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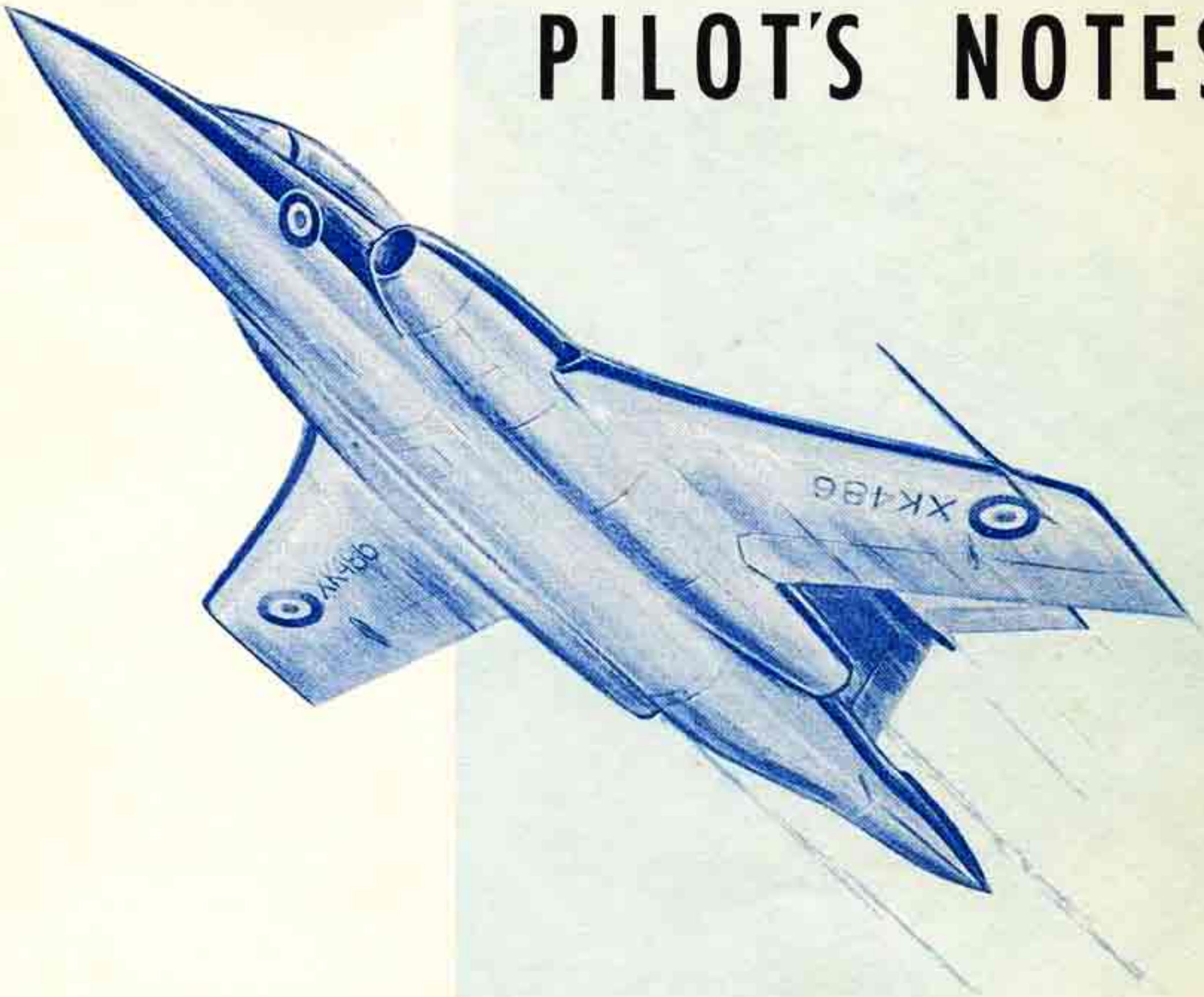
BROUGH : YORKSHIRE

M.148 Aircraft

PROVISIONAL PILOT'S NOTES



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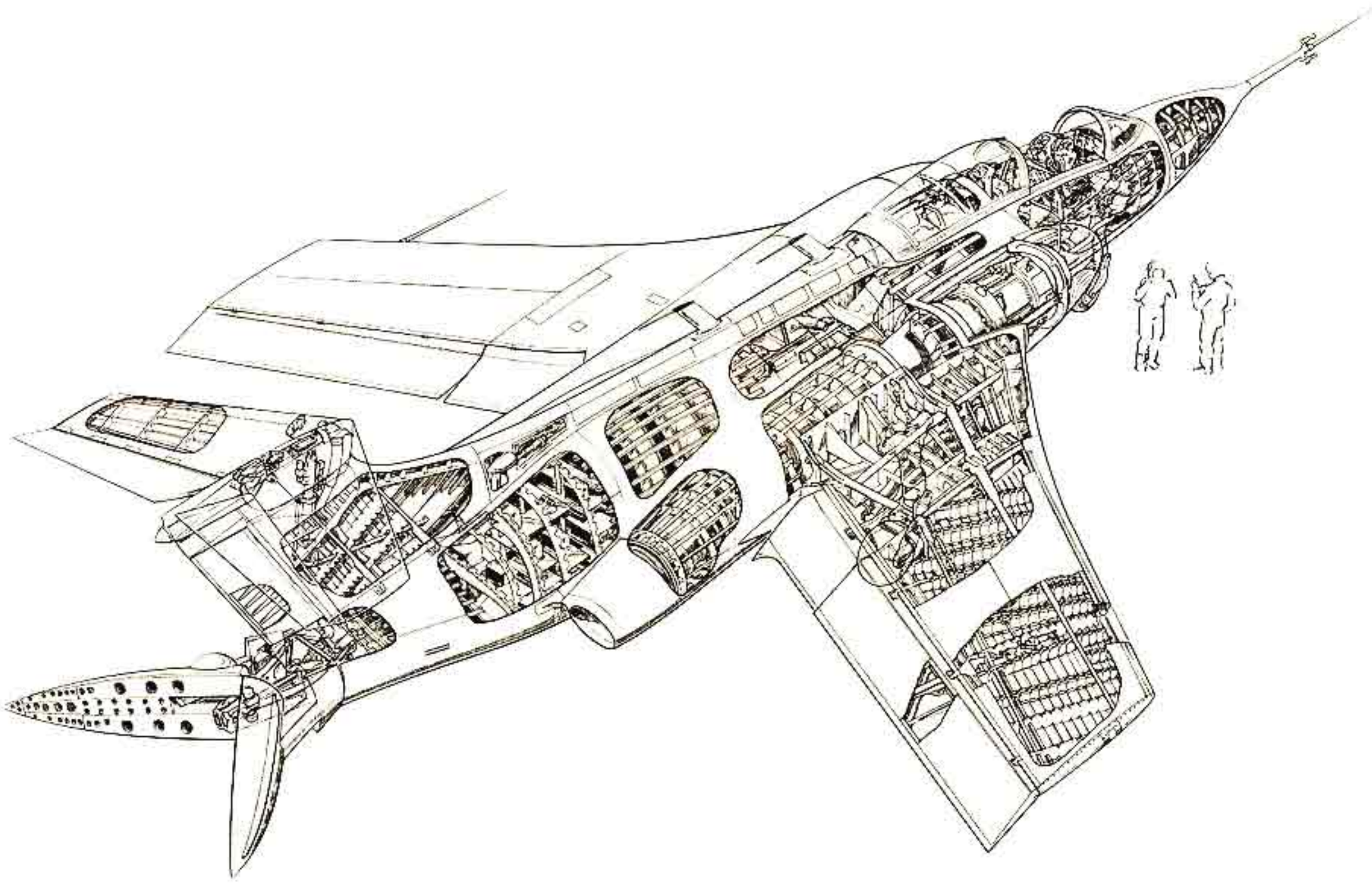

FOREWORD

These notes have been compiled to familiarise pilots with the M.148 Aircraft. They do not presume to be a manual on flying in general, and are to be interpreted against a background of sound flying experience.

Throughout this publication the following conventions apply:-

(i) Words in capital letters indicate the actual markings on the control or instrument concerned.

(ii) Unless otherwise stated, all airspeeds quoted are indicated airspeeds.

Comments and suggestions are welcome and should be forwarded to:

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AMENDMENT RECORD SHEET

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A.L. No.	Amended by	Date
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PART I

DESCRIPTIVE

PART 1 DESCRIPTIVE

LIST OF CONTENTS

1. Introduction

(i) This prototype aircraft, designed to Spec. M.148, is a low-level, long-range naval strike aircraft; it is powered by two de Havilland Gyron Junior D.GJ.1 turbo-jet engines. Two crew members, pilot and observer, are seated in tandem in a single cabin which can be pressurized for high-altitude flight.

(ii) The pilot's controls and instruments are mounted on two consoles and four panels which are referred to in these Notes, commencing from the port side, as:-

Port console
Port control panel
Instrument panel
Standby control panel
Starboard switch panel
Starboard console

FUEL AND OIL SYSTEMS

2. Fuel tanks

(i) Fuel is carried in eight integral fuel tanks which extend the entire length of the centre fuselage, immediately above the accessories and weapons bays. The tanks are identified numerically, No.1

being the front tank. The tank capacities are approx.:-

	Gall.	lb. AVCAT	lb. AVTUR
No.1 tank	170	1,411	1,360
No.2 tank	205	1,701	1,640
No.3 tank	170	1,411	1,360
No.4 tank	170	1,411	1,360
No.5 tank	170	1,411	1,360
No.6 tank	205	1,701	1,640
No.7 tank	205	1,701	1,640
No.8 tank	205	1,701	1,640
Total capacity	1,500	12,450	12,000

(ii) A pressure refuelling point is located on the starboard side of the fuselage (para.4). All tanks are fitted with filler caps, accessible from the top of the fuselage by removal of the appropriate access panels.

(iii) During normal operation, tanks No. 2, 4, 5 and 7 supply the port engine and tanks No. 1, 3, 6 and 8 supply the starboard engine. Hydraulically-driven fuel flow proportioners, one for each engine and installed on the weapons bay walls, regulate the amount of fuel drawn from each tank. In the event of an emergency, the fuel flow can be re-directed by an inter-tank transfer system and a cross-feed pipe connecting the port and starboard engine fuel supply lines. During inverted flight or negative G conditions, fuel supply to the engines is maintained for a limited period by two air-operated recuperators.

(iv) Surplus fuel in the engines, when a false start is made and during shutting down, is returned to the fuel tanks by a spill return pipe line system. Fuel from the port engine is returned to No.1 tank and fuel from the starboard engine is returned to No.2 tank.

3. Fuel system controls and indicators

(i) A switch, located at the rear of the standby control panel on the starboard side of the cockpit, controls an electrically-operated cross-feed cock, situated in the weapons bay, and permits the inter-connection of port and starboard engine supply lines.

(ii) A cock, mounted on the starboard wall of the cockpit, controls four air-operated transfer valves, located in the base of tanks No. 1, 3, 5 and 7, and permits the integration of port and starboard systems.

(iii) Control of the high-pressure (H.P.) fuel cocks is combined with that of the throttles, initial forward movement of the throttle levers to the gate being used to open the H.P. cocks.

(iv) Manually-operated low-pressure (L.P.) cocks, located one on each side of the weapons bay, control the supply of fuel to the engines. The two L.P. fuel cock control levers, labelled ENGINE MASTER COCK, ON (forward) - OFF, are located at the rear of the port console.

(v) A fuel flow proportioner failure indicator, located on the starboard side of the instrument panel, shows black when both proportioners are functioning normally and white in the event of failure of either proportioner.

(vi) Two fuel pump inlet pressure gauges, located on the starboard console, are provided for instrumentation purposes only.

4. <u>Pressure refuelling and defuelling system</u>

(i) A self-sealing pressure refuelling coupling is located in a pocket on the starboard side of the fuselage, just forward of the nose wheel unit. Also located in the pocket is an indicator containing eleven red lamps, of which only eight are used. Located in a separate panel, immediately forward of the refuelling pocket, are eight tank selector switches, numerically identified 1 to 8 and labelled REFUEL (up) - DEFUEL. A master REFUEL/DEFUEL switch, labelled ON - OFF, is located on the switch panel on the starboard side of the cockpit.

Note...
On the first aircraft the fuel tank selector switches are located in the refuelling pocket.

(ii) During refuelling the master switch is selected to ON and the appropriate tank selector switches are set to REFUEL. When a

selector switch is set to REFUEL with the master switch ON, the associated indicator lamp is illuminated. The indicator lamps are extinguished as the respective tanks are filled.

(iii) Defuelling is carried out through the pressure refuelling coupling by moving the tank selector switches to DEFUEL with the master switch ON. The master switch must be OFF at all times except when refuelling or defuelling.

5. Tank venting and pressurization

(i) The tanks are vented to atmosphere through an outlet located on the underside of the fuselage, immediately forward of the air brakes.

(ii) During refuelling, air displaced by the rising level of fuel passes through the tank vent shuttle valves and the inward/outward vent valves into a common vent line leading to the vent outlet.

(iii) When defuelling is being carried out, air at atmospheric pressure is fed into the tanks through the common vent line and the inward/outward vent valves. These valves are operated to the inward venting position by the depression caused by the evacuation of fuel from the tanks.

(iv) The fuel tanks are pressurized by a regulated air supply tapped from each engine compressor. The four pressurizing air lines, after passing through non-return valves and pressure reducing valves, join the tanks venting system. In this way, air pressure is directed to all tanks, via the individual shuttle valves, and to the valve face of each inward/outward vent valve which will operate to relieve pressures in excess of normal (6 lb. per sq.in.). An electro-magnetic indicator, located at the top of the starboard console and labelled TANK PRESS., shows black when the tanks are pressurized and white if the pressure in any pair of tanks falls below normal.

6. Cross-feed and inter-tank transfer

(i) The port and starboard engine fuel supply lines are connected by a cross-feed pipe line in which is located an electrically-actuated

cock. In the event of a proportioner failure, the remaining proportioner will maintain an adequate supply of fuel to both engines immediately the cross-feed cock is opened. By subsequently selecting the inter-tank transfer control to ON, fuel from all tanks can be supplied, through the serviceable proportioner, to both engines.

(ii) The control switch for the cross-feed cock actuator, labelled CROSS-FEED, OPEN - CLOSE, is located at the rear of the standby controls panel on the starboard side of the cockpit. An electro-magnetic indicator, located at the forward end of the starboard console, shows black when the cross-feed cock is closed and white when the cock is open.

(iii) The inter-tank transfer cock, labelled FUEL INTER-TANK TRANSFER, ON - OFF, is located on the starboard wall of the cockpit. When this cock is selected to ON, air pressure from the engine air bleed system acts upon and opens the inter-tank transfer valves, thus permitting the flow of fuel between the port and starboard fuel tanks.

(iv) In the event of an engine failure, the proportioner supplying that engine will stop due to failure of the hydraulic supply. Fuel from all tanks can, however, be supplied to the remaining engine by closing the L.P. and H.P. fuel cocks of the failed engine and selecting the inter-tank transfer control to ON. Fuel in the tanks which normally supply the inoperative engine will now be transferred to those supplying the other engine.

7. Fuel contents gauge

The fuel contents gauge, calibrated in lb. x 1,000 capacity, is located on the starboard side of the instrument panel. An associated selector switch, immediately below the gauge, is labelled PORT - TOTAL - STARBOARD. With the switch in the centre position the total contents of all fuel tanks is registered on the gauge. When the switch is selected to PORT or STARBOARD, the gauge registers the total contents of the tanks supplying either the port or starboard engine as a percentage; e.g., if the tanks supplying the port engine are half empty, the gauge will indicate 50% when the switch is selected to PORT.

8. Fuel jettison system

(i) Fuel from all tanks can be jettisoned through a single outlet located in the undersurface of the rear fuselage. A spring-loaded control switch marked FUEL JETTISON, PULL AND TURN is located on the cockpit starboard console.

(ii) Operation of the control switch opens an electrically-operated by-pass valve in the hydraulic circuit to each proportioner motor, increasing the fuel flow from the proportioners. At the same time, a jettison valve is opened and fuel, besides being fed to the engines, passes through non-return valves, into a common jettison line and through the open jettison valve to the outlet.

(iii) Fuel jettisoning can be continued until (a) the jettison control is released when the desired quantity of fuel has been jettisoned, or (b) the low-level float switches operate. When jettisoning is continued until the low-level float switches operate, the following amounts of fuel are left in the tanks:-

Tanks 2, 6, 7 and 8	27 gallons each
Tanks 1, 3, 4 and 5	32 gallons each
Combined total	236 gallons)

9. Oil system

Oil for lubricating the engine is carried in the engine sump. Provision is made for replenishing the oil by a pressure re-oiling connection, and a sight glass is provided to ensure that the oil level is correct. Similarly, the accessories gearboxes are replenished through pressure re-oiling connections, each gearbox having its own connection and sight glass. In an emergency, each engine sump and accessories gearbox can be gravity filled through emergency oil fillers.

MAIN SERVICES

10. Electrical system

(i) (a) Two 6 Kw. generators, mounted side-by-side on separate engine-driven gearboxes in the accessories bay, supply the electrical system via the main bus-bar in the d.c.

distribution panel located in the radio bay. Two 24 V., 25 amp. hour batteries, one of which is used as an emergency source of supply, are located in the radio bay. The normal battery is charged from the main bus-bar via a battery isolating relay.

