2nd Edition

A.P. 4491 D—P.N.

RESTRICTED

Pilot's Notes

Javelin F. (A.W.) Mk 4

RESTRICTED

AMENDMENTS

Amendment lists will be issued as necessary and should be inserted in the appropriate place in the Notes. New or amended paragraphs will be indicated by triangles positioned in the text thus: ◀.................▶ to show the extent of the amended text, and thus: ▶◀ to show where text has been deleted. When a page is issued or re-issued by amendment the number of the Amendment will appear at the bottom of the page. When a chapter is issued or re-issued in a completely revised form the triangles will not appear. Incorporation of an Amendment list must be certified by inserting the date of its issue, the date of incorporation and signature below.

Admt. list		Signature	Date of incorporation	Amdt. list		Signature	Date of incorporation
No.	Date			No.	Date		
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			

Comments and suggestions regarding Pilot's Notes should be forwarded to the Officer Commanding, Handling Squadron, Royal Air Force, Boscombe Down, Wiltshire.

NOTES TO USERS

1. These Notes, which are complementary to A.P.129 (6th Edition), Flying, should be read in conjunction with the Javelin Operating Data Manual. 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.

2. 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 APFS. (See A.P.113A). The number of the publication must be quoted in full:—A.P.4491D–PN.

3. Comments and suggestions should be forwarded to the Officer Commanding, Handling Squadron, Royal Air Force, Boscombe Down, Wiltshire.

4. The limitations quoted in Part II are mandatory and are not to be exceeded. The contents of other Parts of the book are mainly advisory, but instructions containing the word "must" are to be regarded as mandatory. (AMFO 101 refers).

5. Throughout this publication the following conventions apply:—

(a) Words in capital letters indicate the actual marking on the controls concerned.

(b) The numbers quoted in brackets after items in the text refer to the illustrations in Part VI.

(c) Unless otherwise stated, all airspeed, Mach numbers and accelerometer readings quoted are "Indicated".

(d) Fuel poundage figures are all calculated at 7.7lb./gallon. (Normal AVTAG).

LIST OF ASSOCIATED AIR PUBLICATIONS AND DIAGRAMS

Title	A.P.
Aden 30 mm guns	1641S
Aircraft hydraulic equipment	1803 series
Aircraft pneumatic equipment	4303 series
Aircraft pressurising and air conditioning equipment	4340
Aircrew equipment assemblies (R.A.F.) ...	1182
Ejection seats and escape equipment ...	4288 series
Electrical equipment manual	1095 series and 4343 series
Instrument manual	1275 series
Javelin Mk. 4 servicing manual Vol. 1 ...	4491D
Powered flying control units and equipment—Lockheed	4602A
Powered flying control units and equipment—Hobson	4604A
Pressure refuelling equipment	4511
R.A.F. Engineering	1464 series
Safety equipment manual	1182 series
Sapphire Mk. 10201 and 10301 Series ECU	4355 B & C
Signals manual	1186 series

	A.D.
Electrical installation	6059
Fuel system	6069 Sheets 1 & 2
Flying controls and lubrication	6070
Air conditioning system	6072
Hood mechanism	6073
Miscellaneous lubrication	6074
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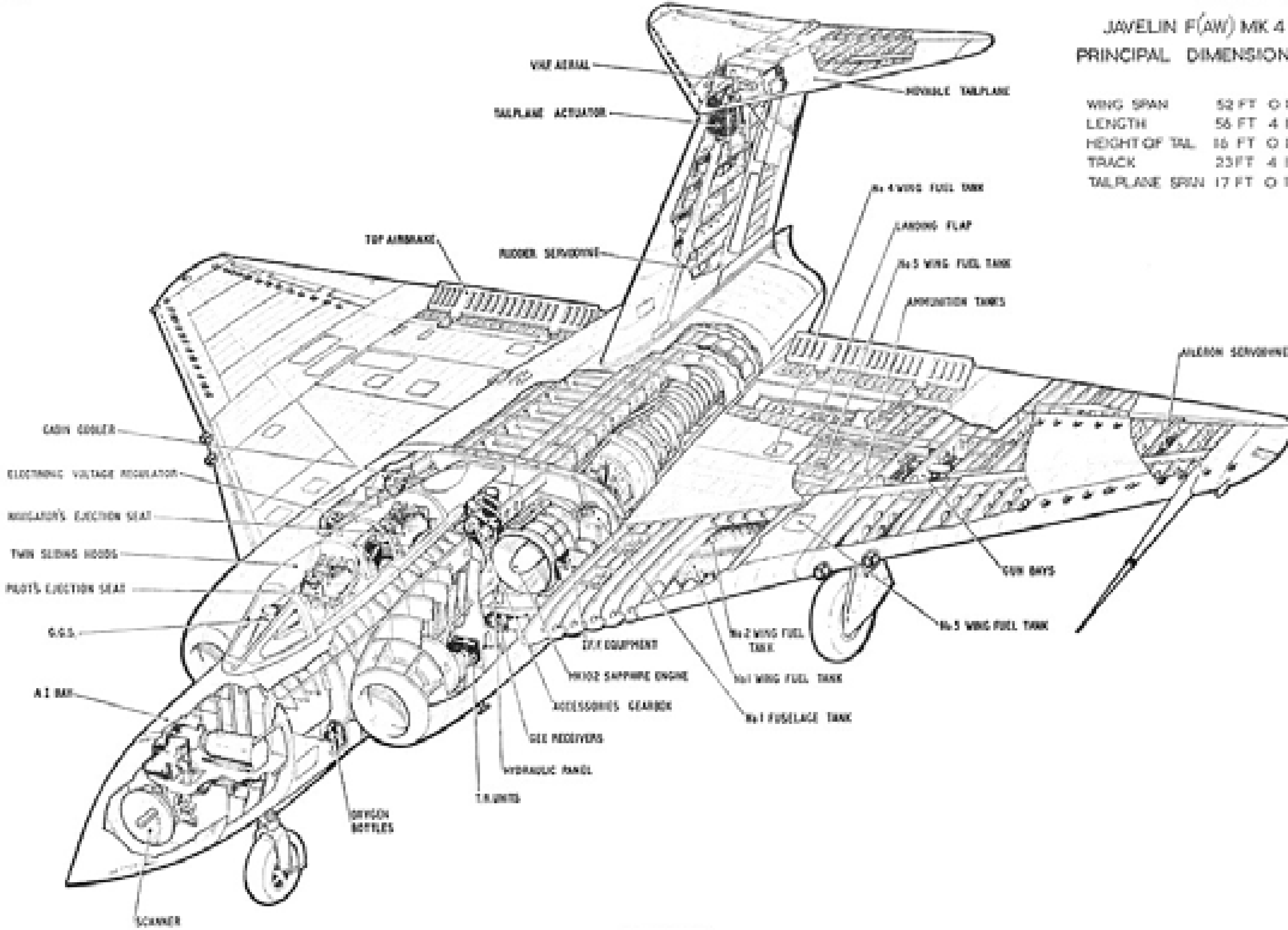
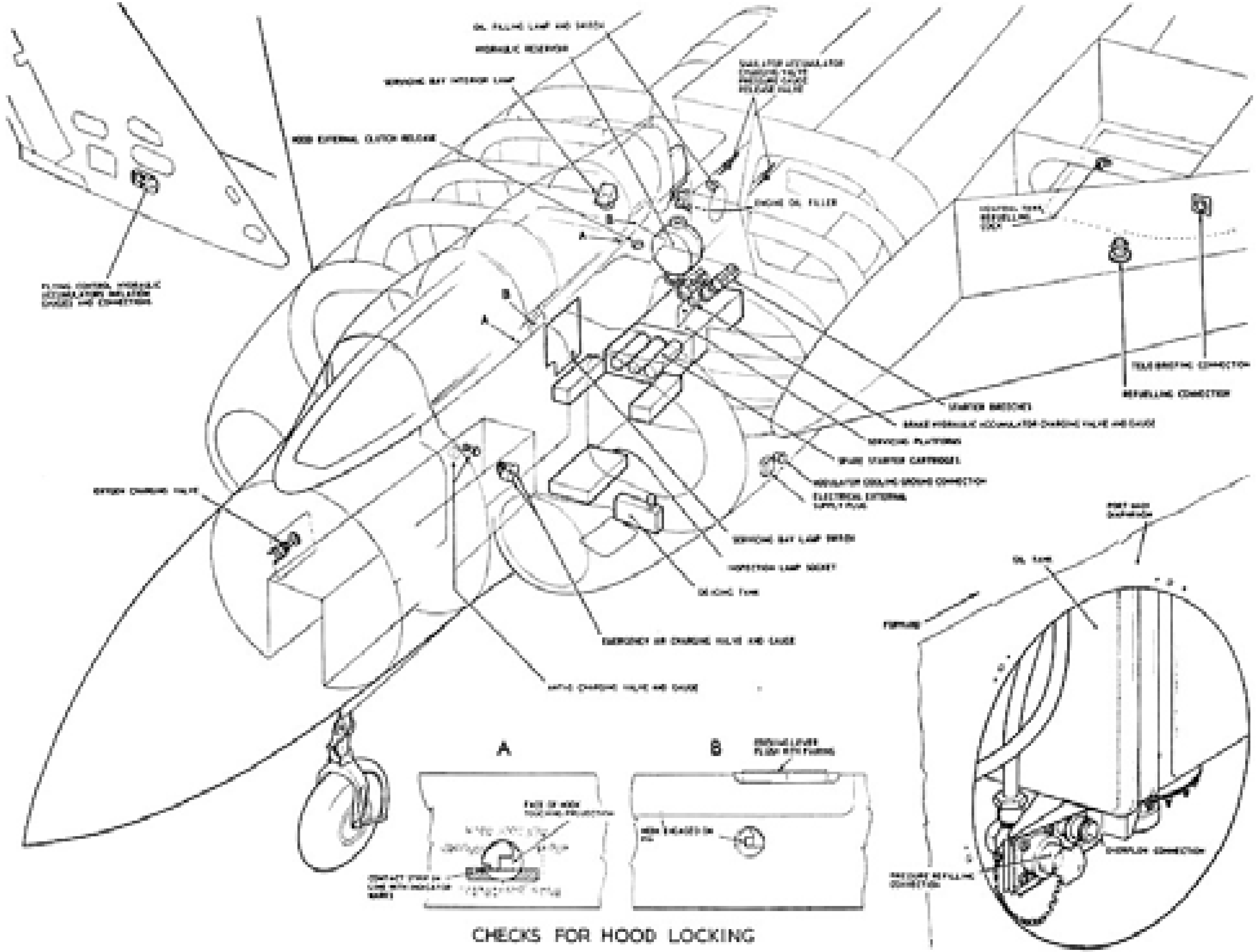
Alighting gear	6076
Gun installation and method of re-arming ...	6077
Hydraulic system	6078 Sheets 1 & 2
Flap and airbrake balancing systems ...	6079
Jet-efflux	6648

JAVELIN F(AW) MK 4
PRINCIPAL DIMENSIONS

WING SPAN	52 FT 0 INS
LENGTH	56 FT 4 INS
HEIGHT OF TAIL	16 FT 0 INS
TRACK	23 FT 4 INS
TAILPLANE SPAN	17 FT 0 INS





JAVELIN MK 4 SERVICING POINTS

RESTRICTED

JAVELIN F(AW) Mk. 4

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INTRODUCTION

1. The Javelin Mk. 4 is a twin-engine, two seat mid-wing all-weather fighter aircraft, having delta-shaped wings and a fully-powered swept-back tailplane with follow-up elevators. Full-power ailerons and a power assisted rudder are fitted.

Hydraulic supplies to the tailplane and ailerons are duplicated; the rudder has manual reversion, should its power supply fail. The cockpits are equipped with ejection seats and forced hood-jettisoning.

2. The power units are one Sapphire Mk. 102 and one Mk. 103 axial-flow gas turbine engines, each developing (approximately) 8,150 lb. static thrust at sea-level. A shaft from each engine drives a common auxiliary gearbox mounted in the fuselage between the engines. A free-wheel device is incorporated so that the gearbox is driven by the faster turning engine The gearbox drive three hydraulic pumps and two generators.

3. A servicing bay in the fuselage, accessible from a manhole under the fuselage, has three fixed servicing platforms and provides access to the engines, the starter system and auxiliary gearbox. A hydraulic panel on the port side includes the reservoir, and accumulator charging valves and gauges. A hand pump is provided at the forward end of the servicing bay. The bay is illuminated by a lamp with an integral switch.

4. Two Aden 30 mm. guns are installed in each wing outboard of the wheel bays. AI is carried.

5. All flying limitations, and temporary restrictions relating to the operation of this aircraft are listed in Part II.

6. The various panels, etc. in the pilot's cockpit on which the pilot's controls and instruments are located are referred to in these Notes as follows:—

(a) The port console.

(b) The port instrument panel (forward of the port console).

(c) The panel under the port coaming.

(d) The panel to the left of the centre instrument panel.

(e) The centre instrument panel.

(f) The panel under the starboard coaming.

(g) The starboard instrument panel (forward of the starboard console).

(h) The starboard console.

7. Access to either cockpit is normally gained from the port side of the aircraft by means of an access ladder, which is part of the ground equipment. Footsteps, also hand-holes and walkways on the port rear fuselage and wing provide a means of entry if the ladder is not available. The retractable footstep remains extended only when there is a weight on it. The remaining footsteps and hand-holes are fixed and are covered by spring-loaded plates.

8. Modifications

(a) This Edition, which includes the basic information given in the 1st Edition, assumes that the following Modifications have been embodied:—

Mod. No.	Effect of Modification
57	Strengthened main undercarriage, etc.
664	Rudder power selector lever deleted.
703	Introduction of per cent RPM indicators.
728	Introduction of new control handle and double-pole trimming.
722	Introduction of ventral tank refuelling isolation cocks.
731	Repositioning of VHF controllers to panel under the port coaming.
792	Introduction of flashing navigation lights.
926	Introduction of oxygen regulator Mk. 17D.
1032	Flowmeter loads are shed when No. 1 flight instruments inverter fails.
1098	Introduction of third hydraulic failure warning light.
1194	Introduction of improved collector tank vent valves and vent pipes of larger diameter.

(b) In addition, reference is made in the Notes to the following Modifications:—

Mod. No.	Effect of Modification
655	Type 201A inverter replaced by Type 201B.
689	Control of cabin temperature becomes semi-automatic only: i.e. Only the hot/warm mixture is automatically controlled.
Sa817	Introduction of Nimonic 105 turbine rotor blades.
996	Telebriefing may be used with battery isolating switch off.
1026	Stall warning flags replaced by vanes.
1311	Type 103 inverter replaced by Type 103A.
1451	Introduction of oxygen regulator Mk. 17E.

9. Special flying instructions

This Edition also includes the following Special Flying Instructions:—Javelin/32, 36, 38, 39, 42 and 51, and Ejection seats S/14.

February, 1961.

PART I—DESCRIPTION AND MANAGEMENT OF SYSTEMS

LIST OF CHAPTERS

PART I

Chapter 1—FUEL SYSTEM

List of Contents

1. Fuel tanks

(a) Fuel is carried internally in fourteen flexible tanks fitted within metal casings. There are five tanks in each wing, two fuselage tanks, and two collector tanks in the fuselage. Two ventral tanks may be carried under the fuselage. The group of tanks in each wing together with its adjacent fuselage tank, and ventral tank if fitted, supply the collector tank from which fuel is fed to its own engine, thus forming an independent system for each engine. The three-position LP cocks, however, permit either engine to be fed from both systems if the other engine is stopped.

(b) Approximately 385 lb./50 gall. of fuel is unusable. This is not included in the capacity quoted below, nor is it gauged.

(c) The approx. effective tank capacities are:—

	Weight (lb.) at 7.7lb./gall.	Gall.
Internal tanks including collector tanks (total usable)	5,890	765
Two ventral tanks when carried (total)	3,850	500
Total (internal and ventral tanks)	9,740	1,265

2. Fuel transfer system and indicators

(a) Fuel is transferred into the collector tanks from all the remaining tanks by air pressure supplied from both engines. A higher air pressure supply to the ventral tanks ensures transfer of fuel from these tanks before that of the internal tanks.

(b) (i) On each side, the fuel from the fuselage side tank and all the wing tanks except No. 3 flows through a flow-proportioning valve so that the tanks empty at approximately equal rates for all normal aircraft attitudes, thus maintaining the C of G within a small range. The flow from No. 3 tank, being on the C of G, is taken to the outlet of the flow-proportioning valve, and joins the main supply to the collector tanks. This tank normally empties before the other wing tanks. When empty, the air shut-off valve in the tank should close.

(ii) Fuel from each ventral tank is transferred to the main supply line and then to the associated collector tank down-stream of the flow-proportioning valve. When empty, the air shut-off valve in the tank should close.

(c) Two fuel transfer air-pressure warning indicators (72), one for each side at the bottom of the centre instrument panel, normally show black in flight.

(d) If the air pressure has failed, or has fallen below that required for full-throttle operation, indicated by either or both magnetic indicators turning white, the engine(s) should continue to run satisfactorily, but if the following RPM are exceeded fuel will be used from the collector tank quicker than the wing tanks can keep it topped up, and eventually the engine(s) will flame out:—

Sea-level	82%
20,000 feet	93%
Above 35,000 feet	No limit.

If air transfer pressure to the ventral tanks fails, the fuel in these tanks will be unusable.

3. Main fuel-feed system

(a) Each collector tank contains an electrically-driven booster-pump, which incorporates an inverted flight valve, and a gravity by-pass pipe to permit the HP pump to draw fuel from the tank, should the booster-pump fail.

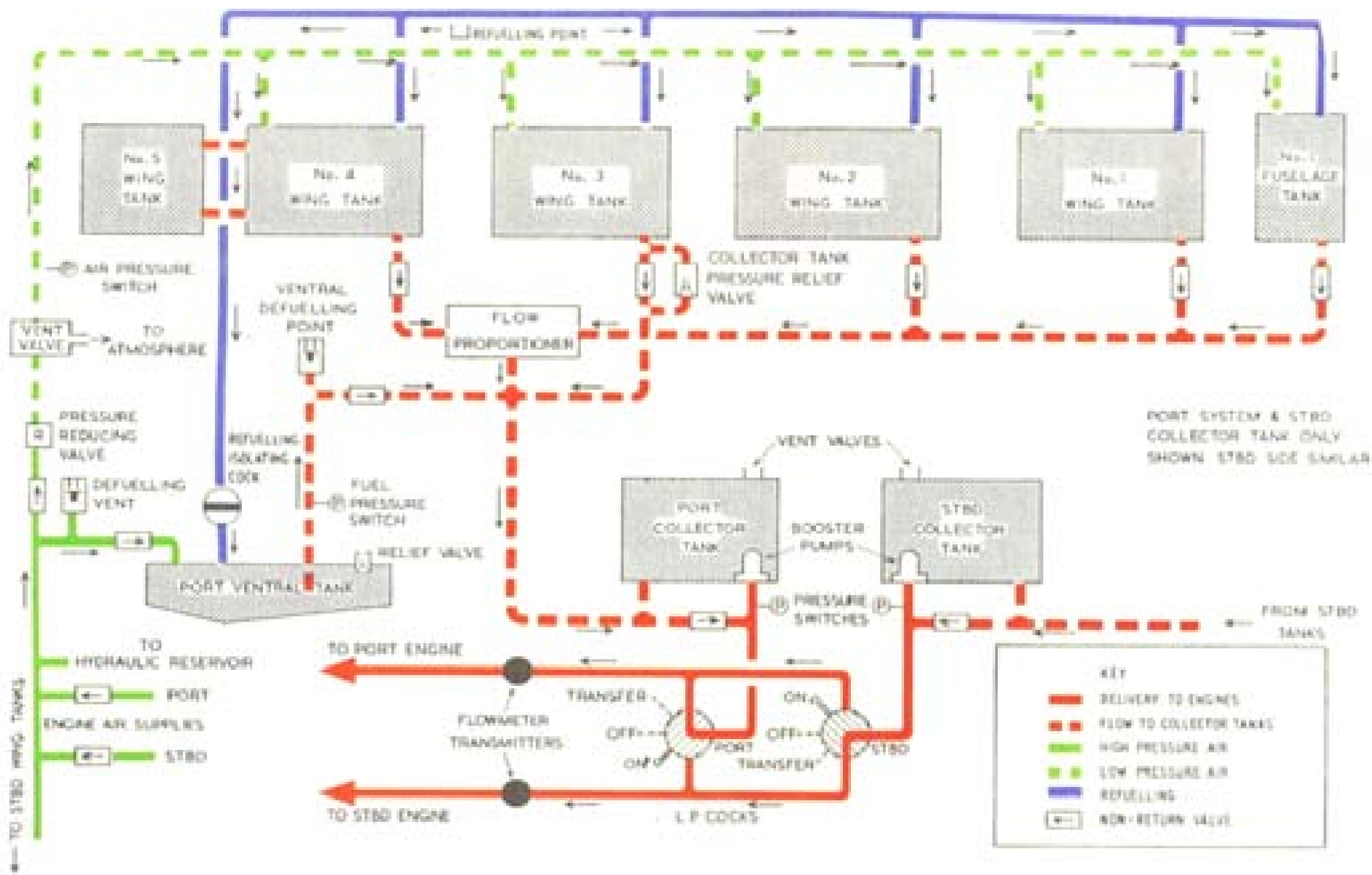

Fig. 1—Simplified fuel system diagram

(b) The booster-pump delivers fuel from the collector tank to its respective LP cock and, depending upon the setting of this cock, fuel may be supplied to the HP cock and HP pump on either engine.

4. Booster-pump controls and indicators

(a) Two booster-pump circuit-breakers (at 103) on the starboard console control the booster-pumps in the collector tanks. They also provide an electrical supply to the starter master switch and each must be closed before the starter circuit of its respective engine will operate.

(b) There are two booster-pump magnetic indicators (82) on the starboard console. If a booster-pump is inoperative its indicator shows white.

5. Ventral tanks control and indicators

(a) Two ventral tank transfer indicators (26), on the throttle-box, show white when fuel transfer from the ventral tanks has failed, when the ventral tanks are empty, when they have been jettisoned, or if they are not fitted. They show black when normal transfer is taking place.

(b) Both ventral tanks may be jettisoned mechanically, in straight and level flight, at any speed within the limitations, by pulling the T-handle (29) on the side of the throttle-box. The tanks cannot be jettisoned separately.

6. LP fuel cocks

(a) Two LP fuel cock levers (1) are fitted on the port console. With the levers at ON (forward), the port group of tanks feed the port engine, and the starboard group of tanks feed the starboard engine. With the levers at OFF (central) there is no flow through the cocks. With a lever in the TRANSFER position, fuel is shut off to the engine on that side and fed to the other engine. When a lever is in the TRANSFER position fuel will be drawn from each wing if both booster-pumps are on, or if both booster-pumps are off. If however, one booster-pump is switched off, only a small amount of fuel will be used from that side until the other side is empty.

(b) If an engine is stopped, fuel can be made available to the live engine by moving the LP cock of the stopped engine to the TRANSFER position. Before doing this ensure that the HP cock of the engine to be shut down is turned OFF. The HP cock of an engine should never be put ON in flight when its LP cock is in the OFF or TRANSFER position.

(c) When transferring fuel, both booster-pumps should normally be left on. (See para. 10(d) of this Chapter.)

7. Fuel tank shut-off valves and collector tank vent valves

(a) Shut-off valves in each internal tank and in the ventral tanks close when the tank is empty, thus preventing air being supplied to the associated collector tank.

(b) (i) A collector tank pressure-relief valve, which bypasses the non-return valve in the pipe-line from No. 3 tank, allows fuel to escape from the collector tank into No. 3 tank if the pressure in the collector tank rises sharply due to temperature increase whilst on the ground.

(ii) Each collector tank is vented to atmosphere through a float-operated vent valve. When the tank is full the float closes the vent.

8. Fuel gauges and flowmeters

(a) Two DC operated mass unit fuel contents gauges (66), on the starboard instrument panel show the total fuel in the ten wing tanks and two fuselage tanks, (5,582 lb./725 gall.). The contents of the two collector tanks (308 lb./40 gall.) are not gauged. When Mod. 703 is embodied, the gauges are repositioned to the panel at the bottom of the centre instrument panel.

(b) Two flowmeters Mk. 2 (107), one for each engine, on the starboard console, show the rate of fuel flow in pounds per minute and the total fuel consumed. The gauges are calibrated in units of ten pounds and are fitted with resetting knobs.

(c) *Power supplies*

(i) The fuel contents gauges operate whenever the battery isolating switch is set to ON, or an external supply is connected.

(ii) Electrical power for the flowmeters is supplied by the No. 1 flight instruments inverter. If this inverter fails the flowmeters will be inoperative.

9. Refuelling system

(a) A pressure-refuelling point under each wing, forward of the main wheel bay, permits refuelling of all tanks (including the ventral tanks, if fitted) simultaneously, and a float valve in each tank cuts off the supply when the tank is full.

(b) The ventral tanks may be isolated from the refuelling system, by setting to OFF the VENTRAL TANK RE-FUELLING cock in each wheel bay, prior to refuelling. In these circumstances, when the remainder of the system is filled, the ventral tanks refuelling cocks may be turned ON and the desired amount of fuel fed to each tank, the quantity being measured from the refueller gauges.

10. Normal management of the system

(a) *Before starting*

(i) The booster-pump circuit-breakers, starter master and ignition switches and the LP and HP cocks must be ON for starting and for all normal forms of flight.

(ii) When a booster-pump is switched on, check that its associated magnetic indicator turns black.

(b) *Before take-off*

(i) As soon as an engine is started and air transfer pressure is available, check that the two air transfer magnetic indicators turn black.

(ii) If ventral tanks are fitted, and contain fuel, check that their associated indicators turn black. It may be necessary to increase RPM to approx. 65% in order to provide the initial pressure. The ventral tank indicators may flicker whilst taxying.

(c) *In flight*

After take-off check that the ventral tanks are feeding. On a normal sortie (climb to 40,000 feet and cruise at 95% RPM) the ventral tanks (if full) should empty after approximately 40 minutes. The indicators will then turn white.

(d) *Flying on one engine and fuel balancing*

When transferring fuel, both booster-pumps should be left on. If uneven feeding occurs, the pump on the lower side may be switched off until a satisfactory balance is achieved. On no account is the booster-pump on a live engine be switched off above 40,000 feet. Fuel will not transfer from the same side as a failed booster-pump unless the serviceable booster-pump is switched off.

11. Booster-pump failure

Failure of a booster-pump will be shown by its associated magnetic indicator showing white. The engine should be stopped if base can be reached on one engine, but for operational or safety reasons it may be maintained at between 75 and 85%. If a flame-out occurs the engine should not be relit except in emergency.

The maximum height for operation without booster-pumps is:—

When ventral tanks are feeding	40,000 feet
When main tanks are feeding	20,000 feet

12. Fuel tank(s) shut-off valve failure

(a) *Ventral tank shut-off valve failure*

Failure of a ventral tank shut-off valve to close, after completion of fuel transfer, will not affect the fuel flow from the wing tanks on the associated side to the collector tank.

(b) *No. 3 tank shut-off valve failure*

Failure of a No. 3 tank shut-off valve to close when No. 3 tank empties, will not affect the fuel flow from the remaining wing tanks on the associated side to the collector tank. However, failure of a No. 3 tank shut-off valve to close when the tank empties following a ventral tank shut-off valve failure (neither of which can be verified in flight), will result in flame-out of the engine. Jettisoning the ventral tanks will restore the fuel system to normal operation and the engine may be re-lit.

Note:—The engine will not flame out even at full power until the fuel on that side is approximately 500 lb.

