PART I

DESCRIPTION AND MANAGEMENT OF SYSTEMS

LIST OF CHAPTERS

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 1 — ELECTRICAL SYSTEMS

(Completely rewritten)

Contents

1 Electrical supplies, general description

(a) DC supplies

(i) The normal DC power supplies are obtained from two generators, one on each engine; the output from each generator (28 volt nominal) is supplied to the main busbar through contactors. From the main busbar supplies are taken through fuses to Normal (secondary) busbars and certain other services. Warning of generator failure is given on the standard warning panel.

(ii) A limited 24 volt supply to the Normal busbar is provided by a battery through a contactor; however, certain services are supplied direct from the battery busbar. Provision is also made for connecting a 28 volt ground supply.

(iii) An additional 24 volt battery is provided for emergency use; there is no control over this battery other than by individual circuit switches. The normal and emergency batteries have no interconnecting facility.

(*b*) *AC supplies*

(i) The 200 volt, 3-phase AC primary supply is provided by an air-turbine alternator (ATA) supplied with air from the engine airbleed system; the secondary supply is by a type 107 inverter.

(ii) A 115 volt, 3-phase AC supply, one phase earthed, is provided from the 200 volt supplies, via a transformer.

(iii) Provision is also made for supplying 200 volt, 3-phase AC from a ground source.

2 Electrical supplies, controls and indicators

Control or indicator	Marking	Location
DC supplies		
Generator control switches (two)	PORT AND STBD. DC GENERATORS ON/OFF —	Port control panel
Generator failure warnings (two)	GEN P and GEN S	SWP
Battery switch	BATTERY MASTER — ON/OFF	Port control panel
AC supplies		
ATA air supply valve switch	ATA VALVE — SHUT/OPEN	Pilot's starboard wall
ATA reset switch	RESET — ON/OFF	Pilot's starboard wall
Inverter switch	INVERTER — ON/OFF	Pilot's starboard wall
AC supply magnetic indicator	AC SUPPLY	Instrument panel

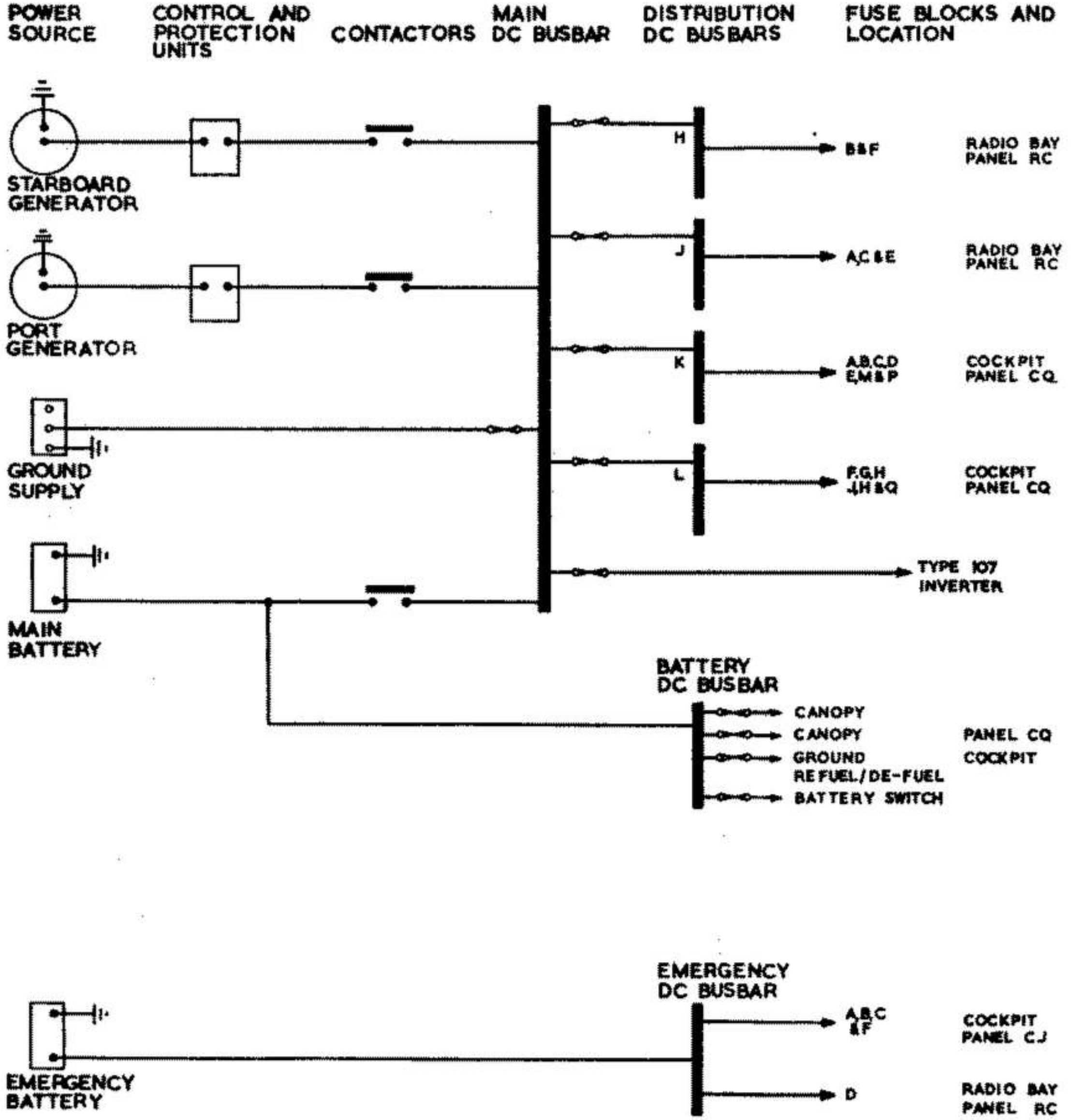


Fig. 1. DC supply and distribution

3 Main DC supply

Each 200 amp generator is driven from the accessories gearbox of its associated engine; operation is automatic. Output is controlled by a voltage regulator and is connected to or disconnected from the main DC busbar by a contactor. The contactor closes when the generated voltage exceeds the busbar voltage and opens when it becomes less than the busbar voltage. An equalising circuit, between the two generators ensures that the busbar loading is shared equally. Each generator switch is in the contactor operating coil circuit of the associated generator and thus provides for manual isolation of the generator from the busbar.

4 Secondary DC supply

(*a*) A 24 volt, 25 ampere/hr. lead-acid battery is connected to the main busbar, through a contactor controlled by the battery master switch. Located in the radio bay, the battery helps to stabilise the busbar under normal conditions and, in emergency conditions, gives the pilot time to change the services over to the emergency battery.

(*b*) Certain circuits are supplied direct from the battery busbar; these are listed in para. 9.

5 Emergency DC supply

An emergency DC supply is available from a second 24 volt, 25 ampere/hr. lead-acid battery in the radio bay. The battery supplies two fuse panels, one in the pilot's cockpit and the other in the radio bay. Refer to para. 8 for the circuits supplied by this battery.

6 Ground DC supply

A 28 volt DC supply from a ground source can be connected through a 3-pin plug on the port side of the aircraft, forward of the bomb bay. The third pin of the plug completes the circuit to the mute relay of the standard warning system, thereby cancelling all indications on the SWP except fire warning and wingfold.

7 DC distribution

(*a*) *Normal supplies*

Both generators and the main battery are connected to the main DC busbar by contactors; DC from a ground source is connected through a fuse. The main busbar supplies four Normal busbars, two (J & H) in the radio bay and two (P & Q) on panel CQ in the observer's cockpit. Each Normal busbar supplies a number of fuse assemblies.

(*b*) *Direct battery busbar*
The main battery supplies direct, the battery busbar on panel CQ. This busbar has four fuses (J9 to 12).

(*c*) *Emergency battery*
The emergency battery supplies four fuse assemblies on panel CJ in the pilot's cockpit and one assembly on panel RC in the radio bay.

8 Circuits supplied from the emergency battery busbar

Panel C-J, fuses A, B, C and F, on pilot's cockpit starboard wall.
Panel R-C, fuses D, in radio bay.
Services, other than those marked with an asterisk, are normally supplied from the Normal busbars.

Fuses	*Service*
A1, A3, D8	Mainplane flaps
A4	Tailplane trim
A5, D11	Aileron droop and tailplane flap
A6, A12	Arrester hook
A7, C7	*Fuel jettison (fuselage tanks)
A9, B5	*GS system valves change-over and indication
A10, C1	Bomb-door
A11, C8	Airbrakes
B1, B2, B10	Undercarriage (B2 indication)
B3, B4	*SWS (pre-mod. 497)
B6	*Emergency lighting
B7	Flight refuelling probe
B12	Cabin pressure failure warning
C2, C3	*Stores jettison
C4	Standby horizon and direction indicator
C5	Standby UHF
C6	BLC control
F1	ADD (audio only)
F3	*Fuel jettison (wing tanks)
F12	Bullpup (mod. 502)
◀D1	*Crash relays (Fuse removed by STI/BUCC/151B) ▶

D2, D4	*Engine fire warning
D3, D5	*Engine fire extinguisher
D6	*Fuel tanks bay fire warning and extinguishers
D7	*Bomb bay fire warning and extinguishers
D10	Airspeed contactor
◀D12	Wing tanks explosion suppression (Fuse removed by STI/BUCC/151B) ▶

9 Circuits supplied from the main battery busbar

Panel CQ, in the observer's cockpit.