(b) Alternating current for the electrically-operated instruments and radio equipment is supplied by a 400 c.p.s. 115 V. 3 phase inverter. A standby inverter is fitted in case of failure of No.1 inverter.

(ii) Generator control

(a) Operation of the generators is fully automatic upon starting the engines. The voltage regulators, differential contactors and test sockets are located in the radio bay. The voltage regulators maintain an output of 27.5 volts d.c. The differential contactors are automatic in operation and are used to (1) connect the generators to the bus-bar at the correct voltage and polarity, and (2) disconnect the generators from the bus-bar when the engines are stopped and if the system develops a fault.

(b) To safeguard the generator and system against excessive voltages which may develop due to a fault, an over-voltage relay is incorporated in the circuit. In the event of such a fault, this relay operates, blowing the generator field circuit fuse and opening the main contactor. In this way the generator is permanently isolated from the bus-bar.

(c) Visual indication of power failure is given by warning lamps located on the centralized warning panel on the starboard console.

(d) In the event of a heavy landing two inertia switches, located in the accessories bay, are operated to provide a short circuit through the generator field fuse, thus isolating the generators from the main bus-bar. Simultaneously, the generator field circuit will be broken, thereby preventing further generation.

(iii) External supply

A three-pin external supply plug is provided on the port side of the fuselage.

(iv) Batteries control

(a) The battery isolating relay is located in the radio bay and, when tripped, isolates the circuits supplied by the normal battery, except for the supply to the canopy operation circuit. The isolating relay can be tripped by switching OFF the battery master switch, located on the port side of the pilot's instrument panel, or, in the event of a heavy landing, by the action of an inertia switch located in the accessories bay.

(b) When the battery master switch is selected to ON, the normal battery is connected to the main bus-bar and is automatically charged in flight.

(c) The fire warning and fire extinguisher circuits, incorporated in the centralized warning system, and the crash-trip switches are supplied by the emergency battery which, in the event of failure of the normal battery, also supplies the following services:-

Cabin pressure warning
Standby aileron droop
Standby main flaps
Standby tail plane trim
Standby tail plane flap
Standby bomb door
Centralized warning system
Emergency hydraulics
Standby air brakes
Turn and slip indicator
Fuel jettison
Standby undercarriage operation and indication
V.H.F. radio
Fatigue meter

(v) Distribution

(a) The combined output of the two generators is connected to the main bus-bar in the d.c. control panel at the forward end of the radio bay. Each generator is connected to the bus-bar by a differential relay and contactor unit, also located on

the control panel. Three 100 amp. H.R.C. fuses feed the supply from the bus-bar to the fuse panels, C-AE and R-C.

(b) Nine 12-way fuse blocks are incorporated in panel C-AE which is located at the observer's station. Panel R-C is located in the radio bay and incorporates four 12-way fuse blocks, three banks being supplied by the normal battery and the lower bank 'D' by the emergency battery. The emergency battery also supplies the emergency fuse panel C-AD, located on the starboard side of the pilot's station.

(c) The a.c. fuse panel R-B is located in the radio bay and incorporates two 12-way a.c. fuse blocks and one d.c. fuse block 'S'.

(vi) Alternating current supplies

(a) Two inverters provide alternating current for the electrically-operated instruments and the automatic pilot. The inverters are controlled by two selector switches, located on the switch panel on the starboard side of the cockpit and labelled FLIGHT INST. No.1, No.2. Both switches should be selected ON during flight.

(b) An inverter changeover circuit is incorporated which automatically maintains the a.c. supply in the event of failure of No.1 inverter. When the switches are selected ON, both inverters run up, but when No.1 inverter attains normal voltage and phase sequence, a torque switch operates to switch off No.2 inverter. In the event of failure of No.1 inverter, the torque switch again operates, automatically restarting No.2 inverter.

(c) When the No.1 inverter is operating normally, an inverter failure indicator, located on the instrument panel, shows black. If No.1 inverter fails, the indicator changes to white.

11. Hydraulic system

(i) Three completely separate hydraulic systems are installed, two

for operation of the flying controls and the other for operation of the aircraft general services.

(ii) Flying controls system

(a) Two hydraulic pumps, one on each engine-driven gearbox, provide power for twin independent hydraulic systems, operating at 3,000 lb. per sq.in. pressure. Both systems serve the flying controls powered control units so that, in the event of failure of either engine or pump, the flying controls will remain operative at reduced rates.

(b) The port hydraulic system supplies the auto-stabilizer, auto-pilot and forward jacks of both the aileron and tail plane powered control units and also the auto-stabilizer and forward jack of the rudder control unit. (The rudder does not incorporate auto-pilot.) The starboard system supplies the rear jacks of the control units and is completely isolated from both the auto-pilot and auto-stabilizer. Therefore, in the event of failure of the port hydraulic system, the auto-pilot and auto-stabilizer facilities are inoperative.

(c) Two accumulators are fitted in each system and are located two on each side of the weapons bay. One accumulator is charged with fluid by the engine-driven pumps whilst the second accumulator contains the necessary air pressure. Located adjacent to each accumulator is an associated air charging connection and pressure gauge. During normal engine running they are maintained at the system pressure of 3,000 lb. per sq.in. The function of the accumulators is to cater for sudden demands by the control units.

(d) A flow indicator in each system transmits a signal to the centralized warning panel in the event of pump failure.

(iii) General services system

(a) Two engine-driven hydraulic pumps, supplied by a common main reservoir, provide the power for all the general

services hydraulic circuits, and operate at 4,000 lb. per sq.in. pressure.

(b) Should the main reservoir piston 'bottom', due to fluid leakage, the general services hydraulic system will be transferred to both emergency hydraulic and electrical supply. Two emergency reservoirs are provided, each of which contains sufficient fluid to operate the general services emergency circuits as follows:-

Undercarriage	-	DOWN
Main plane flaps	-	DOWN
Tail plane flap	-	UP
Air brakes	-	OUT and IN once only
Bomb door	-	OPEN and CLOSE once only
Fuel proportioners	-	Until no fluid remains
Nose wheel steering	-	Not available

(c) Two accumulators, one normal and one emergency, are fitted in the wheel brakes circuit which operates at 1,500 lb. per sq.in. pressure. Associated with each accumulator is a ground charging connection and a pressure gauge. A triple pressure gauge, mounted above the cockpit port console, records the pressure of the main accumulator and the individual brake pressures. The emergency accumulator pressure gauge is mounted aft of the standby switch panel on the starboard side of the cockpit.

(d) In the event of pump failure, a flow indicator in the appropriate circuit transmits a signal to the general services hydraulic system failure warning indicators on the cockpit starboard console. With both hydraulic pumps operating normally, the indicators show black; in the event of a pump failure, the associated indicator will show white. Between the pump failure indicators is a three-position indicator which shows NORM when the hydraulic system is operating normally, EMGY. when the system is transferred to emergency, and black and white cross hatching when the engines are not running and the electrical power supply is switched off.

12. Engine air bleed system

A bleed from each engine compressor provides air pressure for the operation of the boundary layer control system and the following services:-

Fuel tank pressurization
Fuel system negative G recuperators
Fuel system inter-tank transfer
Hydraulic fluid reservoir pressurization
Rudder stop
Radio bay air conditioning

AIRCRAFT CONTROLS

13. Flying controls - main

(i) General

The flying controls for the pilot consist of a control column, in a horizontal slide assembly which forms part of a central controls pedestal, and two rudder pedals. The rudder pedals are adjustable for leg reach by means of an adjuster wheel situated below the control column.

(ii) Powered control units

(a) The ailerons, tail plane and rudder are operated by hydraulically-powered control units supplied by the flying controls hydraulic system. Each control unit essentially comprises a tandem ram, each half being supplied by a separate system. There is no provision for manual reversion but, in the event of failure of either hydraulic system, full control will be maintained by the other system, with some limitation to the maximum manoeuvres otherwise obtainable.

(b) The powered control units for the ailerons are mounted one in each outer wing; the rudder unit is mounted in the rear fuselage and the tail plane unit is mounted in the fin.

(iii) Feel system

Pilot's 'feel' at the controls is simulated by spring box feel units which are connected into the control runs.

(iv) Aileron droop system

(a) In order to provide increased flap area when required, the ailerons can be drooped to a maximum of 30 deg. The droop position does not affect the conventional operation of the ailerons.

(b) An electrical actuator, mechanically connected to the aileron control circuit, comprises two identical motors, one for normal operation and one for emergency. Normal control is by a selector switch, located on the port control panel and labelled AILERON DROOP, NORMAL - TAKE-OFF - DOWN. Intermediate 5 deg. positions can be selected, with definite 'gates' at the 20 deg. (take-off) and 30 deg. (landing) position.

WARNING...
The boundary layer control system must be switched ON before the ailerons are drooped in flight. The ailerons must not be drooped when the auto-pilot is engaged, or when the flying controls hydraulic system is not pressurized.

(c) In the event of failure of the normal control, the ailerons can be drooped once only, by operating the standby switch, located on the standby control panel and labelled AILERON DROOP, NORMAL - OFF - DOWN. Intermediate positions can be obtained by selecting the switch to OFF when the desired angle of droop is reached. The ailerons cannot be raised after standby operation (Part 5, para.11).

(d) An aileron droop position indicator is located at the top of the pilot's instrument panel.

(v) Tail plane flap

(a) The tail plane flap is operated by a hydraulic jack powered by the general services hydraulic system. Two flap settings only are available, NORMAL and UP. In the NORMAL position the flap is in line with the tail plane and is mechanically locked; in the UP position the flap is raised through 30 deg.* and is hydraulically locked. There are no intermediate selections.

* 20 deg. XK486

(b) Control of the flap is by a selector switch, located on the port control panel and labelled TAIL PLANE FLAP, NORMAL - UP. In the event of electrical failure, or failure of the hydraulic supply to the operating jack, the tail plane flap can be raised, once only, by operating the standby switch, located on the standby control panel and labelled TAIL PLANE FLAP, OFF - ON. After the tail plane flap has been raised by a standby selection it cannot be selected down by either the emergency or normal hydraulic supply until a release valve in the hydraulic system has been manually reset on the ground.

(c) An electro-magnetic position indicator, located at the port side of the pilot's instrument panel, shows NORM on a white background when the tail plane flap is in the NORMAL position and UP on a black ground when the flap is UP. The indicator displays black and white diagonal stripes when the tail plane flap is in travel, i.e., unlocked, or in the event of failure of the normal electrical supply to the indicator.

(vi) Rudder stop

(a) In order to prevent the inadvertent application of excessive rudder movement at high speed, made possible through the pilot being isolated from the aerodynamic loads imposed upon the control surface, a safety device in the form of a mechanical stop is fitted to restrict the movement of the rudder quadrant in the mechanical input circuit to the rudder powered control unit.

(b) The stop is operated by air pressure piped from the air bleed system and is electrically selected by a two-position switch, located on the port console outboard of the throttle levers and labelled RUDDER STOP, OFF - ON. An associated magnetic indicator, located on the left hand side of the instrument panel indicates ON when the stop is engaged and shows black when the stop is disengaged.

14. Flying controls locking

The flying controls are hydraulically locked through the powered control units.

Note...
Prior to the installation of auto-pilot, mechanical locking devices are provided for fitment to the ailerons and the tail plane to prevent control surface droop when the aircraft is static. The locks are fitted immediately after shutting down the engines and are removed prior to starting. Each lock carries a red warning pennant which is clearly visible when the lock is in position.

15. Trimming controls

(i) Trimming of the ailerons and the rudder is effected by electrically actuated 'spring bias' mechanisms which are connected to the primary control systems. Tail plane trimming is provided by an electrically-actuated 'datum shift' mechanism which is incorporated in the gearing unit at the aft end of the tail plane control system.

(ii) Control of the aileron and rudder trim actuators is by a single trim switch, mounted on the port console and labelled RUDDER - AILERON - TRIM. The control works in a natural sense and associated trim indicators, located on the port console forward of the throttle levers, show the state of trim.

(iii) The tail plane trim actuator consists of a two-speed normal motor, with a solenoid-operated gear change, and a standby motor for use in emergency. Two rates of trim operation are provided, a low rate of 0.1 deg. of tail plane angle per second, for normal flight and a higher rate of 0.8 deg. per second when flying with main flaps down and ailerons drooped. The appropriate rate of tail plane trim can also be selected by a switch, mounted on the port console, inboard of the throttle levers, and labelled TAIL PLANE TRIM RATE, HIGH - LOW. The high rate of operation is obtained automatically upon lowering the flaps, irrespective of the position of the tail plane trim rate switch, a flap-operated micro switch completing the electrical circuit to the high speed solenoid of the trim actuator normal motor. When operating on the standby motor the high rate of trim operation is not available.
Note...
On the first aircraft the tail plane trim rate switch is mounted on the port coaming of the instrument panel.

(iv) Normal control of the tail plane trim actuator is by a thumb switch, mounted on the top of the control column handgrip. Use of the switch is instinctive - forward for nose down and aft for nose up

trim. In the event of failure of the normal motor or its electrical circuit, the standby motor can be selected by operating the standby control switch. This switch is located on the port console, adjacent to the rudder/aileron trim switch, and labelled STANDBY TAIL PLANE TRIM, NOSE UP - NOSE DOWN. An associated trim indicator is located on the port console, adjacent to the rudder trim indicator.

16. Flaps control and position indicator

(i) The flaps are operated by hydraulic jacks which are supplied by the general services hydraulic system, and are selected electrically by a control lever switch, located on the port control panel and labelled FLAPS, UP - TAKE-OFF - DOWN.

(ii) The flap control switch can be selected to seven positions and the flaps are raised and lowered at a fixed rate. When a flap selection is made, an electrical circuit is completed between the switch and the flap actuator unit. Movement of the actuator is then transmitted by cable and control rods to the two flap jacks. When the selected flap position is reached, a drum switch interrupts the electrical supply to the actuator unit.

(iii) In the event of electrical failure, or failure of the normal hydraulic supply, the flaps may be lowered, once only, by emergency selection. The emergency selector switch is located on the standby control panel on the starboard side of the cockpit, and is labelled FLAPS, OFF - DOWN. When an emergency DOWN selection has been made the flaps cannot be selected up by the normal system until a release valve on the flap actuator unit has been manually reset on the ground.

(iv) A flap position indicator is located at the top of the instrument panel. The port and starboard flaps operate in synchronism and the indicator is controlled by the port flap.

17. Air brakes control

(i) The air brakes are located at the aft extremity of the fuselage and comprise two halves which, in the closed position, form the fuselage tail cone. Operation of the air brakes is by a double-acting hydraulic jack which is supplied by the general services

hydraulic system, selection being by a switch, located in the starboard throttle lever handle and labelled AIR BRAKE IN - AIR BRAKE OUT.

(ii) Intermediate positions of the air brakes can be obtained by selecting the switch to OUT and returning it to the neutral position when the desired setting is reached. When selected IN the air brakes will retract fully before responding to a further selection. An air brakes position indicator is located centrally at the top of the instrument panel.

(iii) In the event of electrical failure, or failure of the normal hydraulic supply, the air brakes can be extended and retracted, (once only) by selecting the AIR BRAKE STANDBY switch, located on the port control panel; intermediate positions can be obtained by returning the standby switch to OFF when the required setting is reached. When a standby selection has been made the air brakes cannot subsequently be re-selected by the normal system until the release valve in the hydraulic system has been manually reset on the ground.

18. Bomb door operation

(i) In its closed position the rotatable bomb door completely encloses the weapons bay, and provides a rigid structure upon which a variety of weapons may be carried. The door is mounted on fore and aft pivotal bearings and is hydraulically operated by a single double-acting jack which is supplied by the general services hydraulic system. Selection is by a gated lever switch, located on the port console immediately aft of the throttle levers, and labelled BOMB DOOR, OPEN - CLOSED.

(ii) The bomb door will complete its travel to a selected position before responding to a reverse selection. A position indicator, mounted on the port console adjacent to the inboard throttle lever, shows black when the door is closed and locked, black and white diagonal stripes when the door is in travel, i.e. unlocked, and white when the door is open and locked.

(iii) In the event of failure of the normal electrical or hydraulic supply,

the bomb door can be operated by selection of a standby switch, located on the standby control panel and labelled BOMB DOOR, OPEN - CLOSE. Following a standby selection, the bomb door cannot be re-selected by the normal supply until the release valve in the hydraulic system has been manually reset on the ground.

19. Anti-spin parachute

Early prototypes are provided with an anti-spin parachute which is located on the port section of the air brake. The parachute is retained in position by a blister cover which, when released, permits the parachute to be deployed by the airflow. Release of the cover is electrically controlled by a gated lever switch, located on the port console immediately aft of the throttle levers, and labelled SPIN CHUTE, JETTISON - SAFE - STREAM. A spring-loaded safety stop prevents the switch being inadvertently selected to the JETTISON position. In addition, a micro switch, operated by the cover, prevents the parachute being jettisoned before it has streamed.

