

## PART I DESCRIPTIVE

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

- (a) Words in capital letters indicate the actual markings on the controls concerned.
- (b) The numbers quoted in brackets after items in the text refer to the illustrations in Part V.
- (c) Unless otherwise stated, all speeds quoted are indicated airspeeds.

### INTRODUCTION

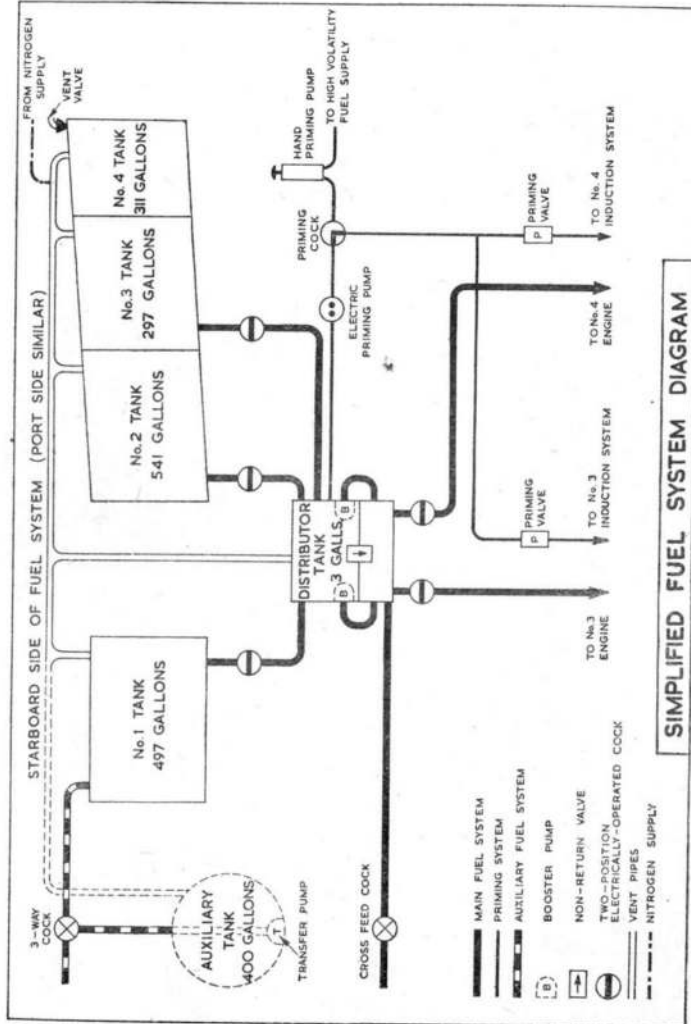
The Shackleton M.R. Mk. 1 is a four-engine, mid-wing monoplane designed for reconnaissance and anti-submarine duties. It is powered by Griffon Mk. 57 power plants with 6-bladed contra-rotating propellers. Many of the controls for the different services, as well as the majority of the engine instruments, are grouped on two panels, the main panel and the side panel, at the flight engineer's station, behind the pilots' cockpit.

### FUEL, OIL AND COOLANT SYSTEMS

#### 1. Fuel tanks

- (i) Fuel is supplied to the engine injector pumps from 8 tanks mounted in the mainplane. There are four tanks in each wing (numbered outboard 1, 2, 3 and 4), and an auxiliary tank can be fitted in the bomb bay. The port and starboard sides of the fuel system normally function independently but they are interconnected by a crossfeed line and cock to allow all four engines to be fed with fuel from either side. The tank capacities are as follows :—

No. 1 tanks	...	...	each 497 gallons
No. 2 tanks	...	...	each 541 "
No. 3 tanks	...	...	each 297 "
No. 4 tanks	...	...	each 311 "
Total fuel capacity (normal)			3,292 "
Auxiliary long-range tank			400 "
Total fuel capacity (overload)			3,692 "



- (ii) Fuel flows by gravity from each set of tanks to a distributor tank, situated behind each inboard firewall, through separate fuel lines from Nos. 1, 2 and 3 tanks; No. 4 tank feeds No. 3 tank and is not directly connected to the distributor tank. Each distributor tank supplies fuel to the inner and outer engines on one side through separate pipelines.
- (iii) The fuel from the auxiliary tank (when fitted) is fed by means of a transfer pump and a three-way cock to either of the No. 1 tanks.
- (iv) No. 1 tanks, are fitted with self-sealing protective covering, and Nos. 2, 3 and 4 tanks are of self-sealing flexible construction. The auxiliary tank has no self-sealing covering.

