handle is pulled.

(c) Withdraw the feet from the rudder pedals. Place the feet in the footrests, at the same time grasping the firing handle. The elbows must be drawn in close to the body and both hands must grasp the handle firmly, the backs of the hands facing forward.

(d) Draw the handle and face-screen firmly over the face, keeping the head pressed hard against the headrest. It is not necessary to jerk the handle and in no circumstances should the blind be pulled outwards away from the face as it may not then be possible to fire the cartridge. The secondary firing handle, if fitted, should be used if G conditions preclude the use of the primary handle.

(e) After ejection the drogue gun will fire automatically.

(f) If ejection takes place above 10,000 ft. automatic separation will not occur until that height is reached. If ejection takes place at or below 10,000 ft. automatic separation will be immediate.

(g) *Action if the automatic system fails after ejection*

(i) When forward speed is sufficiently low discard the face screen and disconnect the main oxygen tube.

(ii) Pull the override D-ring to disconnect the parachute from the seat.

(iii) Operate the seat-harness quick-release and push clear of the seat.

(iv) Lift the flap over the rip-cord D-ring and pull the rip-cord handle.

(h) *Action if the automatic seat fails to eject*

(i) Pull first D-ring on parachute harness.

(ii) Proceed as on aircraft not fitted with an ejection seat. (Under these circumstances the parachute will not be opened automatically.)

90. **Jettisoning the hood**

The seat should be lowered and the pilot must have his head well down before pulling the jettison handle. To ensure a clean jettison the speed must be in excess of 140 knots, and the hood fully closed and the control switch at off. There is a risk of damage to the aircraft controls and injury to the pilot if the hood is not fully closed before it is jettisoned. Successful hood jettison trials have been carried out between 140 and 280 knots.

91. **G.G.S. emergency lowering**

The G.G.S. is automatically lowered on jettisoning the hood provided that electrical power is available. It may be lowered manually by striking the knob on the port side a sharp blow.

92. **Electrical system failures**

(a) *Generator failures*

(i) If one generator fails, the output of the other is sufficient to meet all electrical demands.

(ii) If both generators fail, the battery will last for only a short time, probably in the order of 5 to 10 minutes. Set the V.I. tailplane to —1°. Switch off all non-essential electrical services, and reduce altitude as quickly as possible to below 12,000 ft. When at or below 12,000 ft. reduce and maintain r.p.m. below 7,000 and switch off the fuel master switch. Note that only the front and centre tank booster-pumps will operate following double generator failure provided that battery power is available. Switch the alternative electrical supply for the turn and slip indicator to EMERG and return to base without delay.

(b) To assist the pilot in deciding which loads should be shed if a double generator failure occurs, the following table lists the major services and the current they require:—

Service	Load (Amps)
2 VHF sets (one transmitting)	13
Internal tanks booster-pumps	79
Belly tank booster-pumps	27
Pressure head heater	3
V.I. tail actuators (running)	80
Flight instruments	14

NOTE.—With Mod. 607 incorporated the flight instruments *cannot* be turned off in flight.

(c) *Inverter failure*

If No. 1 inverter fails, automatic change-over to No. 2 inverter takes place and the flight instruments will continue to operate. (See paras. 17 and 18).

93. **Emergency trimming**

(a) If the normal operating system for the V.I. tailplane becomes unserviceable in flight, trimming may be accomplished by operating the duplicate trim switch on the port console. Rate of operation of this is slow regardless of speed selected on the FAST/SLOW switch.

(b) If the tailplane runs away due to failure of the main trim switch, it can be overridden by use of the duplicate trim switch on the port console. However, as corrective action is being taken, operate the MAIN TRIM ISOLATION switch in order to prevent the tail from running away again when the duplicate switch is released.

(c) If complete electrical failure occurs control of the variable incidence tailplane is impossible. It is important therefore, before batteries are fully discharged, to reduce I.A.S., and set the tailplane to approximately —1° incidence which will give a compromise of trim for return flight and landing conditions.

94. **Hydraulic system failure (see para. 76 (c) (ii))**

(a) The only indication of failure of one hydraulic pump is a reduced rate of operation of the undercarriage. Warning of complete hydraulic pressure failure is given immediately by an audible warning signal over the pilot's head set.

(b) If complete hydraulic failure occurs, reduce speed to below 250 knots or 0.8M and select Manual control. Automatic reversion to Manual will occur in any event when the accumulators are exhausted if Manual control is not selected.

(c) Continuous and rapid use of the airbrakes at low r.p.m. may cause intermittent warning signals to be given, but should these signals be given during normal use of the airbrakes a partial hydraulic failure must be suspected. A careful watch should be maintained on the hydraulic accumulator gauges and the aircraft returned to base.

(d) The emergency handling of the undercarriage, flaps/airbrakes and flying controls is dealt with under these respective headings.

95. **Emergency operation of the powered controls**

NOTE.—If complete hydraulic failure occurs the two accumulators for the ailerons and elevator will last for sufficient time to regain straight and level flight at reduced speed.

(a) *Actions in the event of complete hydraulic failure, engine under power or windmilling:—*

Reduce speed below 250 knots or 0.8M and select aileron and elevator Power OFF. Do not use the airbrakes to reduce speed as should the accumulators become exhausted it will be impossible to retract them.

(b) *Actions in the event of engine failure—hydraulics serviceable:—*

(i) *Engine windmilling.* Sufficient hydraulic power should be available for power controls provided that unnecessary operation of airbrakes is avoided. Reference should be made to the hydraulic accumulator gauges to check available hydraulic pressure

remaining. Select elevator and aileron Power off before selecting normal or emergency undercarriage and flap down, if a wheels-down landing is being attempted.

(ii) *Engine seized.* Do not use the airbrakes to reduce speed. As soon as the aileron and elevator accumulators are exhausted the respective controls will revert to Manual, but in any case select elevator and aileron Power OFF before landing.

96. **Undercarriage and flaps emergency operation**

(a) (i) Although the emergency lowering systems will operate irrespective of the position of their normal selectors, the respective normal selector should whenever possible be set to the Down position before operating the emergency control. This will obviate any possibility of the service subsequently retracting should a fault occur in the emergency system.

(ii) Full flap only will be obtained regardless of the position of the limit setting switch.

(b) If either service fails to operate due to an electrical failure the appropriate emergency control should be operated. All other hydraulic services will then continue to operate normally.

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(c) In the event of hydraulic failure indicated by audio warning, power controls should be selected to Manual. The undercarriage should be lowered by pressing the emergency button on the rear face of the port console, after which the flaps may be lowered by use of the adjacent emergency flap lowering button.

(d) If the flaps are lowered on the emergency system it is probable that the flying controls will revert to Manual. Therefore it is preferable to select Manual prior to operating the flaps in this manner.

(e) If the undercarriage lowers when selected normally but three green lights are not obtained because of a micro-switch failure, or failure of an undercarriage lock to engage, operation of the emergency system will lower the hydraulic pressure available by approximately 1,000 lb./sq. in. Harsh movements of the power controls or use of airbrakes will then deplete the hydraulic accumulators and lead to Manual reversion. It is therefore recommended that if the emergency button is going to be used under these conditions power controls be selected to Manual first.

(f) To raise the undercarriage after use of the emergency system, reset the emergency button and select UP on the normal system. If hydraulic pressure is available, the undercarriage should retract.