20. Auto-pilot system

(i) The auto-pilot installation incorporates auto-stabilizer facilities, the auto-pilot, auto-stabilizer and powered control units being fully integrated. The system is operated by a control unit mounted on the starboard console and a grip unit incorporated in the control column. Electrical power is supplied to the auto-pilot when the flight instruments No.1 or No.2 inverter is running.

(ii) Controls

(a) The following controls and indicators are located on the control unit:-

AUTO-PILOT switch
FORCE STICK/LOCK switch
HEIGHT/MACH NO. switch
AUTO-STABILIZER switch
An electro-magnetic indicator which operates in conjunction with the ENGAGE switch on the grip unit

(b) The following controls are incorporated on the grip unit:-

ENGAGE switch
DISENGAGE switch
Cut-out switch

(c) An AUTO-PILOT RESET push-button switch is mounted on the port console. The switch is fitted with a protective flap and is used to apply power to the system and to re-arm the auto-pilot circuits after the cut-out or the limit switches have been operated.

(iii) Control of the auto-pilot system

(a) When the aircraft battery master switch is selected ON, the centralized warning system will immediately operate. This is because the cut-out circuits are not armed. To clear the warning, the AUTO-PILOT RESET switch should be depressed. With no further switches selected the system is in the normal manual mode, i.e., the control column is mechanically coupled to the main valves of the powered control units.

(b) AUTO-STABILIZER switch. When the AUTO-STABILIZER switch is selected ON, the system remains essentially manual, but auto-stabilizer signals are differentially super-imposed on the manual demands; these signals are not transmitted back to the control column. Thus, the final position of the control surface is a combination of the manual and the auto-stabilizer demands.

(c) With the AUTO-PILOT switch made, the following auto-pilot modes are available:-

Height lock) These modes include the auto-
Mach No. lock) stabilizer and also have force stick control in roll.
Force Stick with auto-stabilizer
Force Stick without auto-stabilizer

(d) Height lock. To obtain height lock, the FORCE STICK/

LOCK switch is selected to LOCK and the HEIGHT/MACH switch is set to HEIGHT; the auto-pilot ENGAGE button on the grip unit is then depressed. The auto-pilot will now lock on to the barometric height prevailing.

(e) Mach No. lock. To obtain Mach No. lock the FORCE STICK/LOCK switch is selected to LOCK and the HEIGHT/MACH switch set to MACH; the auto-pilot ENGAGE button on the grip unit is then depressed. The auto-pilot will now lock on to the Mach No. prevailing.

(f) Force Stick. The Force Stick mode is obtained by selecting the FORCE STICK/LOCK switch to FORCE STICK and depressing the auto-pilot ENGAGE button on the grip unit. In the force stick mode there is no height, Mach or heading monitoring.

Note...
To change the mode in which the auto-pilot is engaged, the DISENGAGE button should be depressed, the required mode selected and the ENGAGE button depressed. The auto-stabilizer, however, may be switched ON and OFF as required when the aircraft is being flown under manual control or when the Force Stick mode is engaged. The selection of Mach or height lock modes will automatically engage the auto-stabilizer, irrespective of the position of the AUTO-STABILIZER switch.

(g) The AUTO-PILOT switch on the control unit serves as a safety device to prevent inadvertent operation of the auto-pilot ENGAGE button on the handgrip. The switch must always be in the OFF position on take-off and landing.

(h) Tail plane trim. It is important to trim the aircraft before engaging the auto-pilot and to keep the aircraft trimmed while engaged. Failure to do so may result in the operation of the tail plane limit switches.

(iv) Heading selector

The heading indicator of the Mk.5 F.T. compass system is provided with a conventional heading selector knob and pointer

with which the desired magnetic compass heading is set. The aircraft should be turned on to the desired heading, either manually, i.e., with the auto-pilot disengaged, or by using the force stick; it will then hold the selected heading.

(v) Safety devices

Manual protection against malfunction is provided by the cut-out on the grip unit. A spring box, fitted between the aileron inputs, provides protection against a runaway of one side of the system, and in the case of the tail plane a control surface angle limit switch disengages the auto-pilot automatically should excessive control be applied. The operation of any one of these devices causes the system to revert to manual control, operates the centralized warning system and switches off the electrical supply to the auto-pilot system.

21. Boundary layer control system

(i) The boundary layer control system provides increased lift and manoeuvrability at low speeds. Air is tapped from each engine compressor and discharged over the main planes and under the tail plane through slits in the leading edges; similar slits in the main plane trailing edge direct air over the flaps and ailerons.

(ii) From the compressor outlets the air is fed into a common duct and thence by branch ducts to the discharge points. Four servo-operated butterfly valves, located one in each compressor outlet, control the air supply to the main duct. Two pressure switches, one for each pair of outlets, control the butterfly valve servo units.

(iii) Electrically-operated shut-off valves are located in the main plane leading edge ducts and are closed when the system is switched off. The valves are provided to prevent air being drawn through the ducting from the trailing edge slits and out through the leading edge slits, resulting in an undesirable turbulence over the aerofoil surface.

(iv) The system is controlled by a switch, located on the port control panel and labelled BLOWING SYSTEM, ON - OFF. Selection of

the switch to ON opens the main plane leading edge duct shut-off valves. Associated limit switches then complete the electrical circuit to the pressure switches which, in turn, energize the solenoids of the servo units; the butterfly valves are then opened and air is delivered to the boundary layer control system. After selecting the switch to ON, a time of 3-4 sec. will elapse before blowing commences. Blowing will cease immediately the switch is selected to OFF.

(v) In the event of an engine failure, the back pressure created by the serviceable engine will open the pressure switch of the failed engine; the associated servo unit solenoid is de-energized and the butterfly valves closed, thus preventing pressure escaping from the system through the inoperative engine.

(vi) A 3-position electro-magnetic indicator is located on the upper port side of the pilot's instrument panel and labelled BLOWING SYSTEM. The indicator is controlled by two pressure switches within the boundary layer control system in conjunction with the undercarriage relays. One pressure switch operates at a pressure of 40 lb. per sq.in. before take-off and the other at 20 lb. per sq.in. during landing. Differences in pressure between the port and starboard main plane supply ducts are sensed by a differential pressure switch.

(vii) With the control switch selected to the OFF position, the electro-magnetic indicator will show OFF. During take-off, with the aircraft weight on the wheels and the system switched ON, the indicator will show ON when the system pressure reaches 40 lb. per sq.in.; when the system is switched ON before landing, the indicator will show ON when the pressure reaches 20 lb. per sq.in. If at any time the pressure falls below the minimum in either case, the indicator will revert to OFF. In this event the system must be switched OFF. Should a pressure differential of a pre-determined amount exist between the port and starboard supply ducts, the indicator will show black and white diagonal stripes, and the system must be switched OFF.

Note...

On the first aircraft, two pressure gauges are installed on the port console for instrumentation purposes.

22. Alighting gear and nose wheel steering

(i) The alighting gear is hydraulically-operated and comprises two undercarriage units, which retract inwards into recesses formed in the inner wings and engine nacelles, and a steerable nose wheel unit which retracts rearwards into a bay beneath the cockpit floor. After take-off the nose wheel will automatically centre from approx. 55 deg. either side of the central trailing position. Controlled steering is available through a range of 45 deg. either side of the central position.

(ii) The alighting gear is raised and lowered by hydraulic jacks which are powered by the general services hydraulic system and controlled by solenoid-operated selector valves. Control of the alighting gear is effected by a three-button switch unit, located on the port control panel. The selector buttons are marked UP, DOWN and EMERGENCY DOWN. A locking device in the switch unit prevents the UP button being depressed when the weight of the aircraft is on the wheels. In an emergency, however, this lock may be overridden by turning the button 90 deg. in a clockwise direction.

(iii) Visual indication of the position of the alighting gear is provided by a position indicator, located adjacent to the switch unit. A red warning lamp, located on the port side of the centre instrument panel, illuminates in the event of a landing approach with any alighting gear unit in an unlocked or locked up position.

(iv) Nose wheel steering is provided by a hydraulic jack which is supplied by the general services hydraulic system and controlled by a solenoid-operated selector valve. Steering is selected by a push-button switch, mounted on the starboard throttle lever, and controlled by a drum switch which is mechanically linked to both the rudder controls and the nose wheel, the degree of turn being controlled by movement of the rudder pedals. When the aircraft is on the ground and not under steering control the nose wheel is free to castor through 360 deg.

(v) Two additional contacts in the drum switch are wired in series with the alighting gear UP selector valve to prevent retraction taking place before the nose wheel is in a fore and aft alignment.

23. Wheel brakes

(i) The wheel brakes are hydraulically-operated and are supplied by the general services hydraulic system. Toe pedals are fitted above the rudder pedals and operate transmitters attached to the pedals. These transmitters operate the brakes through a control unit and Maxaret units.

(ii) In the event of failure of the general services hydraulic system, no supply is available to either the normal or the emergency brake accumulator, but sufficient fluid pressure is stored in the normal accumulator to provide sixteen toe-brake applications.

(iii) The emergency accumulator provides a reserve of power in the event of failure of the normal accumulator, sufficient power being available for a minimum of four brake applications, using the parking and emergency brake control mounted on the inboard face of the starboard console. Selection of this control to ON by-passes the Maxaret units and permits the wheels to lock irrespective of the aircraft speed.

(iv) A triple pressure gauge, mounted on the port wall of the cockpit, records the normal hydraulic accumulator pressure and the individual brake pressures. A further pressure gauge, located aft of the standby control panel on the starboard side of the cockpit, records the emergency accumulator pressure.

(v) The Maxaret units permit the use of maximum braking without the risk of wheel locking and tyre damage. Incorporated in the Maxaret units is a cocking device which, in conjunction with a cocking valve, applies the brakes automatically during undercarriage retraction to stop the wheels from spinning, and subsequently releases them when retraction is completed.
Note...
On the first aircraft the brakes must be applied to stop the wheels from spinning before the undercarriage is retracted.

24. Flight instruments

(i) Pressure-operated instruments
(a) Pitot and static pressures for the air-operated instruments

are obtained from the pressure head positioned on the port wing; a pressure head projecting from the aircraft nose provides a supply for instrumentation purposes.

(b) The heating elements of the pressure heads are controlled by a switch located on the switch panel on the starboard side of the cockpit and labelled PRESSURE HEADS, WING AND NOSE, ON - OFF.

(ii) Electrically-operated flight instruments

(a) The Mk.5 F.T. compass, the master reference gyro (M.R.G.) and attitude indicator, and the turn-and-slip indicator are electrically-operated. The Mk.5 F.T. compass and the M.R.G. and attitude indicator are normally supplied from the No.1 inverter; should a failure of No.1 inverter occur, No.2 inverter automatically takes over (para. 10(vi)(b)).

(b) Turn-and-slip indicator. The electrically-operated turn-and-slip indicator is provided with an independent and alternative d.c. supply, the change-over being effected automatically, in the event of failure of one source, by a relay in the circuit. In the event of a failure of the normal power supply, the turn-and-slip indicator can be operated from the emergency battery by selection of the standby switch adjacent to the instrument.

ENGINE CONTROLS

25. Combined throttle and H.P. fuel cock controls

(i) The throttle levers are mounted in a quadrant marked THROTTLE, GROUND IDLING - TAKE-OFF in the throttle control box. At the rear of the quadrant is a section marked H.P. FUEL COCK, SHUT - OPEN. Movement of the throttles in this section operates the H.P. fuel cocks, the gated OPEN position coinciding with the throttle GROUND IDLING position.

(ii) A friction damping control for the throttle levers is fitted on the inboard side of the throttle control box. Clockwise rotation increases friction.

26. Low pressure fuel cock controls

The low pressure fuel cocks are controlled by two levers which are mounted at the rear of the port console and marked ENGINE MASTER COCK, OFF - ON.

27. Engine starting and stopping controls

(i) The engine starting push-buttons are mounted on the port and starboard throttle levers respectively and are marked ENGINE START AND RE-LIGHT. The push-buttons automatically control the air starting trolley and igniter units through relays and a time switch. The buttons are also used for re-lighting in the air.

(ii) To minimize the possibility of a 'wet start', a solenoid-operated by-pass valve is incorporated in each engine fuel system to allow fuel, in excess of that required for starting, to return to the inlet side of the fuel pumps. Each valve is automatically controlled by the engine starting time delay switch. Operation of the valve can also be selected manually as required, after the initial starting cycle (Part 4, para.3 refers), by associated spring-loaded switches, located at the rear of the port console and labelled ENGINE FUEL VALVE BY-PASS, ON-OFF.

28. Jet pipe temperature automatic control

In order to prevent excessive turbine temperatures and consequent reduction in the life of the turbine blades, the jet pipe temperature is automatically limited to a pre-determined maximum value. This is achieved by monitoring the temperature immediately aft of the turbine and, when a pre-determined figure is reached, to progressively reduce the fuel flow to the engine by an actuator incorporated in the fuel system.

29. Engine instruments

The majority of the engine instruments are mounted on the main

instrument panel. Fuel pump inlet pressure gauges, marked FUEL PUMP INLET PRESS. and oil pressure gauges, marked PORT, OIL PRESS. STBD., are mounted on the starboard console. Engine throttle position indicators, marked PORT, ENGINE THROTTLE POSITION, STBD., are mounted on the port console.
Note...
The fuel inlet pressure gauges and engine throttle position indicators are provided for instrumentation purposes only.

AIR CONDITIONING SYSTEM

30. General

(i) A hot air supply, taken from a manifold on each engine compressor, is used for the combined air conditioning and pressurizing system for the cabin. The air supply is ducted into a common delivery line which later separates into two branches. One branch delivers air to the anti-g suits worn by the pilot and observer; the remaining branch is concerned with temperature-controlled supply to the cabin.

(ii) The flow of air is controlled by two electrically-operated shut-off valves, one for each engine. These shut-off valves are controlled by a switch, located on the switch panel on the starboard side of the pilot's station and labelled CABIN PRESSURE, ON - OFF.

31. Cabin pressurization

(i) The pressurized compartment is enclosed by two bulkheads, one just forward of the instrument panel and the other immediately behind the observer's seat. The air supply to the cabin is automatically regulated, according to the operating conditions, by a flow controller.

(ii) Up to the minimum pressurizing altitude of 8,000 ft. above sea level, the air, after passing through the temperature control system, circulates freely within the cabin and is expelled through a discharge valve into the nose compartment. Above this height the discharge valve begins to close, through the action of a capsule-operated pressure controller, thus regulating the amount of air expelled from the cabin and causing a cabin differential pressure to build up. The differential increases at a rate proportional to the rate of climb and continues until the ultimate condition of 4 lb. per sq.in. is reached at 25,000 ft.

(iii) Should the discharge valve fail to function, a safety valve, which also incorporates an inward relief valve, will automatically start to relieve at a differential pressure of 4.25 lb. per sq.in., and will control the cabin below a differential pressure of 4.75 lb. per sq.in. when the full cabin supply is passing through the valve.

(iv) During a descent the cabin differential pressure is maintained at 4 lb. per sq.in. down to 25,000 ft. Below 25,000 ft. the differential pressure is progressively decreased by the combined action of the pressure controller and the discharge valve, the valve opening to release the pressure at a rate proportional to the rate of descent until zero differential is reached at 8,000 ft. In the event of cabin pressure being lower than that of ambient, such as may develop during a rapid descent with power off, the inward relief part of the safety valve will automatically operate to allow pressure equalization.

(v) In the event of failure of the pressure control system, or damage to the aircraft structure, causing a loss of cabin pressure, the cabin pressure warning lamp on the centralized warning panel will operate when the cabin altitude reaches 32,000 ft.

32. Temperature control

(i) The temperature of the cabin air supply can be controlled within a range of +5 deg. C. to +35 deg. C. by manual selection of a temperature selector, located on the aft portion of the starboard console. Automatic or manual control of the selected temperature can be obtained by selecting an adjacent switch to AUTOMATIC or MANUAL as required.

(ii) When the switch is set to AUTOMATIC, the temperature selected on the selector knob is maintained thermostatically, irrespective of any change in aircraft operating conditions.

(iii) The MANUAL position of the switch is intended for emergency use in the event of failure of the thermostatic control. In this condition the cabin temperature is governed directly by rotation of the selector knob, adjustment being made as necessary to compensate for any change in aircraft operating conditions.

33. Emergency ventilation

(i) In the event of failure of the air conditioning system, an emergency ventilation system can be brought into operation by selection of a manually-operated ram-air valve, located on the outboard side of the starboard console.

(ii) When the valve is opened, air at ram pressure and temperature is admitted to the cabin from ducting connected to two small intakes, one on the inboard side of each engine intake. At the same time the discharge valve is opened to exhaust any pressure remaining in the cabin, which is then subject to ambient conditions.

WARNING...
If the ram-air valve is opened rapidly when the aircraft is at altitude, sudden decompression of the cabin will occur. The valve must therefore by opened slowly.

34. Anti-g system

(i) The air supply to the crew's anti-g suits is taken from a branch of the main air conditioning supply, passing through a non-return valve to two stop valves, one for each suit, located on the starboard side of the pilot's and observer's stations.

(ii) When the respective stop valve is opened, a pressure supply is passed to an anti-g valve, mounted adjacent to the stop valve, which permits a controlled supply to pressurize the suits in proportion to the degree of applied positive g. Each anti-g valve incorporates a filter and relief valve, and can be tested by manually operating the knob at the top of the valve.