### 2. Fuel cocks and indicators

- (i) At each outlet from the two distributor tanks (four outlets in all) there is an electrically operated engine master cock, controlled by one of four switches mounted behind the first pilot's seat.
- (ii) Tank isolating cocks for No. 1, No. 2 and No. 3 tanks are controlled by six switches (139) on the flight engineer's main panel.
- (iii) When Mod. 171 is fitted sixteen flag-type indicators are mounted on the flight engineer's main panel, one (showing ON and OFF) for each of the engine master cocks and two (one showing ON and the other showing OFF) for each of the tank isolating cocks. When an engine master cock is fully open, the appropriate indicator moves from OFF to ON.
- (iv) A manually-operated crossfeed cock for connecting the port and starboard fuel systems is fitted on the forward face of the front spar.
- (v) A three-way cock mounted on a bracket on the aft face of the centre-section front spar is manually operated to allow fuel to be fed from the auxiliary tank (if fitted) to either of the No. 1 tanks, or to be shut OFF.

### 3. Fuel booster and transfer pumps

- (i) Two booster pumps are fitted in each distributor tank and are controlled by four ON-OFF switches (156) on the flight-engineer's side panel. Four push switches (157) and an ammeter test socket (148) also on the flight

engineer's side panel allow for testing the current consumption of each pump, which should not be more than 7 amps. This test should be carried out with the engine master cocks and the booster pump selector switches OFF.

- (ii) A transfer pump for transferring fuel from the auxiliary tank to the No. 1 tanks is controlled by a switch (151) on the flight engineer's side panel. A pushbutton (153) for testing the current consumption of the pump in a similar manner to the booster pumps, is beside this switch.

### 4. Fuel contents gauges and flowmeters

Two "gallons-gone" flowmeters (119) and (160) each serving two engines, are mounted on the flight engineer's main panel. Electrically-operated fuel contents gauges (144) for all the wing tanks and for the auxiliary tank (142) are also on this panel. The combined contents of tanks Nos. 3 and 4 are shown on one gauge; in the air this gauge reads up to 450 gallons but on the ground only up to 420 gallons.

### 5. Fuel pressure warning lights

Four fuel pressure warning lights (159) fitted on the flight engineer's side panel come on when the fuel pressure at the injector pumps falls appreciably below normal.

### 6. Engine priming system

- (i) Normally the engines on either side are primed by an electric pump located in the inboard nacelle above the fuel distributor tank. Each pump feeds fuel under pressure from the distributor tank to two solenoid-operated priming valves via a priming cock mounted on a panel in the main-wheel bay and marked ALL OFF, NORMAL DOPING and HIGH VOLATILITY. The four solenoids operating the priming valves are controlled by four pushbuttons (121) on the flight engineer's main panel. Immediately below the buttons is a rotary switch (120), marked PORT ON, OFF and STARBOARD ON, which selects either of the two priming pumps, selection being confirmed by indicating lights one on either side of the switch.
- (ii) An alternative hand priming system facilitates engine starting in cold weather by the initial use of high-vola-

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tility fuel. The hand priming pump, mounted on a panel attached to the starboard undercarriage beam of each main-wheel unit, has an open-ended pipe through which high-volatility fuel can be pumped from a suitable container into the priming system when the priming cock is turned to HIGH VOLATILITY. The appropriate priming pushbutton on the flight engineer's main panel must be held in while the handpump is being operated. The handpump cannot be used to prime the engines when the priming cock is in any position other than HIGH VOLATILITY.

### 7. Water/Methanol system

Two water/methanol tanks are located one in the rear end of each outer engine nacelle. Each tank has a sump at its forward end in which are mounted two electric self-priming pumps, each pump feeding one engine. The system introduces the water/methanol fluid into the supercharger intake at boost pressures above  $18\frac{1}{2}$  lb./sq. in., the flow increasing with boost pressures up to 25 lb./sq. in. To prevent the system being operated in low gear the control switch is ganged to the supercharger gear-change switch (24) on the pilots' panel. This ensures that the system is ON only when the superchargers are in high gear. Four pushbuttons (158) on the flight engineer's side panel and the ammeter socket used for testing the booster pumps, allow for testing the current consumption of each water/methanol pump which should be approximately 4.5 amps.

### 8. Nitrogen system

Nitrogen is carried in 8 bottles mounted in a crate at the forward end of the bomb bay. The eight bottles have a common pipe system terminating in a charge point and a delivery connection, both of which are fitted with screw valves. When required, the nitrogen system is turned on before flight and, as the fuel level decreases, any air present is diluted with nitrogen beyond the point at which the proportion of oxygen is sufficient to support combustion.

### 9. Oil system

Each engine has an independent oil system with its own oil tank which holds 26 gallons oil and has 6-gallon air

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space. An oil cooler forms part of the semi-circular assembly at the lower front of the power plant, and oil temperature (146) and pressure (147) gauges are provided on the flight engineer's main panel.

An oil dilution system is fitted and four switches (155) each for selecting one engine and the pushbutton (154) for operating the system are on the flight engineer's side panel.