Fuses	*Circuit*
J9	Ground re-fuel/de-fuel
J10 and J12	Canopy
J11	Battery master switch

10 Circuits normally supplied from the DC normal busbar

Services marked with an asterisk also require 200 volt AC. Services marked with a dagger also require 115 volt AC.

FLYING CONTROLS AND INSTRUMENTS

Flying controls, pumps failure on SWP
Integration valves
BLC controls, indicators and pressure gauges
Rudder, aileron and tailplane trim
†IFIS
*IFIS lighting
†Standby gyro instruments
ADD (normal operation)
OAT indicator

HYDRAULIC SERVICES

Undercarriage, operation, indication and warning

Flaps Aileron droop Tailplane flap Bomb door Airbrakes Arrester hook	Operation and indication

GS system pump failure MI's
GS system, normal control
Nosewheel steering
Wheelbrakes anti-skid
Wingfold and wing and nose fold warnings

FUEL SYSTEM

Fuel proportioners, controls and MI's
Inter-tank transfer valves
Cross-feed cock operation and MI
FNA valves
FNA valves override switches
Overload fuel transfer
†Explosion suppression (Fuse removed by STI/BUCC/151B)
Tank pressurisation failure
Flight refuelling probe (pre-mod. 881)

AUTOPILOT SYSTEM

*†Autopilot and autostabilisers
*Yaw damper

RADIO AND RADAR

Main UHF and homer
Standby UHF (normal operation)
*HF
*Radio altimeter
*Tacan
*Wide-band homer
*IFF
Intercomm.
*Blue Jacket

WEAPONS AND PHOTOGRAPHIC

*Weapons system
Standby strike sight (mod. 898)
†Weapon protective relays
Armament selection, release and normal jettison
VT fuzing
*Bullpup and RP's
Camera installation
*Camera crate blower/heater
Photo-flash unit

LIGHTING

Downward identification light
Formation, rendezvous and nav. lights
Instrument and floodlighting
Radio and accessories bay

In-flight refuelling
Refuel/defuel
*Fuel flowmeter
Fuel pressure warning

ENGINE SERVICES

Engine starting, relighting and auto-relighting
Fuel pressure MI's
Oil pressure MI's
Engine intakes anti-icing control and MI
Ice detector
*Thrustmeter
IGV indicators

MISCELLANEOUS ITEMS

Circuit protection relays
SWS operation (post-mod. 497)
ATA shut-off valve
Oxygen contents and flow MI's
Canopy control, operation and lock indication
Cabin air conditioning controls
*Cabin and radio bay air intakes anti-icing
*Windscreen heating
Windscreen rain clearance control
Pressure heads heating
Radio bay overheat protection
Miscellaneous temperature indicator
Outside air temperature indicator
AC indicator
Ejection seats
Circuit protection relays
GEN failures on SWP
AC control circuits
Airspeed contactor/fatigue meter

NOTE: The type 107 inverter is supplied from the main busbar.

11 AC supplies

(*a*) The main 200 volt, 3-phase, 400 c/s AC supply is provided by an air-turbo alternator in the radio bay, driven by compressor air from the General services air-bleed system. The air supply is controlled by a pressure regulating and shut-off valve, itself controlled by the ATA valve switch. The full output of the ATA is not achieved until at least one engine is operating at not less than 50% RPM.

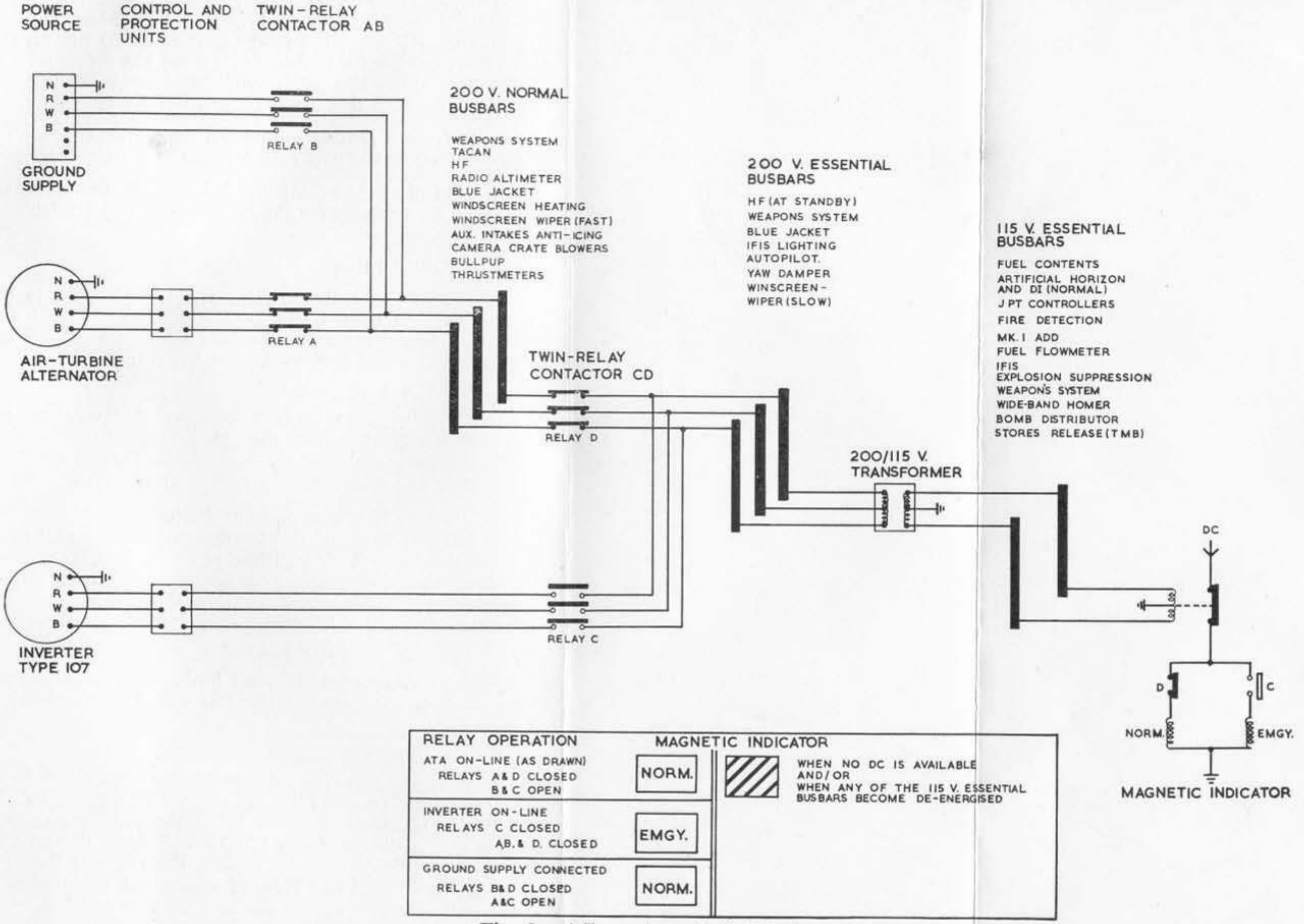


Fig. 2. AC supply and distribution

(*b*) A type 107 inverter provides a 200 volt supply if the ATA fails. The inverter is not normally running, except when the undercarriage is down. In this case, operation of the circuit protection relays provide DC to run up the inverter, but it is held off-line unless the ATA comes off-line (see para. 12). The DC is supplied through the inverter switch, but once this is on, control is fully automatic.

(*c*) AC from a ground source can be provided through a six-pin plug on the port side, forward of the bomb bay.

(*d*) Control of the AC supplies is hy DC circuits, therefore DC must be available for the AC supplies to be available.

12 AC distribution

(*a*) The AC is distributed from a distribution box in the radio bay, by three busbars. The 200 volt Normal and 200 volt Essential Services busbars have three phases; the 115 volt Essential Services busbar has two phases.

(*b*) 200 *volt Normal busbars*
The 200 volt Normal busbars are supplied, from either the ATA or a ground source, through a twin-relay contactor. The relays are electrically and mechanically locked so that only one source can be on-line at any time.

(*c*) 200 *volt Essential Services busbars*
The 200 volt Essential Services busbars are supplied from either the 200 volt Normal busbar or the inverter through a twin-relay contactor. The relays are electrically and mechanically inter-locked so that the Normal busbars must be de-energised before the inverter can come on-line.

(*d*) 115 *volt Essential Services busbars*
The 115 volt Essential Services busbars are supplied by a transformer connected to the 200 volt Essential Services busbar.