PART I

Chapter 2—ENGINE CONTROLS AND INSTRUMENTS

List of Contents

1. Engines

One Sapphire Mk. 102 and one Mk. 103 axial-flow gas-turbine engine is fitted in the port and starboard engine nacelles respectively. Each engine develops approximately 8,150 lb. static thrust at sea-level.

2. HP pumps

(a) A servo control system limits the HP pump output and a governor limits over-speeding of each engine.

(b) Control of the fuel flow is effected by:—

- (i) The throttle, to meter fuel to the burners.
- (ii) A barometric flow control (BFC) to vary the pump output in relation to intake pressure.
- (iii) An air/fuel ratio control (AFC) to prevent an excess supply of fuel to the engine during periods of engine acceleration.

Both BFC and AFC are connected to the servo control system.

3. HP fuel cocks and relighting buttons

Two HP fuel cock levers (8), the handles of which incorporate relighting buttons, are fitted to the throttle box and are moved up from OFF to ON. A gate in the ON position prevents the levers being moved accidentally to the OFF position.

4. Starting controls and system

(a) The engine starting controls are grouped together on the starboard console and consist of:—

(i) Two booster-pump circuit-breakers (at 103), one for each engine.
(ii) Two master starting switches (at 103), one for each engine.
(iii) Two ignition isolating switches (at 103), one for each engine, and
(iv) Two engine starter push-buttons (at 101), one for each engine.

Before each circuit is operative (i) must be closed and (ii) and (iii) ON. The starter master switches and the ignition isolating switches should remain ON in flight to permit relighting.

(b) Starting is by means of a twin-breach cartridge starter which accelerates the engine until it becomes self-sustaining. Depressing one of the two starter push-buttons when switches (a), (i), (ii), and (iii) are set for starting, fires the cartridge and starts a time-switch, which keeps the ignition in operation for 5 seconds. The starter push-button remains in for 30 seconds during this period to prevent a second selection. After 30 seconds, depression of this button a second time selects and fires the second cartridge.

(c) With the booster-pump circuit-breaker closed, the master starter switch ON, but with the ignition isolating switch OFF, depression of a starter push-button will fire the cartridge but not energise the igniters.

(d) Three spare cartridges and a spare safety-disc assembly are stowed in the forward part of the servicing platform, and are enclosed by a sliding cover plate.

5. Throttle controls

The two throttle levers (10) are mounted in a box on the port side of the cockpit, the port throttle incorporating a twist-grip for GGS manual ranging. A throttle friction control (25) is provided. The port throttle is restricted to 20 per cent travel with the flying controls locked. The throttle lock is operated by the knurled catch (24) at the front of the throttle-box. This is automatically disengaged when the flying controls locking lever is pushed into the gate.

6. Engine instruments

The engine instruments comprise a dual jet-pipe temperature gauge (68), oil pressure gauges (67) and per cent RPM indicators (77), the latter being positioned at (66) when Mod. 703 is embodied.

7. Oil system

The oil system is self-contained on each engine. Oil is carried in a 1.8 gall. capacity tank on the inboard side of the engine. Pressure re-oiling points for the tanks are reached via access panels in the bottom skin of the fuselage in this area.

8. Fire detection system

(a) Six re-setting flame-detector switches are situated around each compressor casing and six in the exhaust cone shroud on each engine. Operation of any of these switches causes the appropriate ENGINE FIRE warning light (61) or (63) incorporated in the fire extinguisher push-button to come on, provided electrical power is available. The extinguisher does not function automatically. When the push-button (61) or (63) is pressed, the extinguisher serving that engine discharges its contents through the spray rings. If the fire is extinguished, the warning light goes out.

(b) The system can be operated whether the battery isolating switch (110) is OFF or ON, so long as electrical power is available.

9. Fire extinguishing system

(a) Two fire extinguisher bottles are stowed between the engines on the rear of the front fire wall; each serves one engine, and connects to two spray rings around that engine. Operation of either system is by:—

(i) Manually-operated push-buttons (61) and (63) in the cockpit under the starboard coaming or

(ii) Two automatically operated inertia switches in the centre fuselage which operate in the event of a crash landing.

(b) The inertia switches operate the extinguisher bottles automatically if the aircraft is crash landed. They also isolate the aircraft battery and generators in these circumstances.

(c) The fire warning lights may be tested by pulling out the extinguisher push-button. Do not release suddenly.

Some aircraft are provided with a test push-button on the right of the extinguisher push-buttons. On such aircraft the lights should be tested by pressing the test push-button.

PART I

Chapter 3—ELECTRICAL SYSTEM

List of Contents

DC SUPPLIES

1. Generators

(a) Two 6,000 watt generators, driven by the gearbox, supply the whole electrical system and charge the single 24 volt 25 amp. hour aircraft battery. Two generator failure warning lights (65) on the starboard instrument panel in the front cockpit, and duplicated (115) in the rear cockpit, come on when their associated generator is not supplying power.

(b) If either generator fails, the output of the other is sufficient for normal flying but all non-essential electrical services should be switched off as soon as the failure occurs. If both generators fail all electrical services will be supplied from the battery. The maximum output of each generator is 200 amps.

(c) A generator control panel, on the port console in the rear cockpit, includes two guarded switches which are spring-loaded to the NORMAL (centre) position. The guard also enables a switch to be locked in the forward position for ground testing purposes. Before flight the switches must be in the NORMAL (centre) position.

(d) Each generator in the common gearbox is supplied with cooling air from its associated engine. When a single engine is run on the ground the generator normally cooled by the dead engine is driven by the gearbox but not supplied with cooling air. When one engine is ground run therefore, the other engine should also be started.

2. Battery control

(a) *Aircraft battery*

The battery is switched on by a double-pole BATTERY ISOLATING switch (110) on the starboard console. When set to OFF the switch isolates all electrical services from the battery except the engine fire extinguishers. The capacity of the aircraft battery is small, and for this reason the cockpit check must be done without delay. The battery isolating switch is put on at the start of the check, and care must be taken not to switch on the booster-pumps until immediately prior to starting, or to select VHF or hood motors until after the generators are on line. The battery isolating switch should be turned OFF as soon as the engines are stopped, but after the generator warning lights come on.

(b) *Emergency battery*

(i) A 24 volt 0.4 amp. hour alkaline battery is in the AI bay. In an emergency it can be used to supply the cockpit lighting, E2B compass, and the turn-and-slip indicator.

(ii) An emergency lamp under the starboard coaming is operated by the switch (81), on the port instrument panel. The switch also controls the emergency supply to the E2B compass via the normal dimmer switch (85).

(iii) The stand-by supply to the turn-and-slip indicator is controlled by the switch (64) on the starboard side of the centre instrument panel.

3. External supply

An external ground supply socket is provided outboard on the port nacelle, and is for use when a 28-volt trolley is used for servicing purposes. When this trolley is in use the aircraft battery may be switched ON to maintain the battery in a fully-charged condition. A 24-volt ground battery should not be used for servicing.

AC SUPPLIES

4. Inverters

AC is provided by inverters driven by the main DC supply:—

Type	Serving
103 (No. 1 flt. insts)†	Flight instruments. Part-load of AI Flowmeters. Zero-reader.
100A (No. 2 flt. insts)	Early start facilities and stand-by for flight instruments and zero-reader.
*201A (No. 1 radar)	IFF and AI; emergency supply for ARI. 5870 and Gee.
200 (No. 2 radar)	ARI.5870 and Gee.
300	Gun firing.

* Replaced by Type 201B when Mod. 655 is embodied.
† Replaced by Type 103A when Mod. 1311 is embodied.

5. Flight instruments supplies

(a) All flight instruments (apart from the turn-and-slip indicator) are normally run off the No. 1 flight instruments inverter. The instruments will begin to function as soon as a generator cuts in, or alternatively, on the ground with an external supply plugged in, when the AI START switch (at 142) in the rear cockpit is closed. Part of the AI equipment is supplied from the No. 1 flight instruments inverter; when the AI equipment is functioning, therefore, the flight instruments are automatically supplied.

(b) (i) The No. 2 flight instruments inverter is provided as an automatic stand-by supply for the main flight instruments, should the No. 1 flight instruments inverter fail. Current for this inverter will be supplied by the generators, or if these have failed by the aircraft battery, **provided this is switched on by the EARLY START switch** (111) on the starboard console. The EARLY START switch also enables the main flight instruments to be run up on the ground before the generators come on line.

(ii) To avoid draining the battery care should always be taken to see that the EARLY START switch is off when the battery isolating switch is ON and the engines are not running.

(iii) If the EARLY START switch has been used for running up the instruments, the No. 2 flight instruments inverter will be closed down as soon as the engines are started and the generators (and the No. 1 flight instruments inverter) come on line.

(c) In the event of No. 1 inverter failing in flight the No. 2 inverter will automatically start up regardless of the setting of the early start switch and take over the flight instrument supplies. The flowmeter and AI supplies will, however, be shed. At the same time the Type 201A inverter, if running, will be shut down. It is impossible to run the two flight instrument inverters simultaneously.

(d) A magnetic indicator (58) labelled STAND-BY INVERTER ON (or MAIN INVERT. FAIL), on the panel under the starboard coaming, shows white to indicate failure of No. 1 flight instruments inverter.

(e) Since sudden electrical loads at low idling RPM on the ground can cause the No. 1 flight instruments inverter torque switch to open and change-over the instruments supply to No. 2 inverter, a spring-loaded RESET switch (at 109), is provided on the starboard console to enable the No. 1 inverter to be regained. The switch must only be operated when on the ground. Attempts to regain a failed No. 1 inverter in flight will cause a serious fire hazard, due to possible overheating of the failed inverter.

6. Radar supplies

(a) *AI supply*

(i) This installation draws its AC supply from the No. 1 flight instruments inverter and from the No. 1 radar inverter, and is controlled by the AI START and STOP switches (at 142) in the rear cockpit.

(ii) With the engines running, and therefore the No. 1 flight instruments inverter operating, closure of the AI start switch will provide a supply for the installation.

(iii) Closure of the AI START switch, when an engine is not running and an external supply is plugged in, will start the No. 1 flight instruments inverter, which will automatically start up the No. 1 radar inverter, thus providing a supply for the AI installation.

(iv) Failure of the No. 1 flight instruments inverter will result in the No. 1 radar inverter being automatically switched off, thereby preventing damage to the installation.

(v) Should a generator fail the AI equipment should be switched off immediately in order to prevent overloading the remaining generator. In the event of a double generator failure the equipment will become inoperative.

(b) *IFF Mk.* 10 *supply*

AC supply for operating the Mk. 10 IFF is obtained from the No. 1 radar inverter, which is controlled by the IFF ON-OFF switch on the port console in the rear cockpit. No alternative supply is available for the IFF should the No. 1 radar inverter fail, or cut out due to failure of the No. 1 flight instruments inverter.

(c) *GEE and ARI.* 5870 *supplies*

These installations are normally supplied with AC from the No. 2 radar inverter controlled by the NORMAL-OFF-EMERGENCY switch (at 111) in the rear cockpit. Should this inverter fail, an alternative supply can be made available from the No. 1 radar inverter by setting the abovementioned switch to EMERGENCY, and the AI START switch adjacent to START. In this case, the AI will be rendered inoperative. The GEE and ARI.5870 controlling switches are on the port console in the rear cockpit.

7. Zero-reader supplies

This installation is normally supplied by the No. 1 flight instruments inverter. If this inverter fails, an alternative supply is automatically available from the No. 2 flight instruments inverter.

8. Gun firing supply

AC for gun firing is supplied by a Type 300 inverter, which is brought into operation whenever the GUNS MASTER switch (34) on the port console is set ON, provided that the gun firing circuit is operative. (See Chap. 14, Para 3, of this Part.)

9. Warning lights and indicators

The following tables lists the various electrical warning lights and indicators in the cockpits:

Service	Indication	Function
Fire warning	2 red lights (61) (63)	Gives warning when temperatures in engine installations are excessive.
Undercarriage warning	3 red, or 3 green lights (38)	Indicate position of each undercarriage unit separately:— No light—unit locked up. Red light—unit between locks. Green light—unit locked down.
Fuel-transfer air-pressure warning	2 magnetic indicators (72)	Show white when air pressure in wing tanks is insufficient.
Fuel booster-pump warning	2 magnetic indicators (82)	Show white when the associated booster-pump is inoperative.
Ventral tanks transfer	2 magnetic indicators (26)	Show white when fuel is not being transferred.
Generator failure	2 red lights (65) (115)	Indicate associated generator failure.
No. 1 flight instruments inverter	1 magnetic indicator (58)	Indicates inverter failure.
Cockpit pressure warning	1 red light (60)	Indicates 1 lb. drop in cockpit pressure.
Hydraulic failure	1 amber light (48)	Gives warning of failure of No. 1 hydraulic pump or supply.

Service	Indication	Function
Hydraulic failure (cont'd)	1 red light (53)	Gives warning of failure of No. 2 hydraulic pump or supply.
	1 red light (54)	Gives warning of failure of No. 3 hydraulic pump or supply.
Stand-by trim actuator	1 magnetic indicator (43)	Shows white when the stand-by trim actuator is not in the neutral position.
Radio altimeter	1 red limit light (47)	Indicates low limit (front cockpit).
	Red, green amber lights (119)	Limit indicator lights (rear cockpit).
Gun-bay scavenge valves	2 magnetic indicators (52)	Show white when gun bay valves are open.
Emergency intercomm.	1 red light (44) (127)	For use in the event of intercomm. failure.
ILS	1 blue light (56)	Indicates when over marker beacons.
	1 amber light (at 92)	Indicates when ILS is switched on.
Oxygen	1 magnetic indicator (at 83) (at 133)	Shows a vertical white line when oxygen is demanded.
Telebriefing	1 amber light (23)	Indicates telebriefing in use.

10. Management of the electrical system

(a) *Battery capacity*

The capacity of the aircraft battery is small and for this reason the cockpit check has been designed to reduce battery load to a minimum and at the same time to allow full operational freedom. The battery isolating switch is on during these checks which must be done without delay leaving all the largest electrical loads e.g. booster-pumps until immediately before the engines are started. The use of the hood motor and/or the VHF must be avoided until either a ground supply is provided or the generators are charging.

(b) *Generators*

If either generator fails, the output of the other generator is sufficient for non-combat flying but all non-essential electrics should be switched off. If both generators fail all electrical services will be supplied from the battery. (See para. 11(b) below.)

(*c*) *Start up*

If the generators do not both come on line after the start of the first engine the ground crew can set them on line from the servicing bay. This failure can be minimised by not switching off the battery isolating switch until the generators have come off line after shut down of the engines.

(*d*) *Inverters and instruments check*

When the battery isolating switch is put ON the turn-and-slip indicator should function. The operation of the main electrically-operated flight instruments should be checked before starting the engines, by closing the EARLY START switch. This should start up the No. 2 flight instruments inverter; after approximately ten seconds check that the Mk.4B compass and the artificial horizon function (OFF flags not visible). When an engine is started and the the generators cut in, check that the No. 1 flight instruments inverter takes over and the STAND-BY INVERTER ON (or MAIN INVERT. FAIL) indicator goes black.

(*e*) If the EARLY START switch has been used for running up the instruments, the No. 2 flight instruments inverter will be closed down as soon as the engines are started and the generators (and the No. 1 flight instruments inverter) come on line.

Warn the navigator of generator failure.

(ii) All non-essential electrics to be switchd off.

(b) *Double generator failure*

Warn the navigator of generator failure

(i) If both generators fail the only available power (apart from the emergency supply for the turn-and-slip indicator, emergency cockpit lighting and E2B compass lighting) will be from the aircraft battery of nominally 25 amp/hr. capacity. Under service conditions this will probably be reduced to 20 amp/hr.

NOTE.—Whatever electrical fault caused the two generators to come off line may have reduced the life of the battery to less than 5 minutes.

(ii) *Above* 40,000 *feet*

Switch off all non-essential electrics except booster-pumps. Descend immediately to 40,000 ft.

At 40,000 feet switch off both booster-pumps if the ventrals are still feeding and one booster-pump if main tanks are feeding.

Continue the descent to 20,000 feet if the mains are feeding.

Switch off the remaining booster-pump at 20,000 feet. Keep the engine speed between 75 and 85% with the minimum of throttle adjustment.

Continue the descent to as low an altitude as possible without jeopardising the chances of returning with the available fuel.

Select the stand-by turn-and-slip supply and cockpit lights as necessary.

Maintain speed between 200 and 250 knots and set the trim to 1½° nose down.

(iii) *Between* 20,000 *and* 40,000 *feet*

Turn off both booster-pumps if the ventrals are feeding.

Turn off one booster-pump if the mains are feeding.

Proceed as in (ii) above.

(iv) *Below* 20,000 *feet*

Switch off all non-essential electrics including both booster-pumps.

Proceed as in (ii) above.

(v) With both generators off line the No. 1 flight instruments inverter will be inoperative and although the No. 2 flight instruments inverter may be brought into operation by use of the EARLY START switch the following services will be lost.

(f) *No. 1 flight instruments inverter failure*
If the STANDBY INVERTER ON (or MAIN INVERT. FAIL) indicator shows white, the No. 1 flight instruments inverter has failed and change-over to the No. 2 flight instruments inverter should take place automatically. If this occurs after start-up an attempt should be made to restart the No. 1 inverter by closing the RESET switch momentarily. If the indicator remains white, the No. 1 inverter has failed and the aircraft should be considered unserviceable. No attempt should be made to reset the No. 1 flight instruments inverter in flight.

(g) *Flight instruments failure*
HGU and Mk.4B compass

(i) Failure of the HGU will be indicated by the OFF flag appearing on the face of the instrument. If the STAND-BY INVERT. ON (or MAIN INVERT. FAIL) indicator remains black when the OFF flag appears, a fault in the circuit supplying the instrument is indicated and no further reliance should be placed on the instrument.

(ii) If, however, the STAND-BY INVERT. ON (or MAIN INVERT. FAIL) indicator shows white, the probable cause is failure of the No. 1 inverter followed by failure of the No. 2 inverter or the change-over torque switch. In the event of failure of the HGU the annunciator of the Mk. 4B compass should be checked for operation. If it is operating the instrument may be regarded as serviceable.

(iii) *Turn-and-slip indicator*
Failure of the turn-and-slip indicator will be indicated by the OFF flag appearing on the face of the instrument. The emergency battery supply can be brought into use by switching on the stand-by supply switch (64).

11. Action in the event of generator failure

(a) *Single generator failure*
(i) AI (if in use) must be switched off immediately.

Flowmeters.
Blower for electronic regulator.
Windscreen demister.

(vi) When the battery is exhausted all electrical services, except those provided by the emergency battery will be inoperative. The most important of these are:—
Fuel gauges.
Hydraulic failure warning lights.
Tailplane trim.
Hood motor.
Undercarriage lights.
All magnetic indicators (including oxygen indicators).
Intercomm.
Emergency intercomm. light.
GEE
VHF/UHF.
Relighting.
Booster-pumps.
Stall warning.
Pressure head heaters.

(vii) If it is necessary to continue the flight without these facilities the following is recommended:—
Remain below 20,000 feet
Do not cut an engine. (Relights no longer possible).
Land as soon as possible. (Fuel gauges inoperative)
Avoid icing conditions.
Keep all turns well within the G limitations.
Use emergency air for the undercarriage after normal selection.
Fire detection, warning and extinguisher inoperative.

(c) The following lists the loads taken by the services:

AI & IFF	145 amps
Booster-pumps	20 amps
Gee	19.5 amps
Pressure head heaters (3) ...	14 amps.
VHF	12 amps (13 amps when transmitting)
Cockpit lighting	3.8 amps
Radio altimeter (AYF) ...	2.7 amps
Intercomm.	2.0 amps
Navigation lights	2.0 amps

PART I.

Chapter 4—HYDRAULIC SYSTEM

List of Contents

Illustration

1. Hydraulic pumps and indicators

(a) *Hydraulic pumps*

Three hydraulic pumps driven by the gearbox maintain a live-line pressure of 3,000 PSI and operate the following services:—

Pump	Normal operation	Indication of failure	Consequence of failure and remarks.
No. 1	Wheel brakes Undercarriage Airbrakes Flaps	Amber light (48) on.	1. No. 2 pump takes over automatically and operates these services at a reduced rate. 2. When operating main services, the No. 2 system will be at reduced pressure and the likelihood of an intermittent red light (53) is increased.

Pump	Normal Operation	Indication of failure	Consequence of failure and remarks.
No. 2	As above plus:— one side of the tailplane motor, and feel simulator. Rudder servodyne Port aileron servodyne, and stand-by for starboard aileron servodyne.	Red light (53) on	No. 1 pump operates main services at reduced rate. The tailplane stick forces will be approximately halved. Rudder reverts to manual. No. 3 pump operates both port and starboard aileron servodynes. No. 1 pump will not receive assistance from No. 2 pump the amber light will tend to remain on longer than usual after selection of a main service.
No. 3	One side of the tailplane motor, and feel simulator. Starboard aileron servodyne and standby for port aileron servodyne Aileron feel simulator Wheel brakes by selection on emergency lever.	Red light (54) on	The tailplane stick forces will be approximately halved. No. 2 pump operates both port and starboard servodynes. Aileron feel will disappear. Emergency selection inoperative.

A pressure regulator is fitted in the pressure line between Nos. 1 and 2 pumps. Its purpose is to maintain a pressure of at least 1,600 PSI in the No. 2 pump circuit for the flying controls when No. 2 pump is boosting No. 1 pump.

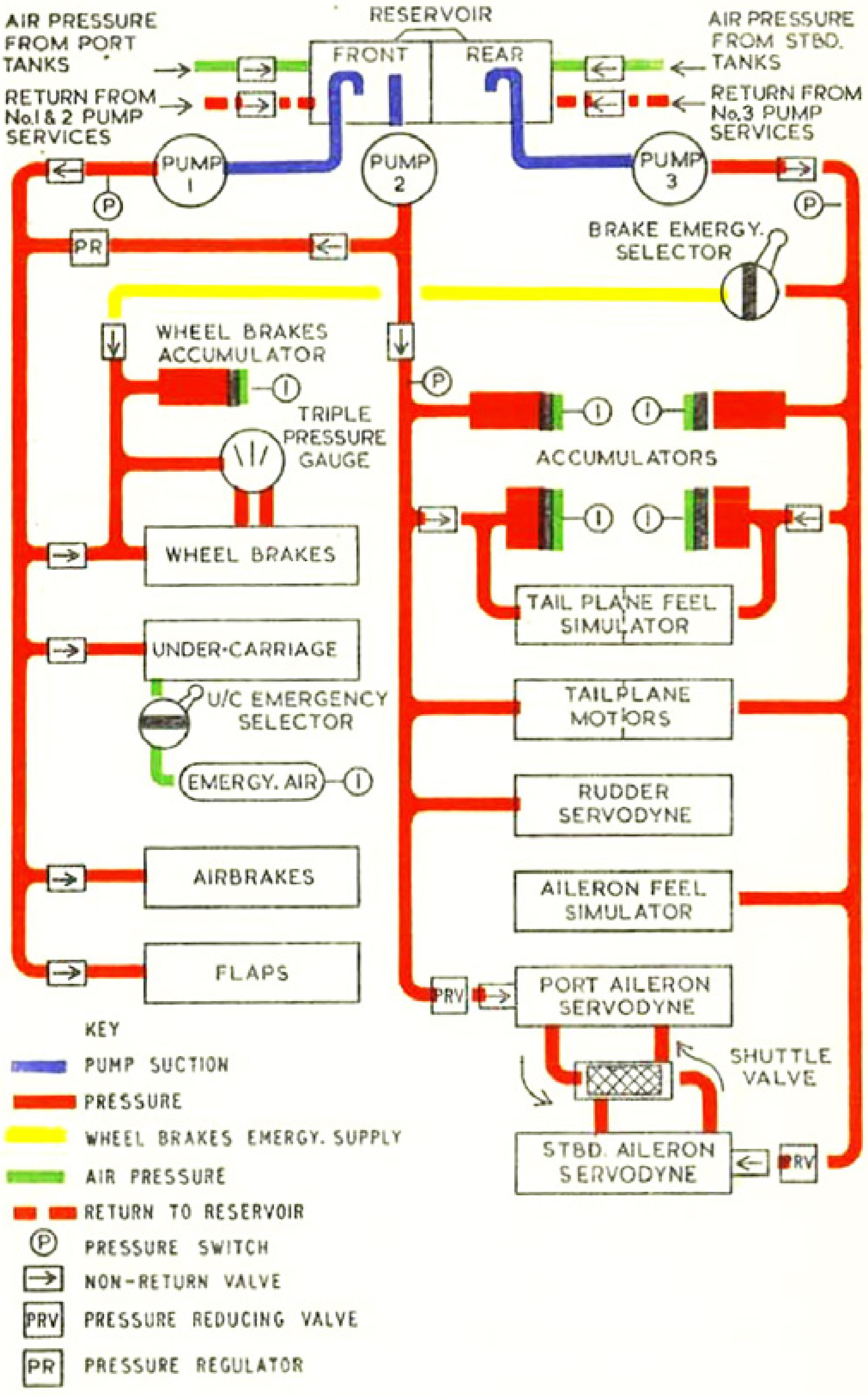

Fig. 1—Simplified hydraulic system diagram

(b) *Indicators*

One amber light (48) marked 1, and two red lights (53) and (54) Marked 2 and 3, on the panel under the port coaming, glow to indicate failure of the associated pump or system. The amber and red lights operate at a system pressure of 700 PSI and 2,400 PSI respectively.

2. Hydraulic accumulators

Five hydraulic accumulators are fitted to the system, one in the servicing bay, two in the centre fuselage and two in the fin.

(a) One is fitted to the wheelbrake circuit, and provides pressure when the engines are not running, or in the event of failure of both No. 1 and No. 2 pumps. It is initially charged with an air pressure of 750 ± 50 PSI and during normal engine running is at the system pressure of 3,000 PSI.

(b) *Flying controls accumulators*

Two large capacity accumulators in the fin are fitted, one in each supply line from Nos. 2 and 3 pumps. They supply the ailerons, aileron feel simulator, rudder, and also the tailplane motors and duplicated simulator. They are charged with an air pressure of 1,565 ± 50 PSI. The pressures are indicated on two gauges at the starboard base of the fin.

(c) *Tailplane feel simulator accumulators*

Two smaller accumulators to supply the duplicated feel simulator are fitted one in each supply line from Nos. 2 and 3 pumps. Non-return valves are fitted so that these accumulators cannot be used for the flying controls. They are charged with an air pressure of 500 ± 50 PSI. The pressures are indicated on two gauges in the centre fuselage, aft of the servicing bay.

3. Triple-pressure gauge

A triple-pressure gauge (39) on the port instrument panel shows the pressure available in the brake accumulator, and when the brakes are applied, the pressure applied at each wheel.

4. Emergency air supply

A high-pressure air bottle charged to 2,700 PSI (approx.) is provided for the emergency lowering of the undercarriage. The air pressure gauge for the bottle is located at the top of the port wall of the nosewheel bay.

5. Undercarriage control and position indicator

(a) The undercarriage is operated hydraulically after mechanical selection by the UP or DOWN selector push-buttons (17), on the port instrument panel. As the undercarriage is retracted the doors close mechanically. If the undercarriage UP button is not pressed fully home the undercarriage will retract, but subsequent vibration may cause the button to creep and cause the undercarriage to be lowered inadventently. If the button has an abnormally spongy or springy feel inadvertent lowering of the undercarriage may also result. Therefore if,

(i) The button does not go fully home, or

(ii) The button feels spongy or springy,

the undercarriage should be lowered and the flight discontinued.