(g) If it is necessary to retract the undercarriage whilst the aircraft is on the ground, rotate the UP selector button clockwise and press.

NOTE.—1. This must not be used to retract the undercarriage in the air if it is found that the UP button cannot be pressed in. In this case the wheels must be left down and the aircraft landed.

2. If the undercarriage has not been lowered by normal selection the air extractor valve will not be in the correct position. The engine should be shut down at the end of the landing run to prevent overheating.

97. **Wheel brakes emergency operation**

(a) The wheel brakes accumulator provides sufficient pressure for brake operation during landing down to a pressure of 1,750 lb./sq. in. approximately.

(b) If full brake is applied, the maxaret units will deplete the accumulators sooner than necessary. It is therefore recommended that a visual check of the brake gauge is kept and a steady application of approximately 600 lb./sq. in. is made. The amount of pressure remaining is shown by the top needle of the triple pressure gauge. Brakes will fail completely at approximately 1,750 lb./sq. in.

98. **Flapless landing**

A normal circuit and approach should be made and the threshold crossed at a speed 5 to 10 knots in excess of the normal final approach speed.

99. **Forced landing**

NOTE.—1. Unless the proposed landing area is known to be suitable in all respects it is recommended that the aircraft is abandoned.

2. The minimum height/airspeed combination for safe ejection in straight level flight is 100 ft./120 knots.

(a) The engine, unless it is damaged, will windmill at sufficient r.p.m. to provide power for the flying controls, but excessive and coarse control movements must be avoided to prevent using hydraulic pressure more rapidly than the pump can replace it.

(b) With a windmilling engine (1,800 r.p.m. at 200 knots), the generator r.p.m. are too low to provide power for all the electrical services. There will therefore be some drain on the batteries. Switch off all unnecessary electrical services.

(c) If committed to a forced landing on the airfield without power the recommended procedure is as follows:—

(i) Jettison the belly tank (if fitted) and the hood.

(ii) The best range gliding speed for the clean aircraft is 200 knots.

(iii) Aim to be over the airfield at 6,000 ft. (7,000 ft. in Manual) and downwind opposite the caravan at 4,000 ft. (4,500 ft. in Manual) A.G.L.

(iv) Maintain 200 knots until the turn on to the final approach has been completed.

(v) The final approach should be made at 190 knots. When it is certain that there is no possibility of undershooting or overshooting, the power controls should be set to off and emergency undercarriage and flap selected.

100. **Belly tank jettisoning**

The belly tank mechanical release is operated by pulling up the jettison handle, on the port shelf, after first releasing the safety catch. A nose-down pitch is apparent when jettison takes place. It is therefore recommended that a slight nose-up attitude is adopted before jettisoning at very low altitude. Belly tank jettison tests have been carried out between 180 and 550 knots.

101. **Ditching**

(a) Model tests indicate that except in calm sea and air conditions the pilot should bale out rather than attempt ditching.

(b) If ditching is inevitable, the attempt should be made at the lowest forward speed compatible with good control, full flap being used. The hood should be jettisoned prior to touchdown to prevent its jamming under fuselage distortion.

102. **Landing with an undercarriage unit not locked down**

NOTE.—Experience has shown that these techniques cause minimum damage to the aircraft and none to the pilot.

(a) *Both main wheels only locked down*

(i) Use up as much fuel as is safe in order to move the C. of G. as far aft as possible. Unless circumstances dictate otherwise land on a runway.

(ii) Check harness tight and locked.

(iii) Select hood open when crossing the threshold.

(iv) Make a powered approach at the normal speed; on touch-down turn the H.P. cock off and maintain a moderate nose-up attitude.

(v) Trim the tailplane to give full nose-up trim and as the speed falls below 100 knots maintain a high nose-up attitude without actually touching the tail cone on the ground.

(vi) Lower the nose on to the runway at approximately 80 knots and use the brakes gently to keep straight.

(b) *Nosewheel and one main wheel locked down*

If all attempts to lower the undercarriage satisfactorily fail and only the nosewheel and one main wheel come down, make a normal approach and landing; on touch-down turn the H.P. cock off and hold the wings level for as long as possible by use of the ailerons. When aileron is applied and when the wing finally drops, the aircraft will swing in the direction of the unlocked wheel; this should be counteracted as much as possible by opposite brake. Experience has shown that the distance from

the landing path to the point of rest averages approximately 250 yards, varying from 100 yards (min.) to 400 yards (max.). A runway should be chosen which has an area about 400 yards wide available in the direction of the anticipated swing.

(c) *Belly landing*

If it is necessary to land with the undercarriage retracted, jettison the belly tank. A normal approach should be made flying the aircraft on to the runway at the normal speed.

PART VI

OPERATING DATA

103. Loading and C.G. data

NOTE.—When making C.G. calculations reference should always be made to A.P.4348E Vol. 1 Sect. 2. Chap. 3.

(a) *C.G. limits*

The following are the C.G. limits with the undercarriage up.

Forward limit .. .. 5.5 ins. aft of datum.
Aft limit .. .. .. 9.6 ins. aft of datum.

(b) *Ballasting*

If any of the following are not installed, the aircraft must be ballasted according to the following table.

Item	No. of 10 lb. ballast weights (see NOTE 2)
Guns and fittings	14
D.M.E.	1
I.F.F.	1
V.H.F.	1 per set
G.G.S.	1
G.45 camera	1
F.95 nose or beam camera	2 per camera
F.95 gun bay camera	1 per camera

NOTE.—1. Five standard ballast weights must always be carried additional to those carried in lieu of equipment.

2. The ballast weight bars are each equivalent to one standard weight: the ballast pedestals

are together equivalent to one standard weight. Allowance must be made for the effect of either or both, e.g. if 14 weights are specified above, this is equivalent to 2 bars and 12 weights.

(c) *Effect of expendable stores*

(i) Firing ammunition causes the C.G. to move aft.

(ii) Use of belly tank fuel causes the C.G. to move slightly forward. Consumption of internal fuel causes the C.G. to move forward, the furthest forward position being reached when about 1,500 lb. (195 gallons) fuel remain. The C.G. then moves aft again.

(d) *Typical service loads*

Configuration	Weight lb.
Full external and internal fuel, full ammo. 3 cameras	21,250
Full internal fuel, full ammo., 3 cameras	19,200
Max. landing weight Full ammo. 3 cameras. 1,900 lb. fuel remaining No ammo. 3 cameras 2,300 lb. fuel remaining Full ammo. no cameras 1,960 lb. fuel remaining No ammo., no cameras 2,360 lb. fuel remaining	17,000

(e) *Baggage*

Personal luggage and small items of equipment may be carried in the empty ammunition tanks (170 lb. max. per tank) and in the equipment bays (50 lb. max. per bay). No alteration to ballast is required.