(*e*) *Supply magnetic indicator*
The AC supply magnetic indicator shows the state of the AC system; it is operated by DC. The NORM coil of the indicator is energised when either the ATA or a ground supply is on-line and the EMGY coil when the inverter is on-line providing, in both cases, the 115 volt Essential busbaıs are energised. This is because both DC supplies to the indicator are routed through a relay which is only closed when the 115 volt busbars are live.

13 Circuit protection relays

(*a*) Four relays, whose contacts are in various circuits, are energised by operation of micro switches when the port and starboard oleos extend on take-off. They remain energised until landing, although the oleos are shortened during retraction. The relays, when energised:

1. Prevent movement of the wingfold lever by de-energising the locking solenoid.

2. Energise the undercarriage "up" button locking solenoid, allowing an "up" selection to be made.

3. Energise the nosewheel automatic centring circuit.

4. Switch off the deck approach light on landing.

5. Allow full, instead of reduced, voltage to be available to the windscreen heater elements.

6. Energise the fuel jettison circuits.

7. Permit fuel transfer from the overload tanks.

8. Permit stores release, jettison and fuzing.

(*b*) Setting a key in the ground test micro switch, in the starboard wheelbay, and turning it to TEST overrides the circuit protection relays for ground test purposes.

14 Crash switches (RENDERED INOPERATIVE BY STI BUCC/1518)

Pairs of crashtrip elements are located one forward of the nosewheel, one each on the port and starboard wingtip fairing and one aft of the bomb bay; all are on the under surface. Four elements, one in each pair, are wired in parallel with a crashtrip relay unit; the remaining elements, also wired in parallel, are connected to a second relay unit. If both relays become energised they complete the circuits and energise two additional relays which:

Discharge the engine fire-extinguishers.
Discharge the fuel tanks and bomh bay fire extinguishers.
Operate the wing tanks explosion suppression systems.
Isolate the generators and the main battery from the main husbar and thus the ATA or the inverter.

Normal Operation

15 Management of the electrical systems

(*a*) *Before starting*

Whenever possible ensure that DC from a ground source is connected. Irrespective of whether there is a ground supply, switch on the battery master switch. Check that the GEN lights on the SWP are illuminated. Ensure that the generator switches and the inverter switches are on and that the AC supply magnetic indicator shows EMGY, with no AC from a ground source, or NORM if a supply is connected.

(*b*) *After starting*

Before starting the functional checks of the various systems ensure that the ATA valve switch is at OPEN and that, as the RPM are increased, the AC supply magnetic indicator changes to NORM, indicating that the ATA has come on-line.

Malfunctioning

16 Electrical supply failures

NOTE: The following services and busbars are associated and can be used as a quick check to ascertain which busbars are energised.

Emergency DC — Cockpit emergency lighting

Normal DC — SWS test

115v Essential AC — IFIS

200v Essential AC — IFIS lighting

200v Normal AC — Wide-band homer

AC supply failures

Indication	Probable cause	Result	Actions	Notes
AC MI = EMGY	ATA off-line 107 inverter on-line	200v Normal busbar de-energised 115v and 200v Essential busbars energised	Make 3 attempts to reset ATA. If unsuccessful select ATA valve shut	No supply to 200v Normal busbar
AC MI = Cross-hatched No AC services	ATA and inverter off-line	All AC busbars de-energised; all AC services unserviceable	Make 3 attempts to reset ATA. Ensure inverter switch is ON. If unsuccessful, shut ATA valve	
AC MI = Cross-hatched 200V AC services available	Failure of 115v transformer	200v busbars energised 115v busbars de-energised	None possible	If the services supplied by the 115v Essential busbar are also serviceable, it indicates an MI failure only

DC supply failures

GEN P or S on SWP	Single generator failure	DC services continue to operate	Confirm generator switch is ON	If the ATA also fails, load shedding is required as the inverter comes on-line
GEN P and S on SWP	Double generator failure	DC available only from main and emergency batteries	Load-shed as quickly as possible	If load shedding is rapid, main battery should last at least 20 mins. AC services will operate as long as DC is available from the main battery

17 Load shedding table

(*a*) Standing loads on the DC busbars, which cannot be switched off

	Normal busbar (Amps)	Emergency busbar (Amps)
Normal conditions	31·0	0·7
	—	Nil (post-mod. 985)

In emergency conditions the following loads are transferred to the emergency busbar: —

GS hydraulic system on emergency	—	4·0
Blow system on emergency	—	4·4
Surfaces anti-icing on emergency	—	2·8

(*b*) Loads under the control of the aircrew

Service	DC busbars (amps)		AC busbars (V/amps)		
	Normal	Emergency	Norm 200V	Essential 200V	Essential 115V
Type 107 Inverter ...	118·0*				
Aux. intakes anti-icing	80·0				
Cameras	60·0†		1019		
Main UHF and homer					
Transmit	15·0				
Receive	10·5				
Autopilot	13·0			120	
Pressure head beaters (including ADD probe)	12·8				
Blow control ...	11·2 or 4·0				
Bullpup	15·0				
HF	10·0		685 or 685		
EL EA fuzing	10·0				120
EP fuzing	10·0				
Blue Parrot/strike sight					
Transmit	8·0		2575		
Receive	8·0		2435		
Tailplane flap operation ...	8·0 or 8·0				
Cockpit lighting ...	6·6				
Rendezvous light ...	6·0				
Engine relighting (each engine)	5·0				

† For one minute.

	DC busbars (amps)		AC busbars (V/amps)		
	Norm.	Emergency	Norm 200V	Essential 200V	Essential 115V
◀ Standby UHF (pre-mod. 1117) ▶					
Transmit	3·5 or	3·5			
Receive	2·5 or	2·5			
Inter-tank transfer valves	3·0				
Radio altimeter	3·0		200		
Ice detector	2·5				
◀ Standby UHF (post-mod. 1117)					
Transmit	1·5 or	1·5			
Receive ... ▶	0·08 or	0·08			
Engines anti-icing (switched OFF) ...	2·5				
Standby gyro instruments	0·1 or	2·6			40
IFF and SIF	2·0			130	
Navigation lights ...	2·0				
Tailplane trim	1·4 or	1·4			
Aileron trim	1·3				
Wide-band homer ...	1·07		30		
Aileron droop	1·2 or	0·6			
Downward ident. light ...	1·2				
Tacan	0·71		460		
Formation lights ...	0·7				
Attitude light	0·6				
Cross-feed cock	0·43				
Blue Jacket					
HT ON				400	40
HT OFF				275	40
Airbrakes operation ...	0·4 or	0·75			
IFIS lighting				30	
Yaw damper				50	
W'screen de-icing (high power)			1250		
W'screen wipers				600	
Rudder trim	1·3				
Bomb door	0·8	2·2			
Stores jettison	2·0	2·0			
Fuel jettison		2·2			
Cabin pressurisation ...	2·7	2·3			
ADD	3·0	0·2			
Undercarriage	1·2	1·2			
Flaps	0·4	0·3			

* 40 amps when running, but off-line.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 2 — FUEL SYSTEM

Contents

Description and Controls

1 Fuel system, general description

(*a*) Fuel in eight internal tanks, four for each engine, is fed by two hydraulically-operated proportioners to their respective engines, via the LP cocks. The tanks are pressurised by air from both engines, and two recuperators, one for each engine, provide a supply of fuel under negative-G conditions. To cater for various failures, two inter-tank transfer valves and a cross-feed cock can be opened so that one proportioner can draw fuel from all tanks and deliver it to both engines. Pressure refuelling/defuelling is employed; the control panel and hose coupling are on the starboard side of the nose. Provision is made for in-flight refuelling. The tanks can also be gravity refuelled through filler caps at the top of each tank. Two external tanks can also be carried, one under each wing.

(*b*) Provision is made for fire detection, warning and suppression in the fuel tank bay and the bomb bay ~~and for explosion suppression in the fuselage and overload tanks.~~

2 Fuel system, controls and indicators

The following table shows the location and markings on all the fuel system controls and indicators. The controls are on the pilot's starboard console unless otherwise stated.