35. Canopy sealing and de-misting

The canopy inflatable seal and the de-misting duct are supplied with air pressure from a branch connection on the cabin supply line downstream of the heat exchanger. After passing through a non-return valve the supply pipe divides, one branch connecting to the de-misting galleries and controlled by a manual control valve located on the starboard wall of the pilot's station; the other branch passes through a reducing valve, which reduces the

pressure to 8 lb. per sq.in., and a stop valve to the canopy seal. The canopy seal stop valve is automatically operated by the sliding canopy control so that the valve is opened when the canopy is moved to the closed position.

GENERAL EQUIPMENT AND CONTROLS

36. Sliding canopy

(i) The cabin is enclosed by an electrically-operated, one-piece, sliding canopy. Two rollers at the forward end of the canopy locate in guide rails along each side of the cabin, the rear of the canopy being hinged to a shuttle unit which runs in guide rails in the dorsal fin structure.

(ii) The canopy is operated by an electrical rotary actuator, mounted in the dorsal fin structure immediately behind the observer's station. The actuator drive is connected to the canopy shuttle by chain and cable, the actuator being controlled by a handle located on the starboard side of the cockpit. From a central LOCKED position the selector handle is moved forward to close the canopy and rearward to open it; this movement operates the canopy pressure seal valve, releases the canopy locking mechanism and operates the actuator. Limit switches, operated by stops on the canopy, automatically switch off the actuator when the canopy reaches the fully open or closed position. The canopy is locked by returning the selector handle to the central position.

(iii) The canopy selector handle can be locked in the OPEN position to facilitate manual opening of the canopy in the event of electrical failure. Should such a failure occur, the actuator must be de-clutched before the canopy can be opened. The de-clutching control knob is mounted on the starboard side of the pilot's station and is operated by pulling the knob forward and turning it through 90 deg. into a locked position.

(iv) The canopy can be operated from outside the cabin by an external selector handle and de-clutching control. The external handle is integral with the internal control, but is independent in operation.

When not in use, the handle is flush-fitting in the surface skin; depression of an adjacent spring catch causes the handle to be ejected from its recess into the operating position. The de-clutching control is situated in the recess and is operated in a similar manner to the cockpit control.

(v) Early prototypes are provided with a canopy inching facility to enable the pilot to control the canopy between the closed and fully open position. An inching switch, labelled NORMAL - STOP - REVERSE, is mounted on the canopy internal selector handle. With the inching switch selected to NORMAL, operation of the canopy remains as described in sub-para. (ii); to obtain an intermediate open position, move the inching switch to STOP when the canopy reaches the desired position. If it is desired to partly close the canopy from a previously selected intermediate position, set the inching switch to REVERSE, move the canopy selector handle to CLOSE and, when the canopy reaches the required position, select the inching switch to STOP.

WARNING...
The canopy must not, under any circumstances, be inched to the fully open position as this will damage the operating mechanism.

37. Pilot's seat

The pilot's seat is a Martin Baker Mk. 4M ejection seat. The seat is adjustable for height by a seat raising lever on the starboard side of the seat pan. A shoulder harness release lever is located on the port side of the seat pan. The angle of the arm rests may be adjusted by depressing a catch at the front of each arm.

38. Internal lighting

(i) Cockpit

Early prototypes are not provided with cockpit lighting.

(ii) Accessories bay

A single cockpit-type lamp in the roof of the bay provides general illumination. The lamp is controlled by an ON - OFF switch

located at the forward end of the bay.

(iii) Weapons bay

The weapons bay is illuminated by four cockpit-type lamps, which are controlled by the bomb door isolating micro switch. The switch is automatically operated by the opening of a flap, located immediately aft of the bomb door.

(iv) Radio bay

Three cockpit-type roof lamps provide illumination for the radio bay. The lamps are controlled by an ON - OFF switch, located on the tele-communications panel on the starboard side of the bay.

39. External lighting

No external lighting is provided on early prototypes.

40. Oxygen system

(i) Normal supply

(a) The pilot and observer are supplied with oxygen from four oxygen cylinders, each of 750 litres capacity, stowed in the radio bay. Provision is made for the addition of a fifth cylinder when required. Located on the pilot's starboard console and the observer's port console is a Mk.17D demand regulator which incorporates the following controls and indicators:-

(1) A manually-operated air inlet shutter, marked NORMAL OXYGEN - 100% OXYGEN.

(2) An emergency toggle switch, marked EMERGENCY, PRESS TO TEST MASK.

(3) An ON - OFF control switch which is normally wire-locked in the ON position.

(4) An electro-magnetic blinker-type flow indicator.

(5) A pressure gauge (medium pressure supply).

Above 30,000 ft. cabin altitude the regulators automatically supply 100% oxygen.

(b) The supply from the cylinders is separated into two feeds, each of which is served by one pair of cylinders. Inter-connecting pipes between the two supplies, in the form of cross-feeds, ensure that if damage or failure occurs to one side of the system, both crew members will continue to receive a supply from the serviceable pair of cylinders. The cylinders can be charged in situ through an adjacent charging valve.

(c) Two electro-magnetic flow indicators are located on the pilot's and observer's instrument panels. The indicators operate in conjunction with the regulator flow indicators and provide positive indication that oxygen is flowing to the masks. An oxygen contents gauge is mounted on the pilot's starboard console.

(ii) Operation

The supply of oxygen is fully automatic immediately the regulator ON - OFF switch is selected to ON. Under normal flight conditions the air inlet shutter is selected in the NORMAL OXYGEN position; if, however, the presence of carbon monoxide or other toxic fumes is suspected, the shutter should be selected to 100% OXYGEN. As an additional precaution the EMERGENCY toggle switch should be deflected to the left or right, when the supply pressure to the mask is increased.

(iii) Emergency supply

(a) Each ejection seat is equipped with a Mk.7 emergency oxygen set, comprising a cylinder of 55 litres capacity and a simple regulator. Each installation is automatically operated, in the event of ejection, by a static line which releases oxygen from the cylinder to the seat occupant's mask.

(b) The emergency oxygen can also be used in the event of failure

of the normal system supply by operating the EMERGENCY OXYGEN manual control knob, located on the starboard console at each crew station. Approximately 10 minutes oxygen supply is contained in each emergency cylinder.

NAVIGATION, WIRELESS AND RADAR EQUIPMENT

41. Compasses

(i) Mk.5 F.T. Gyro-magnetic compass

(a) The gyro-compass installation comprises the following units:-

(1) Detector unit, Type A, mounted in the starboard wing tip.

(2) Amplifier unit, Type A.

(3) Heading indicator, Type A, on the pilot's instrument panel.

(4) Observer's repeater, Type A, on the observer's starboard console.

(b) The heading indicator is provided with a conventional course setting knob (HDG) and synchronizing knob (SYN). Disposed centrally between the HDG and SYN knobs is a small button control which, when pressed, permits the instrument to function as a directional gyro. In this case the SYN knob may be used to reset the dial to correct for azimuth gyro wander.

(ii) Standby compass

A magnetic compass, Type E2B, is mounted centrally on the windscreen frame.

42. Radio and intercomm.

(i) The wireless equipment consists of twin V.H.F. installations and an integrated intercomm. system. The V.H.F. sets are mounted in the radio bay in the rear fuselage.

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Provisional Pilot's Notes

M.148 AIRCRAFT

Advance Information Leaflet No.1/58

Insert this leaflet in Provisional Pilot's Notes, Part 1, to face para.45

Para.45 refers:-

Canopy jettison tests have shown the observer's canopy jettison unit to be ineffective. A recent modification removes the observer's jettison handle and renders the jettison unit inoperative. Provision is made for the observer to operate the jettison unit at the rear of the pilot's seat by a handle which is attached directly to the sear of the jettison unit. This modification is included on the third aircraft (XK 488) and will be incorporated on aircraft XK 486 and XK 487 by retrospective action.

Note...
The information contained in this leaflet will be incorporated by normal amendment list action in due course.

October, 1958

(ii) The twin V.H.F. sets are controlled by the pilot through the control units, located on the port console and labelled No.1 and No.2, and an adjacent changeover switch. In the event of failure of the normal electrical supply, an emergency supply is available by switching the POWER SUPPLY switch, on the port console, from NORMAL to EMERGENCY. A press-to-transmit button is incorporated in the starboard throttle lever handle, and a mute switch marked NORMAL - MUTE, is located on the port console.

(iii) The observer's station is equipped with a press-to-transmit switch, located on the port console, and a foot-operated push-button mute switch, mounted on the starboard side of the floor.

(iv) A mic-tel socket is located on the rear port side of the pilot's and observer's seat structure, each socket being provided with a protective spring flap. A further mic-tel socket and associated control switch, labelled MUTE - OFF - TRANS., is mounted on a panel in the radio bay and is used for test purposes. A type 3570 quick release connector, located in the port wheel bay, permits intercomm. between ground crew and pilot up to the moment of take-off if necessary.

(v) The V.H.F. aerials are mounted in the dorsal fin structure; No.1 V.H.F. set is connected to the forward aerial and No.2 set to the rear.

43. Radio altimeter

Early aircraft are not equipped with a radio altimeter.

44. Radar

No radar equipment is installed in early prototypes.

EMERGENCY EQUIPMENT AND CONTROLS

45. Sliding canopy jettison control

(i) The canopy can be jettisoned by either the pilot or observer, using the handle provided on the port side of each crew station. Each

handle is connected by Bowden cable to the corresponding cartridge-operated canopy jettison unit, located at the rear of each ejection seat.

(ii) Operation of either handle causes its respective jettison unit to be fired, unlocking the canopy jettison rail and ejecting the canopy.

46. Ejection seat

(i) The Mk.4M fully automatic lightweight ejection seat is designed to provide safe escape at all altitudes and speeds within the aircraft range and, after ejection, to deploy the parachute automatically and lift the occupant from the seat.

(ii) If ejection is made at high altitude a barostatic control, attached to the seat, delays opening of the main parachute and separation of the occupant from the seat until an altitude of approximately 10,000 ft. is reached. At very high ejection speeds the opening of the main parachute is delayed by a G switch, fitted to the time delay mechanism, until a safe speed for deployment is reached.

(iii) The seat is fitted with a cartridge-operated canopy jettison unit, operated by the face screen firing control, a one second delay occurring before the seat ejection gun is fired. An alternative firing handle is fitted in the leading edge of the seat pan. To enable the canopy to be jettisoned separately, an override canopy jettison handle is provided in each cockpit (para.45).
Note...
Pending modification to the canopy jettison system, the ejection seat firing handles are disconnected from the canopy jettison gun, so that the canopy and seat must be operated separately.

(iv) The main parachute is a standard Irvin 24 ft. canopy and is stowed in a pack behind the pilot's shoulders. The parachute and seat harness are combined and connected to a single box as one harness.

47. Emergency equipment

(i) Survival pack. The survival pack, which forms the ejection seat

cushion, contains a Type K single seat dinghy and Type P survival equipment. The Type K dinghy is inflated from a CO_2 cylinder, housed in a sleeve on the side of the buoyancy chamber, which is actuated by an operating strap attached to the head of the cylinder.

(ii) A hand-operated fire extinguisher is clipped to the port wall of the cockpit at the observer's station.

48. Engine fire extinguisher equipment

(i) Engine fire protection is provided by an automatic-type fire extinguisher bottle with a dual operating head, mounted on the inside of each engine outboard nacelle cowling. A firewire sensing element, looped around the engine and heat shield, is connected to a relay box located in the radio bay, which operates an associated warning lamp on the centralized warning panel.

(ii) The two engine fire warning lamps are duplicated in the two engine push-button fire switches, located on the centralized warning panel (para.50). On receipt of an engine fire warning, the appropriate extinguisher can be brought into action by depressing the associated fire switch, when extinguishant will be discharged through the forward part of the operating head to the engine spray ring.

(iii) Automatic operation

In the event of a crash landing, the operation of any one of four crash-trip switches will cause each engine fire extinguisher to be discharged, the forward part of the operating head delivering extinguishant to the engine spray ring, and the rear part delivering extinguishant to the heat shield muff, where it is discharged into the annular space between the jet pipe and heat shield.

49. Fuel tanks and weapons bay fire extinguisher equipment

(i) An automatic fire detection and extinguishing system is provided for the fuel tanks and the weapons bay. Two single head type extinguisher bottles are mounted one on each side of the radio bay and connected to gallery spray pipes routed down the weapons bay sides. Connected to each gallery pipe are a series of pipes which

project upwards into the space between the fuel tanks and the fuselage skin. Further pipes project into the hollow bulkhead forward of the fuel tanks and the bulkhead at the rear of the weapons bay. Two firewire sensing elements are incorporated, one being clipped to the spray pipe circuit round the fuel tanks and weapons bay, and the other projecting into the rear of the weapons bay.

(ii) Two fire warning lamps, associated with the system, are located on the centralized warning panel.

(iii) Operation

The system is automatic in operation by either of the following methods:-

(a) In the event of a crash landing, the operation of any one of the crash-trip switches will cause both extinguishers to discharge extinguishant into the spray pipe system.

(b) Abnormally high temperatures or fire in any part of the system is detected by the firewire sensing elements which, acting in conjunction with a relay, cause the fire warning lamps to be illuminated and both extinguishers to discharge simultaneously into the spray pipe system.

WARNING...
Methyl bromide fumes are toxic and must not be inhaled.

50. Centralized warning system

(i) The centralized warning system provides visual and audible warning in the event of fire in the vicinity of the engines, fuel tanks or weapons bay, and in the event of failure of any of the following services:-

Auto-pilot
Cabin pressure
D.C. supplies (port and starboard generators)
Flying controls hydraulic system (port and starboard hydraulic pumps)

(ii) Visual warning is provided by twelve lamps incorporated in the centralized warning panel, located on the starboard console. The operation of any one of these lamps causes two attention warning lamps, mounted on the coaming above the instrument panel, to flash intermittently. At the same time an audible warning note is transmitted to the pilot's earphones.

(iii) Port and starboard engine fire extinguisher push switches are also located on the centralized warning panel. Lamps in the switches are illuminated when an engine fire relay is operated. When the port or starboard switch is pressed, extinguishant is discharged from the forward head of the appropriate fire extinguisher.

(iv) A lamp incorporated in the CANCEL push switch flashes in synchronism with the attention warning lights when the centralized warning panel receives a signal. On pressing the CANCEL switch the audible and flashing warnings cease.

(v) In the pushed position, the MASTER push/pull switch completes the circuit for the following warning lamps on the panel:-

Oxygen	Controls, port
Cabin pressure	Controls, starboard
Generator, port	Auto-pilot
Generator, starboard	

With the MASTER switch in the pulled position, the circuit for the above warning lamps is broken and a lamp in the switch is illuminated. During flight the MASTER switch must be left in the pushed position.

(vi) Continuity of the warning panel lamps and the attention warning lamps, and the operation of the audible warning, can be tested by operating a TEST push switch on the warning panel. Providing the a.c. supply is switched on, depression of the TEST switch will also test the continuity of the firewire sensing elements.

PART 2

LIMITATIONS

PART 2 LIMITATIONS

These limitations are applicable to aircraft Serial No. XK 486 for first preview by A. & A.E.E.

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1. Engine data - de Havilland Gyron Junior D.GJ.1 - Phase 1(a)

(Serial Nos. 3220 & 3222)

The principal engine limitations are as follows:-

Condition	R.P.M.	Time limit per flight (min.)	J.P.T. (°C)
Max. with air bleed . . .	9,000	5	710
Max. without air bleed . .	9,000	10	650
Military rating	8,550	30	565
Max. continuous	8,300	Unlimited	525
Min. approach with air bleed	6,000	Unlimited	-
Min. approach without air bleed	4,500	Unlimited	-
Ground idling	4,200	Unlimited	-

Oil pressures

Ground idling . . . . . 10 - 20 lb. per sq.in.

Normal (at max.continuous R.P.M.) . . . . . 20 - 25 lb. per sq.in.

Oil temperature (sump) . . . . . 80°C.

2. Design limitations

Maximum speeds:-

Flaps down to 30 deg. (blow OFF)	260 knots
Flaps down to 45 deg. (blow OFF)	200 knots
Flaps down to 30 deg., ailerons drooped to 20 deg. (blow ON)	210 knots
Flaps down to 45 deg., ailerons drooped to 30 deg. (blow ON)	160 knots
Tail plane flap operation	175 knots
Alighting gear lowering	200 knots
With alighting gear locked down	225 knots
Boundary layer control ON	300 knots

3. Temporary flying limitations

(i) Speed

Maximum permissible speed . . . . . 450 knots E.A.S.
(to be corrected for scale altitude for I.A.S.)

Maximum Mach No. 0.9

Minimum flying speeds (knots I.A.S.)

A.U.W. (lb.)	30,000	35,000	40,000
Flaps 0 deg.	150	160	170
Flaps 30 or 45 deg., blow OFF	142	152	162
Flaps 30 or 45 deg., aileron droop 15 deg., blow ON	128	138	148

(ii) Normal acceleration

+ 5.0 indicated
- 2.4 indicated

(iii) Altitude

Altitude not to exceed 30,000ft.