### 10. Coolant system

- (i) A mixture of water and glycol, the proportions of which vary with climatic conditions is used as coolant. A separate supply for each engine is circulated through a header tank and radiator.
- (ii) Pressure in the systems is controlled by thermostatic relief valves in the header tanks and airflow through the radiators is regulated by shutters which can be either manually or automatically controlled, by electro-pneumatic rams.
- (iii) In the event of electrical or pneumatic failure, the shutter will trail open.

## MAIN SERVICES

### 11. General

The following table shows the distribution of the power supply for the aircraft main services:—

No. 1 ENGINE	...	D.C. Generator
No. 2 ENGINE	...	D.C. Generator
		Air Compressor
		Vacuum Pump
No. 3 ENGINE	...	D.C. Generator
		Hydraulic Pump
		Air Compressor
		Vacuum Pump
No. 4 ENGINE	...	D.C. Generator
		Hydraulic Pump

### 12. Hydraulic system

- (i) Two pumps (fitted on No. 3 and No. 4 engines) draw fluid from a pressurised reservoir and operate the following services:—

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Bomb doors  
Flaps  
Undercarriage  
Windscreen wipers.

- (ii) The undercarriage, flaps and bomb doors are electro-hydraulically operated, and in the event of electrical or hydraulic failure provision is made for operating these services by compressed air.
- (iii) A handpump, provided for ground servicing, is mounted on the front wall of the starboard wheel bay.

### 13. Pneumatic system

- (i) There are two separate pneumatic systems supplied by compressors on No. 2 and 3 engines, each compressor feeding a storage bottle to maintain a pressure of 1,000 lb./sq. in.
- (ii) The system supplied by No. 2 engine operates:—  
Main wheel outer brakes  
Pressurisation of windscreen de-icing fluid tank  
Pressurisation of the hydraulic fluid tank  
Engine air cleaner rams  
Engine radiator shutter rams  
Engine charge temperature control rams.
- (iii) The system supplied by No. 3 engine operates:—  
Main wheel inner brakes.
- (iv) The storage bottle for the No. 2 engine system is the forward cylinder in the fuselage roof and its gauge (165) is the lower of the two gauges on the flight engineer's main panel. The bottle is fitted with a pressure-maintaining valve which ensures that only the brakes are supplied should the pressure fall below 150 lb./sq. in.
- (v) The storage bottle for the No. 3 engine system is the aft cylinder in the fuselage roof and its gauge (166) is the upper of the two pressure gauges on the flight engineer's main panel.

### 14. Vacuum system

Two vacuum pumps are fitted, one on each of the inboard engines, and a change-over cock (170) is mounted on the left-hand side of the flight engineer's main panel. When this cock is set to NORMAL:—

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No. 2 engine serves the bombsight and camera  
No. 3 engine serves the instrument flying panel.  
When the cock is set to EMERGENCY these connections are reversed. A vacuum gauge (171) fitted beside the change-over cock indicates the suction in the pipeline to the instrument panel.

### 15. Electrical system

#### (i) Description

Four 6,000-watt generators, one on each engine, charge the four aircraft batteries (24 volts) which are situated at the starboard side of the fuselage immediately forward of the rear spar. Alternating current is provided by D.C. to A.C. inverters.

#### (ii) Generator control

- (a) The main power panel assembly (see Fig. 4, Part V) at the starboard side of the fuselage, forward of the front spar, contains all the controlling equipment for the generator and battery supply circuits and is accessible through detachable panels secured by quick-release fasteners. Four generator circuit breakers Type D (107), (109), (110) and (113) are provided to give overload protection for their associated generators, and if the circuit is broken the appropriate one of the four resetting push switches (85) on the power panel must be operated to bring the generator back into circuit. Also four generator field circuit breakers Type A (82), in the field circuit of each generator, are mounted beside the main circuit-breaker re-setting push switches. To disconnect a generator the appropriate reset pushbutton should be held in and the generator field circuit breaker tripped. Four generator failure warning lights (140), one in each generator circuit, are mounted on the flight engineer's main panel.
- (b) The generators cut in at an engine speed of approximately 1,150 r.p.m. and cut out at approximately 750 r.p.m. To avoid a heavy discharge of the batteries when operating in this range of r.p.m., e.g. when taxiing, the generators should be disconnected. They should be brought back into circuit immediately before opening up the engines for take-off.
- (c) A voltmeter (79) fitted immediately above the main

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power panel indicates the controlled voltage at the bus-bars. Facilities for checking the electrical circuits of each generator are provided by an ammeter test socket (80) and a six-position selector switch (81).

### (iii) Batteries control

- (a) A master electrical switch (88) on the power panel has two positions, GROUND and FLIGHT. With the switch in the GROUND position the batteries are disconnected and the electrical services are connected direct to the generators and to the external supply socket. With the switch in the FLIGHT position the batteries are connected to the main bus-bars and are automatically charged during flight.
- (b) An external supply socket is fitted on the starboard side of the fuselage for engine starting and test purposes.