(b) When the weight of the aircraft is on its wheels, micro-switches on the main undercarriage oleo legs de-energise a solenoid thus allowing a locking plunger to engage in a groove in the locking sleeve of the UP push-button unit. The UP button cannot then be depressed by normal force but, in emergency, a pressure of approximately 40 lb. will push the button in and enable the undercarriage to be raised. When this is done an override plunger locks the UP push-button in the depressed position. If a micro-switch fails or complete electrical failure occurs, the solenoid will not be energised and the locking plunger will remain in, even when the weight of the aircraft is off the wheels. If the "override" force is then applied and the undercarriage raised, it will not be possible to lower the undercarriage by normal means.

(c) A standard position indicator (38) is fitted to the right of the push-buttons.

(d) Safety locks, fitted with warning pennants, are provided for the main wheel and nosewheel units when the aircraft is on the ground.

6. Undercarriage emergency operation

(a) *Emergency lowering*

Should hydraulic failure occur, the undercarriage may be lowered irrespective of the position of the normal selector, by pulling the undercarriage emergency release (18), above and to the right of the pushbuttons. The handle must be pulled out to its fullest extent (2¾ ins.) when it will become automatically locked. This admits air (at 2,700 PSI) from the emergency air bottle, in the nose of the aircraft, to the unit jacks, forcing them to lower and lock. When the emergency air has been used it will not be possible to retract the undercarriage either in the air or on the ground.

(b) *Emergency retraction*

To raise the undercarriage on the ground in an emergency following normal selection, apply a push force of approximately 40 lb. to the undercarriage UP button by any convenient part of the hand which allows a heavy push force to be exerted. This will overcome the override spring and permit the button to be depressed when it will lock in the UP selected position.

7. Flaps control and position indicator

(a) The flaps are operated hydraulically after selection, by the lever (31) on the throttle-box. The lever operates in a gate marked RAISE-OPT. LIFT-LOWER, but the flap position is infinitely variable and follows the movement of the control lever.

(b) A flap position indicator (42) is fitted on the port instrument panel. Full extension is 55°.

8. Airbrake control

The airbrakes, which are fitted to the upper and lower surfaces of the mainplanes aft of the rear spar, are operated hydraulically by the OFF–ON lever (13) on the throttle-box. The airbrakes may be extended to any degree by movement of the lever towards the ON (back) position, but they will not extend fully above 430 knots. At speeds below 430 knots the setting is infinitely variable and follows the movement of the control lever.

9. Wheel brakes control

(a) The wheel brakes are operated hydraulically by means of foot-plates on the rudder pedals, the braking force to each wheel being in proportion to the pressure applied to the plate.

(b) The inclination of the foot-plates (71) may be adjusted by pressing outwards the catch (70) on the outer edge of the foot-plate.

(c) The brake system pressure (3,000 PSI normal) is shown on the triple-pressure gauge (39) on the port instrument panel, together with the pressure at each main wheel (1,500–1,650 PSI). On start-up, the centre needle of the triple-pressure gauge will show the live-line pressure of No. 1 and No. 2 pumps. However, once the brake accumulator is charged a non-return valve prevents a subsequent loss of pump pressure showing on the centre needle until the brakes are used. A white line on the glass of the triple-pressure gauge at the 750 PSI mark indicates the figure below which the brake operating pressure is zero.

(d) Maxaret brake-units are fitted and permit the use of full braking, when necessary, without the danger of wheel-locking and tyre damage. The units can come into operation only if the wheels are rotating and in no circumstances should the brakes be applied before touchdown.

(e) A parking-brake control (69) is on the starboard instrument panel and is independent of the foot plates. The T-handle is pulled out until it locks to apply the brakes, and the knob in the centre pressed to release the brakes.

10. Wheel brakes emergency operation

(a) Should the hydraulic supply from both No. 1 and No. 2 pumps fail, operation of the lever (2), marked BRAKE EMERGENCY SELECTOR on the port console, to the ON (rearwards) setting will permit the No. 3 pump to supply the brake accumulator. The control should not be operated until after touch-down because if the original failure is in the brake pipe-lines, operating the selector will drain fluid from the flying controls. For this reason no attempt should be made to select OFF and go round again.

(b) If the supply from both the No. 1 and No. 2 pumps has failed, and the EMERGENCY BRAKE SELECTOR is left OFF, the pressure in the wheel brakes accumulator should be sufficient for landing (if 3,000 PSI is shown on the triple-pressure gauge), but not for taxying. The brakes must be applied carefully, as each operation of the maxaret units and each on-off operation of the foot pedals exhausts some of the pressure in the accumulator. Only low braking pressure should be applied immediately after touch-down and, as the aircraft slows down the pressure can be increased progressively to a degree which will not cause too rapid operation on the maxaret units.

(c) Check the accumulator pressure after landing. Braking pressure is exhausted when the accumulator pressure has fallen to 750 PSI.

11. Normal operation of the system

As soon as an engine is started hydraulic power will be generated and the three hydraulic failure lights will go out. Pending modification the No. 1 pump amber light may come on when a main service is operated, but unless it remains on for longer than 10 seconds after completion of the operation it can be disregarded. The No. 2 pump red light may come on when a service is selected and large control movements at low RPM are being made at the same time. Unless it remains on for more than 2 to 3 seconds it can be disregarded. Either or both red lights may also come on after one reversal when carrying out the pre-flight check of the tailplane control. See Chapter 5, Para. 6, Part I). The pressure switch settings are as follows: —

Red lights 2,400 PSI.
Amber light 700 PSI.

NOTE.—If at any time a red warning light comes on for more than 2 to 3 seconds, and no other symptoms of hydraulic failure (loss of feel, etc.—see next paragraph) are immediately apparent, the warning light must not be ignored. If a hydraulic leak develops in either No. 2 or No. 3 pump circuits the drop in line pressure may be sufficient to bring on the associated red warning light, but not sufficient to affect the operation of the services. Depending on the size of the leak, a considerable time may elapse before all fluid in the reservoir and accumulator is lost.

12. Action in the event of hydraulic failure

The following is the recommended action in the event of failure of any one or combination of hydraulic pumps: —

Pump failure	Indication	Action and remarks
No. 1	No. 1 pump amber light on.	1. Allow for main services to operate at reduced rate. 2. When operating main services, the No. 2 pump red light may flicker intermittently.
No. 2	No. 2 pump red light on. Tailplane stick forces halved. Rudder reverts to manual.	1. Reduce speed as soon as possible to 400 knots. 2. Allow for main services to operate at reduced rate. 3. When operating main services the No. 1 pump amber light may flicker intermittently.
No. 3	No. 3 pump red light on. Aileron feel will be lost. Tailplane stick forces halved. Rudder remains in power.	1. Reduce speed as soon as possible to 400 knots. 2. Restrict rolling manoeuvres. 3. Avoid large control movements when selecting any main service, otherwise some aileron stiffening may be felt.

Pump failure	Indication	Action and remarks
Nos. 1 and 2	No. 1 pump amber and No. 2 pump red lights on. Tailplane stick forces halved. Rudder reverts to manual.	1. Reduce speed as soon as possible to 400 knots. 2. If sufficient fuel is available — select airbrakes out. 3. Undercarriage to be lowered with emergency air. 4. Carry out flapless landing. 5. *After* touchdown move brake emergency selector ON.
Nos. 1 and 3	No. 1 pump amber and No. 3 pump red lights on. Tailplane stick forces halved. Aileron feel will be lost.	1. Reduce speed as soon as possible to 400 knots. 2. Restrict rolling manoeuvres. 3. Avoid large control movements when selecting any main service, otherwise some aileron stiffening may be felt. 4. Allow for main services to operate at reduced rate.
Nos. 2 and 3	No. 2 and No. 3 pump red lights on. Aileron feel will be lost. Rudder reverts to manual.	Power for the flying controls will soon be lost, and the aircraft must be abandoned.

NOTE 1.—When either No. 2 or No. 3 pump fails, the control column will, after a short time, move forward very slightly. This will occur an appreciable time after pump failure, and will vary according to speed (up to 5 minutes at 250 knots and less than 1 minute at 400 knots).

2.—It will take approximately 25 seconds for the aileron feel to die away if No. 3 pump fails.

PART I.

Chapter 5—POWERED FLYING CONTROLS AND TRIMMERS

List of Contents

Illustrations

1. General

The ailerons, and tailplane are fully power-operated, i.e. irreversible. Hydraulic supplies are duplicated, and there is no manual reversion. The rudder is power-assisted and has manual reversion.

2. Tailplane control

(a) *Operation*

Longitudinal control is effected by movement of the tailplane, with a follow-up movement of the elevator. The tailplane is fully powered, operation being by a screw-jack driven by two hydraulic motors. The elevator moves in the same direction as the tailplane, through gearing in the ratio 4:1.

(b) *Hydraulic power*

Hydraulic power is provided by Nos. 2 and 3 pumps. If either fails, the other will continue to operate its respective tailplane motor but the rate of tailplane operation will not be affected although stick forces will be halved. Speed should be restricted to below 400 knots to prevent the possibility of jack-stalling. Accumulators in the line ensure steady operation of the system, and provide a small reserve of pressure.

(c) *Feel*

(i) Tailplane feel is provided by duplicated feel simulators. These each consist of a hydraulic jack mounted in a common swinging frame, the pressure in the jacks being regulated by two controllers sensitive to airspeed, the pressure in the jacks being constant above 370 knots. Hydraulic power for the feel simulator is provided by Nos. 2 and 3 hydraulic pumps. If either pump fails the other will continue to operate its respective feel simulator, but the tailplane forces will be approximately halved.

The pressure and static supplies to the controllers are duplicated, two pressure heads being mounted on top of the fuselage. The statics are taken from the fuselage servicing bay. Artificial static stability is obtained by biasing the stick forward by means of a spring.

(ii) The heating elements in the pressure heads are switched on by the switch (at 80) which also controls the heating element of the flight instruments pressure head.

(d) *Trimming*

(i) *Normal trimming*

Operation of the tailplane trimmer switch (73) energises an electric actuator which, in extending or retracting, alters the position of the feel simulator frame, resulting in movement of the control column fore-or-aft of its neutral position. At the same time the position of the controlling valve in the tailplane power control unit is moved so that the tailplane remains at the set incidence with no push-or-pull force on the control column.

The thumb bar on the trimmer switch may be lifted after pressing in the catches, at each side of the front bar; this exposes the two switches which together operate the tailplane trimmer. Operation of either switch singly should not cause the trimmer to operate.

To avoid difficulty in disengagement and re-engagement care should be taken not to lift the thumb bar higher than necessary.

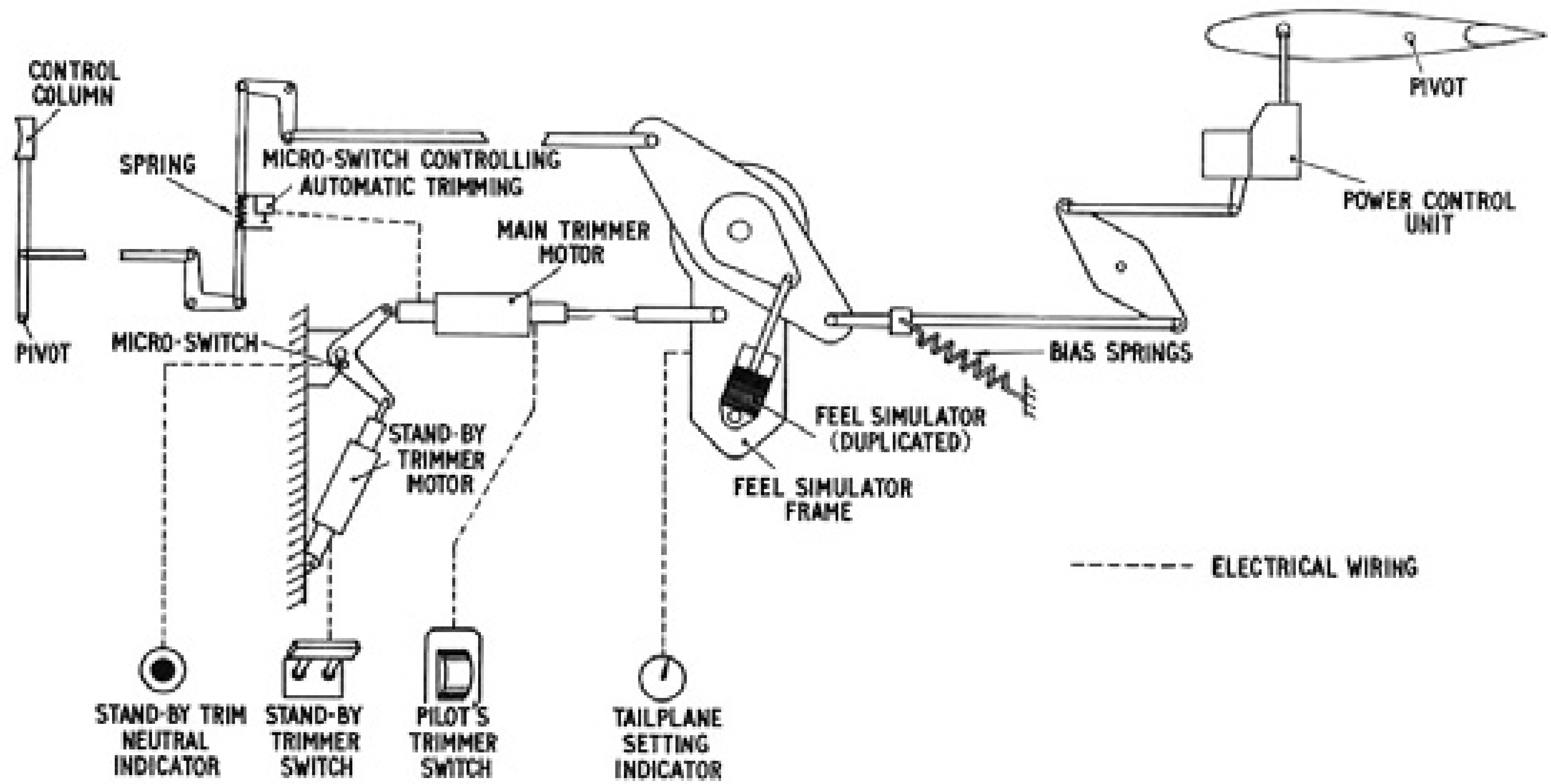

Fig. 1—Simplified diagram of tailplane control system

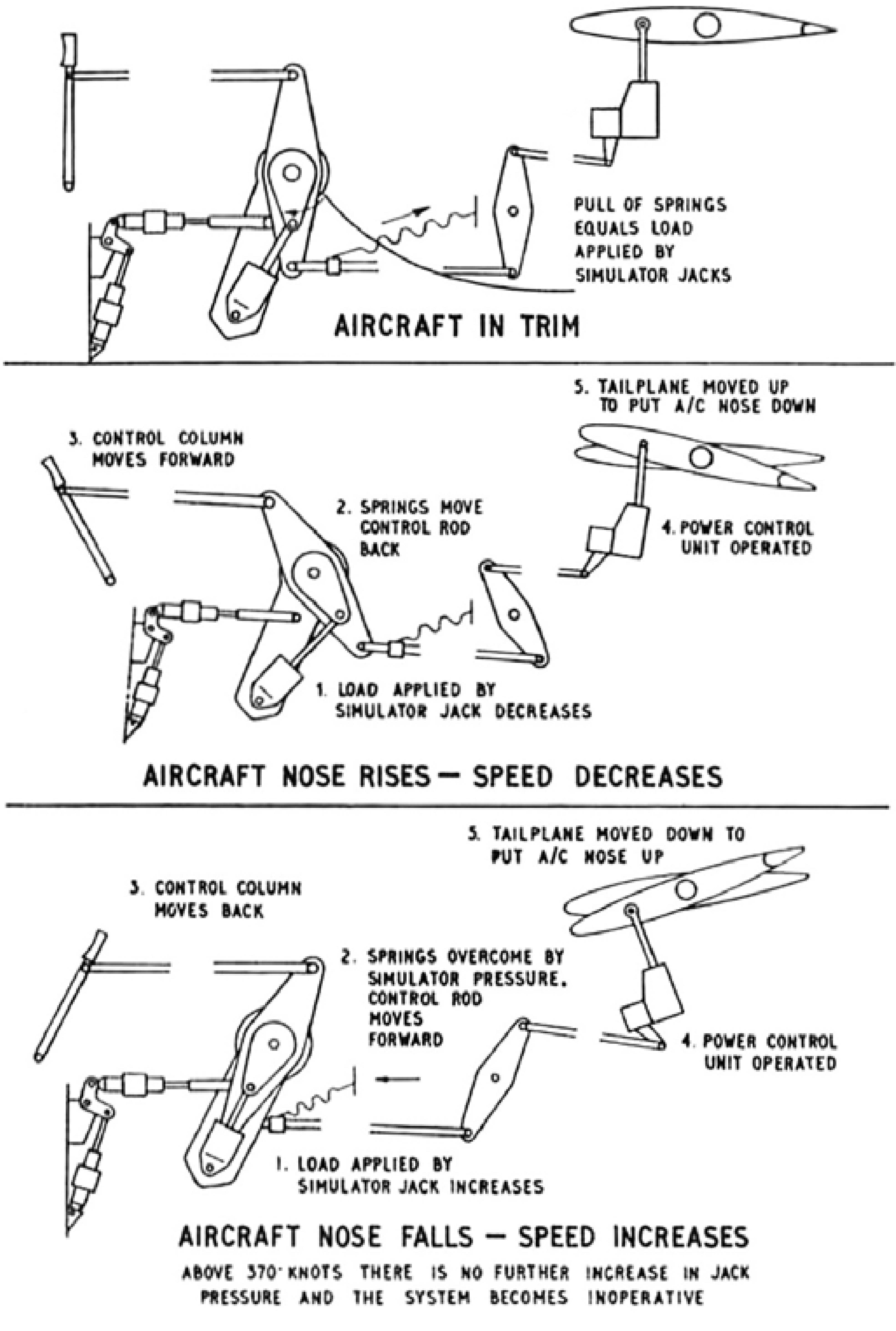

Fig. 2—Artificial static stability

(ii) *Automatic trimming*

This system only operates when a push-force in excess of 10 lb. is applied to the stick and has no effect on pull forces. The main trimmer motor automatically applies nose-down trim when a push-force of more than 10 lb. is applied. The system is operated by a push rod in the elevator control run which is in three sections and is kept apart at its full length by two springs. When compression of the springs (caused by a push-force on the stick) reaches 10 lb. two micro-switches are operated and the main trimmer operates to trim the aircraft nose-down until the push-force is reduced below 10 lb. The micro-switches then open and the trimmer ceases to operate.

A sharp forward movement of the control column will check the trim before take-off. Slight forward trim will be indicated on the trim indicator.

(iii) *Stand-by trimming*

1. The STAND-BY TAILPLANE TRIM control switch (28) on the port console acts as an alternative trimmer; its use does not affect the main trimmer circuit. The stand-by trimmer motor operates at the same rate but has twice the stroke of the main trimmer motor to allow for the latter's failure at extremes of its movement. To allow the main trimmer motor to operate through its full range during normal operation the stand-by trimmer motor is set so that its jack is at its mid-position. A magnetic indicator (43) on the port instrument panel is provided; when this is black, the jack is at its mid-position, and should remain so until the stand-by trimmer is used.

2. The switch is provided with a release button on the inboard rear face, which permits separation of the switches for testing purposes. Operation of either switch singly should not cause the trimmer to operate.

3. If the normal tailplane trimmer fails to operate, the tailplane stand-by trimmer should be operated. If the normal tailplane trim circuit has failed, auto-trimming is inoperative and this must be borne in mind if an overshoot is carried out as the push-forces are very much increased. If complete electrical failure occurs control of the tailplane trimming is impossible.

(iv) *Tailplane trim indicators*

The tailplane trim setting is shown by the indicator (40) on the port instrument panel.

3. Aileron control

(a) *Operation*

The ailerons are power-operated, hydraulic supplies being fully duplicated from Nos. 2 and 3 pumps. Normally the port aileron servodyne is supplied by No. 2 pump, and the starboard servodyne by No. 3 pump. If either pump fails, both servodynes are supplied from the other pump. Both normal supply lines to the servodynes incorporate pressure reducing valves which cut down the hydraulic pressure, thus reducing the angle of movement at high speeds.

No provision is made for trimming the ailerons in flight.

(b) *Feel*

A hydraulic feel simulator supplied by No. 3 hydraulic pump is provided; the force required to apply aileron increases with stick travel; at full travel the force is 20 lb. The force does not vary with aircraft speed. If No. 3 pump fails, and the accumulator is exhausted, aileron feel will disappear.

4. Rudder control

(a) The rudder is hydraulically power-assisted, the boost ratio being 5 : 1. The rudder is supplied from No. 2 pump, and if that fails, and the accumulator is exhausted, the rudder will revert to manual.

(b) *Rudder trimming-tab control*

The rudder tab is controlled by a hinged handwheel (35) on the port console, which operates in the natural sense. An indicator (41) is provided on the port instrument panel, to the right of the undercarriage selector.

(c) *Rudder bar adjustment*

The rudder pedals in each cockpit are adjustable for leg reach by means of the spring-loaded RUDDER ADJUSTER LOCK RELEASE (99) on the starboard console. Depressing this knob will release the lock and the rudder bar may be slid backwards or forwards the desired distance. Releasing the knob will allow the lock to engage in the nearest hole in the adjustment.

5. Flying controls locking gear

(a) The aileron and rudder controls may be locked by moving the lever (15) in the throttle-box inboard to clear its gate, and pulling it back, after first pressing forward the knurled catch (24) at the front of the throttle-box. The flying controls should be centralised *before* pulling the lever fully back.

(b) To unlock the flying controls the lever should be moved fully forward and into the gate, when the knurled catch will spring back into position thereby positively locking the lever in the gate.

NOTE 1.—Care should be taken when unlocking the controls. If the lever moves forward with a jerk it is possible that the hand may strike the undercarriage UP button.

2.—At no time should the locking lever be left in an intermediate position. If the locking lever is not fully forward and in the gate, the knurled catch which operates the throttle lock will not be disengaged and movement of the port throttle will be restricted.

6. Management of the powered flying controls

(a) *Tailplane*

(i) When the battery isolating switch is put on, the standby trim magnetic indicator should go black. If it does not, the stand-by jack is not in its neutral position, and so the stand-by trimmer must be operated until the indicator turns black. The stand-by trim indicator may flicker in flight but this can be disregarded. It may also turn white when applying a holding force on the control column when in an out-of-trim condition, but should go black when the aircraft is trimmed out.

(ii) As soon as hydraulic pressure is available, the control column will become free and will take up a forward position dependent on the trim setting. When the trimmer is operated the control column should move slightly in the same sense.

(iii) If the control column is moved quickly from the fully back position forwards the automatic trimmer should show a slight movement of nose-down trim.

(iv) With the engines idling, at least one complete stroke (fully forward to fully back) of the tailplane should be possible before either or both red hydraulic lights come on. The control column should be held still as soon as the lights come on and the lights should go out after 2-3 seconds. At 70% RPM 4 to 6 reversals should be possible taking three seconds for each reversal. If at any time a ratchety feeling is felt, or there is evidence that the tailplane is not moving smoothly the aircraft must not be flown until the tailplane motors have been inspected.

(v) On closing down the engines ensure that the control column is fully forward. If hydraulic pressure is exhausted with the control column in the rear position it will remain there, making entry into the cockpit difficult.

(b) *Ailerons*

As soon as hydraulic pressure is available, power will be supplied to the aileron servodynes and the control column will become free, the only resistance being that provided by the aileron feel simulator. If the control column is moved vigorously whilst at idling speed an increase in resistance will be felt and either or both hydraulic failure lights will show red: this is normal and the light(s) will go out as soon as control movement ceases.

(c) *Rudder*

As soon as hydraulic pressure is available the rudder bar becomes completely free and will take up a position dependent on the trim setting. When the rudder trimmer is operated the rudder bar should move in the same direction.

7. Flying without feel

(a) *Tailplane*

Following a hydraulic failure of either No. 2 or 3 pump the tailplane feel forces will be approximately halved. As the flying controls accumulator on the failed circuit exhausts, the control column will move forward slightly, but even at low speeds the nose-down out-of-trim force to be held is slight and can quickly be trimmed out. If the airspeed is high (above 400 knots) when either pump fails, there will be a tendency to overcontrol and porpoise particularly in turbulent conditions, and large control movements should not be made until speed is reduced. At speeds below 400 knots it takes little time to become accustomed to the light stick forces.

(b) *Ailerons*

Following failure of the No. 3 pump circuit, aileron feel is lost completely. There are no forces at all and no self-centering. The condition takes little time to become accustomed to and steady laterally level flight can be maintained easily after a minute or so. The aileron restrictors still operate to limit the angle which can be applied at high speed (see para. 3 of this Chapter).

(c) *Rudder*

(i) At speeds below 200 knots the rudder forces in manual are moderate. Above 200 knots they become heavy. With the rudder trimmer set at neutral, it is possible to hold the aircraft straight at 120 knots on full asymmetric power with a heavy foot-force.

(ii) In cross-wind and turbulent conditions, and when exceeding 0.95M care must be exercised.

(iii) Intermittent failure of No. 2 pump hydraulic pressure will cause the rudder to revert to manual and vice-versa at irregular and possibly infrequent intervals. The rudder must be used with care if this occurs.

PART I.

Chapter 6—PRESSURISATION AND AIR CONDITIONING SYSTEM

List of Contents

1. General

Air is bled from the two engine compressors to supply the heating, pressurising, windscreen de-misting and hood seals. A series of automatic valves controls the temperature of this air by suplying it via hot, warm or refrigerating systems. When Mod. 689, which replaces the refrigeration controlling thermostat by a metal strip, is embodied, however, control of the air temperature is semi-automatic, i.e. only the hot/warm mixture is automatically controlled. With this arrangement, therefore, the cabin temperature control must be turned to LOW before the cold air system will cut in.
It has been necessary to introduce this Modification to obviate the pressure fluctuations mentioned in para. 5(d) of this Chapter. When closed both hoods and the direct-vision panel are sealed automatically.

2. Air supplies to cockpits

Air is supplied via spray pipes at floor level. On modified aircraft an adjustable louvre is provided on the pilot's starboard instrument panel, and two adjustable louvres, fitted with shut-off valves, are provided in the rear cockpit.

3. Control of pressure

The cockpit pressure is automatically controlled as follows:—Up to 7,500 feet conditioned air of the required temperature is supplied to the cockpit. Above this altitude the differential pressure starts to build up until at 25,000 feet the full pressure differential of 3½ PSI is achieved. At 48,000 feet the cockpit altitude is approximately 26,000 feet.

4. Temperature control

A cockpit temperature control (89) marked LOW–NORMAL–HIGH on the starboard wall of the cockpit is fitted with a click stop at the NORMAL position. Rotating the wheel clockwise increases the temperature. The control permits selection of temperatures which are automatically controlled at the selected level. When Mod. 689 is embodied the control permits selection of temperatures which are semi-automatically controlled (see para. 1 above).

5. Use of temperature control

(a) Due to the possibility of damage to the cold air unit when running up an engine on the ground above 80% RPM with LOW selected on the cockpit temperature control, the other engine must be run at the same time at 70% RPM or more, or alternatively NORMAL or HIGH must be selected. LOW must never be selected if only one engine is being run up.

(b) When the hoods are closed with an engine running the hood seals automatically inflate and the cockpit is pressurised. Hood seal inflation can be checked by feeling the seal on the rim of the top of the hood.

(c) When Mod. 689 is embodied, only the hot/warm air is automatically controlled. The cockpit temperature control must be set to LOW before the cold air system will cut in.