104. Pressure error corrections

(a) *A.S.I. sea level pressure error corrections*

I.A.S. Kts.	150	200	250	300	350	400	450	500	550	600
P.E.C.	—4	—3	—1	0	+1	+1	+1	0	—1	+1

(b) *Machmeter pressure error corrections*

Mach number	0·9	0·925	0·95	0·965	1·0
Corrn. S. L.	+·01	+·02	+·03	+·04	+·018
10,000 ft.	+·01	+·02	+·03	+·04	+·018
20,000 ft.	+·01	+·02	+·03	+·04	+·018
30,000 ft.	+·01	+·02	+·03	+·04	+·018
40,000 ft.	+·005	+·015	+·025	+·037	+·015

105. **Fuel consumptions**

The approximate fuel consumptions in lb./hour at various r.p.m. and altitudes are given below:

Height	Full Throttle		7,800 r.p.m.	7,550 r.p.m.
	Reheat	Non-Reheat		
Sea Level	22,800	9,000	8,100	6,600
10,000 ft.	17,100	7,200	6,300	5,400
20,000 ft.	12,600	5,400	4,800	4,200
30,000 ft.	9,000	3,900	3,600	3,300
40,000 ft.	6,000	2,700	2,400	2,100

106. **Take-off distances**

The following tables give the take-off distances in yards, clean and with belly tank, with and without reheat.

CLEAN AIRCRAFT, WITHOUT REHEAT

Temperature			I.S.A. —30° C.	I.S.A. —15° C.	I.S.A.	I.S.A. +15° C.	I.S.A. +30° C.
Sea Level	Zero wind	Ground run	1,080	1,250	1,510	1,860	REHEAT SHOULD BE USED.
		Dist. to 50′	1,610	1,910	2,280	2,680	
	30K wind	Ground run	680	785	950	1,170	
		Dist. to 50′	1,105	1,320	1,570	1,830	

Clean Aircraft, without Reheat—*contd.*

Temperature			I.S.A. —30° C.	I.S.A. —15° C.	I.S.A.	I.S.A. +15° C.	I.S.A. +30° C.
2,000′	Zero wind	Ground run	1,220	1,420	1,700	2,080	REHEAT SHOULD BE USED.
		Dist. to 50′	1,800	2,150	2,570	3,240	
	30K wind	Ground run	780	910	1,090	1,330	
		Dist. to 50′	1,250	1,505	1,800	2,000	
4,000′	Zero wind	Ground run	1,380	1,620	1,940	REHEAT SHOULD BE USED.	
		Dist. to 50′	2,020	2,400	2,880		
	30K wind	Ground run	900	1,060	1,270		
		Dist. to 50′	1,425	1,700	2,040		
6,000′	Zero wind	Ground run	1,560	1,850	2,220		
		Dist. to 50′	2,280	2,680	3,250		
	30K wind	Ground run	1,035	1,230	1,470		
		Dist. to 50′	1,635	1,920	2,325		

CLEAN AIRCRAFT, WITH REHEAT

Sea Level	Zero wind	Ground run	760	875	1,045	1,260	1,520
		Dist. to 50′	1,200	1,340	1,560	1,840	2,180
	30K wind	Ground run	480	550	660	790	955
		Dist. to 50′	835	925	1,070	1,260	1,490

Clean Aircraft, with Reheat—*contd.*

Temperature			I.S.A. —30° C.	I.S.A. —15° C.	I.S.A.	I.S.A. +15° C.	I.S.A. +30° C.
2,000′	Zero wind	Ground run	840	990	1,175	1,420	1,710
		Dist. to 50′	1,320	1,500	1,760	2,060	2,470
	30K wind	Ground run	540	635	755	910	1,100
		Dist. to 50′	930	1,050	1,230	1,430	1,720
4,000′	Zero wind	Ground run	950	1,120	1,340	1,600	1,920
		Dist. to 50′	1,400	1,680	2,020	2,360	2,800
	30K wind	Ground run	620	730	875	1,045	1,250
		Dist. to 50′	990	1,190	1,435	1,670	1,975
6,000′	Zero wind	Ground run	1,070	1,260	1,500	1,800	2,150
		Dist. to 50′	1,540	1,860	2,280	2,720	3,220
	30K wind	Ground run	710	835	995	1,195	1,430
		Dist. to 50′	1,100	1,335	1,645	1,910	2,320

WITH BELLY TANK, WITHOUT REHEAT

Sea Level	Zero wind	Ground run	1,340	1,600	1,900	2,300	SHOULD BE USED
		Dist. to 50′	1,960	2,340	2,840	3,420	
	30K	Ground run	865	1,035	1,230	1,480	
		Dist. to 50′	1,380	1,640	2,000	2,395	
2,000′	Zero wind	Ground run	1,520	1,820	2,180	REHEAT	
		Dist. to 50′	2,180	2,640	3,240		
	30K wind	Ground run	1,000	1,200	1,440		
		Dist. to 50′	1,535	1,875	2,315		

For higher altitudes reheat should be used.

WITH BELLY TANK, WITH REHEAT

Temperature			I.S.A. —30° C.	I.S.A. —15° C.	I.S.A.	I.S.A. +15° C.	I.S.A. +30° C.
Sea Level	Zero wind	Ground run	935	1,100	1,310	1,560	1,920
		Dist. to 50′	1,440	1,620	1,920	2,280	2,760
	30K wind	Ground run	605	710	845	1,010	1,240
		Dist. to 50′	1,020	1,135	1,345	1,600	1,930
2,000′	Zero wind	Ground run	1,070	1,250	1,490	1,790	2,160
		Dist. to 50′	1,540	1,860	2,230	2,640	3,130
	30K wind	Ground run	705	825	980	1,180	1,420
		Dist. to 50′	1,090	1,325	1,590	1,880	2,220
4,000′	Zero wind	Ground run	1,200	1,400	1,680	2,000	2,420
		Dist. to 50′	1,620	2,060	2,560	3,070	3,600
	30K wind	Ground run	805	935	1,125	1,340	1,620
		Dist. to 50′	1,155	1,485	1,855	2,230	2,600
6,000′	Zero wind	Ground run	1,320	1,560	1,880	2,270	2,710
		Dist. to 50′	1,680	2,260	2,880	3,500	4,180
	30K wind	Ground run	895	1,060	1,275	1,540	1,840
		Dist. to 50′	1,200	1,645	2,165	2,570	3,070

107. **Flight planning data**

(a) The tables on the following pages show the flight planning data for:—

(i) *Climbing*

The climb tables give the data for climbs in I.S.A. conditions using the speeds recommended in para. 74. (Repeated in Col. 1 of the tables.) The cruise data tables are based on reheat take-offs followed by non-reheat climbs. (Reheat climb data is given on page 98.)

(ii) *Cruising*

Each separate altitude block in the cruise table shows:—

(1) The speed for maximum range, the approximate A.N.M./100lb. and the approximate fuel consumption for the particular height. In addition a 95% range speed is given, use of any speed between it and the best range speed should not cause more than a 5% reduction in range.

(2) The range obtainable for various amounts of available fuel when flying at the best range speed for the height. The range given is to the point of let-down, allowance being made for the descent fuel required.

(3) The range obtainable for various amounts of available fuel, including the distance covered on the climb, if a climb is made to another altitude. In this case the climb must be made at the speed given in para. 74 and the flight continued at the new altitude at the best range speed for that height.

NOTE.—The range at any altitude is independent of temperature, but dependent on the weight of fuel carried.

(iii) *Descent*

The descent tables give the data for descending from one height to another.

(b) *Use of the tables*

(i) *Pre-flight planning*

Enter the cruise data table in the sea level block at the fuel state applying immediately after take-off. Select the height at which maximum range is available at that fuel state. The distance available includes distance covered on the climb, but not on the descent. (Absolute maximum range is obtained by adding on the descent distance, provided that the let-down is commenced at that distance from the destination.)