(iv) Manoeuvre limitations

Max. rate of roll . . . . . 100 deg./sec. for 360 deg. roll

Minimum speed for 360 deg. roll . . . . . 330 knots

Maximum angles of sideslip

deg.	17	11.5	6.5
knots E.A.S.	260	300	400

Maximum angle of climb . . . . . 60 deg.

Maximum angle of dive . . . . . 60 deg.

Maximum speed for bomb door rotation . . . . . 350 knots

Maximum speed for air brake operation . . . . . 400 knots

The operation of air brakes in yawed flight is prohibited.

4. Weight limitations

Max. take-off weight . . . . . 40,000 lb.

Max. landing weight . . . . . 34,500 lb.

5. C. of G. limitations

Forward . . . . . 18 in. aft of datum (0.27 S.M.C.)

Aft . . . . . 25.17 in. aft of datum (0.32 S.M.C.)

6. Electrical actuator limitations

To avoid overheating the respective electrical actuators, the following operating limitations are to be observed:-

(i) Aileron droop - each complete cycle, i.e., full droop and retract, is to be followed by a rest period of two minutes.

(ii) Aileron trim - each complete cycle, i.e., full trim and back to neutral, is to be followed by a rest period of one minute.

(iii) Rudder trim - as for aileron trim.

(iv) Tail plane trim - operation of the trim through its full range should be effected only at high rate and must be followed by a rest period of five minutes. Operation at low rate should be confined to short bursts of two or three seconds duration, where possible, each followed by a rest period of eighteen seconds.

(v) Canopy operation - each operation of the canopy, i.e., opening or closing, must be followed by a rest period of three minutes.

7. Boundary layer control system limitation (ground running)

When operating the boundary layer control system on the ground, a maximum operating time of 3 minutes must not be exceeded.

PART 3

MANAGEMENT OF SYSTEMS AND EQUIPMENT

PART 3

MANAGEMENT OF SYSTEMS AND EQUIPMENT

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MANAGEMENT OF THE FUEL SYSTEM

1. Fuel from all the tanks is automatically fed to the engines, via hydraulically-driven fuel flow proportioners, when the L.P. cocks and the H.P. cocks are on.

2. Use of the cross-feed cock

(i) Normally, tanks No. 2, 4, 5 and 7 supply the port engine and tanks No. 1, 3, 6 and 8 supply the starboard engine. In the event of a proportioner failure with both engines running, the remaining proportioner will maintain an adequate supply to both engines immediately the cross-feed cock is opened. It should be noted that this fuel supply will be drawn only from the tanks which normally supply the serviceable proportioner; to obtain fuel from all tanks, the inter-tank transfer control should be selected ON (para. 3).

(ii) To ensure that a supply of fuel is maintained in the event of proportioner failure during take-off, it is recommended that the cross-feed cock is opened before take-off and closed when a safe height is attained.

(iii) To cross-feed, select the cross-feed control switch to OPEN and note that the magnetic indicator changes to white.

3. Use of the inter-tank transfer cock

In the event of an engine failure, the proportioner feeding that engine will stop due to failure of the hydraulic supply. Fuel from all tanks can, however, be supplied to the remaining engine by closing the L.P. and H.P. cocks of the failed engine and selecting the inter-tank transfer control to ON.

4. Fuel jettisoning

Fuel from all tanks can be proportionately jettisoned through a single electrically-controlled valve. To jettison fuel, pull up the jettison control and turn it to the FUEL JETTISON position. Fuel will be discharged overboard until the control is released or until one of the low level float switches operates.

MANAGEMENT OF THE HYDRAULIC SYSTEM

5. Starting and taxying

(i) Before starting the engines, and with an external electrical power supply connected, check the following:-

(a) The two power controls warning lamps on the centralized warning panel are illuminated.

(b) The two general services system pump failure indicators show white.

(c) The general services system indicator shows NORM.

(d) The brakes emergency accumulator pressure gauge indicates 3,000 lb. per sq.in. (minimum).
Note...
Accumulator hydraulic pressure is exhausted when the gauge indicates 1,550 lb. per sq.in.

(ii) As each engine is started, check that:-

(a) The corresponding power controls warning lamp is extinguished.

(b) The corresponding general services pump failure indicator changes to black.

(c) The brakes normal and emergency accumulators pressure increases to 4,000 lb. per sq.in.

(iii) Before take-off, check the flying controls over their full range of movement. Check the operation of the main plane flaps, tail plane flap and air brakes.

6. General services system - emergency operation

(i) Should the general services hydraulic system develop a fluid leakage resulting in the 'bottoming' of the main reservoir piston, the whole of the hydraulic system will be automatically transferred to emergency hydraulic and electrical supply. The general

services hydraulic system indicator will change to EMGY, and the hydraulic services must be operated, as required, by selection of the standby controls (Part 5, para. 4 to 8).

(ii) In the event of any hydraulic service failing to operate on a normal selection, the service can be selected on the appropriate standby control. With the exception of the bomb door and the air brakes (IN selection only), an emergency selection, once made, must be retained on all services, to ensure that the service is maintained in the selected position. In the case of an air brakes or bomb door standby selection, the remainder of the hydraulic system will revert to normal when the air brakes are fully closed and when the bomb door is fully open or closed.

MANAGEMENT OF THE AIR CONDITIONING SYSTEM

7. Cabin pressurization

(i) Cabin pressurization is fully automatic in operation upon selecting the CABIN PRESSURE switch to ON.

(ii) Should the pressure control system fail or damage to the aircraft structure cause a loss of cabin pressure, the warning lamp on the centralized warning panel will illuminate when the cabin altitude reaches 32,000 ft. In this event, the emergency ventilation control should be operated and, if possible, a descent made to a more tolerable altitude.

WARNING...
If the aircraft is at altitude, rapid opening of the emergency ventilation control will cause sudden decompression of the cabin. In these conditions, therefore, the control must be opened slowly.

8. Temperature control

(i) The desired temperature, within the range of +5 deg. C. to +35 deg. C., is selected on the temperature control knob and the temperature control switch set to AUTOMATIC. The selected temperature will be maintained thermostatically, irrespective of any change in aircraft operating conditions.

(ii) In the event of failure of the thermostatic control, the temperature can be manually regulated by selecting the temperature control switch to MANUAL. In this condition the cabin temperature is governed directly by rotation of the control knob. It should be noted that the resulting cabin temperature will vary with changes in operating conditions or cabin heat load, necessitating adjustment of the control knob in order to maintain a constant cabin temperature.

MANAGEMENT OF THE AUTO-PILOT

9. Speed limitations

The limitations when the auto-pilot is being used are as follows:-

(a) Minimum speed for engaging auto-pilot . . . . 0.6 Mach.

(b) Maximum speed for continuous cruise . . . . 0.85 Mach.

(c) Climbing speed . . . . . 0.85 Mach.

(d) Maximum speed permissible . . . . . 0.95 Mach.

10. Pre-flight checks

(i) Preliminary check

(a) Ensure that the FLIGHT INST. No. 1 and No. 2 switches are ON and check that the inverter failure indicator shows black.

(b) Check the flying controls for freedom and range of movement.

(c) Note that the centralized warning system is operating (window marked A.P. illuminated).

(d) Press the AUTO-PILOT RESET switch.

(e) Check that the auto-pilot warning lamp on the centralized warning panel is extinguished and re-set the system by pressing

the CANCEL switch.

(f) Allow at least one minute for the rate gyros to run up.

(ii) Auto-stabilizer check

(a) Select the AUTO-STABILIZER switch ON.

(b) Check that the flying controls remain free and return the controls to neutral.

(iii) Force stick check

(a) Centralize the control column and reduce any trim to zero.

(b) Select FORCE STICK on the FORCE STICK/LOCK switch.

(c) Operate the AUTO-PILOT switch on the control unit.

(d) Press the auto-pilot ENGAGE button on the grip unit; check that the doll's eye indicator on the control unit operates.

(e) Grip the lower part of the control column below the force stick unit and check that it is locked in pitch and roll.

(f) Ensure full authority of force stick in roll.

(g) Operate the force stick in pitch and check that the tail plane limit switches operate in both directions (+ 2 deg. and - 4 deg.), causing the centralized warning system to operate.

Note...
When the limit switches operate it will be necessary to press the AUTO-PILOT RE-SET switch and to re-engage the auto-pilot.

(h) Press the auto-pilot DISENGAGE button on the grip unit and check that the doll's eye indicator on the control unit clears.

(j) Switch OFF the auto-stabilizer.

(iv) Height lock check

(a) Select LOCK on the FORCE STICK/LOCK switch and HEIGHT on the HEIGHT/MACH switch.

(b) Press the auto-pilot ENGAGE button.

(c) Check that the control surfaces remain neutral.

(d) Check that the force stick has full authority in roll but is locked in pitch.

(e) Disengage the auto-pilot.

(v) Mach No. lock check

(a) Repeat sub-para. (iv), selecting MACH on the HEIGHT/MACH switch.

(vi) Compass heading check

(a) Synchronize the Mk.5 F.T. compass annunciator.

(b) Adjust the compass heading selector to the indicated aircraft compass heading.

(c) Select LOCK on the FORCE STICK/LOCK switch.

(d) Centralize the control column and press the auto-pilot ENGAGE button.

(e) Displace the heading selector of the compass by 4 deg. to port; check that the ailerons indicate a bank to port.

(f) Restore the heading selector into alignment with the aircraft heading; check that the ailerons return to datum.

(g) Displace the heading selector by 4 deg. to starboard; check that the ailerons indicate a turn to starboard.

(h) Repeat operation (f) above.

(vii) Cut-out check

(a) Operate the cut-out button on the grip unit.

(b) Check that the centralized warning system operates and that the flying controls revert to manual with full freedom of movement.

(c) Re-set the centralized warning system by depressing the CANCEL switch.

(d) Switch OFF the AUTO-PILOT switch.

(e) Press the AUTO-PILOT RE-SET switch.

Note...
The AUTO-PILOT and AUTO-STABILIZER switches on the control unit must be selected OFF before take-off; the AUTO-PILOT switch must also be switched OFF before landing.

11. Operation in flight

(i) Engaging the auto-pilot

(a) Select the AUTO-PILOT switch ON.

(b) Select the required auto-pilot mode, trim into the appropriate flight condition and press the ENGAGE button; check the operation of the doll's eye indicator on the control unit.

Note...
To change the mode in which the auto-pilot is engaged, the DIS-ENGAGE button must be depressed, the required mode selected and the ENGAGE button operated. The auto-stabilizer, however, may be switched on and off as required when the aircraft is being flown under manual control or when the Force Stick mode is engaged.

(ii) Height lock

To engage the height lock, select LOCK on the FORCE STICK/LOCK switch and select HEIGHT on the HEIGHT/MACH switch.

Trim the aircraft to fly hands and feet off and depress the ENGAGE button. With the height lock engaged the aircraft will maintain the barometric height prevailing at the time the ENGAGE button is depressed.

(iii) Mach lock

To engage the Mach lock, select LOCK on the FORCE STICK/LOCK switch and select MACH on the HEIGHT/MACH switch. Trim the aircraft in the desired flight attitude and depress the ENGAGE button. The aircraft will now maintain the Mach No. prevailing at the time the ENGAGE button is operated. In this mode an increase or decrease in power will produce an increased rate of climb or descent respectively.

Note...
Selection of the height lock or Mach lock modes automatically engages the auto-stabilizer, irrespective of the position of the AUTO-STABILIZER switch. In both of these modes bank can be applied by the Force Stick.

(iv) Force stick

The Force Stick mode is engaged by selecting FORCE STICK on the FORCE STICK/LOCK switch and depressing the ENGAGE button.

(v) Use of the heading selector

The principal function of the heading selector is to maintain a selected course when in height or Mach lock modes. To obtain the required course, the aircraft must be flown either manually, i.e., with the auto-pilot disengaged, or by Force Stick in bank with the auto-pilot engaged. When the turn is completed, adjust the heading selector to the new course.

(vi) Disengaging the auto-pilot

To disengage the auto-pilot, press the DISENGAGE button on the grip unit.

12. Checks before landing

Before landing, check that the AUTO-PILOT switch is selected OFF.

13. Operation of limit switches

In the event of any of these switches operating in flight, the auto-pilot may be re-engaged by operating the AUTO-PILOT RE-SET switch and, after an interval of not less than one minute, pressing the ENGAGE button. Should further automatic disengagement occur, the auto-pilot should not be used for the remainder of the flight.

14. Emergencies

In the event of malfunctioning of the auto-pilot, the cut-out button on the grip unit must be operated and, if necessary, immediate recovery action taken. Re-set the centralized warning system. Do not operate the AUTO-PILOT RE-SET switch.

PART 4

HANDLING

PART 4

HANDLING

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STARTING, TAXYING AND TAKE-OFF

1. External checks

Commencing at the starboard side of the front fuselage, check the following:-

Pressure head and yaw vane and incidence meter	General condition; cover removed
Front fuselage	General condition Security of panels
Nose wheel	Security and condition of door Nose wheel ground locks removed Dust excluder circlip fitted Tyre for inflation, cuts and creep Valve free and dust cap secure
Starboard undercarriage	Undercarriage ground lock removed Strut fairing for damage, dents, etc.; security of linkage Tyre for inflation, cuts and creep Valve free and dust cap secure Brake hydraulic pipes undamaged
Starboard wing	Engine intake cover removed and free from obstruction General condition Security of panels Aileron control lock removed Jet pipe cover removed
Rear fuselage	General condition Panels and aerials for security Arrester hook ground lock removed
Tail unit	General condition Tail plane control lock removed

Port wing	As for starboard wing, plus:- Pressure head secure; cover removed
Port undercarriage	As for starboard undercarriage
External electrical power supply	Trolley plugged in and switched off

2. Cockpit checks

(i) Before entering the cabin, carry out the following checks on the ejection seats:-

Pilot's seat

(a) Check that the safety pins are in position in the ejection gun sear, and in the canopy gun sear, and that the seat pan firing handle safety pin and the canopy jettison handle safety pin are in position.

(b) Ensure that the top latch is in the correct position; the red line should not be visible.

(c) Check that the drogue gun and time delay mechanism trip rods are correctly secured. Ensure that the quick release pin has been removed from the drogue gun safety lock.

(d) Check that the drogue withdrawal line is not trapped under the lifting line.

Observer's seat

(e) Check that the light alloy safety pin is in position in the ejection seat headrest, and that the seat pan firing handle safety pin and canopy jettison handle safety pin are in position.

(f) Carry out the checks (b), (c) and (d) above.

(ii) When seated, adjust the rudder pedals and seat. Check the parking brake pressure and set the parking brake control to ON. Check that oxygen and R/T connections are made.

(iii) Have the external electrical power supply switched on.

(iv) Select the Flight Instruments No.2 switch ON. Check that the inverter failure indicator shows white.

(v) Select the Flight Instruments No.1 switch ON. Check that the inverter failure indicator changes to black.

(vi) Push the MASTER switch on the centralized warning panel and check that the centralized warning system is operating, then depress the CANCEL switch; check that the attention warning lamps go out and that the audible warning ceases. Working round the cockpit from left to right, carry out the following checks:-

Engine master cocks	ON
Voice recorder switches	As required
Auto-pilot reset switch	Press. Check that the auto-pilot warning lamp on the C.W.P. clears
V.H.F. switches	No.1 set selected on NORMAL supply
Engine fuel valve by-pass switches	OFF
Radio altimeter control switch	OFF
Tail plane trim standby switch	Central (off)
Anti-spin parachute switch	SAFE
Bomb door switch	CLOSE. Check indicator shows black
Throttle levers	Closed. H.P. cocks SHUT
Air brakes slide switch	OFF. Check indicator shows IN
Tail plane trim rate switch	As required

Rudder stop switch	OFF. Check indicator shows black
Battery master switch	ON
Undercarriage selector unit	Selected DOWN. Check red warning light out
Blowing system switch	OFF. Check indicator shows OFF
Flap selector switch	UP. Check position indicator
Aileron droop selector switch	NORMAL. Check position indicator
Tail plane flap selector switch	NORMAL. Check indicator shows white
Undercarriage position indicator	Three green lights. Check bulb changeover
Canopy jettison control handle	Fully forward. Check safety pin in position
Fuel contents	Check
Undercarriage emergency override switch	OFF
Bomb door standby switch	OFF
Tail plane flap standby switch	OFF
Aileron droop standby switch	Normal
Flaps standby switch	OFF
Fuel cross-feed switch	CLOSE. Check indicator shows black
Compressor blade tip clearance indicator	Two green lights

Fuel tank pressure failure indicator	White
Fuel proportioner failure indicator	White
General service hydraulic pump failure indicators	White
General services hydraulic system indicator	NORM.
Emergency ventilation control	CLOSE
Fuel inter-tank transfer cock	OFF
Fuel jettison control	Fully in
Oxygen contents	Check
Emergency oxygen control	Fully down
Auto-pilot	AUTO-PILOT switch OFF AUTO-STABILIZER switch OFF
Oxygen	ON and reaching mask. Check indicators, EMERGENCY switch and 100% switch
Nose wheel standby control	Fully down
Cabin pressure switch	As required
Pressure heads heater switch	OFF
Engine de-icing switch	OFF
Refuelling master switch	OFF
De-misting control	OFF
Cabin temperature switch	AUTOMATIC

Cabin temperature selector control	As required
Anti-g stop valve	OFF
Ejection seat safety pins	Remove and stow
Canopy jettison handle safety pin	Remove and stow
Emergency oxygen	Check safety pin removed and stowed

3. Starting the engines

(i) The following starting procedure is applicable to both engines:-

Ground starter	Connected
Battery master switch	ON
Engine master cock	ON
Engine fuel valve by-pass switch	OFF
Throttle lever	GROUND IDLING (H.P. cock OPEN)
Engine start and re-light push-button	Press for 3 seconds

(ii) When the engine starts, check that the oil pressure begins to rise. The r.p.m. will rise and stabilize at 2,000 - 2,200 r.p.m. during the starting cycle, subsequently increasing to the ground idling figure. During this period, manipulation of the engine fuel valve by-pass switch may be required to prevent compressor stall on acceleration to idling r.p.m. Check that the appropriate power controls warning light on the centralized warning panel goes out, and that the corresponding general services hydraulic pump failure indicator changes to black.