Control or Indicator	Markings	Location
Normal operation LP cocks (two)	ENGINE MASTER COCK — ON/OFF (PORT & STBD)	At rear of pilot's port console
Fuselage tanks contents indicators (two banks)	FUSELAGE TANKS (PORT ENGINE & STBD ENGINE)	
Contents indicators supply change-over switch	FUEL IND SUPPLY — NORMAL/CHANGEOVER	
Recuperator check button	RECUPERATOR CHECK	
Malfunctioning		
Proportioner failure magnetic indicators (two)	PROPORTIONER FAILURE (port and starboard)	
HP pump inlet pressure failure magnetic indicators (two)	PUMP INLET FUEL PRESSURE (PORT ENG & STBD ENG)	
Tank pressurisation failure magnetic indicator	FUEL TANK PRESS	
Cross-feed cock switch and magnetic indicator	CROSS FEED COCK — CLOSE/OPEN	
Inter-tank transfer valves switch	FUSELAGE INTER TANK TRANSFER — ON/OFF	

Control or Indicator	Markings	Location
Fuel/no-air valve switches (four)	FUEL NO AIR VALVES PORT ENGINE TANK 2—NORMAL/CLOSE TANK 6—NORMAL/CLOSE STBD ENGINE TANK 3—NORMAL/CLOSE TANK 5—NORMAL/CLOSE	
Overload tanks		
Tanks contents indicators (two)	PORT WING STBD WING	Observer's auxiliary panel
Fuel transfer switch	OVERLOAD TANKS FUEL TRANSFER WINGS — ON/OFF	Observer's auxiliary panel
Fuel jettisoning		
Fuselage tanks jettison control	FUEL JETTISON PULL AND TURN	
Overload tanks jettison switch	OVERLOAD TANKS FUEL JETTISON — ON/OFF	
In-flight refuelling		
In-flight refuelling probe selector switch (pre-mod. 881)	FLIGHT REFUEL PROBE — IN/OUT	
In-flight refuelling switch (post-mod. 881)	FLIGHT REFUEL—ON/OFF	

3 Internal tanks

The eight internal tanks are integral with the upper half of the fuselage. The tanks are paired 1 & 3, 2 & 4, 5 & 7 and 6 & 8, the odd and even number tanks supplying the starboard and port engines respectively. Numbers 1, 4, 7 and 8 tanks are slave tanks, the contents of which are fed into their respective master tanks, through internal connections, under the influence of the pressurisation system. Each master tank has two fuel/no-air (FNA) shut-off valves in parallel, operated by General Services air and controlled by their own float switch. ▶◀ Each pair of FNA valves is also controlled by a switch on the starboard console.

NOTE: Elsewhere in this book the term FNA valve refers to a pair of valves and the term FNA valves refers to more than one pair.

4 Overload tanks

Provision is made for the carriage of one slipper-type jettisonable wing tank under each inner plane. When fitted, the tanks are connected to the main systems in the bomb bay by transfer pipes. Fuel from the overload tanks is transferred to the main tanks under the influence of the pressurising system when the observer selects the pressurising valves open.

5 Fuel tank capacities

The capacities of the tanks are: —

Fuselage tanks	Gallons	lb. Sp.G 0·80
No. 1	205	1640
No. 2	220	1760
No. 3	183	1464
No. 4	168	1344
No. 5	180	1440
No. 6	198	1584
No. 7	192	1536
No. 8	184	1472
Totali nternal	1530	12,240
External tanks		
Port	250	2000
Starboard	250	2000
Total	2030	16,240

6 Unusable fuel

(a) Fuselage tanks

Unusable fuel should be considered to be 300 lb. This is distributed between the four master tanks and allows for variations between aircraft and for gauge readability and accuracy. A tank should be considered to be empty if its gauge indicates 75 lb. or less.

(b) Wing tanks

In level flight, between 2½ and 7 gallons is unusable in each tank.

7 Fuel tank pressurising and venting

(a) Pressurisation

Air from the engine air-bleed system (Chapter 4) is ducted,

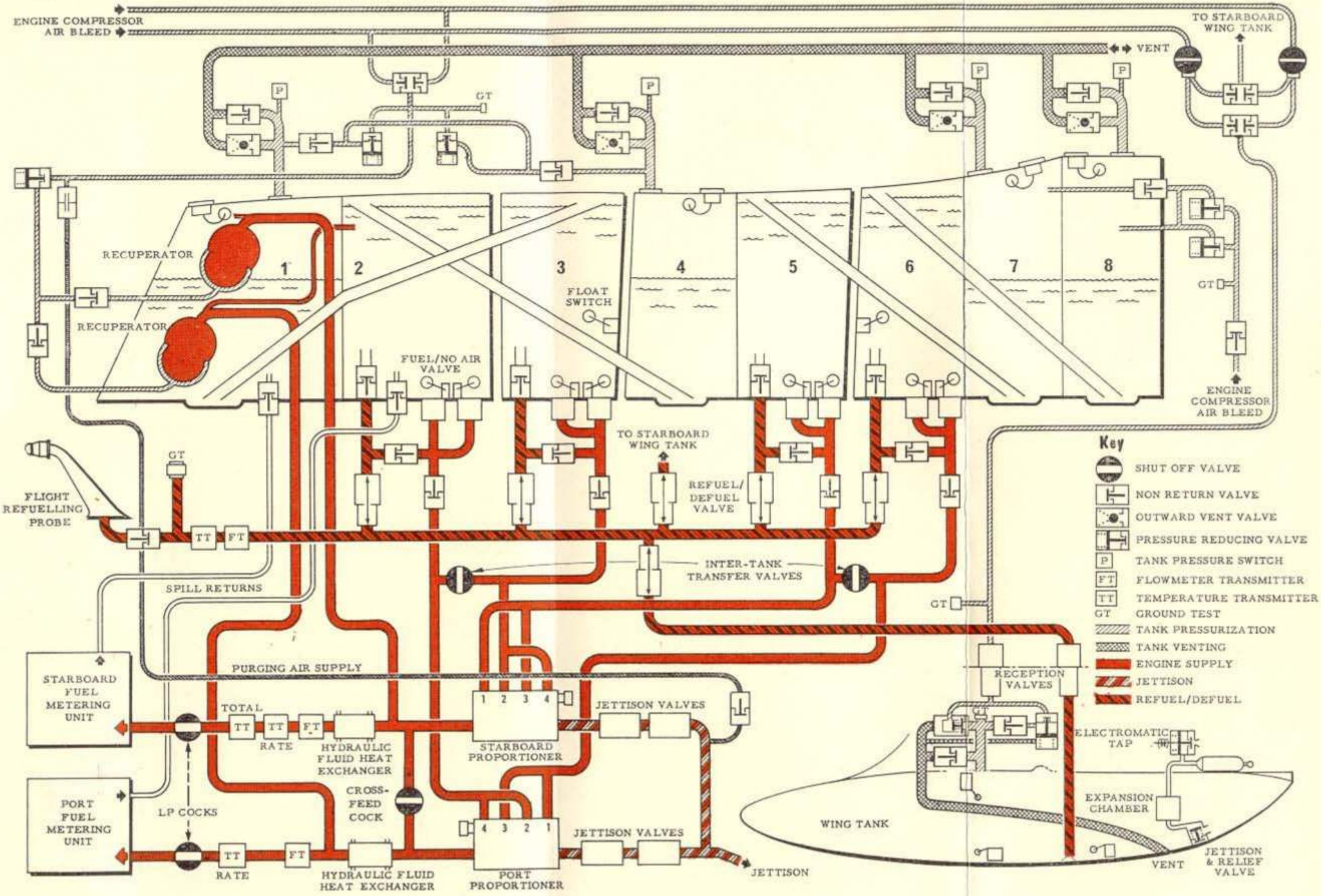


Fig. 1. Fuel system

RESTRICTED

through non-return valves and pressure reducing valves, to the slave tanks and fuel recuperators. Pressurisation is controlled by the pressure reducing valve and protected by the inward and outward-vent valves (sub-para. (*b*)). Four pressure switches, one in the line to each pair of fuselage tanks, are wired in series to a magnetic indicator which shows black when all tanks are correctly pressurised. Pressurisation of the overload tanks is governed by a shut-off valve in the supply line to each tank.

(*b*) *Venting*

As all fuselage tanks are paired, only the slave tanks require venting. For outward venting, the line from each slave tank is connected to a common vent which terminates under the fuselage; four vent valves, one in each vent line, lift when the tank pressure rises to 7¾ PSI. The common vent line is also used for inward venting, the outward vent valves being by-passed in this case; outward venting through these by-pass pipes is prevented by non-return valves. To prevent fuel aeration after refuelling, a small bleed hole in each non-return valve allows the tanks to become depressurised when the aircraft is standing. This takes approximately 25 minutes. Venting of the overload tanks takes place through an independent system in each overload tank.

8 Overload fuel transfer

During normal operation, fuel from the wing tanks is transferred to the main tanks via transfer pipes which feed into the refuel/defuel gallery. Fuel transfer is controlled by the overload tanks fuel transfer switch in the observer's cockpit. Selection of this switch to ON energises, to open, the overload tanks pressurisation valve and prepares the refuel/defuel valves for fuel transfer. The switch should be returned to OFF when transfer is complete. It should also be off during flight refuelling, although this is done automatically when probe/drogue contact is made. To prevent the transfer of fuel until airborne, the electrical circuits are linked to the circuit protection relays.

9 Fuel proportioners

The two hydraulically-operated fuel proportioners, one for feed cock is opened, the dry proportioner will overspeed and can then pump sufficient air to affect both engines.

11 Fuel recuperators

(*a*) Two recuperators in No. 1 fuselage tank each supply one engine when its supply pressure falls below 17 PSI e.g. under negative-G conditions when the proportioner stops. Each recuperator contains approximately 5 gallons of fuel which is sufficient to allow for 10 seconds operation at full power. The recuperators are pressurised at 17 PSI by air from the engine air-bleed system. Air pressure acting on a diaphragm at the head of the recuperator also holds open the fuel inlet valve, allowing the bag to become charged with fuel by the proportioner. If the shell of the recuperator fractures, the air is released, thus closing the valve and preventing fuel entering the bag. If the bag punctures, a non-return valve in the air supply line prevents fuel entering that line and a restrictor in a pressure relief valve prevents excessive loss of fuel.