For short range flights inspect the sea level block and select the height at which the distance to be covered requires the least amount of fuel. This is the best altitude for the flight.

(ii) *In-flight planning*

At any stage of a flight the available range may be ascertained by applying the fuel state to the level flight range in the particular altitude block.

If an increase in range is required, or if a climb has to be made, the new available range may be obtained by entering the existing altitude block at the particular fuel state and moving vertically downwards within the block until the new altitude is reached. Figures in heavy type indicate the best altitude for the maximum increase in range. Above these heights no further range increase is possible. If a descent is necessitated, the new range is shown by moving direct from the existing altitude level flight range for the particular fuel state to the new altitude level flight range.

(c) *ANM per 100lb./T.M.N./R.p.m. curves*

The graphs on pages 99 and 100 show the ANM per 100lb., for various altitudes, plotted against True Mach Number. Superimposed on the curves are dotted lines which show the approximate r.p.m. required for a given speed.

CLEAN AIRCRAFT

CONTENTS:—506 gall. = 3,900 lb. (AVTAG)
4,048 lb. (AVTUR)
TAKE-OFF AND TAXY ALLOWANCE .. .. 350lb.
LANDING ALLOWANCE (excluding descent fuel) .. 460lb.

CLIMB DATA

From	To	Fuel (lb.)	Dist. (N.M.)	Mins.
Sea Level* (400 K)	5,000′	470	5	2
	10,000′	585	15	3¼
	20,000′	810	35	5¾
	30,000′	1,010	60	8¾
	40,000′	1,240	95	13¾
5,000′ (400 K)	10,000′	115	10	1¼
	20,000′	340	30	3¾
	30,000′	540	55	6¾
	40,000′	770	90	11¾
10,000′ (400 K)	20,000′	225	20	2½
	30,000′	425	45	5½
	40,000′	655	80	10½
20,000′ (0·8M)	30,000′	200	25	3
	40,000′	430	60	8
30,000′ (0·85 M)	40,000′	230	35	5

* In this block times are from wheels rolling. Fuel used includes taxy and take-off allowance. Climb at 7,800 r.p.m. to 20,000 ft., then at full throttle.

DESCENT DATA
(Excluding landing allowance)

From	To	Fuel (lb.)	Dist. (N.M.)	Mins.
40,000′	30,000′	15	5	1
	20,000′	30	10	1½
	10,000′	60	15	2½
	5,000′	100	20	3½
	Sea Level	175	30	5½
30,000′	20,000′	15	5	½
	10,000′	45	10	1½
	5,000′	85	15	2½
	Sea Level	160	25	4½
20,000′	10,000′	30	5	1
	5,000′	70	10	2
	Sea Level	145	20	4
10,000′	5,000′	40	5	1
	Sea Level	115	15	3
5,000′	Sea Level	75	10	2

R.P.M. — 6,000 down to 2,000′. Then 6,500.
AIRBRAKES — OUT.
SPEEDS — 0·79M to 33,000′. Then 270K reducing to 240K at 2,000′.

CRUISE DATA—CLEAN AIRCRAFT

FUEL STATE—LB.			3550	3400	3000	2600	2200	1800	1400	1000
Sea Level		Range	315	300	260	220	180	140	100	**60**
ANM/100 lb.	—10·2	5,000′	340	325	280	235	190	140	95	50
Lb./min.	—57	10,000′	375	355	305	250	200	145	95	40
Speed	—350K	20,000′	455	430	365	295	230	165	**95**	—
95% Range	—420K	30,000′	555	525	440	355	265	**170**	80	—
		40,000′	**620**	**580**	**475**	**370**	**265**	160	—	—
5,000 ft.		Range	—	330	285	240	195	150	105	**55**
ANM/100 lb.	—11·65	10,000′	—	365	315	260	210	160	105	50
Lb./min.	—51	20,000′	—	445	380	315	250	180	**110**	40
Speed	—350K	30,000′	—	540	455	370	280	**190**	100	—
95% Range	—380K	40,000′	—	**610**	**505**	**400**	**285**	180	—	—
10,000′		Range	—	370	320	270	215	165	110	**55**
ANM/100 lb.	—13·15	20,000′	—	455	390	325	260	190	120	50
Lb./min.	—48	30,000′	—	565	480	395	310	**220**	**130**	—
Speed	—330K	40,000′	—	**630**	**525**	**420**	**315**	210	105	—
95% Range	—0·7M									
20,000′		Range	—	—	400	335	270	200	130	60
ANM/100 lb.	—16·9	30,000′	—	—	505	420	335	245	**155**	**60**
Lb./min.	—42	40,000′	—	—	**560**	**455**	**350**	**245**	140	—
Speed	—310K									
95% Range	—0·8M									
30,000′		Range	—	—	525	440	355	265	**175**	**85**
ANM/100 lb.	—21·8	40,000′	—	—	**590**	**485**	**380**	**275**	170	65
Lb./min.	—36									
Speed	—0·8M									
95% Range	—0·85M									
40,000′		Range	—	—	—	**510**	**405**	**300**	**195**	**90**
ANM/100 lb.	—25·9									
Lb./min.	—30									
Speed	—0·81M									
95% Range	—0·85M									
FUEL STATE—LB.			3550	3400	3000	2600	2200	1800	1400	1000

WITH BELLY TANK

CONTENTS:—726 gal. = 5,590 lb. (AVTAG)
5,808 lb. (AVTUR)
TAKE-OFF AND TAXY ALLOWANCE .. .. 350lb.
LANDING ALLOWANCE (excluding descent fuel) .. 460lb.

CLIMB DATA

From	To	Fuel (lb.)	Dist. (N.M.)	Mins.
Sea Level* (400 K)	5,000′	485	5	2¼
	10,000′	620	15	3½
	20,000′	890	35	6¾
	30,000′	1,160	70	11
	40,000′	1,580	140	20½
5,000′ (400 K)	10,000′	135	10	1¼
	20,000′	405	30	4½
	30,000′	675	65	8¾
	40,000′	1,095	135	18¼
10,000′ (400 K)	20,000′	270	20	3¼
	30,000′	540	55	7½
	40,000′	960	125	17
20,000′ (0·8M)	30,000′	270	35	4¼
	40,000′	690	105	13¾
30,000′ (0·85M)	40,000′	420	70	9½

* In this block times are from wheels rolling. Fuel used includes taxy and take-off allowance. Climb at 7,800 r.p.m. to 20,000 ft., then at full throttle.

DESCENT DATA
(excluding landing allowance)

From	To	Fuel (lb.)	Dist. (N.M.)	Mins.
40,000′	30,000′	15	5	1
	20,000′	30	10	1½
	10,000′	60	15	2½
	5,000′	100	20	3½
	Sea Level	175	30	5½
30,000′	20,000′	15	5	½
	10,000′	45	10	1½
	5,000′	85	15	2½
	Sea Level	160	25	4½
20,000′	10,000′	30	5	1
	5,000′	70	10	2
	Sea Level	145	20	4
10,000′	5,000′	40	5	1
	Sea Level	115	15	3
5,000′	Sea Level	75	10	2

R.P.M. — 6,000 down to 2,000′. Then 6,500.
AIRBRAKES — OUT.
SPEEDS — 0·79M to 33,000′. 270K reducing to 240K at 2,000′.