### (iv) Circuit breakers and fuses

- (a) The combined output of the four generators is fed via the power panel main bus-bars to the feeders which supply the fifteen fusebanks below the power panel assembly, and the seventeen circuit-breakers (twelve type A, three type B and two type D) which are on the power panel assembly. The Type A circuit breakers (77), have direct manual control, and protect some of the heavier circuits. They are grouped together at the forward end of the power panel, and each is identified for its particular service by an adjacent label. The type B and type D circuit breakers are remotely controlled by push-switches; the type B circuit breaker (106) for sonobuoy heating is at the forward end of the power panel, while those for the turret (118) and galley services (117) and the type D circuit breakers (115) and (116) for the radar are at the aft end of the power panel. They are each labelled for their respective services and their push switches are located at the relevant crew stations.
- (b) Most of the electrical services in the aircraft are fed from and protected by the fusebanks (89) to (103) situated below the power panel assembly, but some of the equipment in the vicinity of crew stations is fed from fusebanks or panels at or near the appro-

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prate stations. The supply cables from the main bus-bar to these panels are protected by one of the Type A circuit-breakers (77) referred to above.

- (v) *Control of supply to G4B compass, auto pilot and A.S.V. scanner.*
  - (a) To provide A.C. supply to the A.S.V. scanner, the auto pilot and the G4B compass, two inverters, No. 1 and No. 2, are fitted at the starboard side of the fuselage nose, and obtain the D.C. supply via the Type A circuit-breakers. Normally No. 1 inverter supplies the auto-pilot and No. 2 inverter the G4B compass and the scanner, but in the event of failure of No. 2 inverter No. 1 inverter can be transferred from the auto-pilot services to the essential services of the G4B compass and the scanner.
  - (b) No. 1 inverter is controlled by an ON-OFF switch (138) on the flight engineer's main panel. No. 2 inverter is switched on automatically before flight by the operation of any one of the engine starting push switches and should be switched off after flight by operating the re-set relay (129) on the flight engineer's main panel.
  - (c) A faulty A.C. supply from No. 2 inverter will cause a power failure warning light (132) on the flight engineer's main panel to come on; in this event the two-way switch (128) on the flight engineer's main panel, labelled NORMAL—EMERGENCY OR TEST should be placed in the EMERGENCY OR TEST position and the single-pole switch (126) beside it labelled NORMAL—EMERGENCY should be put to EMERGENCY. This action disconnects the auto-pilot from and connects the G4B compass and the scanner unit to No. 1 inverter; it also starts up No. 1 inverter if it is not already running and switches off the faulty No. 2 inverter.

## AIRCRAFT CONTROLS

### 16. Flying controls

The dual flying controls comprise pendulum-type rudder pedals and two handwheel-type control columns. Each rudder is adjustable by holding aside the spring-loaded latch on each inside pedal arm and raising and moving the foot-rest over the ratchet mechanism.

**17. Flying controls locking gear**

- (i) The flying controls internal locking gear which, when not in use, is stowed on the starboard side of the fuselage nose compartment, consists of:—
- A strut, to be fastened to the top of the first pilot's seat and to a bracket on the control column.
  - A strut, one end of which is to be inserted into the cockpit port rail and the other end secured by two screwed hooks to the handwheel.
  - A T-strut, the transverse member of which is to be inserted in the hollow footrest of each rudder pedal, and the other end attached to the bracket on the control column.
- (ii) External locking devices are provided for both the ailerons and the rudder and, when not in use, are stowed on the starboard side of the fuselage just aft of the main door.

**18. Trimming tab controls**

The elevator (6), rudder (4) and aileron (7) trimming controls to port of the first pilot's seat, and duplicated to starboard of the second pilot's seat (70), (71) and (69), all operate in the natural sense and each has an adjacent indicator showing the setting of the tab.

**19. Undercarriage control**

The undercarriage is raised and lowered by electro-hydraulic power and the control, which consists of two buttons, marked UP and DOWN, is on the extreme left-hand side of the pilots' panel. Operation of either button causes the other button to spring out. At airspeeds below 80-85 knots, a spring-loaded locking device engages with the up button and prevents inadvertent selection of undercarriage up. In an emergency, however, it is possible to raise the undercarriage on the ground by exerting a force of at least 40 lb. on the button. In the event of electrical or hydraulic failure the undercarriage may be operated by an emergency compressed air system controlled by a lever (163) on the flight engineer's main panel. (See para. 83).

**20. Undercarriage position indicator**

An electrically-operated undercarriage indicator is mounted on the pilot's panel beside the undercarriage control buttons, and indicates as follows:—

Two green lights ...	main wheels down and locked
Two red lights ...	main wheels unlocked
No lights... ..	main wheels locked up.