(*b*) When the recuperator check pushbutton on the starboard console is pressed, it has the same effect as negative-G, stopping the proportioners; this allows recuperator discharge to be checked.

12 Flight under negative-G conditions

When negative-G is experienced, the proportioners are stopped and fuel transfer from the fuselage tanks ceases; the engines are then fed from their respective recuperators. These have a capacity sufficient for 10 seconds operation at maximum power. Application of negative-G operates the float switches of the fuel/no-air valves in the master tanks; these cause a solenoid to be energised which allows air pressure to close the valves, effectively cutting off the fuel supply to the proportioners. At the same time inverted flight switches energise the proportioners hydraulic supply shut-off valves to stop the proportioners. As the pressure in the fuel supply lines to the engines decreases, the air pressure in the recuperators discharges the fuel.

13 Fuel jettison

(*a*) *Fuselage tanks*

Fuel from all fuselage tanks can be jettisoned through a single outlet on the underside of the rear fuselage. Operating the FUEL JETTISON PULL AND TURN rotary switch energises two jettison valves in each line from the proportioners. The proportioners' maximum speed is limited by a flow control valve. Fuel jettisoning continues until the rotary switch is returned to its normal position, or until two low-level float switches, one each in No. 3 and 6 tanks, open, tbus de-energising, to close, the jettison valves. In the latter case the rotary switch should be returned to the normal position after jettisoning ceases. The low-level float switches are so located that approximately 500 gal. (4,000 lb.) fuel remains in the tanks. Restriction in tbe line prevent fuel starvation at the ◀engines during fuel jettisoning. With mod. 880 and STI/BUCC/89 are embodied, air pressure from the tank▶ pressurisation system automatically purges the fuel jettison lines when the fuel jettison valves close.

(*b*) *Overload tanks*

Fuel from the wing tanks can be simultaneously jettisoned through valve-controlled outlets on the undersurface of the rear portion of eacb wing tank. The pneumatically-operated valves are selected electrically by operating an overload tanks fuel jettison switch, on the starboard console. The principle of operation is the same for each tank. Selecting the jettison switcb to ON fires a detonator, shattering a frangible pillar assembly which is screwed into tbe neck of the fuel jettison air bottle. High pressure air then operates the jettison valve; at the same time a valve is energised to close an exhaust line from the air bottle. The valve remains open until all the fuel has been jettisoned. The jettison switch should then be selected to OFF to de-energise the electromatic tap which exhausts the residual air pressure to atmosphere and allows the jettison valve to close under spring pressure. If jettisoning is stopped, by selecting the switcb to OFF, it cannot be restarted. Fuel jettisoning is facilitated if the overload tanks are pressurised.

14 Wing tanks jettisoning

The wing tanks can be jettisoned by moving the jettison selector switch, on the pilot's port console to WINGS INNER and pressing the STORES JETTISON pushbutton.

NOTE: The wing tanks can also be jettisoned with the jettison selector in the ALL position, but it must be remembered that this action jettisons all underwing stores.

15 Fuel-flow and fuel-remaining indicators

A fuel-flow indicator is on the starboard side of the instrument panel, in the pilot's cockpit. The adjacent fuel-remaining indicator is reset automatically during refuelling but not during fuel jettisoning. The indicators are controlled by three fuel-flow transmitters, one in each engine fuel supply line and one in the refuelling line. To correct ◀for changes in density due to temperature variation, four temperature transmitters are fitted, one in the port supply line, two in the starboard line and one in the refuelling line. A manual fuel-density corrector is on the refuelling▶ panel.

16 Fuel contents indicators

(*a*) *Fuselage tanks*

The fuel contents indicators are in two banks, each controlled by its own system. The forward bank indicators show the fuel in the slave tanks (4, 8, 1 and 7) and the rear bank the fuel in the master tanks (2, 6, 3 and 5). The systems automatically compensate for changes in fuel temperature and are manually pre-set for density; they are operative whenever a 115 volt AC supply is connected. The supply changeover switch is used to changeover the oscillators, the most likely cause of failure, if one bank fails.

(*b*) *Overload tanks*

A fuel contents indieator for each wing tank is on the observer's auxiliary panel.

17 Cross-feed cock and inter-tank transfer valves

(*a*) *Cross-feed cock*

The cross-feed cock, when open, interconnects the two engine supply lines downstream of the proportioners, allowing one proportioner to supply both engines. When the cock is open, the magnetic indicator adjacent to the controlling switch shows a horizontal white line; with the cock closed, a vertical line is shown. When DC is disconnected, the indicator shows cock closed, therefore, if a DC failure occurs after the valve has been opened, the indication is false, as the valve remains open.

(*b*) *Inter-tank transfer valves*

The inter-tank transfer valves are controlled by a FUSELAGE INTER-TANK TRANSFER — ON/OFF switch. There are no indicators for these valves. If the valves are open when a DC failure occurs they stay open.

NOTE: Opening the inter-tank transfer valves may cause out-of-balance but will not restore any previous out-of-balance condition.

18 Engine inlet pressure indicators

Two PUMP INLET FUEL PRESS magnetic indicators, labelled PORT ENG and STBD ENG respectively, are controlled by pressure switches at their respective HP pump fuel inlets. An indicator normally shows black when its engine is running but shows cross-hatched when the pump inlet pressure is low, or when the DC supply is disconnected.

19 Fuel/no-air valve manual override switches

The four fuel/no-air valve switches enable the pilot to override the FNA valve automatic float switches when the valves are open; there are no indicators for the valves. Closing the FNA valves associated with an empty tank prevents possible fuel aeration in the engine feed line and the consequent risk of engine flame-out.

20 In-flight refuelling

(*a*) *Pre-mod.* 881

A retractable probe is under a door in the starboard side of the nose. Both door and probe are operated by hydraulic pressure from the General Services system but are sequenced electrically. Selecting probe OUT, first opens the door, then extends the probe and finally closes the door and at the same time energises, to open, the refuel solenoids of the refuel/defuel valves in the refuelling lines to the master tanks. When the master tanks are full, the valves to the overload tanks are then opened. Selecting probe IN reverses the sequence. During refuelling the total-fuel-remaining indicator is reset by action of the fuel flow transmitter in the refuelling gallery. The hydraulic supply is from both the normal and emergency sides of the General Services hydraulic system but the DC supply is from the Normal busbar only.

(b) *Post-mod.* 881

When mod. 881 is embodied, a fixed probe replaces the retractable probe. Selecting flight refuelling ON energises, to open, the refuel solenoids of the refuel/defuel valves to the master tanks. When the master tanks are full, the valves to the overload tanks are then opened. During refuelling, the total-fuel-remaining indicator is reset by action of the fuel flow transmitter in the refuelling gallery.

Normal operation

21 Before starting the engines

With 115 volt AC and 28 volt DC supplies available, check that the contents gauges changeover switch is at NORMAL and then read off the indicators. Check that the cross-feed cock magnetic indicator shows a vertical white line and that the magnetic indicators for the fuel proportioners, the HP pump inlets and the tanks pressurisation, all show cross-hatched. Check that the fuel/no-air valve switches are selected to NORMAL.

22 After starting the engines

(*a*) *First engine*

Check that the magnetic indicator for tank pressurisation and the HP pump inlet and fuel proportioner magnetic indicators associated with this engine now show black. Check flowmeter indicating.

(*b*) *Second engine*

Check that the HP pump inlet and fuel proportioner magnetic indicators for the second engine have turned to black. Check flowmeter indicating.

◀(*c*) *Take-off*

Pre-mod. GJ 1225 open the cross-feed cock before take-off.

23 In-flight

(*a*) *After take-off*

Pre-mod. GJ 1225, close the cross-feed cock after take-off. ▶

(*b*) *Fuel balancing*

The FNA valves can be used to re-balance fuel between two associated master tanks or between two "sides". (See para. 30).

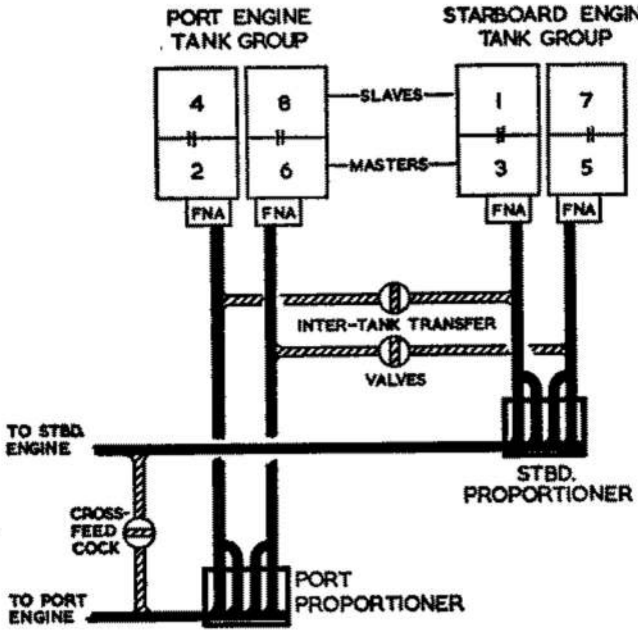


Fig. 2. Fuel system (simplified)

WARNING: Both FNA valves in the same tank group must not be closed at the same time unless the inter-tank transfer valves are open, otherwise a flame-out of the associated engine will result.