(d) Pre-Mod. 689 the cockpit is subject to pressure fluctuations which occur as the result of automatic changes from warm to cold air or vice versa. This is most noticeable when flight conditions are such that selection of a particular temperature level on the cockpit temperature control results in frequent alternative automatic selections being made by the system. Pending embodiment of Mod. 689 this fluctuation can be avoided or minimised by certain combinations of cockpit temperature and windscreen de-misting selections. These depend on outside air temperature, altitude and speed, and are as follows:—

(i) Cockpit temperature control selected hot or cold with de-misting control selected either LOW or NORMAL, or

(ii) Selection of the de-misting control to HIGH for two or three minutes with any convenient selection of cockpit temperature.

6. Warning indicators

(a) *Cockpit altimeter*
A cockpit altimeter (62) is provided under the starboard coaming.

(b) *Warning light*
A cockpit pressure warning light (60) under the starboard coaming glows to give warning of a drop in cockpit pressure of more than 1 lb. below the normal for the particular altitude.

(c) *Warning horn*
A cockpit warning horn is operated by an altitude switch at a cockpit altitude of 42,000 feet. A warning horn isolating switch (at 80) is on the panel to the left of the centre instrument panel.

7. Hood de-misting

When closed both cockpit hoods and the fixed portion between them are de-misted by warm air from hood de-misting pipes supplied by the cockpit pressurising and heating system. Each hood, and the fixed portion of the hooding, has two spray pipes, one on each side.

8. Windscreen de-misting

(a) The windscreen de-misting is inoperative unless the generators are on line.

(b) The windscreen is de-misted internally by a warm air spray from the hood de-misting system, the temperature of the de-misting air being controlled by the three-position NORMAL–LOW–HIGH switch (at 109) on the starboard console. With the switch set to LOW (central), a supply of air at cockpit temperature is fed to the windscreen. When the switch is set to NORMAL, the temperature of this supply is increased by an electric heater element. Setting the switch to HIGH causes the temperature to be further increased by a high flow of hot air direct from the jet-pipe muff.

9. Use of windscreen de-misting

(a) The windscreen de-misting control should be set to HIGH two or three minutes before starting a rapid descent from altitude. If this is done there should be little or no internal misting of the windscreen.

(b) On completion of descent, and when visibility through the windscreen is considered satisfactory, the control should be set to NORMAL at the earliest opportunity.

(c) The temperature of the windscreen air is influenced by engine speed and in extreme conditions of misting it may assist to open the airbrakes and increase engine power.

(d) Under normal conditions the NORMAL setting should adequately counter any tendency for the windscreen to mist over. Failure to do so indicates that the system is unserviceable. Apart from the drill in (a) above, HIGH should *not* be selected unless circumstances make the use of this setting essential. Excessive use at this setting will cause damage to the windscreen.

10. Windscreen de-icing

The windscreen external de-icing system consists of, a tank (which holds 4 pints of fluid) housed in the lower portion of the port engine air intake, a hand pump (37) on the port console, and a spray pipe at the base of the windscreen panel. The pump handle is released by rotating it anti-clockwise. As the handle comes out under pressure the windscreen is sprayed with de-icing fluid. Pressure is raised again by pushing the handle in.

11. Direct-vision panel

The port side panel of the windscreen can be opened to provide a direct-vision window. The handle at the top corner is rotated outboard which deflates the panel seal, releases the cockpit pressure, and allows the window to be opened. A catch engages to lock the window in the open position. When closing the DV panel care must be taken that the cam-plate on the DV panel handle engages with the catch-block correctly, i.e. between the catch-block and side panel. The GGS glass must be in the retracted (down) position and the left leg of the camera recorder bracket must be folded, before the panel is opened.

12. Cockpit pressurisation failure at altitude

(a) Pressurisation failure will be indicated by the warning light.

(b) If the hood seals fail at height it is possible that an extra depression of up to 2,000 feet will occur in the cockpit, e.g. if the aircraft is flying at 48,000 feet when the seals fail, the cockpit altitude may go up to 50,000 feet.

(c) Failure or loss of a hood in flight will result in cockpit altitude exceeding aircraft altitude. At 48,000 feet, depending on the air airspeed, cockpit altitude may increase to a height of 53,000 feet.

(d) In all cases of pressurisation failure, if cockpit altitude exceeds 30,000 feet, the pilot should warn the navigator " Immediate descent, mask toggle down " and descend at maximum rate to a cockpit altitude of 30,000 feet or below.

NOTE.—In these circumstances the windscreen de-icing system should not be used, in order to prevent ingress of noxious fumes.

PART I.

Chapter 7—OXYGEN AND ANTI-G SYSTEMS

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OXYGEN SYSTEM

1. Regulators

(a) Two Mk. 17D demand regulators (83) and (133) on the starboard console in the front and rear cockpits, control the supply of oxygen to the pilot and navigator. Mk. 17E regulators will be fitted by Mod. 1451.

(b) A regulator consists of an ON–OFF valve (wired fully ON) which controls the flow of oxygen, an air-mix NORMAL–100% OXYGEN switch, an EMERGENCY three-position switch, a pressure gauge and a magnetic indicator. The magnetic indicator shows black when oxygen is not being used or if an electrical supply is not available, and a vertical white line when oxygen is demanded. The regulator is fully automatic and supplies oxygen in accordance with the user's demand, from sea-level to 50,000 feet.

(c) Oxygen is carried in six 750 litre Mk. 5D cylinders at the side of the nosewheel bay; the contents gauge (112) is adjacent to the pilot's regulator. The seat/aircraft connection (97) is at the rear of the starboard console in each cockpit.

(d)(i) When the ON–OFF valve is ON, and the air-mix switch is at NORMAL at ground level, a mixture of air and oxygen is supplied. As cabin altitude increases a barometric valve progressively reduces the amount of air in the mixture until at 33,000 feet (cabin altitude) 100% oxygen is supplied. With the air-mix switch at

100% OXYGEN, pure oxygen is supplied at all heights.

(ii) The 100% setting should be selected at all times with regulators Mk. 17D, since if the regulator failed at normal cockpit altitudes with NORMAL selected, 100% air could be breathed through the air inlet valve without any apparent effect on the breathing. If 100% OXYGEN is selected, failure of the regulator to give enough oxygen will be accompanied by difficulty in breathing *in*—the emergency oxygen should then be used and an immediate descent made, (see Part 4, Chap. 2, Para. 8). When Mk. 17E regulators are fitted, however, the NORMAL setting should be used, the 100% OXYGEN setting only being selected if symptoms of anoxia are felt or if noxious fumes are present. (The Mk. 17E regulator has been modified to overcome the defect inherent in earlier Mk. 17 regulators).

(e) When the EMERGENCY switch is moved to the left or right, oxygen is supplied at a slight positive pressure to prevent inward leaks at the mask. Normally the switch should be central, but it should be off-set if the cockpit air becomes contaminated.

2. Mask Type A13A or Type P

A pressure-breathing mask Type A13A or Type P, with toggle-harness, should be used with this regulator. The mask may be tested for leaks before flight, by firmly pressing in the EMERGENCY switch on the regulator, when in the central position. Oxygen is then supplied under pressure; when fully in, the pressure is five times as great as with the switch in either side position. With the emergency switch in either side position the mask fit should be adjusted, *with the harness–toggle in the normal position,* until there is no leakage: with the emergency switch pushed right in, the mask should be adjusted, *with the harness–toggle in the tight position* (down), so that the emergency pressure is retained without leakage. Ensure that the magnetic indicator operates, and breathing is unrestricted with the air-mix switch in both positions, and with the EMERGENCY switch deflected.

3. Emergency bottle system

(a) A manual control (105) is on the starboard console in both cockpits. When pulled, it turns on the emergency oxygen bottle stowed in the seat cushion, provided the safety-pin in the emergency bottle is removed. When the emergency bottle is used in flight, the mask/seat oxygen connection must be disconnected. The emergency oxygen is turned on automatically on ejection.

(b) If the regulator should fail to give the required oxygen pressure automatically on loss of cabin pressure, above 44,000 feet, there is no normal method of selecting pressure breathing from the regulator. The emergency supply must then be used. A blow-off valve in the mask tube connector will give a fixed value of pressure breathing when the tube is disconnected from the main supply, thus enabling a safe immediate and rapid descent to be made from cabin altitudes up to 50,000 feet.

ANTI-G SYSTEM

4. Anti-G system

(a) The anti-G installation provides an automatic means of inflating the pilot's and navigator's anti-G suits as soon as the vertical acceleration on the aircraft exceeds 1½G. It vents the suits to cockpit pressure during normal flight The connection for the anti-G suits is on the port side of the ejection seats.

(b) Air under pressure is stored in two air bottles (1,800 PSI) beneath the cockpit flooring, and is supplied to an anti-G box in the starboard console of the front cockpit. The pressure in the bottles is indicated on a gauge in the nosewheel bay.

(c) The anti-G box has an ON–OFF selector valve (102), which controls the supply to the pilot's and navigator's anti-G connections on the ejection seats, and a test push-button (100) and (139) in each cockpit.

(d) When the ON–OFF valve (102) is ON, and G in excess of 1½ is applied, spring-loaded valves in the anti-G box operate to permit air to pass to the pipe-lines inflating the anti-G suits. The amount of inflation depends on the G applied.

(e) The system may be tested, with the ON–OFF switch ON, by pressing the test push-button (100), or (139), in the appropriate cockpit, as gently as possible to avoid severe discomfort due to rapid inflation.

PART I.

Chapter 8—FLIGHT INSTRUMENTS

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1. Pressure and static system

(a) *Fuselage pressure head system*

Two pressure heads which serve the tailplane feel simulators are fitted on the upper portion of the fuselage.

(b) *Wing pressure head system*

A wing pressure head is fitted on the port outer main plane and provides,

Pressure and static supplies to
Air speed indicators in both cockpits
Machmeter in front cockpit
Low speed warning contacting ASI in the servicing bay
Static supplies only to
Altimeters in both cockpits
Rate-of-climb and descent indicator
Altitude unit of the GGS control unit
Zero-reader flight computor

(c) *Pressure head heaters*

The heater element in the pressure heads on both fuselage and wing, is controlled by the switch (at 80) at the bottom of the panel on the left of the main instrument panel.

2. Electrically-operated flight instruments

(a) *General*

(i) The Mk. 4B compass, artificial horizon (HGU)., and turn-and-slip indicator are on the centre instrument panel. A zero-reader indicator (55) is also on the centre instrument panel. All are electrically-operated.

(ii) Normally the Mk.4B compass, artificial horizon (HGU) and zero-reader are supplied with AC from the No. 1 flight instruments inverter. This inverter starts up automatically when the generators are running, *or* if the AI is switched on with a ground supply connected.

(iii) In the event of failure of the No. 1 flight instruments inverter a torque-switch operates automatically to transfer the flight instrument load to the No. 2 flight instruments inverter.

(b) *Mk.4B compass*

(i) The Mk.4B compass master indicator (116) is located in the rear cockpit on the port instrument panel; the detector unit is mounted in the starboard outer mainplane.

(ii) The control unit (134), wire-locked in the GYRO position, is on the forward end of the side of the starboard console in the rear cockpit.

(iii) In the front cockpit the course-setting and synchronising controls are mounted on the compass indicator and the COMPASS/D.GYRO selector-switch is outboard of the switch row (109) on the starboard console.

(c) *Horizon gyro unit*

(i) An horizon gyro unit is fitted on the centre instrument panel. The HGU which also fulfils the role of an artificial horizon also provides pitch and roll signals for the zero-reader.

(ii) Failure of the power supply to the instrument is indicated by the appearance of the OFF flag on the face of the instrument. If the fast erection button is used before flight it must not be kept depressed after satisfactory erection. In flight the button should only be used in unaccelerated level flight.

(d) *Turn-and-slip indicator*

(i) The turn-and-slip indicator is operated from the aircraft DC supply by one of two sources, each via a separate fuse. The normal source of supply is via a relay, and in the event of failure of this supply the other source is automatically made available. The instrument operates as soon as the battery isolating switch is set ON.

(ii) In the event of a failure of both of these sources a stand-by supply is provided from the emergency battery, controlled by the switch (64) on the starboard side of the centre instrument panel.

(iii) The appearance of the OFF flag on the face of the instrument indicates that the rotor speed is insufficient to provide accurate indication, and no further reliance should be placed on the instrument.

3. Zero-reader

(a) This installation co-ordinates signals from the horizon gyro unit, Mk. 4B compass, altimeter and ILS indicator for operating a single indicator in conjunction with a course selector.

(b) The indicator (55) and course selector (78) are on the centre instrument panel; the control unit (19) is on the panel on the left of the centre instrument panel.

4. ILS

(a) The ILS indicator (79) and marker indicator (56) are on the centre instrument panel; the controller (104), and ON–OFF switch and warning light (92) are on the starboard console. A volume control (90) is located outboard of the low speed/stall warning panel.

(b) Frequency card stowages (88) are on the hood sill.

(c) The three aerials, i.e. the localiser, glide-path and marker aerials, are set in the port and starboard wing-tips and the underside of the fuselage, respectively.

5. Radio altimeter

(a) The radio altimeter is on the centre instrument panel, and the altitude-setting selector (20) is on the panel on the left of the centre instrument panel.

(b) A single red low level limit light (47) is provided in the front cockpit and red, green and amber limit lights (119) in the rear cockpit. The red limit light will normally come on when below the pre-selected height, but will also come on in the event of failure of the equipment.

(c) The transmitter and receiver aerials are on the underside of the port engine nacelle, and the port wing adjacent to the root rib, respectively.

6. Other flight instruments

(a) *Accelerometer*

The accelerometer (51) under the port coaming indicates all accelerations imposed on the aircraft in the pitching plane by means of three concentrically mounted pointers; one pointer indicates instantaneous G and the other two register the maximum positive and the maximum negative G readings until reset by the resetting knob.

(b) *Ambient air temperature gauge*

An ambient air temperature gauge (128) is fitted on the panel forward of the starboard console in the rear cockpit.

(c) *Clock*

An 8-day clock, having provision for computing flying time, is fitted on the panel under the starboard coaming in the front cockpit.

PART I

Chapter 9—RADIO AND RADAR EQUIPMENT

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1. VHF–TR 1985/1986

(a) Two 10-channel VHF controllers (46) with an adjacent change-over switch (49) are on the panel under the port coaming. A volume control (45) is outboard of the controllers—clockwise movement increases volume. A press-to-transmit button (11) and a press-to-mute switch (12) are on the end of the starboard throttle lever. A foot-operated muting switch (135) is on the floor in the rear cockpit. Frequency change card stowages (7) and (88) are on the hood port and starboard sills.

(b) A tele-briefing land-line plug is in the port under-carriage wheel-bay. When the plug is connected the VHF circuit is de-energised and an amber warning light (23) to the right of the throttle-box indicates that tele-briefing is in use. The press-to-speak push-button is adjacent. When Mod. 996 is embodied it is not necessary to have the battery isolating switch ON to use tele-briefing.

(c) The ARI.18006 RCM (D/F) Homer CALL NAVIGATOR switch (30) is aft of the tailplane stand-by trimmer switch.

(d) Two whip-type aerials, one for each set, are fitted to the top of the fin.

2. A.1961 intercomm. amplifier

A switch (50) for the A.1961 intercomm. amplifier is inboard of the VHF controls (46); it has three positions, OFF–NORMAL–EMER. In the NORMAL position intercomm. is obtained through the amplifier and is cut off should the VHF press-to-transmit button be used at the same time. When switched to either the OFF or EMERGENCY position intercomm. is obtained through the VHF sets and can be used whilst transmissions are made. When set to the EMERGENCY position the amplifier is switched on but not in circuit.

3. IFF Mk. 10

(a) The controller and ON–OFF switch for the IFF.Mk. 10 are on the port console in the rear cockpit.
(b) Two "sharks-fin" aerials are fitted, one forward of the windscreen on the port side of the fuselage, and the other on the under surface on the fuselage near the aft end.

4. AI

The collimator for the AI is mounted in front of the gun-sight, and its control panel (36) is on the port console. The collimator ON–OFF switch (14) is on the hood port sill. The controls for this installation are in the rear cockpit and consist of an AI DC circuit-breaker, AI START and STOP switches (at 142), an ON–OFF switch (141) on the port console, an indicator unit (118), and control units Type 901 stowed above the chart-board and Type 902 (131) on the starboard console.

5. ARI.5870

(a) The controls for this installation are in the rear cock-pit, and consist of a control unit on the starboard console, a GEE and ARI.5870 NORMAL–OFF–EMERGENCY switch (at 142) to control the inverters, an ARI.5870 ON–OFF switch on the port console, and an indicator light (140) on the panel in front of this console.
(b) The ARI.5870 aerial is fitted in the trailing edge of of the rudder.

6. GEE Mk. 3

(a) The controls for this installation are in the rear cock-pit on the port console, and consist of a DC circuit-breaker (as for AI) a GEE and ARI.5870 NORMAL–OFF–EMERGENCY switch (at 142) to control the inverters, and a GEE ON–OFF switch adjacent.

(b) The GEE aerial, consisting of a metal plate, is moulded into the head fairing behind the rear cockpit.

PART I.

Chapter 10—HOODS—OPERATION AND JETTISONING

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WARNING.—Cartridge-operated hood-jettison devices are fitted to the aircraft, operated from the hood-jettison handles, in the front cockpit, and in the rear cockpit. It is the aircrew members' responsibility that these handles are locked by the safety-pins provided when they leave the aircraft after flight. The front cockpit pin should be fitted through the bracket attached to the instrument panel and the bracket as shown in Fig. 1. The rear cockpit pin should be fitted through the two brackets so that it passes through the jettison handle grip. The external hood-jettison handle does *not* fire the jettison cartridges. It is essential that *both* the ejection safety-pins *and* the hood-jettison safety-pins are removed before flight. If flown solo, all safety-pins in the rear cockpit may be left in position.

1. General

The hoods, which move together, are opened and closed electrically after selection by a three-position OPEN–off–CLOSE switch (16), on the hood port sill in the front cockpit. A second switch (117) is fitted in the rear cockpit on the port instrument panel. The switches which are guarded are spring-loaded to the central off position.

2. Opening

Holding either switch at OPEN will open the hoods after a short delay to permit the seals to deflate. The hoods may be stopped in any desired position by letting the switch return to the off position. Limit switches operate to stop the hoods at the end of their travel.

3. Closing

When either switch is held to CLOSE, the hoods start to close at once. Unless the hoods are fully closed the cockpit will fail to pressurise as the inflation of the hood seals is controlled automatically by micro-switches. The hoods will not move when CLOSE is selected if the clutch release is not engaged.

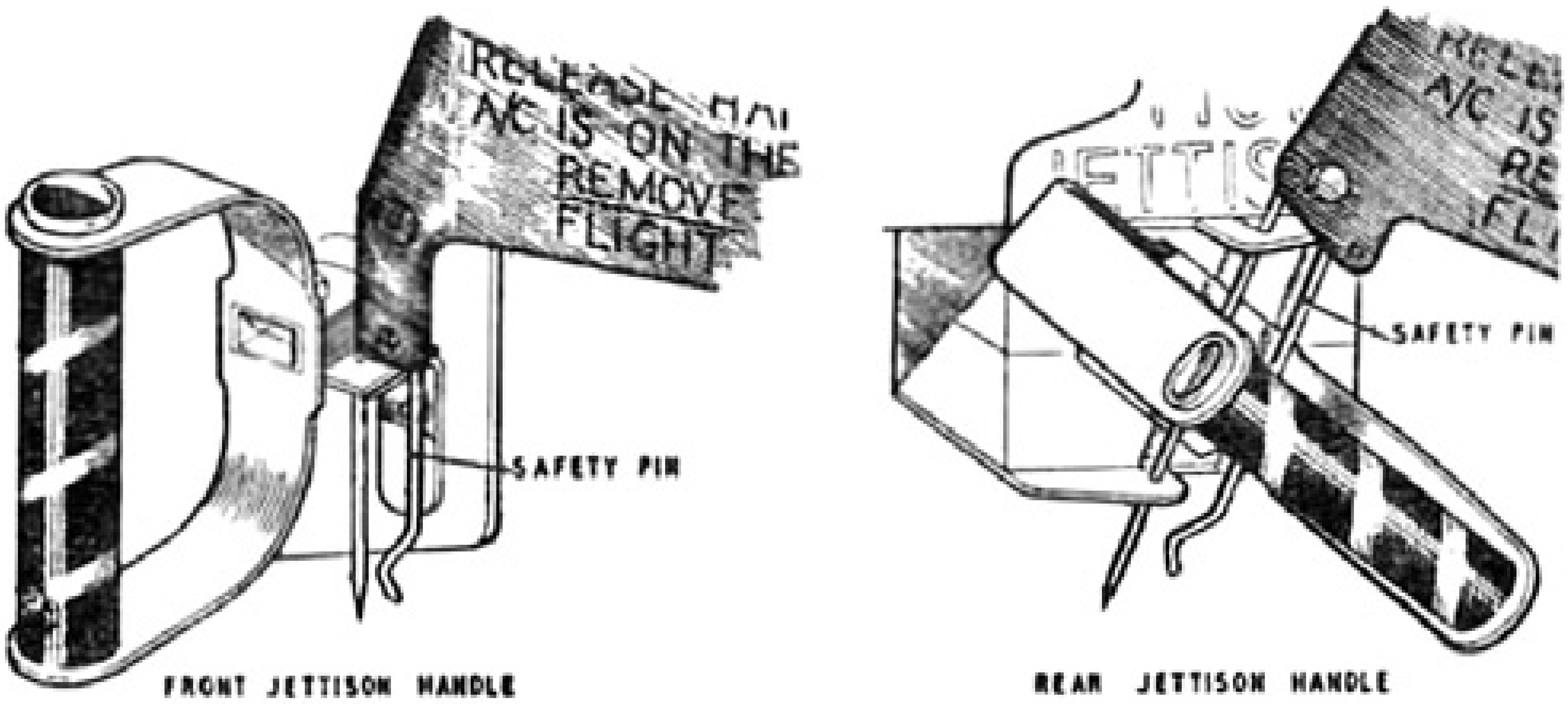

Fig. 1—Locking the Hood Jettison Handles

4. Hood clutches

To permit the hoods to be moved by hand a clutch-release is fitted to the actuator, and may be operated from three release controls, one (5) in each cockpit, and one externally on the port side of the fuselage. Before the hoods can be operated electrically the hood clutch-releases must be in the engaged position. If the electrical actuator fails, the hoods can be moved by hand after pushing down the clutch-release; this action also deflates the hood seals.

5. Correct assembly

(a) When the hood is correctly assembled to the rails the tops of the two cocking levers, one on either side, should not protrude above the fairing. Inspection holes in the side fairing, two on each side of each hood, permit a visual check to be made on contact strips, which should be in line with indicator marks, and engagement of hooks on pins.

(b) *Before entering cockpit*

(i) Check that the cocking levers (one on each side of each hood, painted red) which secure the hood to the rails do not protrude above the fairing.

(ii) Check by means of the front inspection holes on each hood side fairing (one on each side of each hood), that the white mark on the contact strip is coincidental with the white indicator mark on the hood side fairing, and that the hook face is touching the trolley projection.

(iii) Check by means of the rear inspection holes on each hood side fairing (one on each side of each hood), that the contact lever hook is engaged with its pin.

(iv) Check the hoods for security by physically lifting on both sides of each hood. The external clutch release must be in the clutch engaged position (flush).

(v) Check that the hood external jettison handle is fully down, with the long arm of the handle pointing rearwards.

6. Hood jettisoning

(a)(i) Each hood may be jettisoned separately by pulling the jettison handle (22) or (126) in the respective cockpit. When a handle is pulled a cartridge on the ejection seat rail is fired and extends two jettison guns (4) and (94) on each side of the particular hood. This unlocks the jettison mechanism and throws the hood clear of the aircraft. The hood is also jettisoned automatically when the ejection seat blind is pulled down, or the secondary firing handle is operated. (See Chap. 12 of this Part). *The hoods must not be jettisoned when they are open or partially open.* Hoods must not be jettisoned when on the ground, except in cases of extreme emergency, as there is a risk of them falling back into the cockpits.

(ii) Should it be necessary to jettison the hoods whilst stationary, or during the landing run, the front hood *must* be jettisoned first in order to prevent injury to the occupant of the rear seat. The rear hood provides protection to the occupant of the rear seat should the front hood, after jettisoning, land on the rear hood.

(b) An external jettison handle is provided in the top skin on the starboard side of the cockpits. Pulling this handle releases the jettison mechanism in both hoods but does not fire the jettison cartridges.

(c) When the aircraft is on the ground the internal jettison handles should be locked by the safety-pins (21) and (125). In flight the safety-pins are stowed at (27) and (132) on the side of the port and starboard consoles in the front and rear cockpits, respectively.

PART I.

Chapter 11—LOW-SPEED AND STALL-WARNING SYSTEMS

List of Contents

1. Controlling switch and test buttons

An ON–OFF switch (106), normally wire-locked ON, which controls both the low speed and stall warning systems, is on the starboard console outboard of the emergency oxygen control. A TESTC/ASI button and two TEST buttons, are provided adjacent to the ON–OFF switch to enable the low speed and stall warning, respectively, to be checked. Neither warning can be checked in the air.

2. Low-speed warning system

When the ASI indicates approximately 150 knots or below an electrical contact is made by means of a contacting ASI, in the servicing bay, which energises an audio warning box and a continuous raucous warbling note is fed to the earphones. When the warning is operating a relay cuts out all VHF and intercomm. A micro-switch on the port undercarriage door cuts out the noise when the undercarriage is down.

3. Management of the low speed warning system

NOTE.—Before checking the warning see that the low speed/stall warning ON–OFF switch is wire-locked ON.

With an electrical supply available, the serviceability of the low speed audio warning should be checked by pressing the TEST C/ASI button on the starboard console.

4. Stall-warning system

(a) Two stall detectors in the form of small guarded flags are fitted, one to each wing. Their purpose is to give warning of the break-down of airflow over the outboard sections of the wings. When the aircraft is stationary these flags, under the loading of a hair-spring, point towards the wing tips, and in this position a switch contact is broken and the audio box used by the low speed system is energised. When Mod. 1026 is embodied, the flags are replaced by vanes. When the aircraft is stationary the vanes are spring-loaded to an approximately upright position. In this position a switch contact is broken.

(b) In normal flight the flags are held in the trail position under the action of the airflow across the wing. Under these conditions the audio warning box is de-energised. When the stall is approached the changing flow pattern allows the flags to move, until near the stall they rotate towards the wing tips thus energising the audio box. When Mod. 1026 is embodied, the pressure of the airflow over the wings in flight moves the vanes so closing the switch. In this case the audio box does not give out a signal. When the stall is approached the air pressure on the vanes is reduced until the vanes can move forward to open the switch contact and thus energise the audio box. The movement of vanes is too small to be noticeable from the cockpit. The circuit is designed to fail safe so that any fault will bring the noise on.

(c) The audio warning given is a loud discordant note interrupted regularly. When the warning is operating the same relay referred to in para. 2 above cuts out all VHF and intercomm. However, a micro-switch fitted in the starboard undercarriage circuit cuts out the noise when the undercarriage is down.

5. Management of the stall-warning system

NOTE.—Before checking the warning see that the low speed/ stall warning ON–OFF switch is wire-locked ON.

With an electrical supply available, the serviceability of the stall audio warning may be checked by pressing each test button on either side of the ON–OFF switch on the starboard console.