When the undercarriage is locked up, if the throttles are less than one third open, warning is given by the starboard red light in the indicator coming on. This red light can be tested on the ground by means of a pushbutton (127) at the top left-hand corner of the flight engineer's main panel.

**21. Flaps control and indicator**

- (i) The flaps are raised and lowered by electro-hydraulic power, and the control lever switch on the left-hand side of the pilots' instrument panel has three positions UP, TAKE-OFF and DOWN. In the event of electrical or hydraulic failure the flaps can be operated by emergency methods (see para. 83).
- (ii) The flaps position indicator, which is electrically-operated, is on the left-hand side of the pilots' panel.

**22. Wheel brakes**

Two sets of brake drums are fitted to each main wheel, one set being served by a compressor on No. 2 engine and the other set by a compressor on No. 3 engine. Both sets are entirely independent of each other but are operated simultaneously by spectacle-type controls (26) and (43) which are fitted on each control column. A parking catch is also fitted at the centre of the 1st pilot's control column. No gauges are fitted to show the pressure at each main wheel, but the total pressure available to each set of brakes is shown on the gauges (165) and (166) on the flight engineer's main panel.

**23. Automatic pilot**

A Mk. 9 Automatic Pilot is fitted; the switch box is in the canopy roof, the controller (18) is on the right-hand arm of the 1st pilot's seat and an auxiliary cut-out switch (28) and (42) is fitted on each control column.

## ENGINE CONTROLS

**24. Throttle controls**

Two engine control pedestals are mounted, one on the port side and the other on the starboard side of the first and second pilots' seats respectively. Both pedestals have four throttle control levers (9) and (65), each set having a damping lever (10) and (66) located inboard. Moving the damping lever forward increases the friction to locking point.

**25. Propeller controls**

- (i) Four r.p.m. control levers (8) and (67) are mounted below each set of throttle levers and are provided with damping levers similar to the throttle control damping levers. The r.p.m. control levers vary the governed r.p.m. from 1,150 to 2,750.
- (ii) The feathering pushbuttons (34) are mounted on the centre of the pilots' panel and each button incorporates an engine fire warning light (see para. 87).

**26. Superchargers**

The engines are fitted with two-speed single-stage superchargers. The gear-change control is electrically-operated by a switch (24) on the pilots' instrument panel marked M.S. and F.S.; four red warning lights (141) on the flight engineer's main panel indicate when the superchargers are in high gear.

**27. Radiator shutters control**

Four 4-position switches (149) on the flight engineer's side panel provide for automatic or manual control of the radiator shutters which form part of the lower side cowling of each engine and are operated by electro-pneumatic rams. They control the temperature of both the oil and coolant.

When these switches are in the AUTO position, the shutters are "inched" opened and closed automatically according to the coolant temperature. When they are in the OPEN or CLOSE position the shutters are fully opened or closed according to the setting, but the shutters can be

stopped and retained in any desired position by placing the switches to the STOP position. In the event of electrical or pneumatic failure, the shutters will trail in an intermediate position.

**28. Air-intakes system**

- (i) The air-intake system consists of a duct situated under each engine so that air at atmospheric temperature enters the forward facing entry between the two radiators and thence along the duct to the engine.
- (ii) The duct also incorporates an intake at each side to allow hot air which has passed through the radiators to be mixed with the normal intake air. The amount of hot air entering the duct through these intakes is regulated by flaps which normally operate automatically but can be manually controlled by the pilot, if desired, to raise or lower the charge temperature (see para. 30).
- (iii) The air-intake system incorporates an arrangement of flaps, filter elements and shutters allowing clean filtered air to be supplied to the engine when required by operating a switch (25) on the pilots' panel. Operating this switch closes a flap in the rear of the intake system, sealing off the front part of the duct. Air is then drawn through louvres in the rear bottom cowling panel through the air filters and through shutters actuated by the pressure difference between the air-intake system and the atmosphere.
- (iv) A gapless iceguard is fitted in the forward end of the air-intake duct; in the event of the iceguard becoming blocked with ice, cold air is fed to the engine through the filtered air intakes.

**29. Air-intake cleaner controls**

The air cleaner flaps situated one at the rear of the main air intake of each engine are operated by pneumatic rams controlled by a switch (25) marked NORMAL and CLEAN AIR on the pilots' panel. Each flap is spring-loaded to the NORMAL position and will remain so if either the electrical or the pneumatic system fails.

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### 30. Charge temperature controls

Engine charge temperature control is effected by the two shutters in the side of each main air intake duct admitting hot air from behind the radiators. The pneumatic rams which operate the shutters are controlled by 4-position switches (150) below the radiator shutter switches on the flight engineer's side panel, labelled AUTO—COLD—STOP and HOT. Automatic operation during flight of both radiator and hot air intake shutters should normally keep the charge temperature above the minimum of 40°C. If charge temperatures are excessively high or low the air-intake shutters can be manually opened or closed as required.