(iii) When both engines are running, check that the generator failure warning lights are out and instruct the ground crew to remove the ground starter and the external electrical power supply.

4. Procedure in the event of a false start

In the event of an engine failing to light, close the H.P. cock and allow a period of 36 seconds to elapse before making another attempt to start. Ensure that all fuel has ceased to drain before repeating the starting sequence; if the ground beneath the jet pipe is saturated with spilt fuel, the aircraft must be moved to a fresh starting position.

5. Checks after starting

Engine R.P.M.	Correct idling figure
Engine fuel valve by-pass switches	OFF
Oil pressures	10 lb. per sq.in. (min.)
Fuel proportioner failure indicator	Black
Fuel tank pressure failure indicator	Black
Flight instruments switches	Both ON. Check inverter indicator shows black
Mk.5 F.T. compass	Set
Standby compass	Check
Instruments	Check and set

Hydraulic pressures:-

Brakes accumulators	4,000 lb. per sq.in.
Flying controls system	Both warning lights out
General services system	Pump failure indicators black System indicator NORM.

Aileron trim	Check operation. Observe limitations on operating periods
Rudder trim	Check operation. Observe limitations on operating periods
Tail plane trim	(a) Select the tail plane trim rate switch to HIGH and check that a high trim rate is obtained when the control column trim switch is operated. (b) Select the trim rate switch to LOW, operate the trim switch and check that the low trim rate is obtained. (c) Lower the main plane flaps, operate the trim switch and check that a high trim rate is obtained. (d) Operate the tail plane trim standby switch and check that a low trim rate is obtained. Raise the main plane flaps and return trim rate switch to HIGH. Note... During the above checks, note the movement of the tail plane on the tail plane angle indicator and the tail plane trim indicator and check for correct indication.
Services	Check operation of flaps, aileron droop, tail plane flap and air brakes
Flying controls	Check for freedom over their full range of movement
Blowing system	ON. Open each throttle in turn and check that in each case the indicator changes to ON within 4 secs. Switch the system OFF
Compressor blade tip clearance indicator	Two green lights

6. Checks before taxying

(i) Confirm the following:-

Hydraulic pressures

Brakes accumulators, normal and emergency	4,000 lb. per sq.in.
Flying controls system	Both warning lights out
General services system	Pump failure indicators black System indicator NORM.

(ii) Pre-taxying check:

V.H.F.	On. Check communications on both sets, if applicable
Pressure heads heater switch	ON
Wheel chocks	Removed
Canopy	Check operation and leave as required
Flight instruments	Functional check
Wheel brakes	Set parking brake OFF, taxy forward and check operation of toe brakes
Nose wheel steering	Press selector button and check functioning

7. Taxying

(i) Some increase in power may be necessary to start the aircraft moving, but once in motion speed increases and a reasonable taxying speed can be maintained with idling r.p.m. The use of

asymmetric engine power is unnecessary, the normal method of turning being by use of nose wheel steering and/or wheel brakes.

(ii) In the event of the nose wheel steering becoming unserviceable, the aircraft can be taxied by normal use of the wheel brakes.

8. Checks before take-off

Trims	Rudder - neutral. Rudder stop switch OFF Aileron neutral Tail plane - relevant to configuration and rate switch set to HIGH
Air brakes	IN
Fuel contents	Check
Fuel cross-feed switch	OPEN. Check that the indicator changes to white
Fuel tank pressure failure indicator	Black
Flaps	TAKE-OFF. Check position indicator (30°)
Blowing system	ON if required
Aileron droop	NORMAL (0°) if taking off without blow. As required if taking off with blow.
	Check position indicator
Tail plane flap	As required
Oxygen	Check connections, 100% switch and indicators
Centralized warning panel	All lights out

General services hydraulic system	Check indicators
Canopy	Closed and locked
Cabin pressure switch	ON. Select cabin temperature as required
De-misting control	ON
Seat harness	Secure and locked
Auto-pilot switch	OFF
Auto-stabilizer switch	OFF
Flying controls	Final functioning check
Brakes temperature gauge (observer's station)	Within limits

9. Take-off

(i) Taxy on to the runway and ensure that the nose wheel is straight before applying the brakes; open the throttles smoothly to the take-off position. Before releasing the foot brakes, check that the parking brake is fully off and visually check the following:-

Engines r.p.m.
Inlet guide vanes changeover
Jet pipe temperatures
Oil pressures
Blowing system indicator (if taking off with blow)

(ii) Release the brakes. Slight differential braking, or nose wheel steering, may be required for initial directional control until the rudder becomes effective at approximately 50 knots.

(iii) Care should be exercised not to raise the nose too early in the take-off run.

10. Checks after take-off

(i) As soon as the aircraft is safely airborne, brake the wheels and select the alighting gear UP. The following services - if used for take-off - must be retracted in the following order, observing their associated speed limitations: tail plane flap, aileron droop, blowing system, flaps.

(ii) Allow the aircraft to accelerate to a climbing speed of 400 knots and select the fuel cross-feed switch to CLOSED. Select AUTO-STABILIZER switch to ON. Reduce engine r.p.m. to normal climbing power (9.000 r.p.m.) when convenient, observing the engine limitations.

HANDLING IN FLIGHT

11. Climbing

(i) The recommended climbing speed at all weights is 450 knots I.A.S. becoming 0.85 Indicated Mach No. (I.M.N.)

(ii) During the climb the throttle position may require adjustment to maintain the correct engine r.p.m. Above 20,000 ft. the r.p.m. should be reduced to 8.350.

12. Flying controls

(i) General

All controls are effective with normal response throughout the speed range. The following characteristics should, however, be noted:-

(a) Excessive use of rudder can produce marked Dutch rolling effects; the use of rudder auto-stabilizer reduces this characteristic to negligible proportions.

(b) At low speed, the response of the aircraft to tail plane movement is a little sluggish, particularly when the tail plane is operating at large negative angles (e.g., during an approach without the use of tail plane flap).

(ii) Trimmers

All three trimmers are effective throughout the speed range. The following points should, however, be noted:-

(a) The high rate of tail plane trim is the most suitable throughout the speed range 400 knots to 0.9 M.

(b) The trim change resulting from aileron droop selection cannot be completely compensated for by using the high rate of tail plane trim, thus a certain amount of stick correction is also necessary.

(iii) Changes of trim, and characteristics associated with the operation of main services:

Service	Change of trim	Remarks
Alighting gear UP	Negligible	
Alighting gear DOWN	Negligible	
Flaps DOWN	Moderate nose down	
Flaps UP	Moderate nose up	
Aileron droop DOWN	Strong nose down	The blowing system must be operating before ailerons are drooped. It is desirable to operate the aileron droop in stages, both up and down, trimming out at each stage (para. 12 (ii)).
Aileron droop NORMAL	Strong nose up	
Tail plane flap UP	Moderate nose up	There is a pause of approx. 3 secs. after selection before the trim change is apparent. This trim change is within the capabilities of the high rate of tail plane trim available. A maximum of 15 deg. aileron droop can be selected before tail plane flap is required.
Tail plane flap NORMAL	Moderate nose down	

Service	Change of trim	Remarks
Blowing system ON Blowing system OFF	Slight nose down Slight nose up	The aircraft attitude also changes in the same sense. There is a pause of approx. 3 secs. after selection before the indicator changes to ON, accompanied by the appropriate trim change. If max. r.p.m. are being used at the time of blow selection, the r.p.m. will be automatically reduced by the jet pipe temperature control, after a short delay (Part 1, para.28).

13. Flying in turbulent conditions

Dutch rolling characteristics may be encountered if rudder auto-stabilizer is not in use.

14. Stalling

(i) Approach configuration (blow OFF)

Limited investigation into the aircraft stalling characteristics has revealed that in the approach configuration (alighting gear down, 30 deg. flap, engine r.p.m. 7,000) the approach to the stall is indicated by marked airframe buffeting, accompanied by either wing drop in the speed range 138 to 142 knots.

(ii) Approach configuration (blow ON)

(To be issued later)

(iii) Clean aircraft

(To be issued later)

(iv) High speed stall

(To be issued later)

15. Diving

When dived in a clean configuration, the aircraft builds up speed rapidly. Very steep angles of descent can be achieved with throttles closed and air brakes open.

CIRCUIT PROCEDURE AND LANDING

16. Circuit procedure

(i) Pre-joining checks

Auto-pilot switch	OFF
Auto-stabilizer switch	ON (Rudder only)
Seat harness	Secure and locked
Mk.5 F.T. compass	Check for correct annunciation

(ii) Checks before landing (blow ON)

Brakes	Check individual brake pressures 1,500 lb. per sq.in. Check normal and emergency accumulators 4,000 lb. per sq.in.
Air brakes	As required to reduce airspeed below 200 knots
Alighting gear	DOWN. Three green lights
Fuel	Check contents. This aircraft has not been landed with less than 1,500 lb. of fuel remaining, and it is important to note that it is possible to use 1,200 lb. in a full circuit.
Flaps	Select 45 deg. below 200 knots. Reduce speed to 160 knots.
Blowing system	ON. Check indicator changes to ON within 4 secs.
Aileron droop	Select 15 deg.
Tail plane flap	UP, below 175 knots (flap restricted to 20 deg.)

(iii) Checks before landing (blow OFF)

Brakes	Check individual brake pressures 1,500 lb. per sq.in. Check normal and emergency accumulators 4,000 lb. per sq.in.
Air brakes	As required to reduce airspeed below 200 knots
Alighting gear	DOWN. Three green lights
Fuel	Check contents. This aircraft has not been landed with less than 1,500 lb. of fuel remaining, and it is important to note that it is possible to use 1,200 lb. in a full circuit.
Flaps	Select 45 deg. below 200 knots.

(iv) Final approach and landing (blow ON)

The turn on to the final approach should be made at an airspeed of 145 knots, flaps and aileron droop having been lowered fully and air brakes selected OUT. (Throughout the circuit and approach, as much air brake as is desirable should be used, to improve speed stability.) Airspeed should then be progressively reduced to the runway threshold speed of 130 knots.

Note...
Power must not be reduced below 7,500 r.p.m., which is the recommended minimum power setting for an approach with blow.

(v) Final approach and landing (blow OFF)

The turn on to the final approach should be made at an airspeed of 165 knots, flaps having been lowered fully and air brakes selected OUT. (Throughout the circuit and approach, as much air brake as is desirable should be used, to improve speed stability.) Airspeed

should then be progressively reduced to the runway threshold speed of 150 knots.

Note...

(1) In turbulent air conditions, the approach speeds quoted in sub-para. (iv) and (v) should be increased by 5 - 10 knots.

(2) The pilot should guard against inadvertent application of brakes before and during touchdown.

17. Landing (blow ON)

Landing is normal. To obtain the shortest landing run, the power can be eased off completely and the aircraft rotated just above the ground and allowed to stall on at approx. 120 knots, without change of flight path. After touchdown, the aircraft can be further rotated, but the nose should be lowered by 110 knots and full brake applied immediately.

18. Landing (blow OFF)

A similar technique can be used, but it may not be possible to rotate the aircraft to maximum incidence on the ground, as it is necessary to lower the nose at 120 knots and apply the brakes fully.

Note...

Full Maxaret brake should not be applied at ground speeds exceeding 120 knots.

19. Flapless landing

(To be issued later)

20. Crosswind landing

Crosswind landings offer no particular problems. The crab technique is recommended and is satisfactory in crosswind components up to 25 knots maximum.

21. Missed approach

(i) The decision to overshoot can be made at any height.

(ii) Overshoot procedure

Throttles	Open up smoothly to max. power
Air brakes	IN

If it is intended to carry out a further circuit and then land, the remaining services can be left as selected. If, however, it is desired to return the aircraft to a clean configuration, the following additional sequence should be adopted:-

Alighting gear	UP

At a safe height (300 ft. min.):-

Tail plane flap	NORMAL
Flaps	UP
Aileron droop	Select up in stages, retrimming at each stage
Blowing system	OFF
Fuel	3,000 lb. desirable

Note...
It is important to observe the speed limitation appropriate to each control.

22. Checks after landing

After clearing the runway, stop the aircraft, apply the parking brake and carry out the following checks:-

Brakes	Check pressure sufficient for taxying; check brake temperatures are within limits
Aileron droop	NORMAL
Flaps	UP
Tail plane flap	NORMAL
Blowing system	OFF
Air brakes	IN
Trims	Return to neutral
Pressure heads heater switch	OFF
De-misting control	OFF
Canopy	As required

23. Stopping the engines

Check that the nose wheel is straight before applying the parking brake. Have chocks placed in position at the main wheels and have the ground locks fitted to the main undercarriage struts and the nose wheel strut. Stop the engines individually by closing the throttles fully, thereby turning off the H.P. cocks, then carry out the following check:-

Centralized warning panel	Pull the MASTER switch
Engine master cocks	OFF
Electrical services	All off

Battery master switch	OFF
Ejection seat	Insert safety pins
Canopy jettison control	Insert safety pin
Brakes	OFF

PART 5

EMERGENCY HANDLING

PART 5

EMERGENCY HANDLING

LIST OF CONTENTS

1. Action in the event of engine fire

(i) In the air

(a) Warn the observer	
(b) Throttle lever	Closed (H.P. cock SHUT)
(c) Engine master cock	OFF
(d) Reduce speed	
(e) Fire extinguisher	Press the appropriate extinguisher push-button switch

(f)	Oxygen	Select to 100%
(g)	Emergency ventilation control	OPEN

Note...
Do not attempt to restart the engine in flight after operating the fire extinguisher system.

(ii) On the ground

(a)	Warn the observer	
(b)	Throttle lever	Closed (H.P. cock SHUT)
(c)	Engine master cock	OFF
(d)	Fire extinguisher	Press the appropriate extinguisher push-button switch

2. Engine failure during take-off

(i) In the event of engine failure before the aircraft has reached take-off speed, the take-off should normally be abandoned. The brakes should be fully applied and the anti-spin parachute streamed, depending on the length of runway remaining. In cases of extreme emergency, the aircraft should be directed on to a grass surface and the alighting gear retracted (para.9).

(ii) If the aircraft has reached a safe speed - 175 knots (flaps and aileron retraction speed) - the flaps and ailerons should be raised and a shallow climb maintained until a safe height is attained.

3. Engine failure in flight

(i) One engine failed

(a)	Throttle lever	Closed (H.P. cock SHUT)
(b)	Engine master cock	OFF

(c) Fuel inter-tank transfer control — ON

Note...
Failure of either engine will reduce the operating efficiency of the hydraulic services; the remaining hydraulic pumps will, however, supply sufficient power to maintain full control. If the port engine fails, the hydraulic supply to the auto-pilot and auto-stabilizer will cease and these facilities will be inoperative.

(ii) Both engines failed

Providing both engines are windmilling, a sufficient degree of control will be afforded by the flying controls hydraulic system to enable the aircraft to be brought down. Use the minimum control movements during the descent and maintain a gliding speed of 260 knots.

4. Flaps - emergency operation

(i) If the flaps fail to operate on a normal selection, or if the general services hydraulic system is automatically transferred to emergency operation (Part 3 , para.6), select the flaps standby switch, located on the standby control panel, to DOWN.

(ii) Following a standby DOWN selection, the flaps cannot be selected up on either the emergency or normal hydraulic supply.

5. Tail plane flap - emergency operation

(i) If a normal selection fails to raise the tail plane flap, or if the hydraulic system is automatically transferred to emergency operation, the tail plane flap standby switch, located on the standby control panel, should be selected to ON. After the tail plane flap has been raised by a standby selection, it cannot be selected down by either the emergency or normal hydraulic supply.

6. Air brakes - emergency operation

(i) If the air brakes fail to operate on a normal selection, or the

hydraulic system is automatically transferred to emergency operation, the air brakes standby switch, located on the port control panel, should be selected to OUT or IN as required.

(ii) It is possible to operate the air brakes continuously by standby selection until either the emergency hydraulic or electrical supply fails. In flight, however, except in conditions of extreme emergency, the number of standby selections must be restricted to one extension and retraction, as to exceed this may seriously impair the operation of the other hydraulic services on emergency.

(iii) When the air brakes return to the in position, following a standby selection, the remainder of the hydraulic system will, if it is not on automatic emergency, revert to normal supply. The air brakes cannot subsequently be operated on a normal selection.