6. Low-speed and stall-warning failure

If, in flight, a failure occurs resulting in the audio warning sounding continuously, the low speed/stall warning switch must be switched OFF, and care taken not to approach the stall or fly below 150 knots during the remainder of the flight. The system must not be switched on again. If the VHF/I/C remains inoperative after the stall or low speed warnings have sounded it is probably due to a sticking relay in the circuit. An attempt to reset this relay may be made by switching OFF the stall/low speed warning ON–OFF switch. When the VHF/I/C is regained the switch should be switched ON again. If VHF/I/C is not regained the switch should be left OFF.

NOTE.—The low speed and stall warning systems cannot be tested simultaneously: however, in flight they will operate simultaneously when appropriate.

PART I.

Chapter 12—EJECTION SEAT MK. 3J

List of Contents

Illustrations

WARNING 1.—Aircrew must ensure that each safety-pin is removed and stowed before flight, and must lock each firing handle against the possibility of accidental withdrawal on the ground before leaving the cockpit. All personnel must ensure that each firing handle is locked (i.e., fabric safety strap passed through the handle and secured with its safety-pin) before entering the cockpit.

2.—If it is necessary to leave the aircraft in an emergency on the ground, or after ditching, special care must be taken not to foul the secondary handle on the seat-pan if its safety-pin is not in position.

1. General

(a) Two Mk. 3J ejection seats are fitted, each incorporating two firing handles; a primary firing handle above the head rest, and a secondary firing handle on the front of the seat-pan. A type ZF harness, head-rest, parachute container for the Mk. 9 parachute, a seat-well for the personal survival pack and emergency oxygen supply, and leg-restraining cords are also fitted.
(b) The seat height may be adjusted by a lever on the starboard side of the seat; the lean-forward release is also on the starboard side.

(c) At the rear of each seat is the ejection gun and on the port side the drogue gun. The ejection gun of each seat is fired by either the primary firing handle (to which is attached a flexible blind to protect the face) or by the secondary handle.

(d) A G-stop is incorporated to prevent the opening of the main parachute if the speed of the seat after ejection is too high for safe deployment. The stop prevents the operation of the barostatic time-delay unit until the speed of the seat has fallen to a safe figure. The seat has a ground-level ejection capability, provided that the aircraft's flight path is parallel to the ground. If the aircraft is descending, more than the minimum altitude will be required.

2. Leg-restraint

Leg-restraining cords and leg-restraint garters 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 apart after ejection. The 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. The cords are connected to the safety-harness shoulder straps at the safety-harness quick-release box, after first crossing each other and passing through the leg-restraint garter D-rings and thence under the safety-harness lap straps. (See para. 6 of this Chapter). Thus on ejection the cords are pulled downwards through the units pulling the legs together and close to the seat-pan. The legs are held in this position until the safety-harness is released. The cords are then pulled through the leg-restraint garter D-rings and free the legs. 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.

3. Stowages

Harness stowage clips (3) (9) (91) and (93) are provided on the port and starboard sides of the cockpits. Leg restraining cord stowages (57) and (136) are provided under the GGS in the front cockpit and below the crow-bar stowage in the rear cockpit. Stowages for both safety-pins and

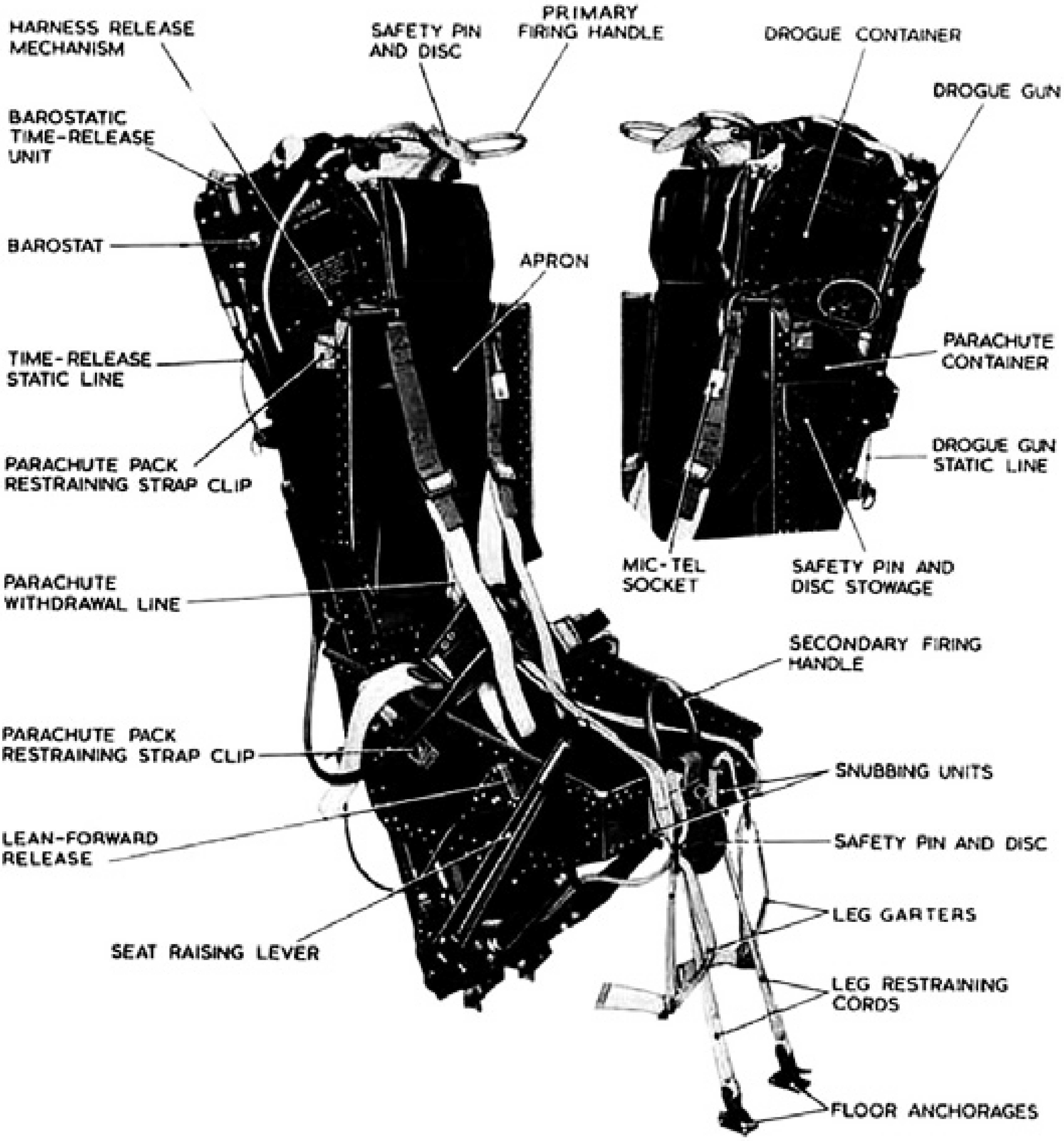

Fig. 1—Ejection Seat Mk. 3J

discs for each seat are provided, one on the port side of each parachute container, one on the starboard console (108) in the front cockpit and one on the port console in the rear cockpit.

4. Normal operation

(a) When either firing handle is operated the hood is jettisoned immediately and a timing unit on the back of the seat started. This unit withdraws the sear from the seat gun one second later and ejects the seat. The drogue fires one half second after ejection. It is important that, should the secondary firing handle be used under conditions of G, which preclude the use of the primary firing handle, the occupant should press his head back on the head-rest to prevent injury to the spine on ejection.

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

(c) As the seat is ejected a static rod sets the barostatic time-delay mechanism. When the free descent reaches 10,000 feet or at once if ejection has taken place below that height, (provided that the G-stop has not operated), the barostat removes an obstruction to the gear train of the mechanism allowing it to operate. After 1¼ seconds automatic withdrawal of the parachute takes place. The occupant is momentarily prevented from leaving the seat by two restraining straps until deployment of the parachute lifts him clear of the seat.

5. Manual override

A manual override D-ring is fitted over the rip-cord D-ring and can be used to detach the parachute from the seat if it is necessary to operate the parachute manually. If the manual override is used it is important that it should be pulled *before* releasing the safety-harness, otherwise there is a danger of falling out of the seat with the parachute still attached to the seat.

6. Strapping in before flight

(a) Check that both safety-pins are fitted at the primary and secondary firing handles and in the hood jettison handle.

(b) Check that the barostat and drogue gun static lines are connected, that the top latch is engaged, that the drogue and drogue gun lines are correctly routed (white over black), that the scissors shackle is secure, and that the pin from the emergency oxygen bottle is removed.

(c) Check the crow-bar for security.

(d) When seated, adjust the seat for correct height, and fasten the leg-restraint garters (if not embodied in the flying suit) below the knees with the D-rings to the inside rear.

(e) Connect up the personal survival pack lanyard, ensuring that the line does not pass through the parachute harness.

(f) Connect up the anti-G suit supply, outside the PSP lanyard.

(g) Connect up the parachute harness straps. Ensure that the shoulder straps pass under the folds of the life saving waistcoat stole. Check that the leg loop does not pass through the secondary firing handle. Check that the quick-release box is locked and then fit the safety-clip.

(h) Fasten the safety-harness lap strap but do not tighten.

(j) Pass the left-hand leg-restraint cord through the right leg garter D-ring, *under* the safety-harness lap strap and insert the right shoulder safety-harness eyepiece through the loop on the cord. Secure the shoulder safety-harness in the quick-release box.

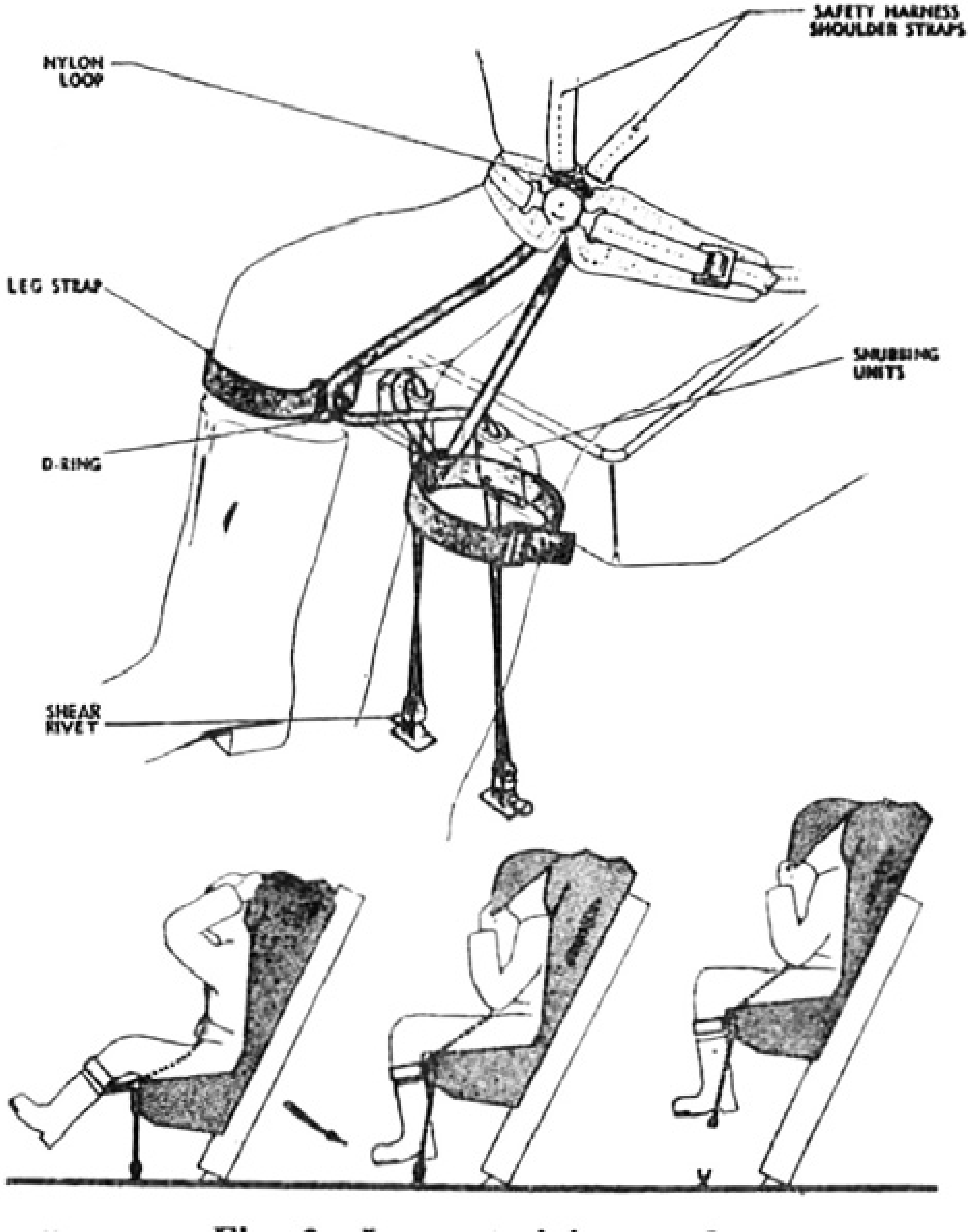

Fig. 2—Leg-restraining cords

(k) Repeat for the other cord, passing the right-hand leg-restraint cord through the left leg garter D-ring, *under* the safety-harness lap strap and insert the left shoulder safety-harness eye-piece through the loop on the cord. Secure the shoulder safety-harness in the quick-release box.

(l) Tighten the lap straps of the safety-harness, ensuring that the quick-release box is positioned as low as possible and is not covering the parachute harness quick-release box. Then tighten the shoulder straps of the safety-harness.

(m) Adjust the leg-restraint cords by means of the release buttons on the snubbing units to give comfortable leg movement. Adjust PSP straps.

(n) Put on the flying and protective helmets and fasten the chin straps. Connect the mic-tel lead.

(o) Connect the main and emergency oxygen supply tubes to the oxygen mask tube—adjust tube to suit and connect the locating chain to the life-saving waistcoat.

NOTE.—Ensure that the emergency oxygen supply pipe passes under the right shoulder strap of the parachute harness before connecting.

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

(q) Remove and stow the cockpit hood jettison handle safety-pin, and the primary and secondary firing handle safety-pins. If the secondary firing handle safety-pin is left in, there is a risk that the control column may be fouled in flight.

NOTE.—The assistance of ground crew is necessary to remove the primary firing handle safety-pin. If ground crew are not available, aircrew *must* remove this pin before strapping into the seat.

7. Normal exit from the aircraft

NOTE.—Ground crew should re-fit the primary firing handle safety-pin. If ground crew are not available, aircrew *must* fit both the primary and secondary firing handle safety-pins before leaving the aircraft.

(a) Replace safety pin in secondary firing handle before releasing harness.

(b) Replace hood-jettison handle safety-pin in handle.

(c) Disconnect main and emergency oxygen supplies from oxygen mask tube.

(d) Disconnect mic-tel lead.

(e) Release safety-harness and return the quick-release box to the locked position.

(f) Remove the safety-clip from the parachute harness quick-release box, release the harness and return the quick-release box to the locked position.

(g) Disconnect the anti-G suit supply pipe and fit blanking plug to end of the pipe.

(h) Disconnect the PSP lanyard from life-saving waistcoat and drape it over the left hand side of the seat and over the anti-G suit supply pipe.

(j) Remove the leg-restraint garters and stow securely in cockpit.

(k) Vacate cockpit.

8. Exit from the aircraft after ditching

(a) If the actions in para. 4, Chap. 3, Part IV have not been completed before ditching, they should be completed as soon as the aircraft has come to rest. Emergency oxygen need not be selected and the front hood should be jettisoned first.

(b) Leave the cockpit as soon as possible using the following drill:—

- (i) Disconnect G suit.
- (ii) Release safety-harness and leg restraint cords.
- (iii) Release parachute harness.
- (iv) Remove oxygen mask and disconnect main tube.
- (v) Climb out as soon as possible.

(c) When clear of the cockpit inflate the life jacket and pull the PSP from the cockpit by means of the 15 ft. lowering line. If the aircraft sinks immediately, as is probable, it may not be possible to recover the PSP if it has caught in the cockpit, and the only action possible will be to disconnect the line from the life jacket and leave the PSP in the aircraft.

(d) If the PSP is recovered, open the survival pack and inflate and board the dinghy.

(e) If time permits, each crew member should assist the other to leave the aircraft. The navigator is more likely to be prepared for leaving the aircraft quickly.

PART I.

Chapter 13—MISCELLANEOUS EQUIPMENT

List of Contents

1. Map stowages

Map stowages (96) and (113) are provided at the rear of the starboard console in the front cockpit, and at the front of the port console in the rear cockpit. A chart board (138) is provided in the rear cockpit.

2. Internal lighting

(a) *Front cockpit*

Four ON–OFF dimmer switches (86) on the hood starboard sill, and two dimmer switches (85) and (87) on the cockpit starboard wall are provided for the control of the internal lighting. The dimmer switches operate the lights as follows:—

Front switch	Port and starboard panels under coaming, plus port instrument panel. Red.
2nd switch	4 Reds. On main instrument panel, two at the top, two at the bottom.
3rd switch	Two red floods over each console.
Rear switch	U/V lighting.
Front switch on cockpit starboard wall (85) ...	Stand-by compass light.
Rear switch on cockpit starboard wall (87) ...	Large red flood on starboard console, VHF and frequency cards stowage.
Anti-dazzle light switch (75)	BRIGHT–OFF–DIM (rear) switch between RPM gauges, (fuel gauges, later aircraft).

(b) *Rear cockpit*

There are four dimmer switches which operate as follows:

Port dimmer outboard (at 114)	Top instrument panel. Compass and oxygen panel.
Port dimmer inboard (at 114)	Port chart-board light.
Starboard top dimmer (at 129)	Starboard chart-board light.
Starboard bottom dimmer (at 129)	Port and starboard console lights.

3. Emergency lighting

An emergency lamp under the starboard coaming is operated by the switch (81), on the port instrument panel, power being supplied by an alkaline battery (which also provides a stand-by supply for the turn-and-slip indicator) in the AI bay. This switch also controls the emergency supply to the E2B compass light.

4. External lighting

The navigation lights are controlled by a three-position STEADY–OFF–FLASH switch (at 109) on the starboard console. The taxying lamps are controlled by the ON–OFF switch in the same switch row.

5. Hand-operated extinguisher

A hand-operated fire extinguisher is on the port wall of the rear cockpit.

6. Rear-view mirror

A rear view mirror is fitted to the windscreen arch.

7. Pencil stowages

Stowages (130) for four pencils is provided on the starboard console in the rear cockpit.

Chapter 14—OPERATIONAL EQUIPMENT

List of Contents

1. Gyro gunsight Mk. 7

(a) The gyro gunsight is fitted above the instrument panel on a fixed mounting; its controlling ON–OFF switch (33) is on the port console, and adjacent is the GGS control unit (32).

(b) The gunsight is ranged manually by a twist-grip (10) on the port throttle-lever, but is normally ranged by the radar installation.

(c) Stowage (84) for two spare bulbs for the GGS are on the panel under the starboard coaming and a stowage (76) for the GGS recorder is in front of the control column.

NOTE.—The GGS ON–OFF switch must be OFF before removing or replacing the electrical connector to the GGS recorder. When not in use the electrical connector is fitted in a clip above the coaming.

2. G45B camera and GGS camera recorder Mk. 3

(a) A G45B ciné camera is mounted in the leading edge of the starboard wing and a recorder camera Mk. 3 is provided for the GGS.

(b) With the camera master switch ON, the ciné and recorder cameras are operated automatically when the ciné camera button (74) is energised. They also operate automatically when the gun trigger (at 59) is operated when the camera master switch is ON.

(c) A CAMERA MASTER switch (at 80) and a SUNNY/CLOUDY aperature switch (at 109) are at the bottom of the panel on the left of the centre instrument panel and the starboard console, respectively.

3. Gun firing

(a) With the guns master switch (34) set to ON and the safety-catch (59) on the top of the control colmn set to FIRE, pressure on the gun trigger at the front of the control column will fire the guns.

(b) A safety relay, coupled to the undercarriage ground lock switches, prevents the guns being fired when the weight of the aircraft is on its wheels. To permit gound firing a butt-test ON–OFF switch in the starboard main wheel-bay may be set to ON. Normally the switch should be set to OFF.

4. Gun-bay scavenging

(a) In order to prevent an explosive concentration of gases accumulating in the gun-bays when the guns are fired, a solenoid-operated valve in each wing which controls the gun heating for that wing, is opened when the gun trigger is pressed.

(b) The solenoid-operated valve in each wing is duplicated, one acting as a stand-by which is controlled by one of two ON–OFF switches (6) labelled GUN SCAVENGE STAND–BY.PORT.STBD. on the port console.
A SOL. TEST STANDBY–NORMAL switch, spring-loaded to NORMAL is provided in each wheel bay to permit ground testing of the system.

(c) When a valve is open an unrestricted flow of hot air is allowed to scavenge the gun bays. Because of the risk of overheating the structure or ammunition should a valve stick open, or risk of an explosion in the gun bay if a valve failed to open, two gun bay scavenging valve indicators (52), one for each wing, are fitted under the port coaming.

5. Management of the gun bay scavenging system

(a) The gun bay scavenging indicators are normally black, but when the guns are fired they should go white to indicate the valves are operating correctly. They will remain white for about ten seconds after the gun trigger has been released.

(b) Should an indicator remain black when the guns are fired, firing must be discontinued. If an indicator goes white in flight, or remains on longer than one minute after firing the guns, it is an indication that the associated valve has failed in the open position. In this event, operation of the appropriate switch on the port console will bring the stand-by solenoid valve into operation, and the indicator should go black, indicating that the valve has shut. Should the indicator remain white the associated engine must be reduced to idling unless the aircraft is engaged on low level firing when the engine must be shut down.

(c) *Testing the system on the ground*
Both engines must be started and the operation of the valves checked by use of the switches in either wheel bay. When a switch is held to STAND-BY the magnetic indicator should go white. When the switch is returned to NORMAL the indicator should go black. In order to close the valves, after operation of the test switches, 85% RPM may be needed.

PART I

Chapter 15—EMERGENCY EQUIPMENT

List of Contents

1. Survival packs

Stowages are provided for survival packs for both crew members behind panels on the port and starboard side of the aircraft forward of the front cockpit.

2. Crowbars

A light crowbar (95) is stowed on the starboard wall in the front cockpit, and at (124) in the rear cockpit.

3. E2B stand-by compass

An E2B compass is fitted to the windscreen arch in the front cockpit.

4. Torches

Stowages (98) for torches are provided on the starboard console of each cockpit.

5. Aircraft destructor

Provision is made to carry a destructor in a container at the top front of the starboard engine nacelle.

6. Call lights

An emergency intercomm. push-button and call-light (44) are on the left of the main instrument panel in the front cockpit. A similar switch and call-light (127) are on the starboard instrument panel above the temperature gauge (128) in the rear cockpit. When either button is depressed the lights in both cockpits come on.
(See Part IV, Chap. 3, para. 3(e)).

7. Asbestos gloves and first-aid outfit

Asbestos gloves and a first-aid outfit are stowed forward of the GEE indicator (123) in the rear cockpit.

PART II–LIMITATIONS

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PART II.

Chapter 1—ENGINE LIMITATIONS

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1. Engine limitations—Sapphire Mks. 102 and 103

Power Rating	Time Limit (per flight)	RPM %	Max. JPT °C
Take-off and Operational Necessity	15 mins. (Aggregate)	100.5	675
Intermediate	30 mins.	97.5	635
Max. continuous	Unrestricted	95.0	595
Ground idling	Unrestricted	35-40	570
During starting	Momentarily	—	750

NOTE 1.—At take-off the max. JPT in ISA conditions when the aircraft is static should not exceed 640°C. This is to avoid the JPT exceeding the max. permissible at altitude.

2.—*Pre-Mod. Sa.* 817 the maximum JPT for take-off and operational necessity is limited to 655°C. and the max. JPT (static) in ISA conditions should not exceed 620°C.

3.—The RPM limitation of 100.5% may be exceeded on the climb to 20,000 feet and in these conditions, a maximum of 101% is permitted for 5 minutes. Above 20,000 feet the maximum engine speed decreases progressively to approximately 97% at 50,000 feet.

4.—At any power rating, the overriding limitation is the one first obtained, either engine speed or JPT.

2. Oil pressure limitations

Normal oil pressure at 95% RPM .... 25–35 PSI
Minimum oil pressure at 95% RPM and above 20 PSI
Minimum oil pressure at ground idling .... 8 PSI

PART II

Chapter 2—AIRCRAFT LIMITATIONS

List of Contents

1. General

The Javelin F(AW) Mk.4 is designed for the duties appropriate to an all-weather fighter. Intentional stalling and spinning and aerobatics in the looping plane are prohabited (See paras. 7 and 10 of Chap. 3, Part III). The maximum permissible altitude is 48,000 feet. The aircraft is cleared for the use of both AVTUR and AVTAG fuel. The aircraft is cleared for use in temperate climates only.

2. Maximum speeds

Clean aircraft	From sea-level to 7,000 feet	535 knots
	From 7,000 feet to 20,000 feet	0.90M
	From 20,000 feet to 35,000 feet	0.95M
	Above 35,000 feet	1.04M
With ventral tanks	From sea-level to 7,000 feet	535 knots
	From 7,000 feet to 20,000 feet	0.90M
	Above 20,000 feet	0.95M
Operating the undercarriage		220 knots
Operating the flaps		200 knots

The maximum speed for operating a service also applies with the service in the lowered position.

3. Minimum speeds

(a) To avoid the risk of an accidental stall, speed in the circuit must not be allowed to fall below 125 knots except in the round-out.

(b) At no other time must the speed be allowed to fall below 150 knots (indicated by the low speed audio warning) because of the rapid falling off in speed if any G is applied.

NOTE.—Particular care is required to observe this minimum speed when attention is concentrated on the gun-sight and collimator.

(c) The minimum speed for lowering flaps is 135 knots, in order to lessen the rate of sink or an accidental stall as a result of the combined effects of increased drag and nose-up trim change caused by lowering the flaps.

4. G limitations

	Clean Aircraft	With empty ventral tanks	With full or partly full ventral tanks
Below 20,000 feet	5½G	5½G	4G
Above 20,000 feet			
Below 0.90M	4G	4G	4G
0.90 to 0.95M	4G	4G	3G
Above 0.95M	3G	—	—

5. Aircraft approach—limitations (AAL'S)

The aircraft approach limitations, subject to the standard conditions of pilot proficiency, airfield approved lighting, minimum visibility and accurate height information, are as follows:—

	Height* True	(feet) Altimeter
(a) ILS (GCA monitored)	315	350
ILS/Zero-reader (GCA monitored)	250	300
GCA	250	300

*Above runway level.

6. Temporary restrictions

(a) The ARI.5870 installation is cleared for use in S band only.

(b) Until Modification action to reduce the effect of aerodynamic heating is introduced the following restrictions on gun-firing apply:—

1. Not more than 135 rounds of HE ammunition per gun may be carried.
2. Clearance is given for temperate climates only.
3. Firing may not be carried out between sea-level and 5,000 feet if 435 knots has been exceeded for longer than 10 minutes. If this time limit is exceeded the three rounds positioned in the gun cylinder must be discarded.

7. Weight limitations

		LCN
Max. permissible all-up weight for flying with ventral tanks full or party full ...	38,000lb.	24
Max. permissible all-up weight for all forms of flying, clean aircraft	33,500lb.	21
Normal max. all-up-weight for landing with or without empty ventral tanks ...	33,300lb.	20

For landing at weights above 33,300lb. special care is required as full strength factors are not attained.

8. C. of G. limits

Forward limit of C of G.	21.6 ins. forward of datum.
Aft limit of C. of G. ...	12.4 ins. forward of datum.