(*c*) *FNA valve failure*

Failure of an FNA valve to close does not normally represent a hazard if the inter-tank transfer valves are kept shut. (See para. 10(*b*)). However, the appropriate switch should be set to CLOSE if a master tank indicates 75 lb.

(*d*) *In-flight refuelling*

If all internal tanks are not completely full on completion of in-flight refuelling, out-of-balance will exist. Rebalancing should be carried out.

24 Overload fuel transfer (two-engine flight)

(*a*) Immediately after take-off, switch on the overload tanks switches. This ensures that all fuselage tanks are kept topped up and that proportioning starts from a sound basis when the overload tanks are empty. When the overload tank(s) become empty their respective switches should be set off.

NOTE: If desired, the transfer switch may be set on before take-off.

(*b*) If in-flight refuelling takes place ⧓ the fuselage tanks (at least) should normally be fully topped-up for the reason given in sub-para. (*a*).

(*c*) If the overload tanks have also been refuelled, transfer to the fuselage tanks cannot start until the FLIGHT REFUEL switch has been set OFF.

25 Intentional single-engine flight

Shut down and restart each engine, in turn, leaving equal fuel available for two-engine recovery.

NOTE: Intentional single-engine flight is not now permitted except for engine relighting practice.

26 Unintentional single-engine flight

If engine failure occurs, first use fuel from the failed engine's tank group by opening the inter-tank transfer valves and then closing the FNA valves of the live engine's master tanks. The FNA valves must be re-opened just before either master tank belonging to the failed engine indicates 75 lb.; the inter-tank transfer valves must then be closed. Any fuel remaining on the failed engine side will be unusable.

27 Overload fuel transfer (intentional single-engine flight)

(*a*) *Pre-mod.* 923

If the whole flight were to be made on one engine and one wing tank emptied first, the fuel remaining in the other wing tank, due to the electrical arrangement, will only transfer to one master tank normally associated with each engine (say No. 3, No. 6). This results in fuel out-of-balance which should be corrected by closing the appropriate FNA valves (No. 2, No. 5 in this case).

(*b*) *Post-mod.* 923

If mod. 923 is embodied, the electrical arrangement ensures that there is no out-of-balance on completion of transfer provided transfer has been selected from the beginning of the flight.

28 Fuel jettisoning

(*a*) Normally fuel jettisoning should take place immediately before landing and with the aircraft in a clean configuration. All non-essential services in the radio bay should be switched off. If one tank group fails to jettison fuel, open the inter-tank transfer valves; all tanks may then jettison fuel but the rate may be reduced. Extra care should be taken to monitor the fuel gauges in this case. After landing, the radio bay should be inspected for ingress of fuel.

(*b*) (i) *Post-mod.* 880 *or* 1091

Fuel jettisoning may be used throughout the flight envelope. The approximate rate of discharge is 1,240lb/min. (155 gal/min.).

(ii) *Pre-mod.* 880 *or* 1091

Fuel jettisoning may be used in emergency only, as this may result in fuel contamination of the radio bay.

(*c*) If an unbalanced fuel state results, balance the contents as described in para. 30.

WARNING: Fuel contents gauges should be monitored during jettisoning and the jettison facility switched off when 4,000 lb. of fuel remain. The auto cut-off facility should not be relied upon.

Malfunctioning

29 Fuel contents indicator failure

The most likely cause of one bank failing to indieate is oscillator failure. Setting the FUEL IND SUPPLY switch from NORMAL to CHANGE-OVER, switches in the oscillator from the other system, allowing a contents check to be made.

30 Re-balancing

NOTE: The fuel gauge pointers are not designed to come down exactly in-line.

(*a*) *Between two associated master tanks*

If malproportioning occurs between two associated master tanks and it becomes necessary to re-balance, this can be done by closing the FNA valve of the master tank with the least fuel, allowing the proportioner to draw fuel only from the other tank. The valve should be opened when balance has been re-established.

NOTE: Closing the No. 2 tank FNA valves may cause the port proportioner magnetic indicator to fluctuate. Closing No. 3 tank FNA valves may have the same effect on the starboard proportioner magnetic indicator.

(*b*) *Between port and starboard engine tank groups*

If it is required to re-balance fuel between engine tank groups, the inter-tank transfer valves must first be opened. Closing the FNA valves of both master tanks of the group having least fuel will then cause both engines to be fed from the group having most fuel. When balance has been re-established, open the FNA valves and close the inter-tank transfer valves.

WARNING: It is recommended that, pre-mod. GJ1225 no attempt to stop malproportioning be made by pressing the recuperator check button as this leads to reduction in RPM and may cause a flame-out.

31 Single proportioner failure

(*a*) If a proportioner fails, fuel will continue to be supplied to its associated engine by tank pressurisation, but contents in the associated master tanks may become unbalanced. The recuperator will discharge.

(*b*) Fuel can be re-balanced by closing the FNA valve of the associated master tank showing least fuel, re-opening when balance has been restored. If an FNA valve, on the failed proportioner side, fails to close when its master tank becomes empty, the engine will flame-out irrespective of the amount of fuel in the other master tank.

(*c*) If a reduction in RPM occurs when the proportioner fails, or if full power is not available, it can be restored by opening the cross-feed cock and allowing the serviceable proportioner to supply both engines. With the cross-feed cock open, the engines are then fed only from the two master tanks supplying the serviceable proportioner; therefore it is recommended that both the cross-feed cock and the inter-tank transfer valves be opened.

◀ NOTE: Post-mod. GJ 1225, full power should be available up to 32,000 ft. but a dead band, varying from 89%-97% RPM at low altitude and 85%-97% RPM at 30,000 ft. may be experienced. If operating above 20,000 ft. open the inter-tank transfer valves and the cross-feed cock to avoid HP pump cavitation. ▶

WARNING: The inter-tank transfer valves and the cross-feed cock must be closed before any master tank becomes empty. (75 lb. indicated).

32 Double proportioner failure

(*a*) *Both proportioners*

(i) If both proportioners fail, each engine will continue to be fed with fuel by tank pressurisation, but full power may not be available. Additionally, the engines may fail to accelerate from low RPM, in which case selecting BLC on, may restore acceleration. This is because some engines, at low fuel inlet pressure, may have sufficient fuel flow for steady running but insufficient flow to accelerate. Selecting BLC also resets the ACU (see Chapter 5, para. 5) and may make available the additional fuel required to accelerate the engine.

NOTE: Post-mod. GJ 1225, full power should be available but a dead band, varying from 89%-97% RPM at low altitude and 85%-97% RPJ at 30,000 ft. may be experienced.

(ii) Balance fuel between associated master tanks as in para. 30.

(iii) If it becomes necessary to re-balance between engine tank groups, re-balance as in para. 30.

(iv) Close each FNA valve before its associated master tank becomes empty. (75 lb. indicated).

(*b*) *One engine and one proportioner*

(i) If one proportioner and the opposite engine fails, open the inter-tank transfer valves. The remaining engine will then be fed from all tanks. Full power may not be available and the engine may not accelerate from low RPM (see (*a*) (i)).

(ii) If unbalance occurs, close the FNA valves of the tanks with the least fuel. Not more than two should be closed at one time. Re-open tbe FNA valves when balance is restored.

(iii) Close the inter-tank transfer valves before any master tank becomes empty. (75 lb. indicated.) Any fuel remaining in the tank group not associated with the serviceable engine will be unusable after the inter-tank transfer valves are shut.

(iv) Close each FNA valve before its associated master tank becomes empty. (75 lb. indicated.)

WARNING: If it seems likely that all the fuel will be required, the fuel in the failed engine side should be used first. To do this, open the inter-tank transfer valves and close the FNA valves of the live engine tank group. Open these FNA valves when either master tank on the failed side shows 75 lb.

⧓

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 3 — HYDRAULIC SYSTEMS

Contents

1 General description

(*a*) Two main hydraulic systems are fitted. One system is used to operate the flying controls and consists of two independent systems each operating its appropriate half of the twin jacks in the powered flying control units. The second main system is called the General Services system and consists of two semi-independent systems which combine to power various services for both normal and emergency operation, and others for normal operation only. Two fuel proportioners, however, are driven by their respective General Services system before the system becomes one.

(*b*) Provision is made for emergency operation of the flying controls by the General Services system through integration valves.

(*c*) A windscreen wiper has its own independent electro-hydraulic system.

2 Flying controls hydraulic systems

Each flying control hydraulic system supplies hydraulic power for operation of its appropriate jack in the rudder, tailplane and aileron powered flying control units (PFCU), the tailplane and rudder artificial feel units and the yaw damper. Both systems supply the main controls, but the artificial feel units and the yaw damper actuator are supplied from the starboard system only.

3 Flying controls systems components

(*a*) The port system is supplied by a pump on the port engine and the starboard system by a pump on the starboard engine, but both systems are similar and only one will be described.