7. Bomb door - emergency operation

(i) In the event of a normal selection failing to operate the bomb door, or if the hydraulic system is automatically transferred to emergency operation, the bomb door standby switch, located on the standby control panel, should be selected to OPEN or CLOSE as required.

(ii) Although it is possible to operate the bomb door continuously by standby selection until either the emergency hydraulic or electrical supply fails, such selections must be restricted in number, when the aircraft is in flight, to one full cycle, i.e., open and closed. To exceed this will seriously affect the operation of the other hydraulic services on emergency.

(iii) When the bomb door reaches the fully open or closed position the remainder of the hydraulic system, if it is not on automatic emergency, will revert to normal supply. Following a standby selection, the bomb door cannot be re-selected on the normal supply.

Note...

The bomb door position indicator is supplied by the normal

circuit fuse; if this fuse is consumed, the indicator will not function during either normal or emergency operation.

8. Alighting gear - emergency lowering

(i) In the event of the hydraulic system being automatically transferred to emergency operation, or if the alighting gear fails to lower on a normal DOWN selection, the EMERGENCY DOWN button on the selector must be depressed.

(ii) If the alighting gear still fails to lower, the cause may be due to the undercarriage door unlock micro switches failing to operate, in which case the EMERGENCY OVERRIDE switch, located on the standby control panel, must be selected to DOWN.

(iii) After the alighting gear has been lowered on an EMERGENCY DOWN selection it cannot subsequently be selected up.

(iv) If the nose wheel 'up' lock fails to release when a normal DOWN selection is made on the alighting gear selector unit, the nose wheel will not lower. In this event, the 'up' lock can be manually released by pulling the NOSE WHEEL STANDBY CONTROL, mounted on the starboard console.

9. Alighting gear - emergency retraction

Should it become necessary to retract the alighting gear when the aircraft is on the ground, the UP selector button must be turned clockwise through 90 deg., to override the safety lock, and then depressed.

10. Tail plane trim - emergency operation

(i) If the tail plane trim normal operating circuit fails, the standby switch, located on the port console, should be held in the NOSE DOWN or NOSE UP position until the desired trim is obtained.

(ii) It should be noted that the high rate of trim operation, normally obtained automatically upon lowering the flaps, is not available when operating on a standby selection.

11. Aileron droop - emergency operation

In the event of failure of the aileron droop normal operating circuit, the standby switch, located on the standby control panel, must be selected to DOWN. When the ailerons reach the fully drooped position, the power supply to the emergency motor is cut off by the action of internal limit switches; the ailerons cannot be raised on emergency following a standby DOWN selection.

12. Abandoning the aircraft

(i) Ejection procedure

The normal method of abandoning the aircraft is by use of the ejection seat, the procedure being as follows:-

(a) Grasp the face screen firing handle with both hands, knuckles facing outwards and elbows as close together as possible.

(b) Pull the firing handle smartly downwards, drawing the face screen over the face, thereby jettisoning the canopy and commencing the ejection sequence.

Note...
(1) If it is impossible to reach the face screen firing handle the alternative handle on the seat pan is to be used.
(2) Pending modification to the canopy jettison system, the face screen firing handle is disconnected from the canopy jettison cartridge unit. Prior to ejection, therefore, the canopy must be jettisoned by pulling the canopy jettison control handle.

(ii) Manual separation from the seat

If, after ejection, the automatic release mechanism fails to function, the occupant can separate himself from the seat by manually unlocking the seat harness and deploying his parachute. It is of vital importance to follow the correct procedure given below:-

(a) Pull the outer 'D' ring to the full length of its travel. This disconnects the parachute from the automatic gear and exposes the inner 'D' ring.

(b) Operate the manual override lever on the port side of the seat to unlock the seat harness.

(c) Roll out of the seat and, when clear, deploy the parachute by pulling the inner 'D' ring.

(iii) Free bale-out from aircraft

In the event of damage to the seat ejection mechanism which prevents it operating, the occupant can make a 'free' bale-out as follows:-

(a) Jettison the canopy by pulling the canopy jettison handle.

(b) Pull the outer 'D' ring to the full length of its travel.

(c) Operate the manual override lever on the port side of the seat.

(d) Leave the aircraft.

(e) Deploy the parachute by pulling the inner 'D' ring.

13. Action after ditching

After alighting on the water, jettison the canopy by pulling the canopy jettison handle. Rotate and strike the plate of the harness release box to free the harness. Pull the manual override lever to unlock the harness and leg lines and abandon the aircraft. Carry out the normal dinghy drill.

PART 6

ILLUSTRATIONS

PART 6 ILLUSTRATIONS

LIST OF CONTENTS

KEY TO FIG. 1 (PORT SIDE OF COCKPIT)

1 ENGINE FUEL VALVE BY-PASS SWITCHES
2 V.H.F. CONTROLLER NO. 2
3 RADIO ALTIMETER HEIGHT SELECTOR SWITCH (not operative)
4 RADIO ALTIMETER ON - OFF SWITCH (not operative)
5 TAIL PLANE TRIM STANDBY CONTROL
6 RUDDER/AILERON TRIM CONTROL
7 WHEEL BRAKES PRESSURE GAUGE
8 EMERGENCY ARRESTER HOOK CONTROL SWITCH
9 THROTTLE LEVERS
10 ENGINE START AND RE-LIGHT PUSH-BUTTON (PORT)
11 RUDDER STOP SWITCH
12 BATTERY MASTER SWITCH
13 AIR BRAKES STANDBY CONTROL
14 UNDERCARRIAGE PUSH-BUTTON SELECTOR UNIT
15 BLOWING SYSTEM SWITCH
16 MAIN PLANE FLAPS SELECTOR CONTROL
17 TAIL PLANE FLAP SELECTOR SWITCH
18 UNDERCARRIAGE POSITION INDICATOR
19 AILERON DROOP SELECTOR CONTROL
20 TAIL PLANE TRIM INDICATOR
21 RUDDER TRIM INDICATOR
22 AILERON TRIM INDICATOR
23 TAIL PLANE TRIM RATE SWITCH
24 ENGINE START AND RE-LIGHT PUSH-BUTTON (STBD.)
25 AIR BRAKE SELECTOR SWITCH
26 PRESS-TO-TRANSMIT SWITCH
27 NOSE WHEEL STEERING PUSH-BUTTON
28 THROTTLE LEVER DAMPING CONTROL
29 BOMB DOOR POSITION INDICATOR
30 BOMB DOOR SELECTOR
31 ANTI-SPIN PARACHUTE CONTROL
32 ENGINE THROTTLE POSITION INDICATORS
33 BLOWING SYSTEM PRESSURE GAUGES
34 RECORDER MASTER SWITCH
35 V.H.F. MUTE SWITCH
36 V.H.F. SELECTOR SWITCH
37 V.H.F. POWER SUPPLY CHANGEOVER SWITCH
38 VOICE RECORDER SWITCH
39 VOICE RECORDER STANDBY SWITCH
40 ENGINE MASTER COCKS
41 AUTO-PILOT RESET SWITCH
42 V.H.F. CONTROLLER NO. 1

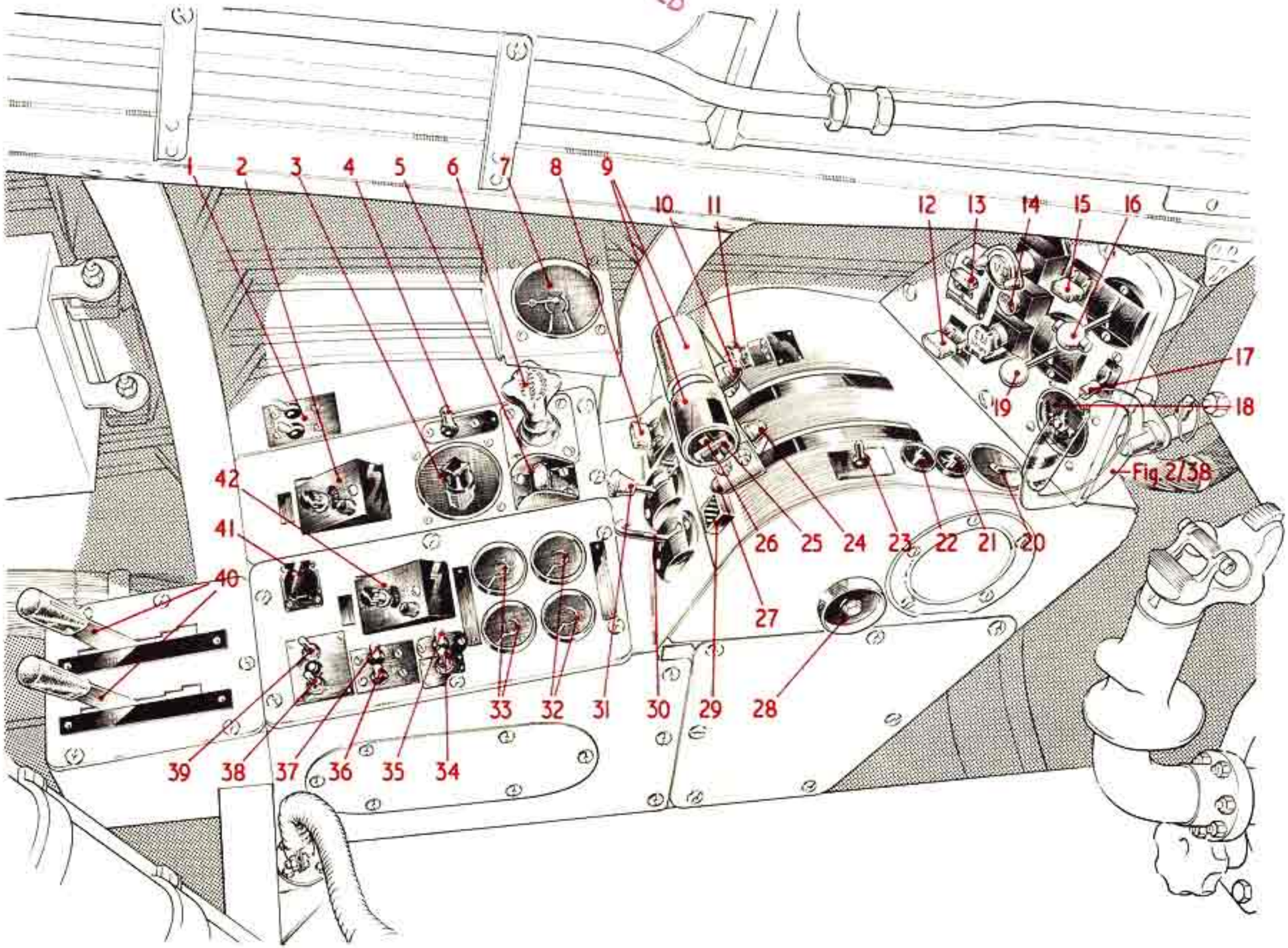

Fig. 1. Port side of cockpit

KEY TO FIG.2 (INSTRUMENT PANEL)

1 ATTENTION WARNING LAMP
2 RUDDER STOP INDICATOR
3 VOICE RECORDER INDICATOR
4 TAIL PLANE FLAP POSITION INDICATOR
5 BLOWING SYSTEM INDICATOR
6 ANGLE OF INCIDENCE METER
7 FLAPS POSITION INDICATOR
8 AILERON DROOP POSITION INDICATOR
9 AIR BRAKE POSITION INDICATOR
10 NORMAL ACCELEROMETER
11 OXYGEN INDICATORS
12 YAW METER
13 ENGINE SPEED INDICATOR (PORT)
14 ATTENTION WARNING LAMP
15 ENGINE SPEED INDICATOR (STBD.)
16 UNDERCARRIAGE WARNING LAMP
17 TAIL PLANE ANGLE INDICATOR
18 ROLLER BLIND ATTITUDE INDICATOR
19 INVERTER FAILURE WARNING INDICATOR
20 INLET GUIDE VANE POSITION INDICATORS
21 MACHMETER
22 AIR SPEED INDICATOR
23 TAIL PLANE TRIM CONTROL
24 MK.5 FT. COMPASS
25 TURN AND SLIP INDICATOR STANDBY SUPPLY SWITCH
26 RATE-OF-CLIMB INDICATOR
27 JET PIPE TEMPERATURE INDICATORS
28 FUEL PROPORTIONER FAILURE INDICATOR
29 CABIN ALTIMETER
30 RADIO ALTIMETER
31 ALTIMETER
32 TURN AND SLIP INDICATOR
33 FUEL CONTENTS GAUGE SELECTOR SWITCH
34 FUEL CONTENTS GAUGE
35 CANOPY JETTISON CONTROL HANDLE
36 RUDDER PEDAL (PORT)
37 AUTO-PILOT CUT-OUT BUTTON
38 AUTO-PILOT ENGAGE BUTTON
39 AUTO-PILOT DISENGAGE BUTTON
40 RUDDER PEDAL (STBD.)
41 COMPRESSOR BLADE TIP CLEARANCE INDICATOR
42 STANDBY COMPASS
43 RUDDER PEDALS LEG REACH ADJUSTER

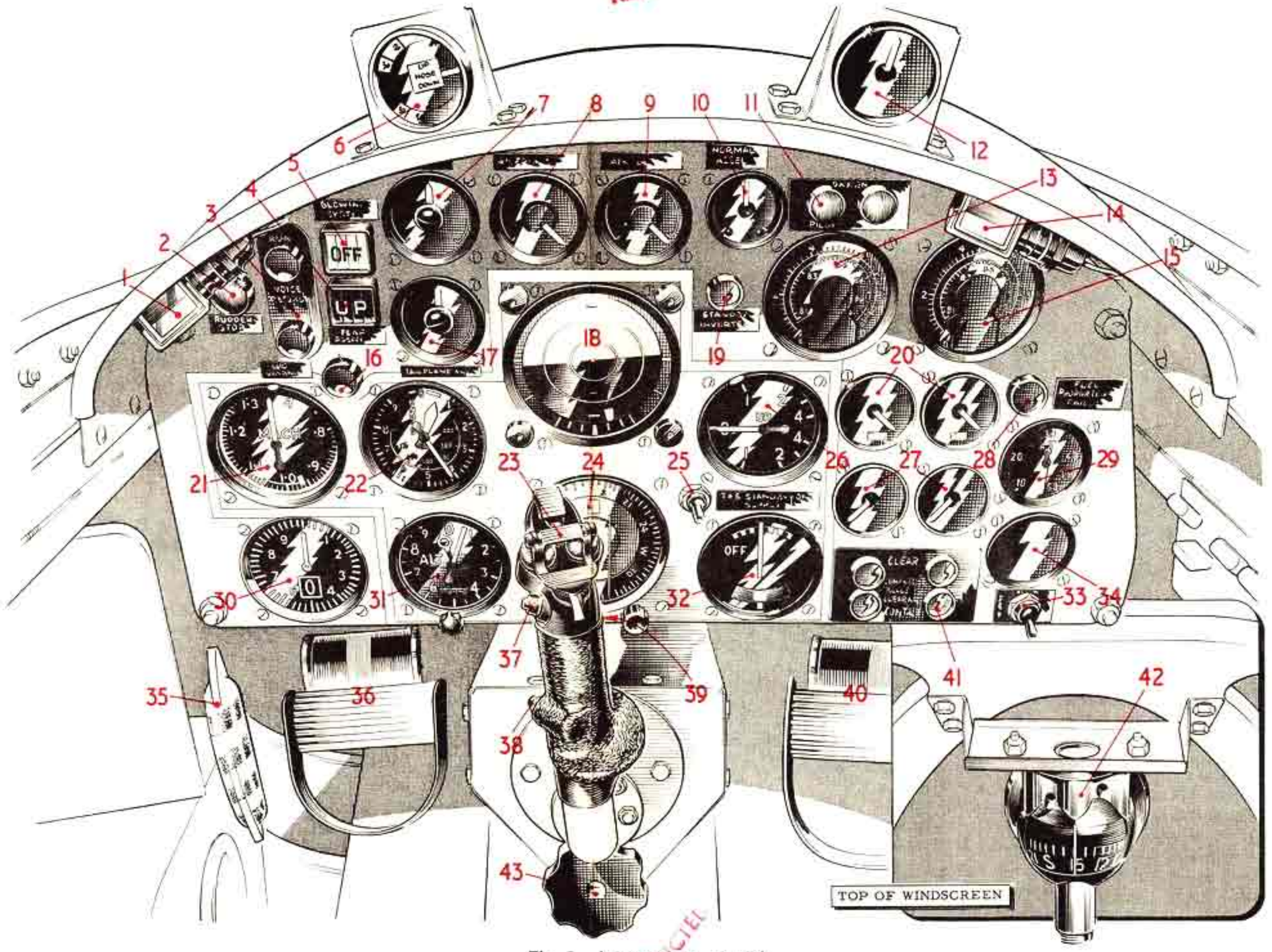

Fig. 2. Instrument panel

KEY TO FIG. 3 (STARBOARD SIDE OF COCKPIT)