CRUISE DATA—WITH BELLY TANK

FUEL STATE—LB.		5,240	5,000	4,000	3,000	2,000	1,000
Sea Level	Range	445	425	330	235	140	**45**
ANM/100lb.—9·3	5,000′	485	460	355	250	145	40
Lb./min. —58	10,000′	535	510	390	270	150	30
Speed —330K	20,000′	660	625	475	325	170	—
95% Range —400K	30,000′	830	785	585	385	**185**	—
	40,000′	**930**	**875**	**640**	**405**	170	—
5,000′	Range	—	470	365	260	155	**50**
ANM/100lb.—10·5	10,000′	—	515	400	280	160	40
Lb./min. —53	20,000′	—	645	495	340	190	35
Speed —310K	30,000′	—	805	605	405	**205**	—
95% Range —360K	40,000′	—	**900**	**665**	**430**	195	—
10,000′	Range	—	525	410	290	170	**50**
ANM/100lb.—11·8	20,000′	—	650	500	345	190	40
Lb./min. —50	30,000′	—	825	625	425	225	—
Speed —310K	40,000′	—	**930**	**695**	**460**	**225**	—
95% Range —360K							
20,000′	Range	—	—	525	375	220	**65**
ANM/100lb.—15·3	30,000′	—	—	655	455	255	55
Lb./min. —44	40,000′	—	—	**730**	**495**	**260**	—
Speed —290K							
95% Range —0·75M							
30,000′	Range	—	—	675	475	275	**75**
ANM/100lb.—20	40,000′	—	—	**760**	**525**	**290**	—
Lb./min. —37							
Speed —0·75M							
95% Range —0·81M							
40,000′	Range	—	—	**790**	**555**	**320**	**85**
ANM/100lb.—23·5							
Lb./min. —33							
Speed —0·78M							
95% Range —0·81M							
FUEL STATE—LB.		5,240	5,000	4,000	3,000	2,000	1,000

REHEAT CLIMB DATA

CLEAN

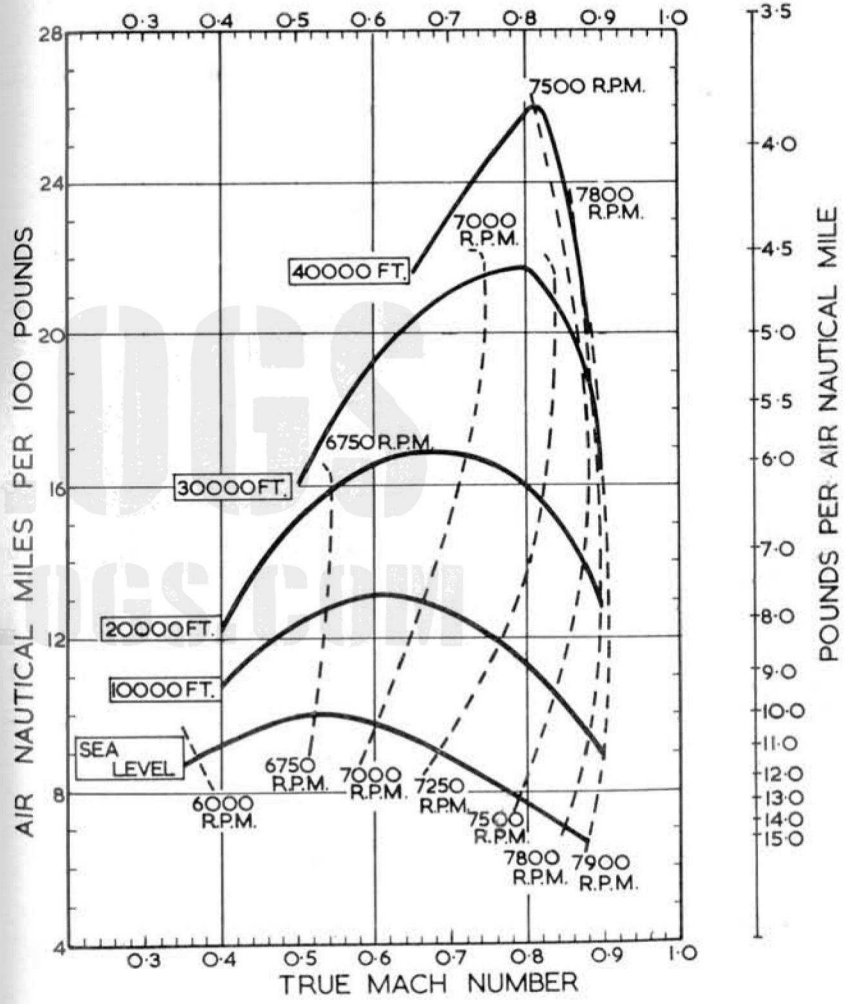
Height (feet)	Time (Minutes)	Distance (N. Miles)	Fuel (lb.)
S.L.	1	0	350
5,000	1·4	3	480
10,000	1·8	6	610
15,000	2·2	10	720
20,000	2·7	15	820
25,000	3·3	20	920
30,000	3·9	25	1,010
35,000	4·7	30	1,110
40,000	5·7	40	1,220