9. Use of control locking gear

Damage to the rudder circuit will be caused in winds above 30 knots unless the controls are locked before turning out of wind, taxying or parking tail-to-wind.

PART III—HANDLING

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PART III.

Chapter 1—PREPARATION FOR FLIGHT

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1. External checks

(a) The outside of the aircraft should be checked systematically for obvious signs of damage and for security of panels and doors. The engine intakes must be free from obstruction and the jet-pipes free from distortion and wrinkling. The main and nose-wheel undercarriage locks shold be removed, the oleos checked for extension, the tyres for cuts and creep and the brake leads for security and leaks. The following specific checks should also be made:—

Nosewheel bay	Undercarriage emergency air bottle pressure—2,700 PSI Anti–G bottle pressure 1,800 PSI
Engine intakes	Blanks removed
Starboard undercarriage bay	Butt test switch—OFF
Vortex generators and stall detector flags/vanes ...	Inspect for security.
Jet pipes	Blanks removed
Footstep	Retracted
Pressure hand covers (Three)	Removed

(b)(i) Check that the cocking levers (one on each side of each hood, painted red) which secure the hood to the rails do not protrude above the fairing.

(ii) Check by means of the front inspection holes on each hood side fairing (one on each side of each hood), that the white mark on the contact strip is coincidental with the white indicator mark on he hood side fairing, and that the hook face is touching the trolley projection.

(iii) Check by means of the rear inspection holes on each hood side fairing (one on each side of each hood), that the contact lever hook is engaged with its pin.

(iv) Check the hoods for security by physically lifting on both sides of each hood. The external hood clutch release must be in the clutch engaged position (flush).

(v) Check that the external hood jettison control handle is fully down, with the long arm of the handle pointing rearwards.

2. Internal checks

(a) If the aircraft is being flown solo the following checks should be made in the rear cockpit: —

Seat and parachute straps ...	Secure.
Crowbar	Secure.
Torch (if fitted)	Secure.
Fire extinguisher	Secure.
Internal lights	OFF.
Generator test switches ...	NORMAL.
Hood clutch release ...	Engaged.
Hood switch	Central.
Variation setting control ...	Zero.
Oxygen	Dummy plug fitted, if supply tube is not fitted with shut-off valve.
Hood jettison handle Primary firing handle Secondary firing handle	Check flags and pins for security.

(b) On entering the cockpit check that both pins are inserted in the primary and secondary firing handles, and the barostat and drogue gun mechanism trip rods are connected. Check the routing of the drogue and drogue gun lines (white over black), the scissors shackle for security, the engagement of the top latch, and that the pin from the emergency oxygen bottle is removed.. Check the crowbar for security.

(c) *Cockpit checks*

(i) The following checks should be done before switching on the battery isolating switch, unless cockpit lighting is essential. If the battery isolating switch is on during the strapping in procedure, all unnecessary delays must be avoided and the booster-pumps, VHF etc. must be off until immediately before the engines are started.

(ii) Connect the personal equipment (See Part I, Chap. 12, Para. 6). Adjust the rudder pedals for reach and the inclination of the foot plates as required. Ensure that the inclination of the foot plates is the same, as difficulty will be experienced in taxying with uneven pedals.

(iii) Have the primary firing handle safety-pin removed, and remove and stow the secondary firing handle safety-pin and the hood jettison handle safety-pin. There is a risk of the control column being fouled in flight if the secondary firing handle safety-pin is left in.

(d) *Carry out the following checks*:

Item.	Check
Toe brakes	Check operation (39).
Parking brake control (69) ...	On.
Battery isolating switch (110)	ON.
Cockpit lighting (85), (86), (87)	As required.

Then check from left to right:—

Brake emergency selector (2)	OFF (wire-locked forward)
Windscreen de-icing pump (37)	Handle screwed down
LP cock levers (1)	Both ON (forward)
Hook clutch release (5) ...	Engaged
Rudder trim (35) (41) ...	Check and set to neutral
Gun scavenge stand-by switches (6)	OFF
Gunsight master switch (33)	OFF
Guns master switch (34) ...	OFF
Tailplane stand-by trim switch (28)	Test (See Part I, Chap. 5, Para. 2(d))
Stand-by trim neutral indicator (43)	Black, if white reset.
HP cock levers (8)	ON Check relight, booster-pumps off, ign. isol. on.
Flaps selector lever (31) ...	At RAISE.
Ventral tanks jettison handle (29)	In.

Ventral tanks transfer indicators (26)	White.
Throttle friction (25) ...	As required.
Airbrakes selector (13) ...	OFF (forward).
Flying controls locking lever (15)	OFF (fully forward and in gate)
Throttles (10)	One-third open.
Collimator switch (14) ...	OFF.
Undercarriage normal selector (17)	DOWN button flush with panel. Three green lights
Undercarriage emergency release handle (18)	In.
Emergency lighting switch (81)	OFF.
Hood jettison handle (22) ...	In. Safety-pin (21) removed and stowed at (27).
Emergency intercomm. call light (44)	Test.
Accelerometer (51) ...	Reset.
Radio altimeter limit light (47)	Cover as required.
Gun bay scavenge valve indicators (52)	Black.
Hydraulic failure warning lights (48) (53) (54) ...	On, covers as required.
VHF sets (46)	OFF. Set selector switch (49) as required.
Intercomm. amplifier (50) ...	NORMAL, or as required.
DV panel	Fully closed.
Instrument panels	Security.
Zero-reader control unit (19)	FLT. INST.
Radio altimeter limit selector (20)	Setting.
G45B camera master switch (at 80)	Off.
Cockpit pressure warning horn (at 80)	Gated ON.
Pressure head heater switch (at 80)	Off.
Radio altimeter	Off.
Altimeter	Set.

Anti-dazzle light switch (75)	OFF.
Fuel transfer air pressure warning indicators (72) ...	White.
Turn-and-slip indicator ...	OFF flag not visible.
Switch for stand-by supply to turn-and-slip (64)	OFF.
Inverter failure indicator (58)	White.
Clock	Check and set.
Cockpit pressure altimeter (62)	Zero.
Engine fire-warning lights (61) (63)	Out. Test. Do not allow button to spring back in.
Generator failure warning lights (65)	On, covers as required.
Fuel gauges (66)	Contents.
Engine oil pressure gauges (67)	Zero.
Jpt gauges (68)	Zero.
Rpm indicators (77) ...	Zero.
Booster-pump failure indicators (82)	White.
Oxygen (83) (97) (112) (133)	Main and emergency supplies connected. Regulator ON-OFF valve wired ON. Contents and delivery; 100 per cent. OXYGEN selected (Mk. 17 D). NORMAL (Mk. 17E). Check for mask leaks by pressing in EMERGENCY switch in central position. Return switch central. Check indicator operates when breathing.
Flight instruments early start switch (111)	Off (central).
Inverter reset switch (at 109)	Gated OFF.
Windscreen de-misting switch (at 109)	LOW (switch central).
Camera sunny/cloudy switch (at 109)	As required.

External lights (at 109) ...	As required.
Cockpit temperature control (89)	NORMAL.
Mk. 4B compass selector switch (at 109)	COMPASS.
Fuel flowmeters (107) ...	Reset.
Emergency oxygen (105) ...	Control in.
Low speed / stall warning (106)	ON (wire-locked). Test both systems.
ILS switch (92) and control unit (104)	OFF.
Engine control panel (at 103)	Fuses in. (Caps screwed down). Master switches ON. Ignition switches ON. Booster - pump circuit - breakers tripped.
Anti-G valve (102)	ON. Test (100), then as required.
Torch (98). (If carried) ...	Stowed securely.
Oxygen connection (97) ...	Secure.
Tailplane trim (73) (28) (40)	Check normal and stand-by trimmer switches (see Part I, Chap. 5, para. 2) Operate normal trimmer over full range. (Switch should operate freely). Then set 1° nose-down.
Stand-by trim neutral indicator (43)	Black, if white, reset.
Gun trigger safety-catch (59)	SAFE.
Booster-pumps (at 103) ...	On, indicators (82) black.

The engines should be started immediately after the booster-pumps have been set on.

PART III.

Chapter 2—STARTING, TAXYING AND TAKE-OFF

List of Contents

1. Starting the engines

(a) *General*

(i) Either engine is capable of driving the accessories gearbox and providing fuel transfer air pressure; therefore, to avoid possible continued undetection of gearbox drive-shaft failure or inadequate air pressure, the order in which the engines are started should be alternated regularly.

(ii) Check the high-energy ignition before starting by pressing the relight buttons with the HP cock in the open position, and listening for the " cracking " noise of the igniter plugs sparking, and that the noise stops when the button is released. The " cracks " should occur regularly when both igniters are firing.

(b) *Starting checks*

Carry out the following checks if the full cockpit check in in Part III, Chap. 1 has not been done before starting.

(i) LP cock levers (1) ...	Both ON (forward).
HP cock levers (8) ...	Both ON.
Throttles (10)	One-third open.
Engine control panel (at 103)	Fuses in. (Caps screwed down). Master switches ON. Ignition switches ON. Booster - pump circuit - breakers tripped.

(ii) Switch on the battery isolating switch (110). (This must be done even if an external power supply is used).

Then check:—

1. *Lights*

3 greens	Undercarriage. Check day/night and bulb change-over.
2 reds	Generators.
1 amber, 2 reds ...	Hydraulic failure.

2. *Magnetic indicators*

All white except,	
Stand-by trim indicator	Black (if white, reset).
Gun bay scavenge value indicators	Black.

3. *Flags*

Turn-and-slip indicator	Not visible.
HGU and zero-reader ...	Visible. (Early start switch off).

4. *Oxygen*

Check magnetic indicator operates when breathing.

(iii) Check the high energy ignition. (HP cocks ON. Booster-pumps off).

(iv) Switch on the EARLY START switch. Check that the MK. 4B compass and HGU start up and the OFF flags on the artificial horizon and zero-reader disappear.

(c) *Starting drill*

Switch on the booster-pump for the engine to be started checking that the magnetic indicator goes black, and then press the starter button in firmly. (The button will remain in for 30 seconds). The cartridge fires over a period of approximately 4 seconds during which time light-up should occur. When the RPM are approaching 35% close the throttle. Check oil pressure (minimum 8 PSI), fire warning light out, both generator failure warning and hydraulic failure lights out, and STAND-BY INVERTER ON (or MAIN INVERT. FAIL) magnetic indicator black.

NOTE.—The maximum JPT during the start must not exceed 750°C. Should this temperature be exceeded, the HP cock must be closed immediately.

(d) Repeat for the other engine.

(e) In cases of operational necessity both engines may be started simultaneously. With this method however, there is no check that both engines are driving the auxiliary gearbox.

(f) *Failure to start*

(i) If an engine lights up, as indicated by the JPT registering but RPM then drop below 17% the HP cock must be closed *immediately*.

(ii) If a cartridge fires, but no light-up occurs, by the time the RPM have fallen to 17% the HP cock must be closed.

(iii) If a cartridge fails to fire, close the HP cock and wait one minute before attempting a further start. It must not be assumed that the breech is empty. If the next cartridge does not fire do not attempt another start until the electrical circuit has been checked.

(g) *Precautions*

(i) If a safety-disc blows out before the engine RPM have reached 17% close the HP cock. If the RPM are above 17% when the disc blows, the engine should start satisfactorily, but a careful watch should be kept on the JPT. It is safe to fly the aircraft in this condition. A burst safety-disc is indicated by a small report accompanied by thick yellow smoke from the starter exhaust pipe.

(ii) The engine run-down time from 35% RPM is approximately 3 mins. No attempt must be made to fire the second cartridge *before the engine has stopped turning*. A period of at least 10 minutes must elapse between firing the second cartridge and reloading the breech.

(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 one minute must elapse before the button is again pressed.

(iv) The run of the time switch must not be shortened by use of the booster-pump circuit-breaker or starter master switch, otherwise in some circumstances overspeeding of the starter may occur.

(v) After starting the engines leave on the ignition and master switches.

2. Checks after starting

Engines	Idling speed 35-40%. JPT max. 570°C. Opening up to approx. 40-45% engine speed will reduce general noise level.
Flaps (31) (42)	Check operation and indicator, set to RAISE.
Airbrakes (13)	Test.
Ventral tanks transfer indicators (26)	Black when engine speed is above 65% (only if tanks fitted).
Brake triple pressure gauge (39)	3,000 PSI accumulator pressure. 1,500–1,650 PSI at each wheel.
VHF and I/C (46) (50) ...	As required.
Gun-bay scavenge valve indicators (52)	Black (at approx. 65% RPM).
Flight instruments ...	Early start switch (111) OFF. Pressure head heater (at 80) –ON. Mk.4B compass synchronised. Check with E2B stand-by compass. Inverter failure indicator (58)—black. Erect horizon gyro if necessary.
Fuel transfer air pressure indicators (72)	Black.
Windscreen de-misting switch (at 109)	NORMAL (switch forward)
Starter master and ignition switches	ON (at 103).
Controls	Full and correct movement. Check tailplane operation. (see Part I, Chap. 5, para. 6(c)).
Control locks	As required.

3. Taxying

(a) Initial response to throttle is slow and large amounts of power are needed to manoeuvre at slow speeds. *Care is necessary to avoid injuring personnel or damaging other aircraft and ground equipment.* Differential throttle has little effect and the aircraft cannot be turned without the use of brakes.

(b) The aircraft may be taxied with the controls locked but taxying with them unlocked will provide practice in use of the toe brakes with the rudder bar free as it would be on the landing run. From considerations of rudder structural strength, the controls must be locked when taxying down-wind if the wind strength is more than 30 knots.

4. Checks before take-off

Trim	Tailplane setting 1° nose-down. Rudder neutral.
Airbrakes	OFF.
Fuel	Contents. HP and LP cocks ON. Booster-pump circuit-breakers closed, indicators black. Transfer indicators black.
Flaps	Up.
Instruments	Check and set. Main inverter indicator black. Pressure head heater ON.
Gun-bay scavenging indicators	Black.
Oxygen	Air-mix switch at 100% (Mk.17D). (NORMAL Mk. 17E) Contents. Operation of magnetic indicator. EMERGENCY switch central.
Harnesses	Tight and locked.
Hood	Closed. Check canopy seal inflated.
Hydraulics	Flying controls locking lever OFF and in gate. Check controls for full and correct movement. Hydraulic failure warning lights out.

5. Take-off

(a) Having aligned the aircraft apply the brakes and open the throttles smoothly to full power. If the aircraft begins to creep forward before 87% has been reached the brakes should be considered unserviceable and the aircraft should not be flown. At full power check that the oil pressure is at least 20 PSI, the JPT is within limits, and the ventral tank transfer indicators are black.

(b) Settled RPM at take-off may vary from 98% to 100.5%. On rapid throttle opening there may be an RPM swing which should damp out in 3 cycles.

(c) Normally there is no tendency to swing. In a cross-wind gentle brake application is necessary to keep straight until the rudder becomes effective at about 60 knots.

(d) With the control column held midway between the neutral and fully back positions, the nosewheel will lift off at about 85 knots, and the aircraft will unstick at 120-125 knots. In strong cross-winds, if the aircraft is pulled off the ground below 115 knots, there will be a tendency for the downwind wing to drop. In these conditions it is recommended that the unstick is delayed until 125 knots.

(e) Safety speed without ventral tanks is 120 knots, and from this speed at maximum all-up weight, with the under-carriage down and flaps up, the aircraft will continue to accelerate and climb away using maximum power on the live engine.

(f) The use of OPT. LIFT flap is not recommended. If flaps are used, they should be selected up as soon as the aircraft is comfortably clear of the ground, and care must be taken that the speed does not build up to more than 200 knots before flap retraction is complete. The undercarriage may be selected up immediately after the flaps have been selected. The tailplane setting for take-off with OPT. LIFT flap should also be 1° nose-down.

(g) *Ventrals fitted.*

When ventral tanks are fitted, check at full power that the ventral tank transfer indicators are black. The aircraft should not be unstuck before a speed of 135 knots has been attained. Safety speed is 150 knots.

6. Checks after take-off

(a) After take-off, apply the brakes momentarily and raise the undercarriage. The undercarriage takes about 5 seconds to lock up and there is no noticeable trim change. Check that the ventral tanks are feeding.

(b) As the aircraft accelerates to climbing speed there is a progressive nose-up change of trim. If the out-of-trim force is allowed to exceed 10 lb. the aircraft will be re-trimmed by the auto-trimmer.

PART III.

Chapter 3—HANDLING IN FLIGHT

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Illustration

1. Climbing

(a) Climb at maximum power within the time and JPT limitations. The recommended climbing speed is 400 knots at sea-level up to the height at which this coincides with a Mach number of 0.85. Then continue the climb at this speed.

(b) If maximum rate of climb is not essential climb at 97.5% and the same speeds as above. Throttle adjustment will be necessary to maintain this power setting.

(c) Particular care must be taken above 30,000 feet to keep the correct climbing speed or a considerable increase in time to height will result.

2. Engine handling on the climb

During the initial climb to 10,000 feet at full power, engine RPM may increase to 101% but above this height a negative creep device reduces RPM with height to maintain the JPT's within limits. As a result, full throttle RPM at 40,000 feet will be about 97.5% to 99.5% and at 48,000 feet 96.5% to 97.5%. However, when climbing at RPM above 93% (but not full power) it may be necessary to reduce the throttle setting to maintain the selected RPM.

3. General engine handling in flight

(a) Engine acceleration is automatically controlled by the air-fuel ratio control and the throttles may, if necessary, be opened or closed rapidly at all heights.

(b) If, whilst at full throttle, the RPM drop excessively at altitude, carry out the following checks, as far as possible, to help the ground crew in diagnosing the fault:—

(c) *RPM Creep and synchronisation checks*

Reduce the throttle setting from fully open to the point at which RPM start to fall. Note the amount of lost throttle movement on each engine, the RPM, JPT and altitude. Continue moving the throttles back together to approximately 87% observing RPM synchronisation at 94%, 93% and 92%. From 87% open the throttles rapidly to full throttle and note any RPM swing at the max. RPM obtainable. If poor synchronisation is evident, place the throttles level and, selecting points throughout the RPM range on one engine, note differences as the throttles are moved forward together.

(d) *JPT checks*

(i) Any tendency for the JPT's to increase beyond max. limits (Part II, Chap. 1) must be corrected by throttling back within limits. The RPM and altitude at which this occurs should be noted.

(ii) The time at maximum and intermediate JPT's quoted in Part II, Chap. 1 must not be exceeded.

4. Flying controls

(a) *Ailerons*

The ailerons are light throughout the speed and Mach. number range giving a high rate of roll. Below 200 knots the ailerons are effective but, at approach speeds, although the effectiveness is still adequate, coarse control movements may be needed in rough air. Above approximately 410 knots full aileron will not be obtained, and therefore the rate of roll is reduced; this is most marked above 500 knots.

(b) *Tailplane.*

(i) The longitudinal control is moderately light and increases in effectiveness with speed. At high airspeed, the control is light and slight over-controlling may be experienced until the pilot is used to the feel. Above 0.9M stick forces increase and this is especially marked above 0.95M.

(ii) If either No. 2 or No. 3 hydraulic pump fails, speed should be kept below 400 knots. Above this speed there is a risk of tailplane jack-stalling; if this occurs it will be impossible to prevent the aircraft climbing and the control column cannot be moved forward until speed is reduced.

(c) *Rudder*

The rudder is light at low speeds but becomes progressively heavier as speed increases until it is almost immovable above 500 knots.

(d) *Trimming*

(i) *Tailplane trimmer*

The normal trimmer switch on the control column is slow in operation. Owing to the geometry of the system, the maximum nose-down out-of-trim force which can occur at any speed is approximately 50 lb. However, if the auto-trimming fails and the trim runs away in a nose-up sense, push forces of up to 100 lb. will build up rapidly at speeds above 250 knots.

(ii) *Rudder trimmer*

The rudder trimmer is powerful and immediately effective.

(e) *Airbrakes*

(i) The airbrakes are powerful and may be used throughout the speed and Mach number range without causing any significant trim changes. *The navigator must be warned before full airbrakes is selected.*

(ii) On selection around 400 knots, deceleration is high (about 1G) and immediate.

(iii) Above 430 knots, the airbrakes do not open fully and produce only moderate deceleration. As the speed falls to 430 knots however, they open to the full position, with a sudden increase in deceleration. If unexpected, this can be disconcerting.

(iv) At high Mach numbers the use of airbrakes reduces the intensity of the buffet.

(f) *Changes of trim*

The out-of-trim forces caused by lowering the under-carriage and flaps are negligible. With the airbrakes out, the trim changes are slightly emphasised.

5. Flying at reduced speed

(a) Fly at 150-170 knots with sufficient airbrakes out to enable the RPM to be kept above 70%.

(b) *With hood open*

The hood may be opened fully below 200 knots without causing undue discomfort in the cockpit, but before doing so the eyes should be protected from the dust and dirt which is initially sucked out. No improvement in forward view is obtained by opening the hood.

(c) *In bad weather*

(i) Landings in heavy rain require extra care as the forward view is bad although lateral view is good. Little assistance can be gained from opening the DV panel unless a curved approach is made. With this panel open at airspeeds above 180 knots the noise level in the cockpit is high and air blast through the opening uncomfortable. VHF communication is likely to be difficult.

(ii) Damage to the engine intakes and radome will occur if the aircraft is flown in hail or heavy rain. If this cannot be avoided speed should be reduced to 200 knots.

6. Flying in severe turbulence

Flying in severe turbulence is permissible between the best range and climbing speeds up to 40,000 feet.

7. Stalling and spinning

NOTE 1. Intentional stalling and spinning are prohibited. The following information on the stalling and spinning characteristics from 40,000 feet, flaps and under-carriage up, is provided to cover the case of an inadvertent stall, which will almost inevitably result in a spin.

2. If the aircraft has not stopped spinning, or is stalled at or below 15,000 feet above the ground, it should be abandoned.

3. The information given below has been obtained as a result of flight trials on the Mk. 1 Javelin. There is no reason to suppose the behaviour of the aircraft fitted with the flying tail to be markedly different.

(a) *Stall warnings in straight flight*

(i) At high altitudes, if the nose is above the horizon, speed tends to fall off quickly, and for this reason an artificial low speed warning has been provided.

(ii) The natural stall warning in straight flight depends upon the rate at which speed is reduced. If speed is reduced rapidly there may be no positive warning, but if the reduction is slow, gentle buffeting will be apparent at 130 knots, increasing until at 115 knots it remains constant. A general sloppiness of control is evident, and at about 110 knots wing heaviness is noticeable but can be controlled by aileron. At about 100 knots a gentle fore and aft pitching may be noticed.

(b) *Behaviour at the stall*

(i) If speed is allowed to fall to about 90 knots in the straight stall, it will then continue to fall extremely rapidly right "off the clock". The aircraft will yaw uncontrollably and roll in the opposite direction to the yaw. After yawing through a considerable angle it will generally reverse its roll and spin.

(ii) Any attempt to recover at the final stages of a stall is not recommended, owing to the erratic behaviour of the aircraft. Close the throttles, move the stick right back and centralise the ailerons and rudder. Allow the aircraft to make one turn of the spin and then carry out the recovery action recommended in (d) below.

(c) *Behaviour in the spin*

(i) It is not always possible to predict in which direction the aircraft will spin, and the direction of rotation may reverse at any time during the spin. The rotation is very slow, and the nose pitches up and down fairly regularly through as much as 70 degrees. The rates of yaw and roll vary with pitching. Aileron and elevator forces are light throughout. However, the rudder moves fiercely fully one way and the other, and the forces are extremely heavy. The airspeed varies from "off the clock" to about 90 knots.

(ii) If outspin aileron is applied during the spin, its effect will be to flatten and smooth out the spin and greatly prolong the recovery. The rudder has little or no effect on the spin characteristics but should be held central to avoid confusion in the recovery.

(d) *Spin recovery actions*

When the aircraft is clearly in a spin take the following recovery action:—

(i) With the control column fully back *apply full aileron in the same direction as the spin* (inspin aileron, i.e. stick to the left in a spin to the left).

(ii) With full inspin aileron applied, move the control column fully forward into the corner. This action will operate the auto-trimmer so that the applied control force may be expected to lighten. Keep the rudder central. It is unlikely that this action will have any effect for one or even two turns.

(iii) The number of turns to recover varies considerably, but the above control actions *must be maintained until recovery occurs.* The directions of spin may reverse and in this case hold the control column right forward and move it sharply and fully over into the new direction of spin.

(e) *Spin recovery characteristics*

Recovery generally follows one of three main patterns, type (i) being the more usual:—

(i) *Bunt.* The rotation ceases and, as it does so, the aircraft pitches sharply nose-down or bunts. As minus 1 to minus 2G is about the usual figure reached, this is quite unmistakable, and recovery is complete.

(ii) *Spiral.* The aircraft goes straight from a spin into a fast spiral in a steep diving attitude. This condition may be recognised because:—

1. The pitching ceases.
2. The speed rises.
3. The rate of rotation is steady and fast.

Once the speed is over 200 knots, centralise the controls and ease the aircraft out of the dive.

(iii) *Delayed bunt*

1. The aircraft may hesitate and hang nose-down, momentarily, after the rotation has stopped and before bunting.

2. *Once the rotation has ceased* centralise the stick (still fully forward). Note the following two points: If the stick is centralised too early, i.e. before the rotation has ceased, the spin may be re-energised. If aileron is held on too long after rotation ceases, a spin in the opposite direction will occur.

(f) *Stall with flaps and undercarriage down*
Tunnel and model tests show that the aircraft should not spin in this condition, but once stalled the only likely method of recovery is to raise the flaps and undercarriage. The aircraft will then probably spin, and recovery as above should be taken. The stalling speed with flaps down is about 90 to 95 knots. Attention is drawn again to Note 2 of this paragraph.

(g) *Stall with airbrakes out*
Select airbrakes in, and recover from the spin as above.

8. G-stalling

NOTE.—*The structural G limitations in Part II, Chap. 2, para. 4, or the audio stall-warning if it occurs earlier, must never be exceeded.* Speed must not be allowed to fall below 150 knots (low speed warning).

(a) *G-Stalling is not permitted at any height or speed,* and turns must not be tightened beyond the point at which the audio stall warning is heard, or the G limitation reached. Before either of these occur mild buffet will be experienced and, at the warning or G limit, stick-force lightening may occur, accompanied by pitch-up.

(b) (i) *Above about* 0.9*M at all heights,* the audio stall warning may not operate until after the stick force lightening occurs, and care must be taken to avoid exceeding the structural limitations.

(ii) *Between* 25,000 *feet and* 35,000 *feet, above* 0.9*M*, these characteristics intensify, with the result that pitch-ups, sufficiently serious to damage the air-frame, can occur. The severity of the pitch-up is dependent upon the rate of application of G. Within this height band a rigid adherence to the G limitations should safeguard the airframe, and it is recommended that a rapid application of G should be avoided.

(iii) *Above* 35,000 *feet, above* 0.9*M*, the stick-force lightening and pitch-up may occur below 4G. However, *provided* immediate action is taken to reduce the G loading when the stick-force lightening begins, there is no likelihood of structural damage or loss of control.

(c) *Maximum rate turn*

(i) *Below* 0.9*M*. When the audio stall warning is heard and maximum rate of turn is required, the backward pressure on the control column must be released until audio stall warning only sounds intermittently. As a guide to the amount of G that should be obtained when the audio warning sounds, the diagram below gives the data for two specific heights at varying airspeeds.