(*b*) A pump draws fluid from a reservoir and delivers it to the system. When a pressure of 3,300 PSI is reached the pump is internally off-loaded and fluid is returned to the reservoir via a fuel-cooled heat-exchanger. The reservoir is pressurised to 28 PSI by system pressure to ensure delivery under negative G conditions and provision is also made for returning excess fluid to the General Services system if an integration valve has been opened.

(*c*) An accumulator, incorporated in the system to act as a pulse damper, is charged with air to 2,000 PSI. In the delivery line from the pump there are tappings for a connection to a pressure gauge on the cockpit starboard wall, a pressure switch for operation of the SWS and a ground connection. An additional tapping and a non-return valve are provided for the integration valve.

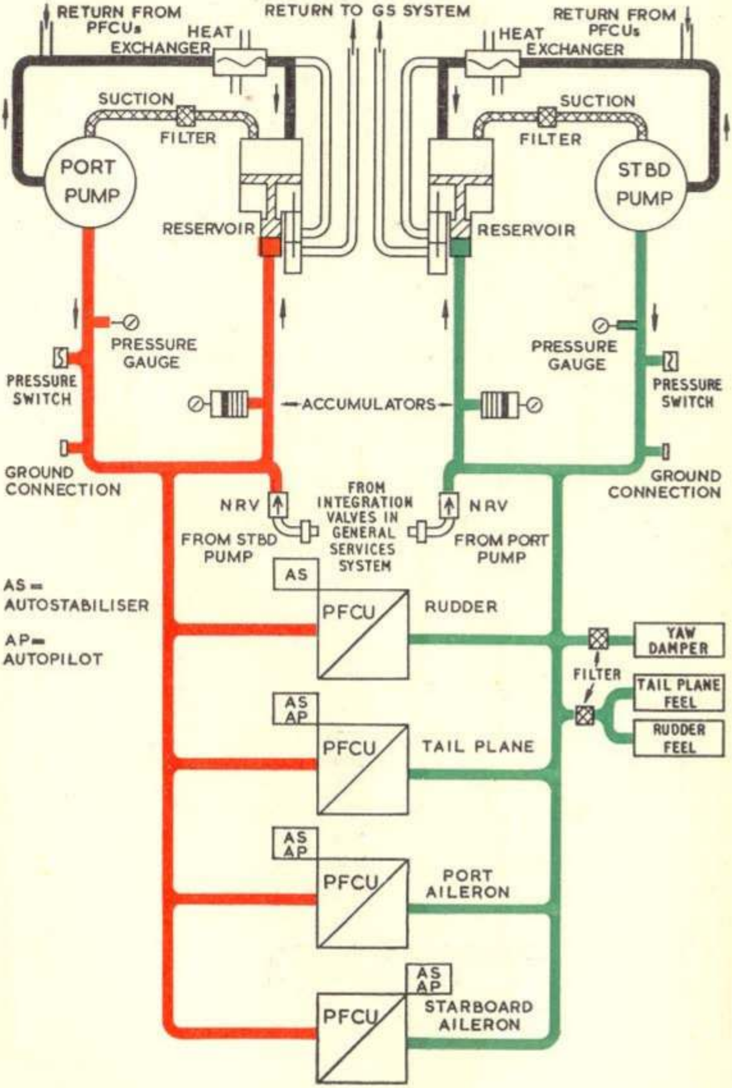


Fig. 1. Flying controls hydraulic systems

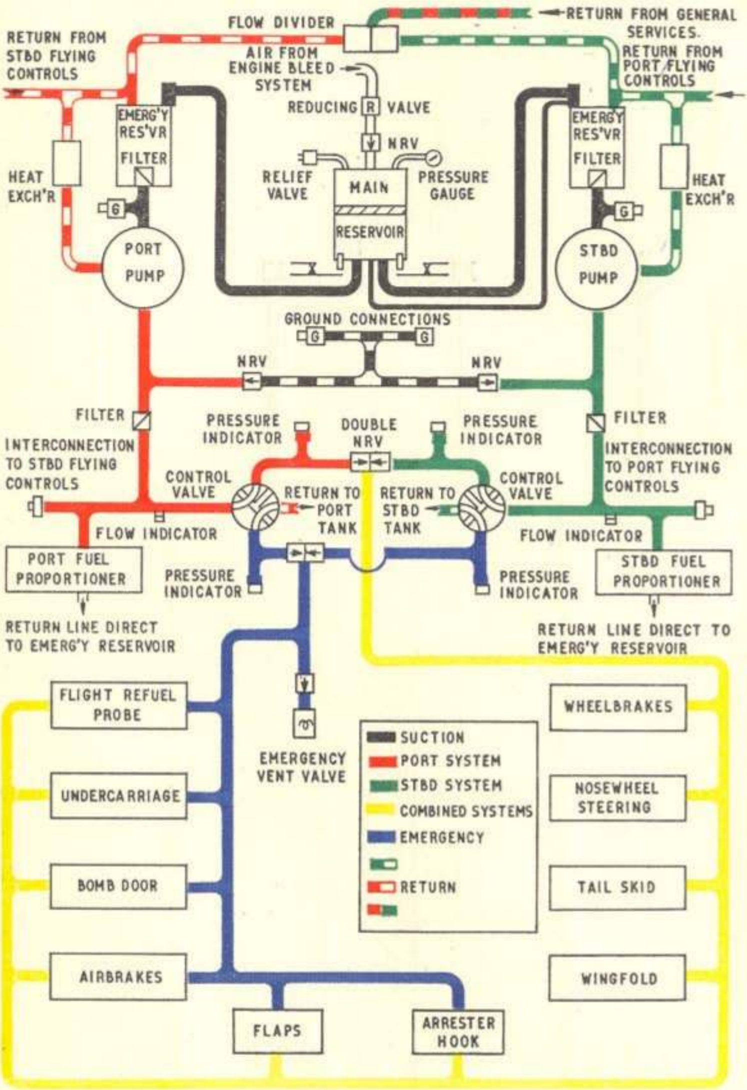


Fig. 2. General services hydraulic systems

◀Flight refuel probe pre-mod. 881 only▶

4. General Services hydraulic systems

The two hydraulic systems which form the General Services system each supply power for operation of a fuel proportioner. The systems then combine to form one system for normal and emergency operation of the flight refuelling probe, undercarriage, arrester hook, flaps, airbrakes and bomb door and, for normal operation only, of the tailskid, wheelbrakes, nosewheel steering and wingfold.

5. General Services systems components

(a) The port and starboard systems are supplied from pumps on the port and starboard engines respectively. The pumps draw fluid from separate emergency reservoirs and supply power to the system at 4,000 PSI. When this pressure is reached the pumps are internally off-loaded and fluid is returned to the reservoir via a heat-exchanger. The emergency reservoirs are themselves fed from a main reservoir which is pressurised by compressor air from the fuel tank pressurisation line. A piston separates the air from the fluid and if, due to loss of fluid this piston bottoms, it operates two contacts in the control valves circuits.

(b) Each pump's delivery line incorporates a filter through which the fluid passes before reaching its control valve. Between the filters and the control valves, tappings are taken which supply the fuel proportioners, flying controls integration valves and flow indicator (pump failure) transmitters.

(c) The control valves each have three positions, normal, neutral and emergency, and are electrically operated. They also incorporate switches for controlling a system magnetic indicator. Adjacent to each valve are two pressure indicators which indicate the position of the valve. When the valves are in the normal position, fluid is passed to a double non-return valve which combines the supplies to form a single power supply for normal operation of the general services; at the same time the emergency lines are connected to return. In the emergency position the valves pass fluid to another double non-return valve which combines the supplies to form a single power supply for emergency operation of certain of the general services; the normal lines are connected to return. When the valves are in the neutral position each pump's delivery is returned to its own reservoir.

(d) The return lines from the services culminate in a flow divider, comprising a double non-return valve, which divides the fluid, one half to each emergency reservoir. If integration has taken place, the return from the flying control system is directed into the appropriate emergency reservoir.

6. Operation of the control valves

(a) Whenever DC from the Normal busbar is available the Normal solenoids of the control valves are energised and the three-position magnetic indicator shows NORM. The supply to the valves is, however, routed through the contacts on the main reservoir and through the bomb door safety switch, so that if the switch is set safe, or if sufficient fluid has been lost from the main reservoir, the DC supply will be broken and the valves de-energised to their neutral position. The magnetic indicator will then show cross-hatching.

(b) If any of the General Services standby selectors are operated they not only select the service but also supply DC from the emergency battery to energise the emergency solenoids of the control valves and de-energise the normal solenoids if the valves were at Normal. The magnetic indicator will show EMGY.

(c) The system will remain on emergency after a standby selection until that selection is cancelled. Exceptions, provided no other standby selection has been made, are:—

1. When the bomb door reaches its locked open or locked closed position.

2. When the flight refuelling probe or the airbrakes reach their fully-in position.

7. Integration of the Flying Controls and General Services systems

In an emergency the port and starboard flying controls systems can be separately supplied from the General Services systems through the integration valves. The port General Services system supplies the starboard Flying Controls system and the starboard General Services system supplies the port Flying Controls system. The port valve is the valve connecting the starboard General Services system to the port flying controls system.