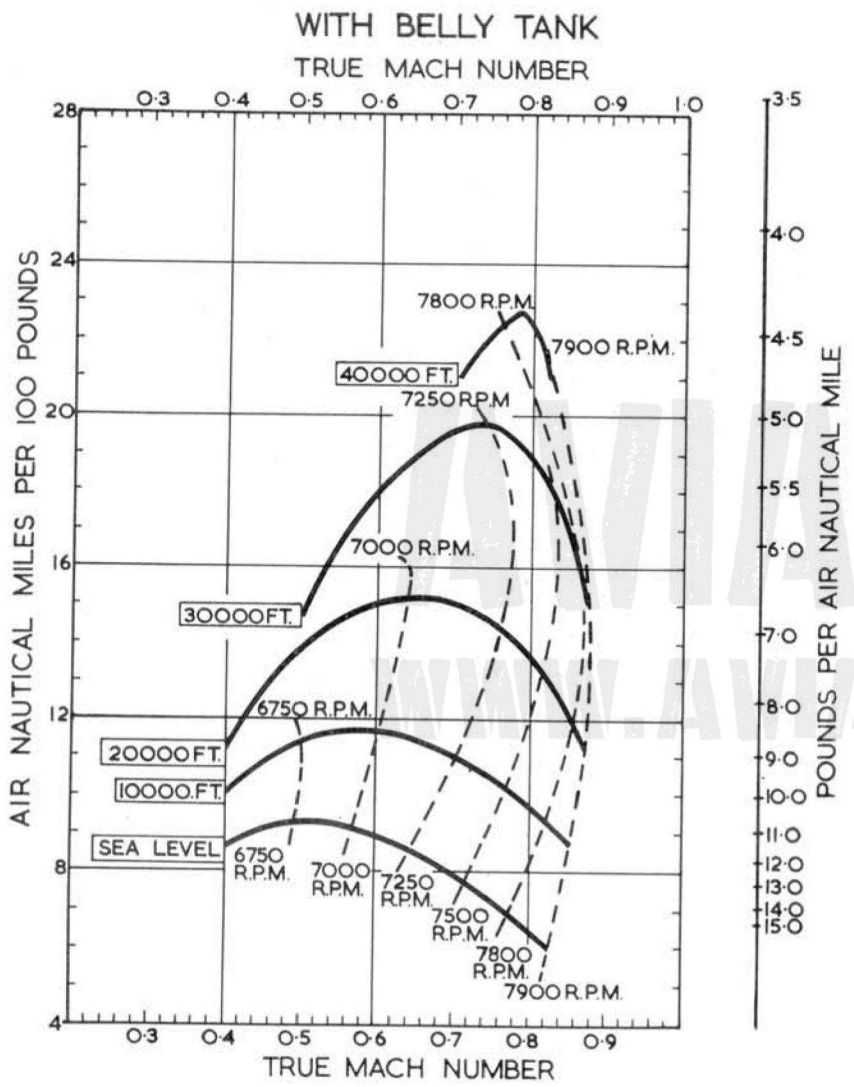
WITH BELLY TANK

Height (Feet)	Time (Minutes)	Distance (N. Miles)	Fuel (lb.)
S.L.	1	0	350
5,000	1·5	4	510
10,000	2·1	8	660
15,000	2·6	12	810
20,000	3·2	17	920
25,000	3·9	22	1,040
30,000	4·6	28	1,150
35,000	5·4	35	1,260
40,000	6·5	43	1,360

Times are from wheels rolling. Fuel used includes taxy and take-off allowance

CLEAN AIRCRAFT





PART VII

ILLUSTRATIONS

KEY TO FIGS. 1, 2 AND 3

1. Rudder trim switch
2. H.P. cock control
3. Belly tank jettison control
4. Flap emergency selector
5. Undercarriage emergency selector
6. Aileron trim switch
7. Cockpit vent
8. Tailplane incidence FAST/SLOW switch
9. Port main accumulator pressure gauge
10. Starboard main accumulator pressure gauge
11. Engine anti-icing switch
12. Windscreen demist switch
13. Cockpit pressure master switch
14. Cockpit temperature control switch
15. Tailplane incidence main trim isolation switch
16. Tailplane duplicate slow control switch
17. Rudder and aileron trim position indicators
18. Hood motor control switch
19. Cockpit temperature indicator
20. Tailplane incidence position indicator
21. Throttle lever. (NOTE—Protective cover on lever obscures flaps inching switch and press-to-transmit switch).
22. Flaps limit-setting switch
23. Flaps position indicator
24. Triple pressure gauge
25. V.H.F. controllers
26. V.H.F. changeover switch
27. Engine L.P. fuel cock
28. Reheat L.P. fuel cock
29. Tailplane incidence preselector switch
30. Battery isolation switch
31. Fuel master switch
32. Ignition switch
33. Starter master switch
34. Aileron power selector
35. Aileron power engaged green light
36. Fuel Take-off—Normal auto override switch
37. Pitot head heater switch
38. Inverter changeover indicator
39. Wheelbrakes boost switch
40. Hood jettison control
41. Undercarriage selector pushbuttons
42. Undercarriage position indicator
43. Reheat nozzle eyelids position indicator
44. Cockpit ventilating louvre
45. Zone 1 and 2 Fire warning light and pushbutton
46. Zone 4 and 5 Fire warning light and pushbutton
47. Reheat shut-off switch
48. Hot gas amber warning light
49. Air extraction failure magnetic indicator
50. G.G.S. emergency lowering control
51. Artificial horizon fast erection button

52. Power controls unsafe flashing red light
53. Cockpit pressure failure light
54. G.G.S. selector dimmer
55. Generator failure indicators
56. F.95 camera switches and lights
57. D.M.E. range and heading meter
58. Fuel flow failure indicators
59. Fuel pressure warning indicators
60. Fuel contents gauge
61. Fuel Auto/Retrim switch and indicators
62. Elevator power engaged green light
63. Belly tank empty indicator
64. Elevator power selector
65. Starter pushbutton
66. Mk. 17 demand oxygen regulator
67. Oxygen contents gauge
68. Cockpit altimeter
69. Tailplane incidence control switch
70. Camera pushbutton
71. Wheelbrakes control
72. Aileron artificial feel trim
73. F.95 cameras window control switch
74. G.45 camera aperture switch
75. G.45 camera master switch
76. Cockpit pressure warning horn override switch
77. Emergency lamp switch
78. Cockpit ventilating louvre
79. Navigation lights switch
80. Cockpit lamps switches
81. F.95 cameras footage indicators
82. F.95 cameras iris setting control
83. F.95 cameras heater switch
84. F.95/G.45 camera selector switch
85. Hydraulic audio warning test and override switch
86. Hood motor clutch control
87. Cockpit lamps switches
88. Windscreen de-icing control
89. D.M.E. control panel
90. Telebriefing light and push switch
91. Main oxygen/seat supply tube clip
92. Anti-G control (Test button aft on bulkhead)
93. Rudder pedals adjustment control
94. Emergency oxygen supply manual control

NOTE.—The following are not keyed: Relight button, hood jettison indicator, G.G.S. master switch.