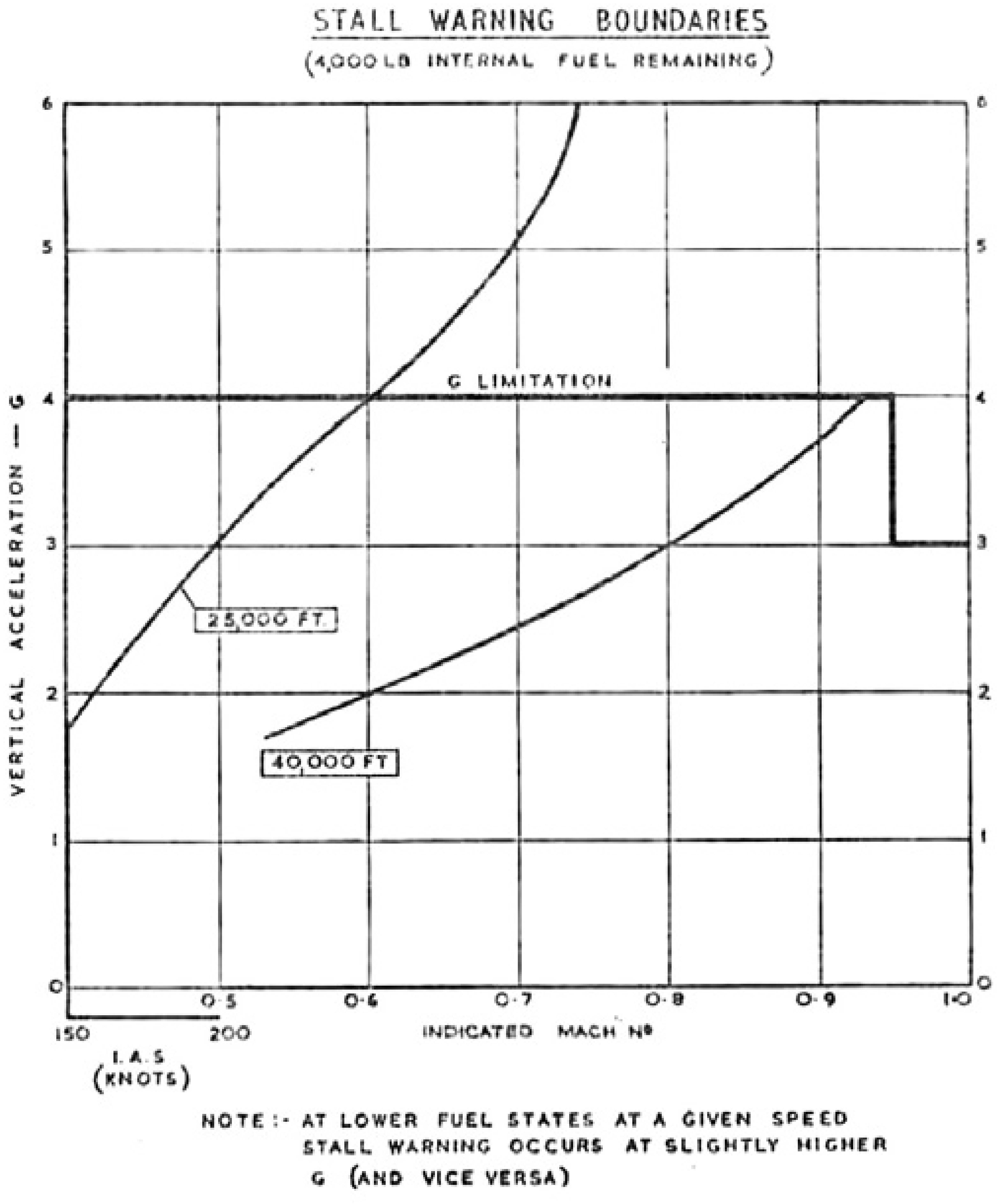

Fig. 1—Stall warning boundaries

(ii) *Above* 0.9*M*. Care must be taken not to exceed the structural limitations as the stick forces reduce with the application of G particularly between 25,000–35,000 feet.

NOTE.—The use of nose-up trim to maintain turns must be avoided at all times.

9. High speed flight

NOTE.—The I.A.S. and Mach. number limitations must not be exceeded. Any references in this paragraph to speeds higher than the limitations are included to give warning of what may happen should the limitations be inadvertently exceeded.

(a) *Clean aircraft*

(i) Below 7,000 feet the *limiting speed is* 535 *knots. The structural limitation up to* 535 *knots is* +5½ *G.* This speed is easily attained and special care is required to avoid exceeding it. Longitudinal control is light and slight over-controlling may be experienced until the pilot is used to the feel.

(ii) Between 7,000 and 20,000 feet *the limiting speed is* 0.9*M*.

The structural limitation is +5½*G*.

(iii) Between 20,000 and 35,000 feet *the limiting speed is* 0.95*M*.

The structural limitation up to 0.95*M is* +4*G*.

(iv) Above 35,000 feet *the limiting speed is* 1.04*M*. *The structural limitation above* 0.95*M is* +3*G*. In the entry to a supersonic dive there is a nosedown trim change between 0.95 and 0.96M. At 0.97M there is a mild rudder buffeting and yawing. At 0.98M the trim-change is nose-up, and a firm push-force is required to push the aircraft above 0.98M. The stick force required to push the aircraft above 0.98M. usually causes the automatic trimmer to operate. Above 0.98M the machmeter readings are erratic. Control forces above 0.96M are high and aircraft response is poor. On recovery there is an abrupt lightening of the stick forces between 0.96 and 0.95M which is dependent on the amount of G being pulled. This can lead to overcontrolling and porpoising and may lead to pitch-up.

(b) *With ventral tanks*

(i) Below 7,000 feet the *limiting speed is 535 knots. The structural limitation up to 535 knots is +5½G with empty ventral tanks. With full or partly full ventral tanks the structural limitation is +4G.*

(ii) Between 7,000 and 20,000 feet *the limiting speed is 0.9M.*

The structural limitations are as in (b) (i) *above.*

(iii) Above 20,000 feet *the limiting speed is* 0.95*M. The structural limitation for empty ventral tanks is +4G. With full or partly full ventral tanks the structural limitation is +3G.*

When ventral tanks are carried, slight occasional sharp twitches in roll and yaw may be encountered between 0.94 and 0.95M. There is a gentle and progressive nose-down change in trim between 0.9 and 0.95M. Care must be taken not to exceed the G limitation in this height band. Longitudinal control forces are heavy above 0.9M but 4G is easily attained. Above 0.9M between 30,000 and 35,000 feet, if 4G is exceeded, a sharp pitch-up will result.

(c) *Engine handling at high speeds*

Throttling back at high indicated speeds causes considerable banging in the engine intake ducts. This does not affect the engine performance, but should be avoided as far as possible as a precaution against loosening of the duct skin and rivets.

10. Aerobatics

NOTE.—Aerobatics in the looping plane are prohibited.

(a) All types of rolls are permitted. When in a steep climb the speed must be watched carefully and not allowed to reach a critical minimum.

(b) The maximum inverted flight time is 15 seconds.

11. Descent

To ensure clearance of icing and misting, set the windscreen de-misting control to HIGH two or three minutes before starting the descent. A rate of descent of approximately 5,000 feet/min. is achieved at 240 knots, with airbrakes out, and 78% RPM selected.

If an increased rate of descent is required, increase speed to 280 knots; this will give a rate of descent of 8–10,000 feet/min.

For maximum rate of descent set throttles closed, airbrakes out, and maintain 0.85M until 300 knots. Some misting-up will occur.

PART III.

Chapter 4—CIRCUIT AND LANDING PROCEDURES

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1. Instrument approach

(a) *Aircraft Approach Limitations* (AAL's)

The aircraft approach limitations are as follows:—

	Height* True	(feet) Altimeter
ILS (GCA monitored)	315	350
ILS/Zero-reader (GCA monitored)	250	300
GCA	250	300

*Above runway level.

(b) The following speeds and approximate power and flap settings are recommended for use during instrument approaches with the undercarriage down. An alternative technique to varying the RPM for adjustment to the glide-path is to maintain a constant power setting and use the airbrakes to vary the rate of descent or airspeed.
There is a negligible trim-change with airbrake selection.

(i) *Normal approach*

	RPM (approx.)	Flaps	Airspeed (knots)
Downwind	82%	UP	170
Base leg	82%	OPT. LIFT	145–150
Glide path	82%	FULL FLAP	140

(ii) *Asymmetric approach*

	RPM (approx.)	Flaps	Airspeed (knots)
Downwind	90%	OPT. LIFT	150
Base leg	90%	OPT. LIFT	150
Glide path	90%	FULL FLAP	140

2. Joining the circuit

NOTE.—Allow a minimum fuel state of 500 lb. (indicated) per engine for the circuit and landing.

Select approximately 80% RPM and then use airbrakes to reduce speed to 200 knots down-wind.

3. Checks before landing

Airbrakes	In
Undercarriage ...	DOWN (below 220 knots). Three green lights.
Flaps	Select OPT. LIFT (below 200 knots).
Fuel	Contents.
Harnesses	Tight and locked.
Wheel-brakes ...	Pressure—3,000 PSI. Operation. 1,500—1,650 PSI. at each wheel. Off - individual wheel brakes needles reading zero.

4. Approach

(a) During the approach to land if RPM are maintained above 60% full thrust can be obtained within 5 seconds. If less power is used, the time taken to attain full thrust is considerably increased. On the ground, the time to accelerate from 35% to 98% is up to 12 seconds.

(b) Turn on to the final approach at 160 knots. Full flap should not be lowered until the final stages. Check that the feet are not depressing the brake pedals. Speed should be reduced progressively until the threshold is crossed at the following speeds:—

Landing condition	Weight (lb.)	LCN	Speed (knots)
Full crew and ammunition; Ventral tanks empty; 600/600 fuel	29,760	18	125
Full crew, no ammunition. Full internal fuel, ventral tanks empty.	33,240	20	130
Full crew and ammunition. Full internal fuel and 3,000 lb. in ventrals.	37,140	24	135

The last two weight conditions exceed the max. landing weight and, if a landing has to be made in these conditions, special care must be taken to achieve a smooth touch-down. Full strength factors are not attained.

(c) *Landing at a maximum all-up weight of* 33,300 *lb.* The following conditions with full crew will give an all-up weight of 33,300 lb. (LCN. 20).

Ammunition (rounds)	Ventrals	Total fuel (lb.)	Gauged fuel (lb.)
Nil	Not fitted	5,890	2,790/2,790*
Nil	Fitted	5,890	2,790/2,790
800	Fitted	5,050	2,370/2,370

(d) If the speed is allowed to fall off early in the approach considerable power will be needed to offset the drag at the resultant high angle of attack.

5. Landing

(a) Approaches and landings may be made with any degree of airbrake out, but considerable extra power is required to avoid excessive rates of descent. The recommended approach and landing speeds are not affected.

*The maximum AUW in this condition is 32,560 lb.

Care should be taken not to reduce power too early, as the aircraft drag is high and speed will fall off quickly. The pull force on the stick increases as the speed falls off for landing, and a definite backward movement of the stick is required for the touch-down.

(b) To achieve aerodynamic braking the nosewheel may be held off the runway, but care should be taken to avoid an excessive nose-up attitude after landing, as the tailplane remains powerful down to about 60 knots and it is possible to strike the tail on the ground. The shortest landing run is obtained by lowering the nosewheel on to the runway shortly after touch-down, and applying the brakes.

(c) *Braking*

(i) When the nosewheel has been lowered on to the runway, the brakes can be used continuously, and the maxaret units will prevent wheel locking; however, to prolong the efficiency and life of the brakes, braking should be judicious according to the length of landing run available.

(ii) The aircraft must be firmly on the ground before applying brakes. If the aircraft is allowed to touch down with the brakes on, the maxaret units will not operate and the wheels will lock. However, if once having started turning, the wheels should stop rotating because of a skid or bounce, they will not lock unless the skid or bounce continues for more than 4 seconds. If a landing is made at a high weight the landing run will be long, and therefore weight should be reduced as much as possible before landing.

6. Overshooting

Open the throttles smoothly to the power required and raise the flaps, followed by the undercarriage; trim changes are negligible. If the wheels are raised before the flaps there will be a nose-down change of trim. If the undercarriage locks up before 150 knots is reached the low-speed warning will sound.

7. Flapless landing

(a) *With airbrakes*

If the airbrakes are available to provide drag in lieu of the flaps, a flapless landing presents no difficulty. The attitude on the approach is about 3° more nose-up, but the forward view is still good and a normal approach and landing technique should be used at the same speeds recommended for landing with flaps.

(b) *Without airbrakes*

Landing without the use of flaps or airbrakes is straightforward, provided that accurate speeds are achieved at the beginning of the approach. It is recommended that a GCA type of glide path is used because the forward view will be better than during a long low approach. Even with the undercarriage down the drag is low, and if the speed at the beginning of the approach is too high it will be extremely difficult to lose excess speed during the descent. The turn on to the final approach should be made at 135–140 knots with sufficient time in hand to stabilise the speed at 130 knots before starting the descent. At 130 knots approximately 65% will give a rate of descent of 500 ft./min. (without ventrals). Fly the aircraft on to the runway, easing the control column forward on touch-down to avoid striking the tail on the ground. The landing run will be only slightly longer than for a normal landing.

8. Cross-wind landing

When landing in strong cross-winds, there is a tendency for the downwind wing to drop if the aircraft is held off and touch-down delayed. Use the runway threshold speeds quoted in para. 4(b) above. After kicking off the drift, place the aircraft firmly on the ground. Selection of airbrake at touch-down will prevent wing-dropping, reduce weathercocking and ensure that the aircraft stays on the ground. Until experience is gained, do not attempt landings in cross-wind components greater than 25 knots.

9. Checks after landing

Brake pressure	Sufficient
Flaps	Up
Airbrakes	In
Windscreen demister	LOW
Pressure-head heaters	Off

10. Shut-down procedure

NOTE.—If parked tail-to-wind with the control column in the forward position, the aircraft may be tipped on to its tail in windspeeds greater than 25 knots.

The hood should not be opened electrically after the engines have been shut down and the generators cease to charge. Check:

All electrical services ...	OFF
HP cocks	OFF when RPM have stabilised at 35 to 40% RPM.
Flying controls	Locked (ensure control column is forward before hydraulic pressure is exhausted).
Battery isolating switch ...	OFF. (After generator lights have come on).

NOTE.—Do not turn off the battery isolating switch until the generator warning lights have come on *and* all electrical services are off.

11. After flight action

Carry out the normal exit from aircraft drill. (Part I., Chap. 12, Para. 7).

Before leaving the aircraft, check:—

Chocks	In position.
Brakes	Off.

PART III.

Chapter 5—ASYMMETRIC FLYING

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1. Stopping an engine

(a) For practice asymmetric flying either engine can be shut down. Carry out the following procedure:—

(i) Close the throttle.

(ii) Shut the HP cock.

(iii) If it is required to fly on one engine for some length of time put the LP cock *of the stopped engine* to TRANSFER. If asymmetric flight is to be of short duration leave the LP cock of the stopped engine ON.

(b)(i) Above 40,000 feet both booster-pumps must be left on. Below 40,000 feet one pump may be switched off provided that the other pump is feeding the engine (LP cock at TRANSFER). If both booster-pumps are switched off the recommended heights in Part I., Chap. 1, para. 11 apply.

(ii) Both booster-pumps should normally be left on, but if the fuel feed from both sides is not even then the booster-pump on the lower side should be switched off until a satisfactory balance is achieved.

2. Single-engine flying

(a) The aircraft has a good single-engine performance and all foot loads can be trimmed out down to 140 knots at maximum power on one engine. However, at high weights, acceleration is poor and performance decreases considerably.

(b) Below 24,000 feet range can be increased by flying on one engine. The best range speed on one engine is about 225 knots at 24,000 feet.

(c) Maximum endurance can be obtained on one engine at all weights up to a height of 30,000 feet. Above 30,000 feet the use of two engines is more economical. The best speed for maximum endurance is 170–230 knots depending upon AUW.

3. **Single-engine circuit and landing.** (At normal landing weight).

(a) On joining the circuit, select approximately 90% RPM and then use the airbrakes to reduce to 180 knots downwind.

(b) Carry out the normal pre-landing checks. Maintain the power setting of 90% RPM which should give a speed of approximately 140–150 knots with the undercarriage down (normal landing weight, no ventral tanks).

(c) Turn on to the final approach at 150 knots and make a normal approach, aiming to lower full flap in the last stages of the approach. If the flap is lowered too early on the approach a considerable increase in power is required.

(d) Cross the threshold at the normal speeds. (See Part III, Chap. 4, para. 4).

(e) Going round again can be done without loss of height from a speed of 125 knots with undercarriage and full flap down. In this configuration the aircraft will climb away on full power at about 200 ft. per minute, but initial acceleration is slow. The following procedure should be carried out:—

(i) Open up to full power.

(ii) Raise the flaps.

(iii) Raise the undercarriage whilst increasing speed to 150 knots, and then accelerate to the best climbing speed on one engine, which is about 265 knots. Until experience is gained practice overshoots should be done from not less than 200 feet.

(f) The speed and power settings for an asymmetric instrument approach are given in Chap. 4, para. 1(b)(ii) of this Part.

(g) At high weight the single-engine performance is decreased considerably. Acceleration is poor, particularly if the aircraft is at low speed. On the approach the speed should not be allowed to fall below 150 knots until the decision to land has been made. Any decision to overshoot should be made early. High nose-up attitudes must be avoided otherwise acceleration will be poor.

4. Restarting an engine

(a) Reduce height to 30,000 feet or below and maintain an airspeed of 170 knots to give a windmilling speed of 15% to 20%. Then set:—

LP cock	ON
Booster-pump	On

and check:—

Throttle	Closed
Ignition	ON
Starter master switch	ON

(b) Press the relight button and open the HP cock keeping the button pressed until the engine lights up and RPM rise by about 3%. The initial rise in JPT may be small. When at idling RPM open the throttle.

(c) If light-up has not occurred after 15 seconds, release the relight button, turn the HP cock OFF and allow 30 seconds to elapse to dry out the engine before the next attempt. If the engine and its fuel system are serviceable and the drill is followed correctly, a relight should occur at the first attempt.

(d) As height is reduced relights may be attempted at progressively higher airspeeds and windmilling RPM.

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PART IV—EMERGENCY PROCEDURES

PART IV.

Chapter 1—ENGINE EMERGENCY PROCEDURES

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1. Engine failure in flight

(a) *Mechanical*

If an engine fails due to obvious mechanical causes the immediate action should be:—

HP cock	OFF.
LP cock	TRANSFER.
Booster-pump	As required (see Part I, Chap. 1, Para. 11).

Do not attempt to relight.

(b) *Flame-out*

(i) If a flame-out occurs a relight may be attempted immediately, while RPM are decreasing, by pressing the relight button with the HP cock open and the throttle at its set position. A successful relight will be indicated by the RPM stabilising and then beinning to rise; the likelihood of a successful relight is increased if the height and airspeed are below the recommended maximum for relighting.

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

Throttle	Closed.
HP cock	OFF.

The LP cock and booster-pump should be left on. Carry out the relighting drill (see Part III, Chapter 5, Para. 4).

(iii) If the flame-out is due to booster-pump failure, a relight may be attempted immediately as in (b) (i) above. If the attempt is successful maintain engine power between 75% and 85% to reduce the chance of a further flame-out. Reduce height as soon as possible to below the following heights:—

If ventral tanks are feeding	40,000 feet
Otherwise	20,000 feet

If base cannot be reached on the available fuel by descending to 20,000 feet, fly at the lowest height which will enable the destination to be reached on both engines. Any further flame-out of the affected engine may be due to a seized HP pump which will prevent any attempt to relight. In these circumstances TRANSFER should be selected on the flamed-out engine. The collector tank on the side with the serviceable booster-pump should not be permitted to drain completely, before switching the booster-pump off; otherwise air may be introduced into the system. Both sides can transfer fuel simultaneously if the serviceable booster-pump is switched off but this is not recommended except in an emergency and then only below 20,000 feet.

2. Action in the event of engine fire

If an engine fire warning light comes on, the throttle should be closed immediately. Then set:—

HP cock	OFF.
LP cock	OFF.
Booster-pump	Off.

whilst reducing speed to a practical minimum. Then press the extinguisher button. Should the light remain on and the fire persist abandon the aircraft. If the fire is extinguished, the warning light should go out. *The engine must not be restarted* owing to the risk of a further fire with the extinguishers exhausted.

PART IV.

Chapter 2—AIRCRAFT SYSTEMS : EMERGENCY PROCEDURES

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1. Stand-by trimming

If the normal tailplane trimmer fails, use the stand-by trimmer. (Auto-trimming will be inoperative).

2. Undercarriage emergency operation

(a) *To select emergency down*:
Pull out fully the emergency selector ($2\frac{3}{4}$ ins.).

(b) *To select up in an emergency on the ground*:—
Override the UP selector push-button.

3. Wheel brakes emergency operation

If the No. 2 pump red and No. 1 pump amber hydraulic warning lights come on:—

(a) *After* touchdown set the brake emergency selector ON.

(b) If the brake main pressure gauge indicates less than 1,000 PSI before touch-down, no braking will be available until the emergency lever has been operated. For this reason land at an airfield equipped with an arrester barrier.

(c) Operate brakes normally, but do *not* select OFF or attempt to go round again.

(d) Check the main brake gauge after landing, and if the pressure is less than 3,000 PSI do not taxy the aircraft back to dispersal.

4. Generator failure

(a) *Single generator failure*
Shed *all* non-essential electrical loads. *Warn the navigator of generator failure.*

(b) *Double generator failure*

(i) Shed *all* electrical loads not immediately essential. *Warn the navigator of generator failure.*

NOTE.—Whatever electrical fault has caused the two generators to come off line may have reduced the life of the battery to less than 5 minutes.

(ii) *Above* 40,000 *feet*
Switch off all non-essential electrics except the booster-pumps.
Descend immediately to 40,000 *feet.*
At 40,000 feet switch off both booster-pumps if the ventrals are still feeding, and one booster-pump if main tanks are feeding. Continue the descent to 20,000 feet if the mains are feeding.
Switch off the remaining booster-pump at 20,000 feet. Keep the engine speed between 75 and 85% with the minimum of throttle adjustment. Continue the descent to as low an altitude as possible without jeopardising the chances of returning with the available fuel. Switch on the EARLY START switch if flight instruments are required, otherwise select the stand-by turn-and-slip supply. Select cockpit lights as necessary. Maintain speed between 200 and 250 knots and set the trim to $1\frac{1}{2}°$ nose-down.

(iii) *Between* 20,000 *and* 40,000 *feet*
Turn off one booster-pump if the mains are feeding.
Turn off one booster-pump if the mains are feeling.
Proceed as in (ii) above.

(iv) *Below* 20,000 *feet*
Switch off all non-essential electrics including both booster-pumps.
Proceed as in (ii) above.

(c) If total electrical failure occurs proceed as follows:—

(i) Remain below 20,000 feet.
(ii) Do not cut an engine.
(iii) Land as soon as possible.
(iv) Avoid icing conditions.
(v) Keep all turns well within the G limitations.
(vi) Use emergency air for the undercarriage after normal selection.

5. No. 1 flight instruments inverter failure

No. 2 inverter will supply the flight instruments automatically.

6. Flight instruments failure

(a) If the No. 1 inverter indicator shows black, and the artificial horizon OFF flag is visible, then a fault in the circuit to the artificial horizon is the cause of the failure. No further reliance should be placed on the instrument.

(b) If the No. 1 inverter failure indicator shows white, and the artificial horizon OFF flag is visible, both inverters have probably failed.

(c) *Turn-and-slip failure*

If the OFF flag appears on the face of the turn-and-slip indicator, turn on the standby supply.

7. Hydraulic failure

(a) *If the No. 1 pump amber warning light comes on*—
Allow for the main services to operate at a reduced rate. The possibility of No. 2 light coming on for short periods is increased.

(b) *If No. 2 pump red warning light comes on*—

The tailplane stick forces will be halved, and rudder will revert to manual. Reduce speed to 400 knots as soon as possible. Allow for the main services to operate at a reduced rate. The No. 1 light is more likely to remain on during selection of main services. Do not exceed 0.95M and exercise caution while landing in cross-winds and turbulent conditions.

(c) *If the No. 3 pump red warning light comes on*—

The tailplane stick forces will be halved, aileron feel will disappear but the rudder will remain in power. Reduce speed to 400 knots as soon as possible. Restrict rolling manoeuvres and avoid large aileron movements when selecting any main service, otherwise some aileron stiffening may result.

(d) *If the No. 1 pump amber warning and the No. 2 pump red warning lights come on—*
The tailplane stick forces will be halved and the rudder will revert to manual. Reduce speed to 400 knots as soon as possible. If maximum range is not essential, select the airbrakes out. The undercarriage should be lowered by use of the emergency air and a flapless landing carried out. *After* touchdown, select the brake emergency lever to ON.

(e) *If the No. 1 pump amber warning and the No. 3 pump red warning lights come on—*
The tailplane stick forces will be halved, aileron feel will disappear but the rudder will remain in power. Reduce speed to 400 knots as soon as possible and restrict rolling manoeuvres.
Avoid large control movements when selecting any main service, otherwise some aileron stiffening may be felt. Allow for the main services to operate at a reduced rate.

(f) *If both the No. 2 and No. 3 pump red lights come on—*
Aileron feel will disappear and the rudder will revert to manual. Power for the flying controls will soon be lost, and the aircraft must be abandoned.

8. Oxygen failure or noxious fumes

(a) *Failure of the regulator*
The immediate results of a serious regulator failure will be either:—

(i) Excessive delivery of oxygen with difficulty in breathing out; or

(ii) When 100% OXYGEN is selected, no delivery of oxygen with inability to breathe in, the mask being sucked on to the face.

(b) *Emergency procedure*
In either case (a)(i) or (a)(ii):—

(i) Bring the emergency oxygen supply into use.

(ii) Disconnect the mask/seat oxygen connection.

(iii) Make a rapid descent to a cabin attitude of below 10,000 feet. As the emergency oxygen becomes exhausted, some resistance to inspiration may be experienced, this being due to air being drawn in through the open end of the mask tube assembly, which contains a spring-loaded inward relief valve.

(c) *Noxious fumes*

If the cockpit air becomes contaminated, check/set 100% OXYGEN selected and deflect the EMERGENCY switch to one side. The extra pressure in the mask will prevent inward leaks.

(d) *Magnetic indicator failure*

(i) If the magnetic indicator ceases to function, check that the main tube is correctly connected, that the pressure on the gauge is normal (200–400 PSI) and that the main oxygen contents gauge is indicating that oxygen is still available.

(ii) If the above indications are satisfactory, check/set 100% OXYGEN is selected and then depress the EMERGENCY switch, when in the central position. A supply of oxygen under pressure indicates that the regulator is serviceable but the magnetic indicator is defective. Otherwise the symptoms of (a)(i) will be apparent and in this event proceed as in (b) above.

9. Cockpit pressurisation failure

If the cockpit altitude exceeds 30,000 feet, the pilot should warn the navigator, "Immediate descent, mask toggle down", descending to a cockpit altitude of 30,000 feet or below.

10. Ventral tank jettisoning

Pull out the T-handle on the side of the throttle-box to jettison the ventral tanks. The tanks should not be jettisoned until the aircraft is above 30 feet. They may be jettisoned at any speed within the limitations, but if there is no emergency involved, the following flight conditions are recommended:

1. Straight and level flight.
2. Undercarrige and flaps up.
3. Speed, 175–250 knots.

PART IV

Chapter 3—CRASH LANDING, ABANDONING AND DITCHING PROCEDURES

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1. Landing with an undercarriage unit not locked down

(a) Jettison the ventral tanks.