### 31. Engine starting and stopping controls

- (i) The four engine starting pushbuttons (123) and the four booster-coil pushbuttons (122) are on the flight engineer's main panel, and the ignition switches are on the pilots' panel.
- (ii) Four fuel cut-off pushbuttons (124) on the flight-engineer's main panel are held in to shut off the engines.

### 32. Engine instruments

The boost gauges and the tachometers for each engine are mounted in the centre of the pilots' instrument panel. The oil temperature (146), coolant temperature (145) and charge temperature (143) indicators, all of which are electrically-operated are on the flight engineer's main panel; also on the panel are the oil pressure gauges (147) which are pressure-operated through capillary tubing.

## GENERAL EQUIPMENT AND CONTROLS

### 33. Internal lighting

- (i) The cockpit lighting system consists of a duplicate installation of ultra-violet and red floodlamps. With the exception of the red floodlamp illuminating the flap position indicator and those for the trimmer controls, all the lamps and their control switches are on the cockpit

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coaming. The red internal floodlamps for the trimmer controls and the compass lamp are controlled by ON-OFF switches (3), (13) and (73), and the remaining floodlamps and the ultra-violet lamps are controlled by dimmer switches, (12), (14), (62) and (63).

- (ii) Two emergency lamps, situated one at each side of the coaming above the pilots' panel, are controlled each by an ON-OFF switch, one at each side of the panel. These lamps are fed from a small battery behind the pilots' panel, and are independent of the aircraft electrical supply.

### 34. External lighting

- (i) Two mechanically-linked switches (46) on the starboard side of the pilots' panel are the master switches for all external lights, and must be down before any of the navigation lights, taxiing lamps, identification lights or landing lamps will come on. The landing lamp motor circuits are, however, independent of this master switch.
- (ii) Two retractable landing lamps are installed, one in each outer wing, and are controlled by two switches (48) and (60) on the pilots' panel.
- (iii) The wing and tail navigation lights are controlled by a 3-way switch marked OFF—DIM—HIGH at the starboard side of the pilots' panel.
- (iv) Taxiing lamps are situated one in each outer wing and are controlled by ON-OFF switches (49) and (59) at each side of the pilots' panel.
- (v) The red, green and amber identification lights are fitted in the undersurface of the rear fuselage. The circuit is controlled by an identification switchbox (44) which provides for steady lighting or signalling. It is on the right-hand side of the pilots' panel together with the three-way colour selector switch.

**35. Heating system**

To be issued by amendment.

**36. Aerofoil de-icing system**

- (i) De-icing fluid is pumped through porous metal inserts in the leading edges of the wings, the tailplane and the fins, and is spread over the remainder of each aerofoil by the airflow.
- (ii) The tank containing the de-icing fluid is fitted in the port wheel-bay on the front face of the rear spar and holds 23 gallons. The de-icing controller (104) is on the power panel at the flight engineer's station and a control panel, (131), incorporating green and red warning lights and three switches, marked AUTOMATIC, MANUAL and EMERGENCY is mounted at the top of the flight engineer's main panel. Automatic operation is not available and the automatic switch is labelled NOT IN USE.
- (iii) When the MANUAL switch is ON, the controller starts the pump motor which runs for an initial period to prime the system. The controller then switches the motor off and on automatically at frequent intervals, the green lamp lighting during each running period of the pump motor.
- (iv) Use of the EMERGENCY switch causes the pump motor to run continuously and the red and green lights both remain on.

- (v) The endurance of the system is 5 hours on MANUAL and 1 hour on EMERGENCY.

**37. Propeller de-icing system**

This system is similar to that for the aerofoils, and the tank which is fitted in the starboard wheel-bay has a capacity of 33 gallons. The fluid is fed to the blades via slinger rings, and the controller (105) on the power panel, and the controls (130) on the flight engineer's main panel are similar to those described for the aerofoil de-icing system. The operation is also similar but the pump is switched on more frequently when on MANUAL than with the aerofoil system. The endurance of the system is 5 hours on MANUAL and approximately 1½ hours on EMERGENCY.

**38. Windscreen de-icing system**

Sprays are provided for the three panels of the pilot's windscreen and the air bomber's window, and the fluid, which is supplied from a 7-gallon tank mounted at the port side of the fuselage nose section, is spread over the panel surfaces by the airflow.

The tank is pressurised, through a pressure-reducing valve, from the pneumatic system, and the pipes feeding the pilots' windscreens are led to two control cocks (23), one on the lower edge at each side of the pilots' panel. Three sprays are mounted, one forward of each pilot's windscreen and one forward of the centre vision panel. Each outer spray is fed from the corresponding control cock and the centre spray is fed when either or both of the cocks are opened. To operate the sprays the cocks are turned ON.