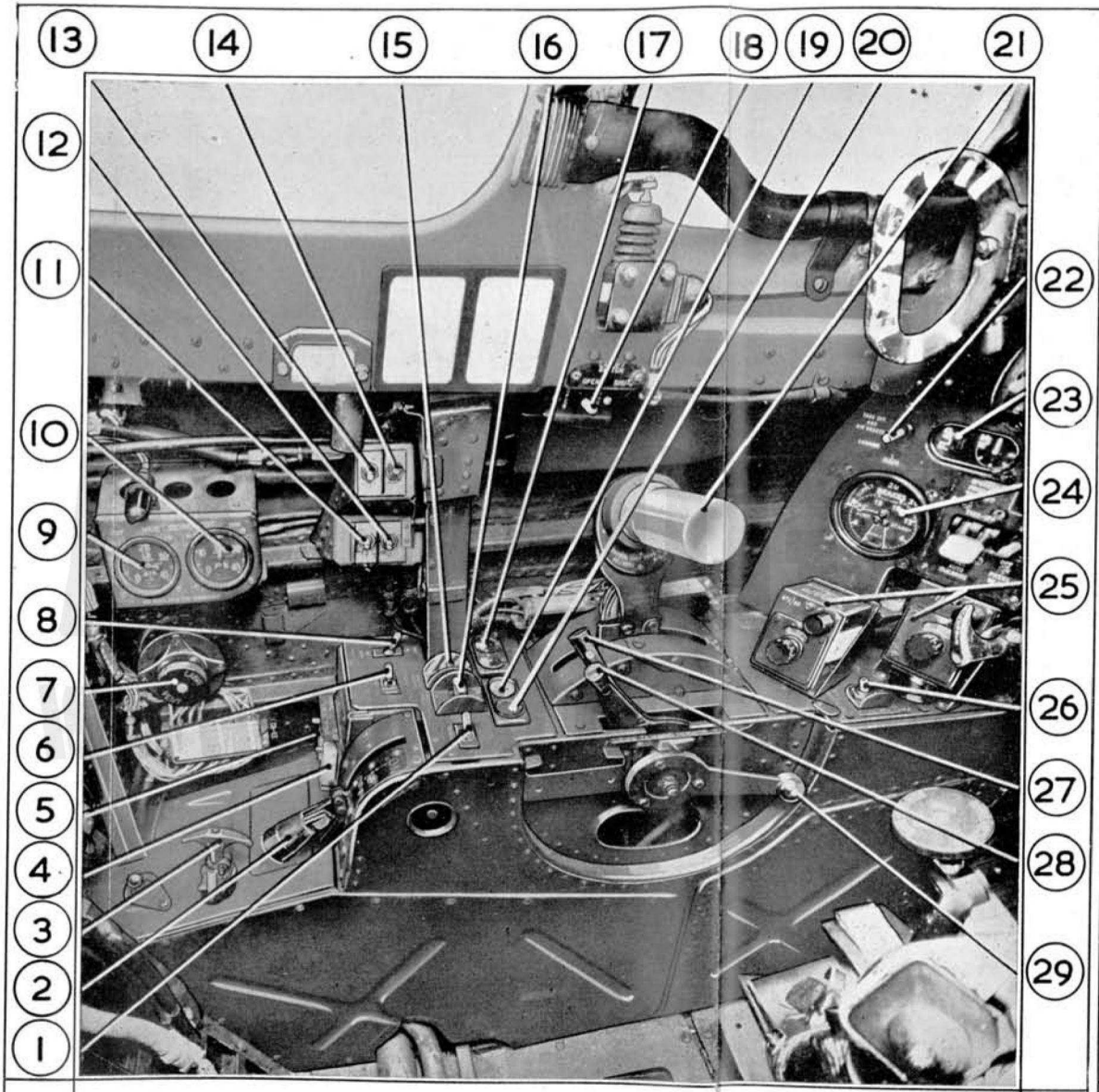


FIG 1

COCKPIT — PORT SIDE

FIG 1

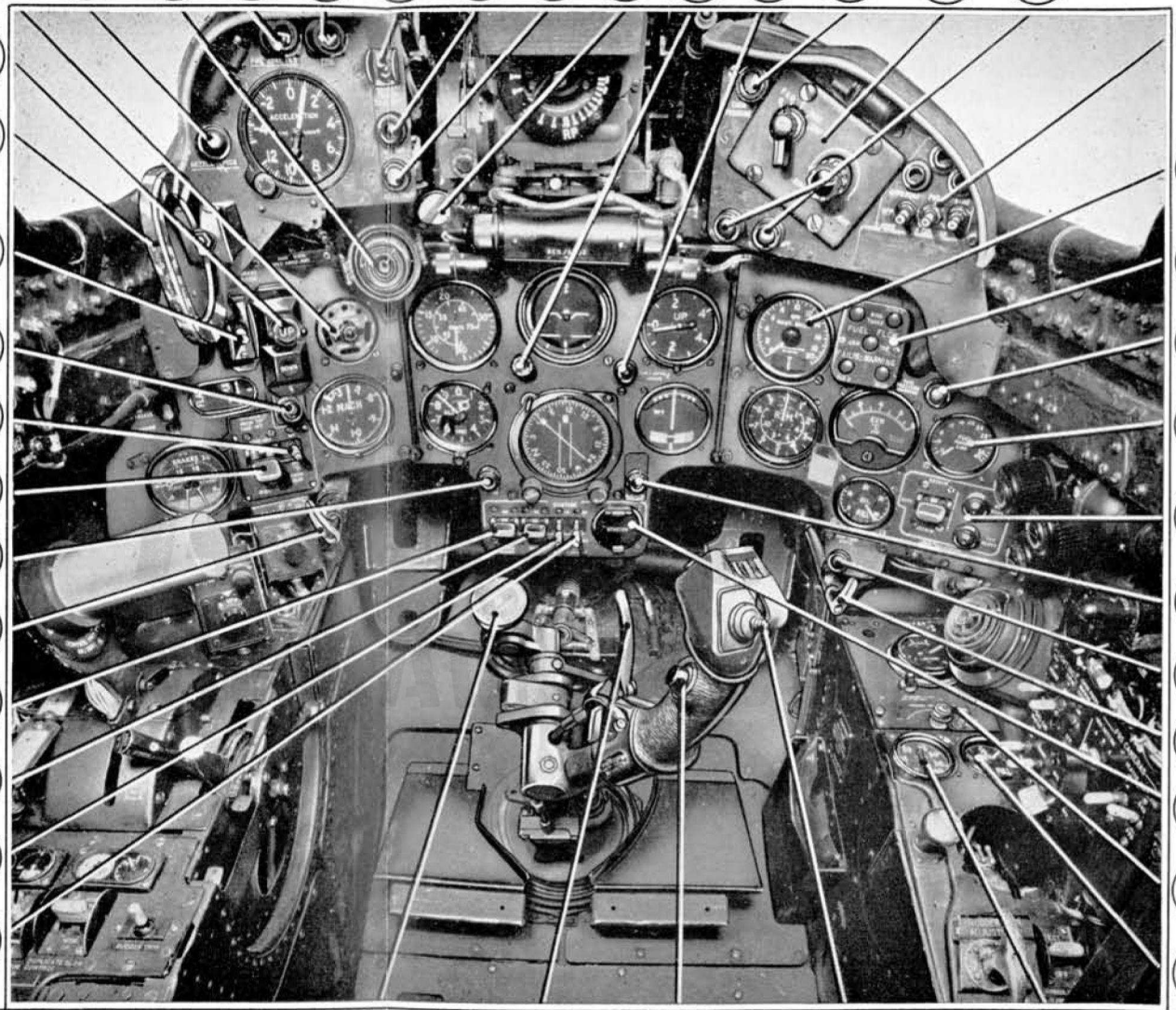


FIG 2

COCKPIT — FORWARD VIEW

FIG 2

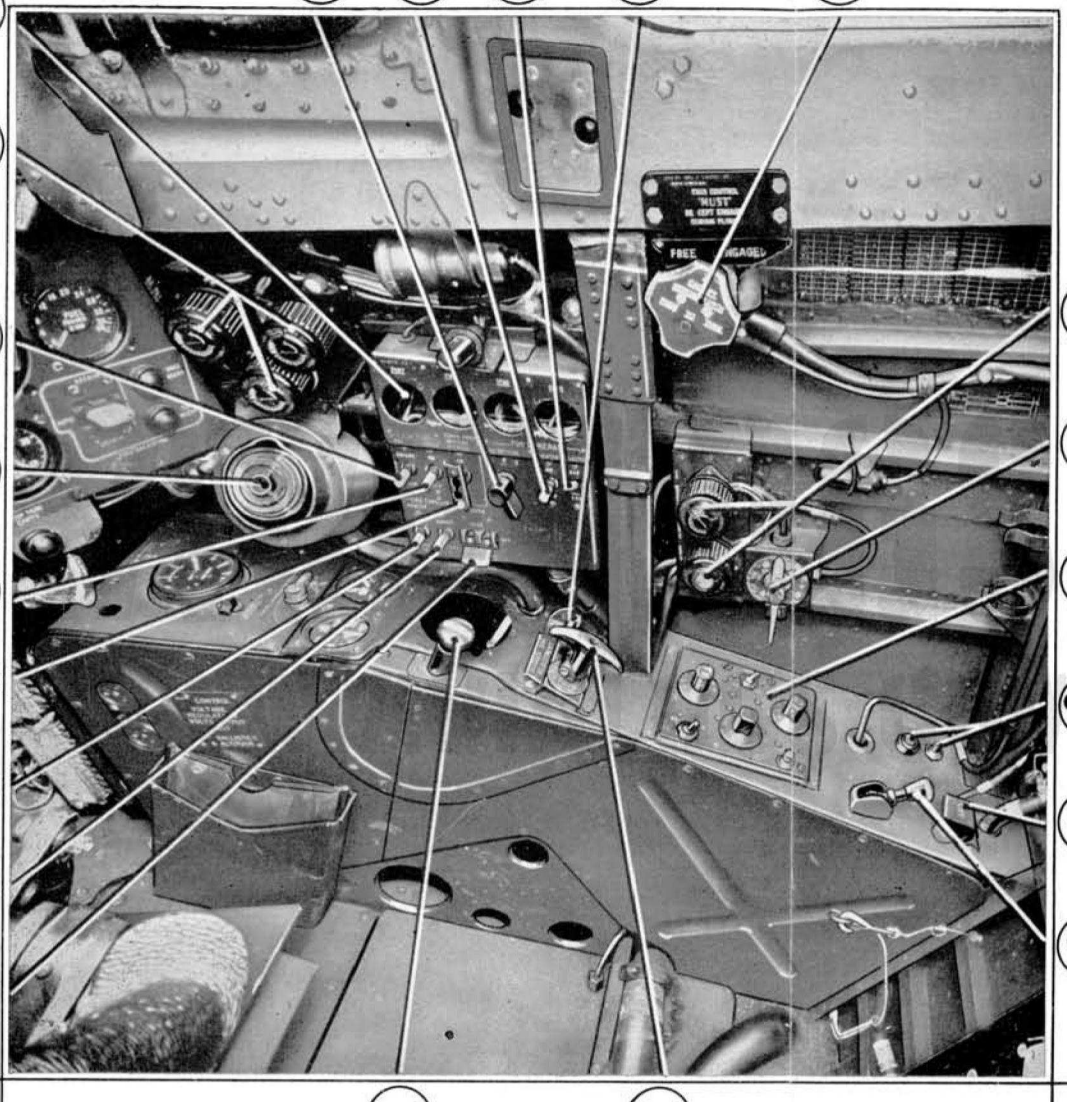


FIG 3

COCKPIT — STARBOARD SIDE

FIG 3

EMERGENCY DRILLS

MANUAL REVERSION
(intentional)

Max. speed	250 knots or 0·80M
Tailplane	In trim
Aileron trim	Neutral
Selectors	Power off, aileron followed by elevator.

ACTION IN THE EVENT OF FIRE

1. Close throttle immediately
2. If light stays on:—

H.P. cock	Off
L.P. cocks	Off
Fuel Master switch	Off

3. Reduce speed and press appropriate extinguisher button.
4. If fire goes out, light goes out.
5. Do not relight.
6. Carry out forced landing or abandon.

IF FIRE PERSISTS ABANDON.

HOT GAS WARNING

Cancel reheat and reduce speed below 0·92M.

HYDRAULICS FAILURE

Flying controls	Select Manual
U/C and Flaps	Lower on emergencies
Wheel brakes	Limited use.

FORCED LANDING

Best gliding speed	200K.
Airbrakes	IN
H.P. and L.P. cocks	OFF
Fuel master switch	OFF
Belly tank and hood	Jettison
All non-essential electrics	OFF

Approach at 190 Knots.

When certain of landing select Manual and lower U/C and flaps on emergencies.

ENGINE FAILURE

1. Seizure

Throttle	Close
H.P. cock	Off
L.P. cocks	Off
Non-essential electrics	Off

Carry out forced landing or abandon.

2. Flame-out

H.P. cock	Off
Throttle	Closed
Eng. L.P. cock	Leave on
R/H L.P. cock	Closed
All non-essential electrics	Off

Descend below 35,000 ft.

RELIGHTING

Height	Below 35,000 ft.
Speed	200K above 25,000 ft. 0·80M below 25,000 ft.
Battery Isol	ON
Starter master	ON
Ignition	ON
Fuel master	ON
Fuel override	TAKE-OFF
Reheat L.P. cock	Closed

Press relight button (30 secs. Max.) and open H.P. cock simultaneously. Release button when r.p.m. rise by about 200.

FAILURE TO RELIGHT

H.P. cock	Off
Throttle	Closed
L.P. cocks	On
Fuel master	Off
All non-essential electrics	Off

Try again at lower altitude keeping airspeed as low as possible

Inside back cover. U/C and Flaps Emergency. A.L.1

UNDERCARRIAGE AND FLAPS EMERGENCY

1. **Select Manual. Then lower the flaps and/or undercarriage by using the emergency buttons.**
