PART I

DESCRIPTIVE

PART 1 DESCRIPTIVE

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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. Pressure refuelling and defuelling system

(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 superimposed 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 CO2 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.