**39. Windscreen wipers**

Two hydraulically-operated windscreen wipers are fitted in front of each pilot's windscreen and are controlled by two valves (22) and (47) mounted one at each side on the lower edge of the pilots' panel. The wipers should not be operated on a dry windscreen.

**40. Pressure heads**

Two pressure heads are fitted, one on the undersurface of each outer wing; the starboard head serves the 2nd pilot's instrument panel, the V.G. recorder (if fitted) and the

airspeed switch (78) for the undercarriage up-button lock; the port head serves the 1st pilot's and the navigator's instrument panels and the air mileage unit (169).

The heating elements of the two pressure heads are controlled each by its own switch (38) on the starboard side of the pilots' panel.

#### 41. Oxygen system

All crew positions, except the galley, are provided with an oxygen feed point. The eight oxygen bottles are carried in a crate slung in the bomb compartment, and a Mk. 10A\* oxygen regulator (74) is mounted on a small panel immediately forward of the inboard edge of the flight engineer's main panel.

To operate the system, the master stop valve on the panel must be turned ON, the H.P. ON/OFF valve on the regulator turned ON and the flow control valve adjusted. Oxygen will flow from the 1st pilot's delivery tube (15) at once, and at other crew stations as soon as the bayonet socket of each delivery tube is removed from its stowage. Flow indicators (72) and (161) are fitted to indicate to each crew member, except the 1st pilot, whether oxygen is flowing satisfactorily. The pilot can observe the oxygen regulator dials to check delivery.

#### 42. Galley services

- (i) Equipment in the galley includes a ten-gallon water tank feeding an electric urn which is controlled by a circuit-breaker switch with an adjacent red light indicating when the urn is being supplied with current. There is also a hotplate controlled by a 4-position switch to give HIGH, MEDIUM or LOW heating.
- (ii) The supply line for these galley services is fed through a main circuit breaker (117) at the aft end of the power panel assembly, this breaker being normally controlled by its own push switches marked START and STOP on the aft face of the galley bulkhead. In an emergency, however, such as the failure of a generator, the circuit breaker can be tripped by operating the normally closed push-switch (133) marked GALLEY ISOLATION SWITCH on the flight engineer's main panel. When this switch has been operated the galley services cannot be brought into operation again until the START switch in the galley is pushed.

#### 43. Pilots' seats and safety harness

Access to the pilots' seats is gained through the fuselage from the main entrance door at the aft end. A ladder which, when not in use, is stowed in the roof of the fuselage just forward of the door, is attached to the bottom of the door frame to assist entry. The pilots' seats are mounted on raised platforms and may be adjusted for height by means of levers (19) at the inboard side of the seats. Each pilot has a quick-release Z type harness with a handle (21) and (75) fitted on the inboard arm of each seat to allow the harness to be unlocked to give necessary freedom of movement.

#### 44. Canopy windows and direct-vision panels

The cockpit side windows may be opened by pushing the handles (5) and (68) forward to release the catches and then sliding the windows backwards. Two panels, one on each side of the cockpit, are hinged along the upper edge so that direct vision may be obtained. Each panel is retained in the closed position by a fastener (11) and (64) which is released by rotating the rubber grip and pressing it downwards. A toggle is provided on the canopy to hold the panel fully open.

#### 45. Instrument flying practice equipment

Clips and fasteners are provided for securing the amber or blue screens which, when assembled, completely cover the cockpit. A stowage is provided for the screens in the rear fuselage on the starboard side.

### OPERATIONAL EQUIPMENT AND CONTROLS

#### 46. Bomb door operation

The bomb doors are opened and closed by electro-hydraulic power and the control switch (52) on the right-hand side of the pilots' panel has two positions OPEN and CLOSE. In the event of electric or hydraulic failure the doors may be opened or closed by an emergency air system (see para. 84). A warning light (51) beside the pilot's control switch comes on when the doors are fully open.

**47. Bomb release**

The bomb fuzing and release controls are duplicated at the air bomber's and navigator's stations, and a relay change-over switch marked NAVIGATOR and AIR BOMBER is on the navigator's control panel. When the switch is at AIR BOMBER the release of bombs selected at the air bomber's station can be controlled by the air bomber or either of the two pilots from pushbutton switches on their control columns; with the switch at NAVIGATOR, however, the release of bombs selected at the navigator's station can be controlled only by the navigator. Jettisoning of bombs will normally be carried out by pulling the handle on the extreme right of the pilots' panel, but for this to be effective the change-over switch must be at the AIR BOMBER position.