2. **U/C up on the ground—Reset emergency button and use normal selector.**

[OVER]

EMERGENCY DRILLS—Contd.

Outside back cover.
Abandoning. A.L.1

ABANDONING

1. Reduce speed to 250 knots, jettison hood, retract G.G.S.
2. Feet in footrests, head on rest.
3. Pull blind handle.
4. Auto separation at or below 10,000 ft.
   MIN. HEIGHT/AIRSPEED
   With G stop—Ground level/90 knots
   Without G stop—200 feet/120 knots

If auto separation fails, operate Override D-ring and seat harness release. Raise flap and grasp rip cord D-ring. Push clear of seat and pull D-ring.

If seat fails to eject, pull Override D-ring and proceed as on a/c without ejection seat.

CHECK LISTS

FINAL CHECKS FOR TAKE-OFF

Trims	All neutral
Airbrakes	Switch at TAKE-OFF and select out.
Fuel	High and low pressure cocks on. Reheat top temperature control—OVERRIDE. Fuel auto override switch—TAKE-OFF (NORMAL if no fuel in belly tank) Reheat shut off switch—NORMAL Fuel master switch—ON Fuel flow and pressure indicators, black. Contents sufficient. Balance switch to AUTO. Belly tank indicator white.
Flaps	No creep from take-off position.
Instruments	Check all. Pressure head heater switch—ON.
Oxygen	100%, blinking, contents, connections.
Harness	Tight and locked.
Hood	Closed, switch at OFF, pointer safe, clutch engaged.
Hydraulics	Flying controls free and correct movement—2 green lights—no flashing red light—3150 ± 150 lb./sq. in. on 3 gauges.

FINAL CHECKS FOR LANDING

Airbrakes	Out.
Undercarriage	Down below 250 knots—3 green lights. Trim out yaw.
Fuel	Contents.
Flaps	Limit switch to LANDING.
Harness	Tight and locked.
Brakes	Operate on/off, check pressures, check lever fully off, pressure at each wheel exhausted and brake boost OFF.

Switch off pressurisation before joining circuit.

THRESHOLD SPEEDS

Light weight	140K.
Max. landing wt.	145–150K.
Overload wt.	160K.

INSTRUMENT APPROACH

	Speed	Flap	R.p.m.
DOWNWIND	200	T.O.	7,200
BASE LEG	200	T.O.	7,200
GLIDE PATH	170	Full	6,800

ENGINE LIMITATIONS

Take-Off (10 mins.)	7,900 ± 50 700°C.
Intermediate (30 mins.)	7,800 685°C.
Max. continuous	7,550 645°C.
Ground idling	2,750 ± 100 550°C.