1 UNDERCARRIAGE EMERGENCY OVERRIDE SWITCH
2 BOMB DOOR STANDBY SELECTOR SWITCH
3 TAIL PLANE FLAP STANDBY SWITCH
4 AILERON DROOP STANDBY SELECTOR SWITCH
5 MAIN PLANE FLAPS STANDBY SELECTOR SWITCH
6 CROSS-FEED FUEL COCK SELECTOR SWITCH
7 WHEEL BRAKES EMERGENCY ACCUMULATOR PRESSURE GAUGE
8 SLIDING CANOPY CONTROL HANDLE
9 SLIDING CANOPY ACTUATOR DE-CLUTCHING CONTROL
10 FUEL INTER-TANK TRANSFER COCK
11 HYDRAULIC PUMP FAILURE INDICATOR (STBD.)
12 CROSS-FEED COCK INDICATOR
13 FUEL TANK PRESSURE INDICATOR
14 GENERAL SERVICES HYDRAULIC SYSTEM INDICATOR
15 HYDRAULIC PUMP FAILURE INDICATOR (PORT)
16 WHEEL BRAKES PARKING AND EMERGENCY CONTROL
17 FUEL PUMP INLET PRESSURE GAUGE (PORT)
18 EMERGENCY VENTILATION CONTROL
19 FUEL PUMP INLET PRESSURE GAUGE (STBD.)
20 FUEL JETTISON CONTROL
21 FLIGHT INSTRUMENTS MAIN INVERTER SWITCH
22 FLIGHT INSTRUMENTS STANDBY INVERTER SWITCH
23 CABIN PRESSURIZATION SWITCH
24 PRESSURE HEADS HEATER SWITCH
25 ENGINE DE-ICING SWITCH
26 REFUEL/DEFUEL MASTER SWITCH
27 ENGINE OIL PRESSURE GAUGE (PORT)
28 ENGINE OIL PRESSURE GAUGE (STBD.)
29 STOWAGE FOR PILOT'S NOTES
30 ANTI-G SUIT ON/OFF VALVE
31 WINDSCREEN AND CANOPY DE-MISTING CONTROL
32 CENTRALIZED WARNING PANEL
33 DEVIATION CARD HOLDER
34 AMBIENT AIR TEMPERATURE INDICATOR
35 OXYGEN CONTENTS GAUGE
36 EMERGENCY OXYGEN CONTROL
37 AUTO-PILOT CONTROL PANEL
38 NOSE WHEEL UP-LOCK STANDBY CONTROL
39 OXYGEN DEMAND REGULATOR
40 CABIN TEMPERATURE SELECTOR
41 CABIN TEMPERATURE SELECTOR SWITCH
42 ANTI-G VALVE

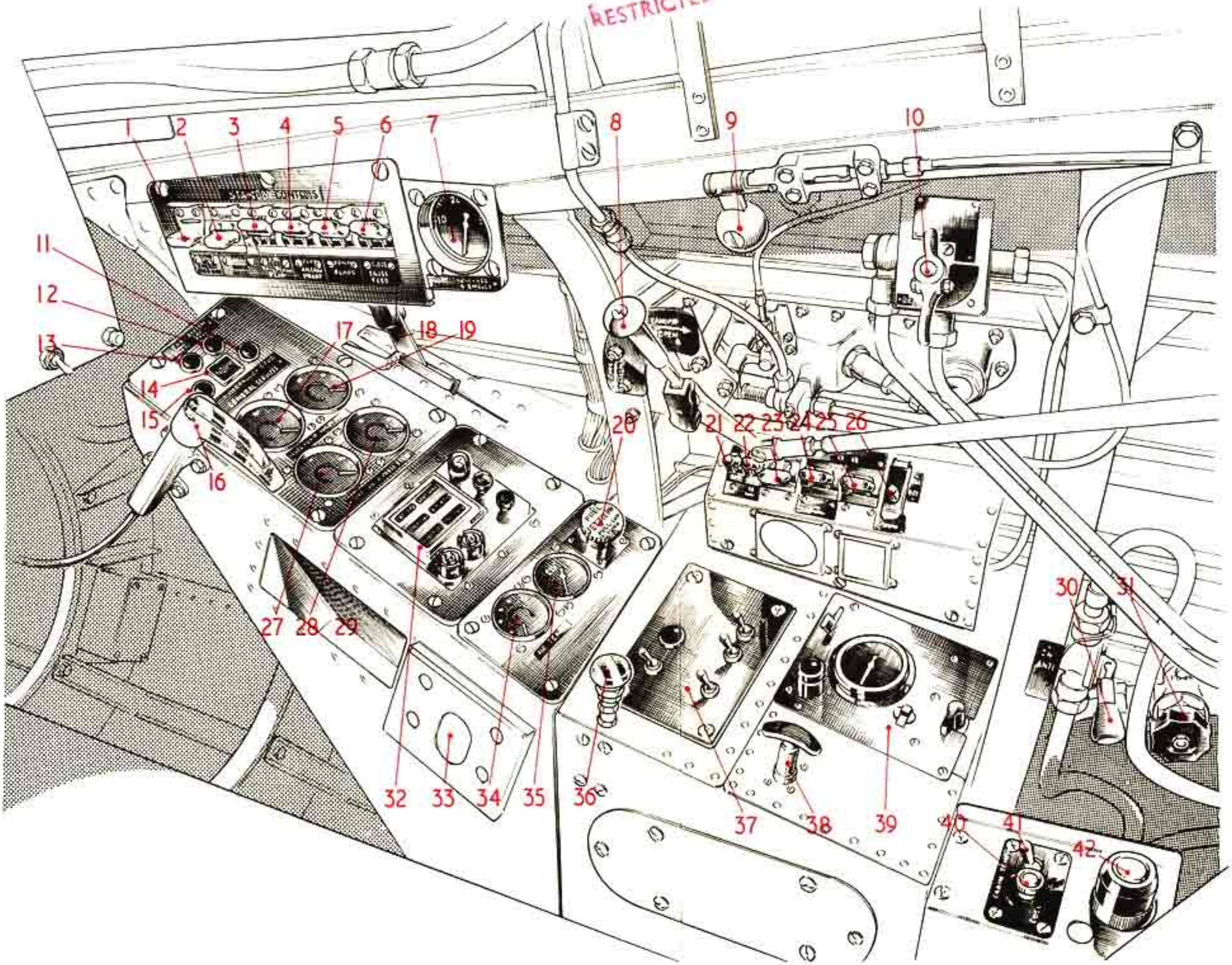

Fig. 3. Starboard side of cockpit

KEY TO FIG.4 (FUEL SYSTEM DIAGRAM)

1 NON-RETURN VALVE
2 PRESSURE REDUCING VALVE
3 PRESSURE REDUCING VALVE
4 TANK PRESSURE SWITCH
5 INWARD/OUTWARD VENT VALVE
6 VENT SHUTTLE VALVE
7 HIGH LEVEL FLOAT SWITCH
8 RECUPERATOR
9 TWIN NON-RETURN VALVE
10 NON-RETURN VALVE
11 INTER-TANK TRANSFER VALVE
12 LOW-LEVEL FLOAT SWITCH
13 FUEL/NO AIR VALVE
14 REFUEL/DEFUEL VALVE
15 GROUND REFUELLING COUPLING
16 LOW-PRESSURE SHUT-OFF COCK (STARBOARD)
17 FLOWMETER TRANSMITTER
18 HYDRAULIC FLUID HEAT EXCHANGER
19 CROSS-FEED COCK AND ACTUATOR
20 FUEL FLOW PROPORTIONER
21 NON-RETURN VALVE
22 JETTISON VALVE
23 LOW PRESSURE SHUT-OFF COCK (PORT)
24 WATER/SEDIMENT DRAIN VALVE

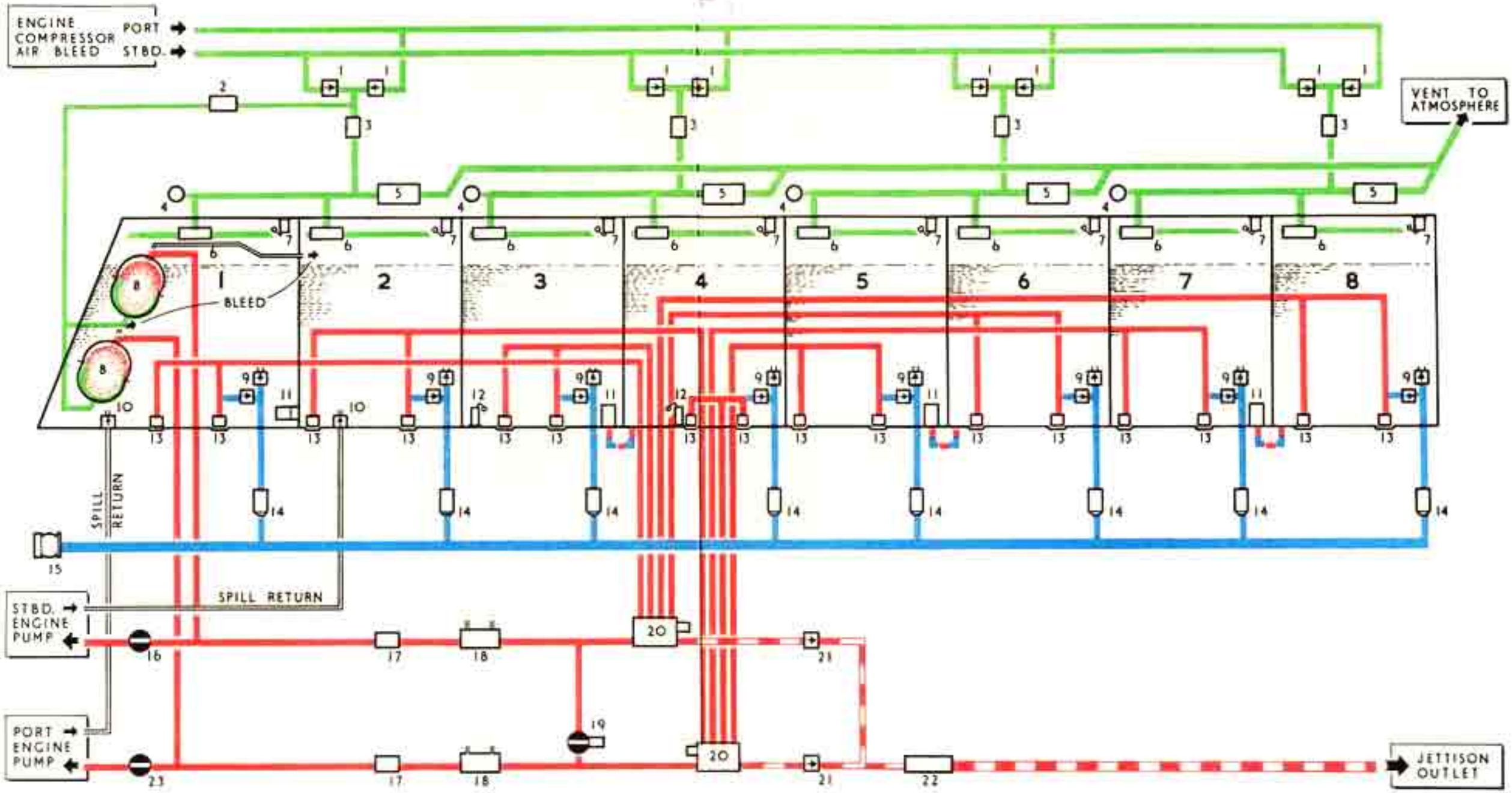

Fig. 4. Fuel system diagram

KEY TO FIG.5 (HYDRAULIC SYSTEM DIAGRAM - FLYING CONTROLS)

1 RESERVOIR

2 ENGINE-DRIVEN PUMP

3 LINE FILTER

4 GROUND TEST CONNECTION

5 GROUND TEST CONNECTION

6 GROUND TEST CONNECTION

7 HEAT EXCHANGER

8 FLOW INDICATOR TRANSMITTER

9 RESTRICTOR

10 THERMAL RELIEF VALVE

11 GAUGE - AIR PRESSURE

12 AIR CHARGING CONNECTION

13 ACCUMULATOR

14 ACCUMULATOR

15 POWERED CONTROL UNIT (RUDDER)

16 POWERED CONTROL UNIT (TAIL PLANE)

17 POWERED CONTROL UNIT (PORT AILERON)

18 POWERED CONTROL UNIT (STARBOARD AILERON)

No. 1 System — port

No. 2 System — starboard

Colour code

- AIR
- PRESSURE SUPPLY
- FEED TO PUMP
- RETURN TO RESERVOIR

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

P

RUDDER
AUTO. STAB.

TAIL PLANE
AUTO. PILOT
AUTO. STAB.

AILERON (PORT)
AUTO. PILOT
AUTO. STAB.

AILERON (STARBOARD)
AUTO. PILOT
AUTO. STAB.

Fig. 5. Hydraulic system diagram — flying controls

KEY TO FIG.6 (HYDRAULIC SYSTEM DIAGRAM - GENERAL SERVICES)

1 FLOW DIVIDER

2 INWARD/OUTWARD VENT VALVE

3 EMERGENCY RESERVOIR

4 HEAT EXCHANGER

5 MAIN RESERVOIR

6 ENGINE-DRIVEN PUMP

7 MICRONIC FILTER

8 THERMAL RELIEF VALVE

9 RESTRICTOR

10 FLOW INDICATOR TRANSMITTER

11 CONTROL SELECTOR VALVE

12 DOUBLE NON-RETURN VALVE

13 DOUBLE NON-RETURN VALVE

14 EMERGENCY ISOLATING VALVE

15 EMERGENCY VENT VALVE

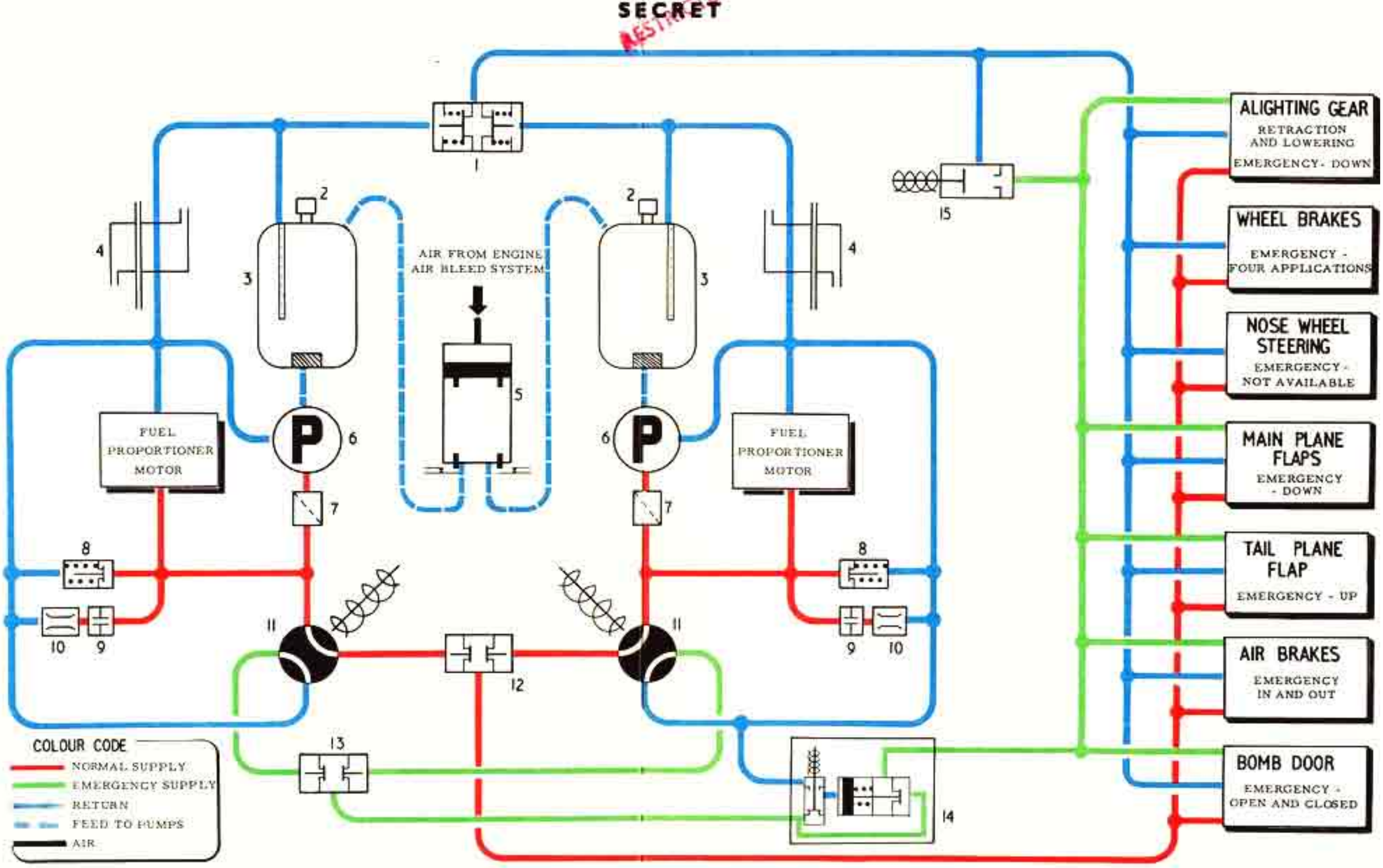

Fig. 6. Hydraulic system diagram – general services