**48. Flares**

- (i) A flare chute is installed on the port side of the aircraft opposite the entrance door. The control panel is mounted near the chute alongside the flares stowage, and release switches are provided at four stations—the 1st pilot's (20), the air bomber's, the flare chute and the port look-out.
- (ii) Provision is made for the carriage of up to twenty-four 4.5 inch reconnaissance flares in the bomb bay and they may be released singly by either of two push switches (27) and (41), one on each control column handwheel. The flares may be jettisoned by depressing the push switch, marked FLARE JETTISON, on the right of the pilots' panel.
- (iii) Installed at the flare station just forward of the entrance door is a battery of four six-barrelled cartridge flare dischargers. The main control unit is mounted at this station and remote control is effected by a duplicated set of stop and start push switches (50) and (58) at each side of the pilots' panel. A flare distributor at the flare station enables the flares to be automatically discharged at half or one second intervals, and the operation of the bomb firing switch automatically stops the further discharge of flares.

**49. Cameras**

Installed in the camera bay below the floor of the fuselage rear centre section are the mountings for cameras intended

## FINAL CHECKS FOR TAKE-OFF

TRIM ... ALL NEUTRAL

SUPER-  
CHARGERS ... LOW GEAR  
HIGH GEAR (with W/M)

CHARGE TEMP.  
CONTROLS ... COLD

AIR INTAKE  
FILTER ... CLEAN

PROPS. ... MAX. R.P.M.

FUEL ... TANKS SELECTED  
CONTENTS  
BOOSTER PUMPS ON

FLAPS ... TAKE-OFF

AUTO PILOT ... OFF

RAD.  
SHUTTERS ... AUTO

## FINAL CHECKS FOR LANDING

BRAKES ... CHECK PRESSURES  
OFF

WHEELS ... DOWN AND LOCKED

SUPER-  
CHARGERS ... LOW GEAR

AIR INTAKE  
FILTER ... CLEAN

CHARGE TEMP.  
CONTROLS ... COLD

PROPS. ... 2,200 R.P.M.  
2,600 R.P.M. ON FINAL

FLAPS ... TAKE-OFF  
DOWN on final

FUEL ... CONTENTS  
BOOSTER PUMPS ON

## PART I—DESCRIPTIVE

for either medium or low level, day or night photography. Selection of the required camera and the operation of the camera doors is controlled from the air bomber's panel. The cameras can be put into operation either by the bomb firing push switches or by an independent camera push switch on the air bomber's panel. For night photography the cameras operate in conjunction with the photoflash installation.

### 50. Photoflash installation

A maximum of twenty-four photoflashes may be carried in the bomb bay and are so arranged that they may be released by operation of either the camera push switch or a bomb-firing push switch. The control unit for the photoflash distributor is mounted on the starboard side of the fuselage nose.

### 51. Signal pistol and signal lamp

- (i) A signal pistol is stowed aft of the wireless operator's seat, and the cartridge stowage is above the electrical power panel assembly at the flight engineer's station. The signal pistol firing position is in the fuselage roof above the cartridge stowage.
- (ii) A signalling lamp is stowed behind the 2nd pilot's seat, and may be plugged into any of the "inspection lamp" sockets throughout the aircraft.

### 52. Lifeboat release

If a lifeboat is carried below the bomb bay, the bomb doors must remain closed in flight. The lifeboat release master switch is on the air bomber's panel, and when this switch is on, the lifeboat can be released by pressing either the pushbutton (56) on the pilots' instrument panel or the one on the air bomber's panel.

A cover is provided and should be fitted over the bomb doors control switch when the lifeboat is carried.

### 53. Radio

- (i) The wireless equipment consists of an MF/HF/DF transmitter/receiver, a twin V.H.F. installation and an intercom. system coupled to both installations. A separate special intercom. system is also provided.

## PART I—DESCRIPTIVE

- (ii) The MF/HF equipment is under the control of the wireless operator who is also responsible for operating the receiver for D.F. work. Two visual indicators, one immediately forward of the D.F. loop and the other (31) on the pilots' panel provide facilities for homing.
- (iii) The twin V.H.F. sets are controlled by the pilot through two control units (35) mounted above the centre of the cockpit coaming, each control unit having a single rotary switch.
- (iv) Fifteen station boxes are installed at the various crew positions in the aircraft, consisting of five type 349 units and ten type 350. Type 349 units (45) and (61) carry the MF/HF services, the No. 1 and No. 2 V.H.F. services and the intercom, and call circuits. They are equipped with press-to-transmit facilities and those at the first and second pilots' stations are also connected to remote press-to-transmit switches (30) and (39) situated one on each control column. At the radar operator's station a foot-operated call-switch is installed. Type 350 units (125) are equipped only with normal intercommunication and pushbutton call services. Connected to each type 349 or type 350 unit is a mic/tel. socket.

### 54. **Radar**

The radar equipment comprises an A.S.V. scanner and indicating system, Gee and Loran navigational aids, Rebecca, I.F.F. and an A.Y.F. radio altimeter. Provision is made for a sonobuoy installation and an operator's station is provided. Separate independent aerials are fitted for sets but the starboard aerial, normally used with Loran, can be switched to the MF/HF equipment in the event of the port fixed aerial becoming defective.

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