(b) *Both main wheels only locked down.*

Use up as much fuel as is safe. Unless circumstances dictate otherwise land on a runway. Check harnesses tight and locked and select hood open. Make a normal approach and touch-down. Turn off the HP cocks. Maintain a nose-up attitude, but ensure that the nose is *lowered* gently on to the runway (approximately 80-85 knots) before tailplane control is lost. When the nose is on the runway use gentle braking to keep straight.

(c) *Nose wheel and one main wheel locked down*

If possible make a landing on a runway which has an area of about 500 yards wide (free of obstacles) in the direction of the anticipated swing.
Make a normal approach and touchdown.
Turn off the HP cocks.
Hold the wings level for as long as possible by the use of ailerons. When the wing finally drops the aircraft will swing in the direction of the unlocked wheel; counteract this as much as possible by opposite brake.

2. Crash landing

(a) If both engines are lost owing to lack of fuel or other causes abandon the aircraft.

(b) If a crash landing has to be made away from an airfield, a wheels-down landing is recommended regardless of terrain. If height and time permit, the navigator should abandon the aircraft. (Risk of nose-wheel breaking off and entering rear cockpit).

(c) In the unlikely event of having to land wheels-up, the landing should only be made on a runway. The aircraft will probably pitch hard forward on to its nose as soon as the tail strikes the ground.

(d) The recommended drill for landing wheels-up on a runway is as follows:

1. Warn the navigator; tighten harnesses and jettison hoods and ventral tanks.

2. Below 10,000 feet disconnect main and emergency oxygen pipes from mask tube.

3. Disconnect personal survival pack lanyard.

4. Make a normal powered approach. Use flaps to reduce forward speed to the lowest value consistent with good control and view, flattening out the approach just before touchdown to keep the rate of descent down to a minimum. If forward view is bad, increase rate of descent slightly rather than forward speed.

5. Close the HP cocks as soon as the runway threshold is reached.

6. When the aircraft comes to rest, release the parachute and the safety-harness and vacate cockpit.

7. After reasonable time, if no signs of fire, return to the aircraft and insert safety-pins of both ejection seat firing handles, in front and rear cockpits.

3. Abandoning the aircraft

NOTE.—Ejections may be initiated in straight and level flight at any height from ground level upwards. However, runway ejections should only be made when the speed of the aircraft is above 90 knots or the circumstances of the emergency dictate that ejection is the only reasonable solution. The occupant of the rear cockpit should eject first, otherwise there is a possibility of collision between seats and hoods.

The following drill is recommended: —

(a) *Controlled ejection*

(i) The pilot warns the navigator to prepare to abandon aircraft, and reduces speed to below 280 knots (ideally 250 knots).
(ii) The navigator acknowledges, adjusts his seat, locks his harness and grasps his seat primary firing handle.
(iii) The navigator calls "ready to go".
(iv) The pilot orders " jump jump".
(v) The pilot ejects as soon as he hears the navigator's seat fired. (One second after hood is jettisoned, i.e. 2nd bang).

(b) *Action should the ejection seat fail to eject*

If the ejection seat fails to eject proceed as follows:

(i) Reduce speed to below 200 knots.
(ii) Select airbrakes in.
(iii) Pull the over-ride D-ring to the full length of its travel to isolate the parachute auto-device.
(iv) Release the safety-harness and proceed as on aircraft not fitted with an ejection seat.

(c) *Action should the automatic system fail after ejection*

If the automatic system fails after ejection or below 10,000 feet proceed as follows: —

(i) When forward speed is sufficiently low, discard the face screen.
(ii) Pull the over-ride D-ring to the full length of its travel to isolate the parachute auto-device *before* operating the seat-harness release.
(iii) Lift the flap over the rip-cord D-ring and grasp the rip-cord handle.
(iv) Fall clear of the seat and pull the rip-cord handle.

(d) *Abandoning in emergency*

(i) If time permits the pilot should order the navigator to "prepare to abandon aircraft", reducing speed as much as possible.
(ii) On the executive order "jump jump", the navigator should eject.
(iii) The pilot should eject as soon as the navigator is heard to fire his seat.

(e) *Abandoning—no intercomm.*

The following procedure for abandoning is suggested if normal intercomm. is not possible:—

(i) The pilot should make a series of dots on the call light, which will be a warning to the navigator to prepare to eject. He should then pause to permit the navigator to acknowledge, also by a series of dots.

(ii) The pilot should then hold the call light on continuously. This is the signal for the navigator to eject.

(iii) The call light should be held on until the navigator is heard to eject. If after five seconds the navigator has not been heard to eject, the pilot should release the button to enable the navigator to indicate by a series of dots, that he cannot eject or is in serious trouble. The The pilot should then put the airbrakes out, descend to below oxygen height and reduce speed below 280 knots.

(iv) If something serious has happened and no communication is possible the navigator should eject. The pilot should then make his own decision.

4. Ditching

NOTE.—*Ditching is not recommended.*

(a) Model tests indicate that ditching behaviour may be satisfactory at low forward speeds, but there will probably be a nose-up change of attitude after touch-down. Above a forward speed of 100 knots this nose-up change of attitude may cause the aircraft to be thrown well clear of the water after the initial touch-down; this may lead to loss of control during the bounce and/or damage to the fuselage by the subsequent severe impact. A touch-down with high forward speed and high rate of descent would be dangerous and must be avoided.

(b) If ditching is unavoidable, carry out the following actions:—

(i) Warn the navigator and jettison hoods (rear first) and ventral tanks.

(ii) Tighten harnesses.

(iii) Select 100% OXYGEN and set the EMERGENCY switch sideways, mask toggle down.

(c) If time permits before ditching, complete the following actions:—

(i) Pull the parachute over-ride D-ring to the full length of its travel.

(ii) Release the toggles attaching dinghy to the parachute harness.

(iii) Disconnect emergency oxygen and G suit connections.

(iv) Select 100% oxygen, EMERGENCY toggle offset and mask toggle down.

(v) Jettison hoods (rear first).

(vi) Remove safety-clip on parachute harness quick-release box.

(vii) Tighten safety-harnesses.

(d) Ditch along the swell, or, if the swell is not steep, into wind.

(e) Use flaps to reduce the forward speed to the lowest value consistent with good control and view, flattening out the approach just before touch-down to keep the rate of descent to a minimum. If forward view is bad, increase rate of descent slightly.

(f) For action after ditching see Part I, Chap. 12, para. 8.

PART V—OPERATING DATA

LIST OF CHAPTERS

PART V—OPERATING DATA

(To be issued by amendment)

PART VI– ILLUSTRATIONS

PART VI.

PART VI—ILLUSTRATIONS

KEY TO FIGURE 1

(Front cockpit—port side)

1. LP cock levers (two)
2. Wheel brakes emergency selector lever
3. Harness stowage clips (two)
4. Hood port jettison gun
5. Hood clutch release
6. Gun scavenge stand-by switches
7. VHF and ILS frequency cards stowages (two)
8. HP cock levers (two), each incorporating a relight button
9. Harness stowage clips (two)
10. Throttle levers, port incorporating G.G.S. manual ranging twist-grip.
11. Press-to-transmit button
12. Press-to-mute switch
13. Airbrakes selector
14. Collimator switch
15. Flying controls locking lever
16. Hood operating switch
17. Undercarriage selector buttons
18. Undercarriage emergency release control
19. Zero-reader control unit
20. Radio altimeter limit switch
21. Hood jettison handle safety-pin and flag
22. Hood jettison handle
23. Telebriefing light and control switch
24. Flying controls locking lever knurled catch
25. Throttle friction control
26. Ventral tanks transfer indicators (two)
27. Stowage for hood jettison handle safety-pin and flag
28. Tailplane stand-by trim control
29. Ventral tanks jettison handle
30. ARI. 18006 RCM (D/F) Homer call navigator switch
31. Flaps control knob
32. GGS control unit
33. GGS master switch
34. Guns master switch
35. Rudder trimmer control
36. Collimator control unit
37. Windscreen de-icing pump

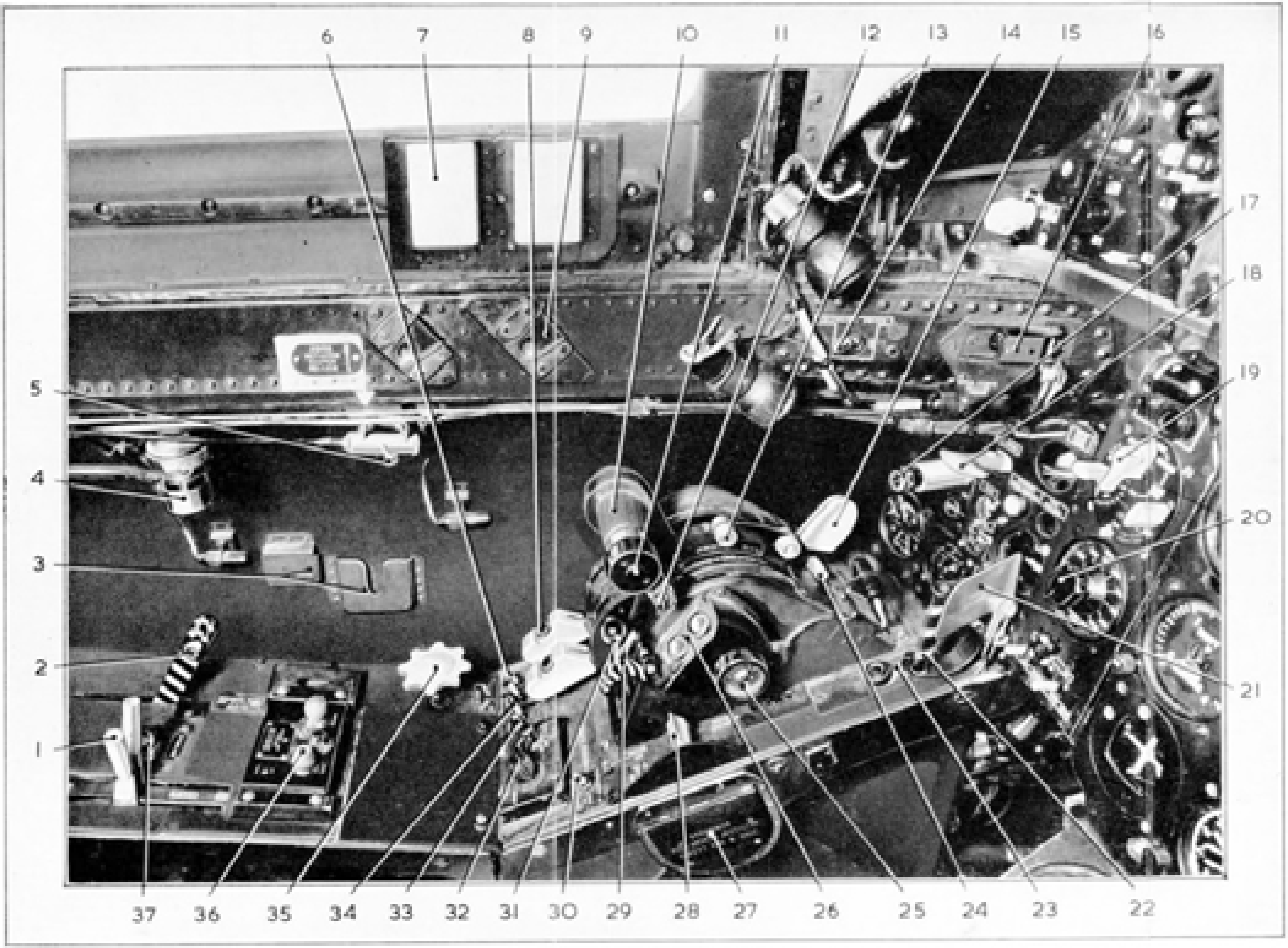

Fig. 1.—Front cockpit—Port side.

KEY TO FIGURE 2

(Front cockpit—forward view)

38. Undercarriage position indicator
39. Brake triple pressure gauge
40. Tailplane trim setting indicator
41. Rudder trim indicator
42. Flap position indicator
43. Stand-by trim neutral indicator
44. Emergency intercomm. push button and warning light
45. VHF volume control
46. VHF set controllers (two)
47. Radio altimeter red limit indicator light
48. No. 1 hydraulic pump failure warning light (amber)
49. VHF set change-over switch
50. Intercomm. amplifier switch
51. Accelerometer
52. Gun bay scavenge valve indicators (two)
53. No. 2 hydraulic pump failure warning light (red)
54. No. 3 hydraulic pump failure warning light (red)
55. Zero-reader indicator
56. ILS marker indicator
57. Leg-restraint cord stowage
58. No. 1 flight instruments inverter failure indicator
59. Gun trigger safety-catch
60. Cockpit pressure warning light
61. Port engine fire extinguisher button and warning light
62. Cockpit altimeter
63. Starboard engine fire extinguisher button and warning light
64. Turn-and-slip standby supply switch
65. Generator failure warning lights
66. Fuel contents gauges (per cent RPM indicators—Mod. 703)
67. Oil pressure gauges (two)
68. Dual jet pipe temperature gauge
69. Parking brake control
70. Foot plate angle adjuster
71. Brake pedal foot plate
72. Fuel transfer air pressure warning indicators (two, at bottom of centre panel)
73. Tailplane trimmer switch
74. Ciné camera button
75. Anti-dazzle light switch
76. Stowage for GGS recorder
77. RPM indicators (two) (Fuel contents gauges—Mod. 703)
78. Zero-reader course selector
79. ILS indicator
80. Switch row: left to right:—G.45B camera master switch
Warning horn isolation switch
Pressure head heater switch
81. Emergency lighting switch

KEY TO FIGURE 3

(Front cockpit—starboard side)

82. Booster-pump warning indicators (two)
83. Oxygen regulator Mk. 17D or Mk. 17E

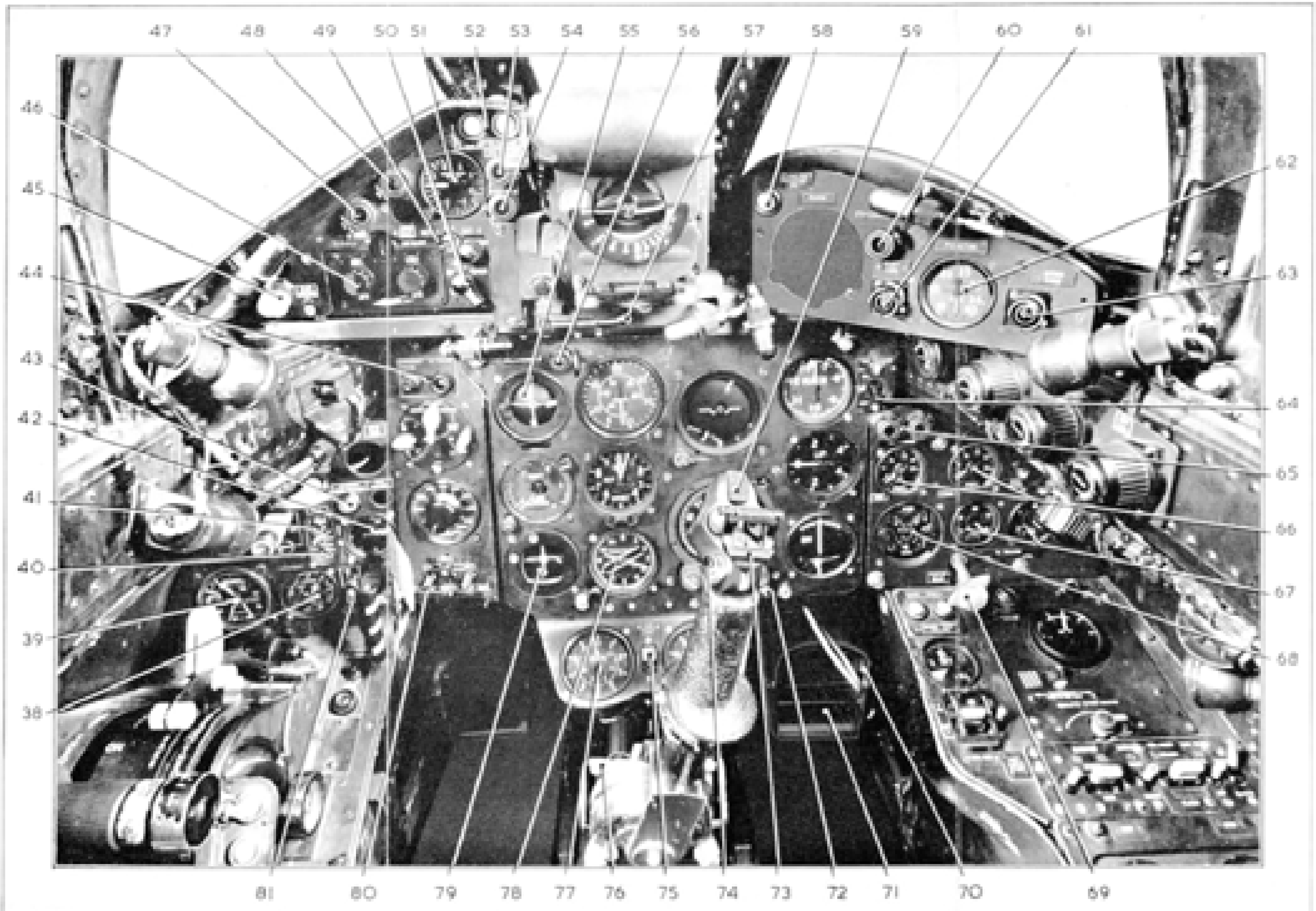

Fig. 2.—Front cockpit—Forward view.

84. Spare bulbs for GGS (two)
85. Stand-by compass light dimmer switch
86. Cockpit lighting dimmer switches (four)
87. Cockpit lighting dimmer switch
88. VHF and ILS frequency card stowages (two)
89. Cockpit temperature control
90. ILS volume control
91. Harness stowage clips (two)
92. ILS switch and warning light
93. Harness stowage clip
94. Hood starboard jettison gun
95. Crowbar
96. Map stowage
97. Oxygen supply connection to seat
98. Stowage for torch
99. Rudder pedal adjuster lock release
100. Anti-G test button
101. Port and starboard engine starter buttons
102. Anti-G selector valve
103. Switch row; left to right:—
    - Port engine starter master switch
    - Port engine ignition isolation switch
    - Port booster-pump circuit-breaker
    - Starboard engine ignition isolation switch
    - Starboard engine starter master switch
104. ILS control unit
105. Emergency oxygen control
106. Stall warning master switch
    - Stall warning test buttons (two)
    - Low speed warning test button
107. Flowmeter (two)
108. Stowage for secondary firing handle safety-pin
109. Switch row, left to right:—
    - Flight instruments inverter re-set switch
    - De-misting control switch
    - Camera aperture switch
    - Navigation lights switch
    - Taxy lamps switch
    - Compass/D gyro selector switch
110. Battery isolating switch
111. Early start switch
112. Oxygen contents gauge

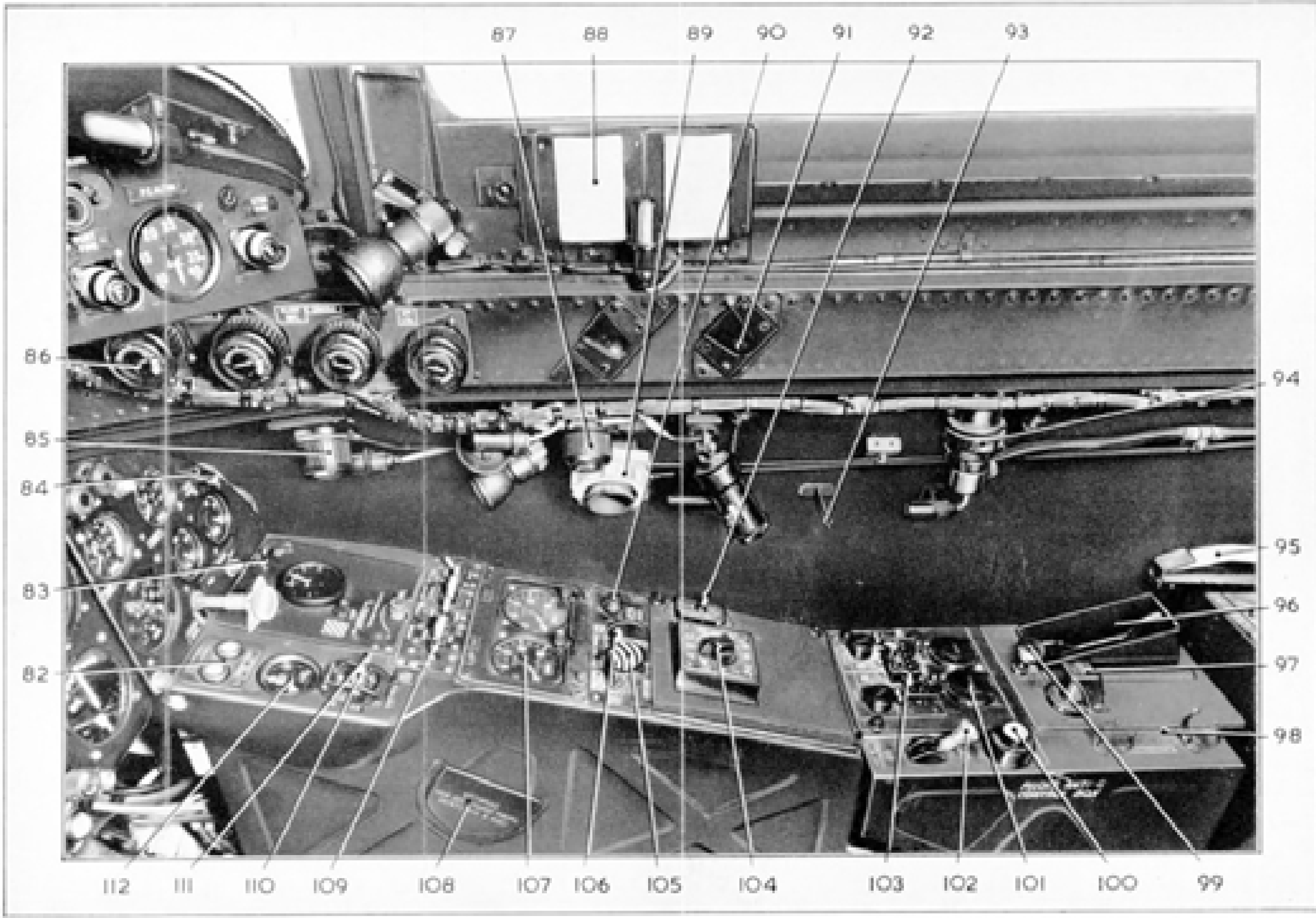

Fig. 3.—Front cockpit—Starboard side.

KEY TO FIGURE 4
(Rear cockpit—forward view)

113. Map Stowage
114. Cockpit lighting dimmer switches (two)
115. Generator failure warning lights (two)
116. Mk. 4B compass master indicator
117. Hood operating switch
118. Stowage for ARI indicator type 100 and ARI 18006 indicator
119. Radio altimeter limit indicator lights (three)
120. Airspeed indicator
121. Altimeter
122. Radio altimeter
123. Gee indicator
124. Crowbar
125. Hood jettison handle safety-pin and flag
126. Hood jettison handle
127. Emergency intercomm. light and push-button
128. Ambient air temperature gauge
129. Cockpit lighting dimmer switches (two)
130. Pencil stowages (four)
131. AI control unit
132. Stowage for hood jettison handle safety-pin
133. Oxygen regulator Mk. 17D or Mk. 17E
134. Mk. 4B compass control unit
135. Press-to-mute switch
136. Leg-restraint cord stowage
137. Vizor stowage
138. Chart board
139. Anti-G test button
140. ARI 5870 indicator light
141. AI on-off switch
142. Switch row, left to right:—
    Gee and ARI.5870 inverter switch
    Gee on-off switch
    AI and IFF inverters start switch
    AI and IFF inverters stop switch

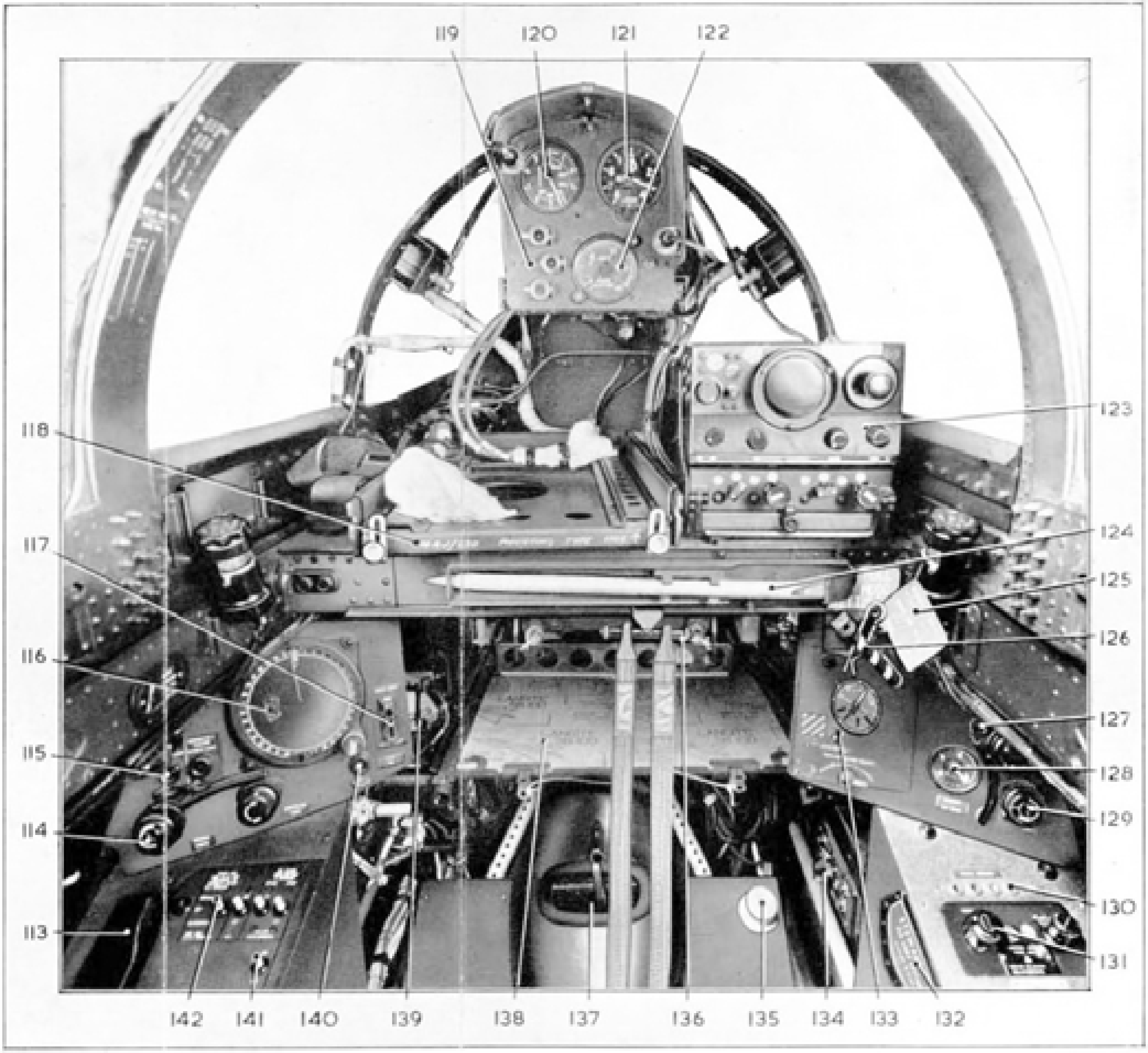

Fig. 4—Rear cockpit—Forward view