WARNING: 1. If loss of fluid causes a flying control failure, opening the associated integration valve will cause a loss of fluid in the General Services system.

2. If one flying control system is operating satisfactorily an integration valve should not be opened, except for landing.

Controls and Indicators

◀8 Flying controls system, controls and indicators

(*a*) There are no controls for normal operation of the flying controls hydraulic system. If system failure occurs a PORT and STBD, FLYING CONTROLS INTEGRATION VALVES — OPEN/CLOSE switches are provided on the standby switch panel (see para. 7).

(*b*) Two (PORT and STBD) FLYING CONTROL PRESSURE gauges are on the starboard wall.

(*c*) CON P or CON S warnings on the SWP give warning of system failure. ▶

9 General Services system, control and indicators

(*a*) Control of the General Services system is fully automatic.

(*b*) Two HYDRAULIC GENERAL SERVICES — PORT and STBD. magnetic indicators are on the starboard console; they show black when the flow from their respective pumps is sufficient for effective operation of the systems and cross-hatching at other times.

(*c*) A three-position magnetic indicator between the magnetic indicators in (*b*) above, shows the state of the General Services system. When the control valves are in their normal position, the indicator shows NORM. If the valves move to the neutral position (see para. 6 (*a*)) the magnetic indicator shows cross-hatching. If a standby selector is operated, the valves move to the emergency position (see para. 6 (*b*)) and the indicator shows EMGY.

(*d*) Two pressure indicators, for use by the ground crew, are associated with each system control valve. The indicators take the form of a pin which protrudes from a housing if the valve is in the position it indicates (either normal or emergency). When both pins of one valve are retracted, the valve is in the neutral position.

Normal Operation

10 Before starting the engines

If a DC supply is connected, the General Services three-position magnetic indicator will show NORM and the two-position magnetic indicators will show cross-hatching, the CON P and CON S lights on the SWP will be on and the flying controls system port and starboard pressure gauges will read zero.

11 After starting the first engine

The appropriate flying controls system pressure gauge will indicate the pump delivery pressure. The appropriate CON light will go out. The General Services three-position indicator will remain at NORM and the appropriate pump magnetic indicator will turn black.

12 After starting the second engine

The remaining pressure gauge will indicate the delivery pressure of the second pump in the flying controls system and the remaining two-position magnetic indicator in the General Services system will turn black.

13 Testing the systems

The flying control system can be tested by functioning the controls, checking that the indications remain normal.

Malfunctioning

14 Flying control system, single system failure

If one system fails, the appropriate pressure gauge will shown zero pressure and the appropriate CON warning on the SWP will be on. The flying controls will continue to operate satisfactorily, but possihly at reduced rate (see Pt. III, Ch. 4 for speed limitation). The integration valve should not be opened except for landing and not then if it is suspected that a fluid loss, as opposed to a pump failure, is the cause of failure, as the General Services system will eventually lose all its fluid.

15 Flying control system, double system failure

If both systems fail, e.g. one system failure and the other engine failed, both pressure gauges will show zero and both CON lights in the SWP will be on. Set to OPEN the INTEGRATION switch associated with the inoperative engine, i.e. port engine stopped, set PORT switch OPEN; the port flying controls system will then be operated by pressure from the General Services system. If the failure is due to leaks (such as splitting of a tandem jack) some of the flying controls may continue to function while fluid remains in the General Services system.

16 General Services system, single pump failure

If one pump fails, the appropriate magnetic indicator will turn cross-hatched. The control valves will remain at normal and the system will continue to be supplied by the remaining pump. All the general services, except the fuel proportioner supplied by that pump and one side of the flying controls system if the inter-connection valve had been opened, will continue to operate satisfactorily, although at a reduced rate.

◀**WARNING 1:** One fuel proportioner will be stopped (see Ch. 2, para. 32 and 33). The other proportioner's speed may be reduced when a heavy demand is made on its side of the General Services system. ▶

WARNING 2: Prior to mod. 835, which introduces filters with a larger capacity, cases have occurred where pump failure has contaminated the fluid, leading to possible failure of the second pump.

17 General Services system, double pump failure

If both pumps fail, the system will be completely inoperative and the only hydraulically-operated services available will be the flying controls.

18 Loss of fluid from the main reservoir

If the main reservoir empties, the piston will bottom and the control valves will move to the neutral position and shut down the system except for the fuel proportioners, which will continue to operate until the emergency reservoir on their side is empty. The three-position magnetic indicator will show cross-hatching. Fluid remaining in either emergency reservoir is sufficient to operate the following services when selected by their standby controls: —

Flight refuelling probe (pre-mod. 881)	— one complete cycle
◀ Undercarriage (less tailskid)	— down only ▶
Flap	— down only
* Airbrakes	— one complete cycle
* Bomb door	— one complete cycle
Wheelbrakes	— until accumulator is discharged
Hook	— down only

* If a flying control interconnection valve has been opened, the airbrakes may only be selected out if it is required to operate the remainder of the emergency services.

If a flying control interconnection valve has been opened, the bomh door should not be operated if it is required to operate the remainder of the emergency services.

NOTE 1: If an emergency selection is made, the whole system will remain on emergency except when the flight refuelling probe or the airbrakes reach their fully-in position, or the bomb-door reaches either the open or closed position. If, however, an emergency selection of the flaps, hook, or undercarriage is cancelled, the system will then revert to normal. The undercarriage emergency down selection can be cancelled by pressing the normal down button. This should not be done until after touch-down, as hydraulic pressure will be removed from the down locks, and then only if brake pressure is getting low during the landing run. Reverting the system to normal will allow the brake accumulator to be re-charged.

NOTE 2: If, due to loss of fluid, the piston in the main reservoir has bottomed, causing the control valves to move to the neutral position (MI cross-hatched) it cannot be reverted to normal and Note 1 will not, therefore, apply.

◀ NOTE 3: With the system at emergency there is no nosewheel steering, neither will the tailskid lower. ▶

19 DC power failure

If the normal DC supply fails, the General Services system selector valves will move to the neutral position and the three-position magnetic indicator will show cross-hatching. It is not possible to tell if the failure is due to the reservoir piston bottoming (see para. 5 (*a*)) or to fuse failure. The emergency services quoted in para. 17 should be used with discretion in order to preserve the emergency battery. If the emergency battery also fails, the General Services system, except for the fuel proportioners, will be completely inoperative.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 4 — ENGINE AIR-BLEED SYSTEM

Contents

1 Air-bleed system, general description

(*a*) Both engines supply air for a common system which supplies air for boundary layer control and certain General Services. The latter are: —

Windscreen rain clearance.
Pressurisation of the main hydraulic reservoir.
Pressurisation of the fuel tanks and the recuperators.
Operation of the fuel no-air valves.
Conditioning of the radio bay.
Operation of the air turbo-alternator.

NOTE 1: Aerofoil anti-icing has been rendered inoperative, therefore, although the control switch markings remain, all other references have been deleted. ▶

NOTE 2: Although supplied from both engines, the air for cockpit pressurisation and conditioning and for engine anti-icing, is taken from different tappings round the combustion chambers and is not part of the air-bleed system as such, refer to Chapters 10 and 11 respectively.

NOTE 3: The general services air supply is always on.

(*b*) The air-bleed system is supplied through two duct tappings, one large and the other small, in an air-bleed muff round the aft end of each combustion chamber. All tappings feed into a large-bore cross-feed duct. The large duct tappings each have their own shut-off valve. When the engine(s) are running the small duct(s) maintains a continuous supply of air for the general services; the large ducts shut-off cocks are closed. If BLC is required the shut-off valves should first be opened (by switch selection — see para. 4 (*a*)) before the required service is selected. Selecting BLC, electrically de-energises to open, the solenoids of the two engine turbine cooling valves, one on each engine. It also resets the acceleration control datum, allowing a greater fuel flow. The valves are opened fully by the time engine RPM are 75% and when this occurs, they operate a micro switch which resets the maximum JPT datum, allowing a higher maximum JPT.

◀2 Boundary layer control valves

Air for boundary layer control is supplied to the outer mainplane leading edge through two valves, one to each side. Two other valves supply the aileron and flap shrouds, one to each side, and a further valve supplies the tailplane leading edge. The valves have a main and a standby solenoid and for Normal operation both are energised, from the Normal busbar. For Emergency operation only the standby solenoid is energised, from the Emergency busbar.

3 Function of valves

When blow is selected the engine supply shut-off valves are de-energised to open. When boundary layer control is selected the outer mainplane leading edge valves (two), the flap and aileron shroud valves (two) and the tailplane leading edge valve, all open fully.

4 Controls and indicators

(*a*) *Engine blow valves control*

The main control is an ENG. BLOW VALVES — OPEN/SHUT switch on the starboard switch panel. When this switch is set to open, it de-energises the supply shut-off valves to open.

(*b*) *Blowing system control*

The main control for the blowing system is a BLOWING SYSTEM — OFF/AUTO switch which has toggle locking in both positions. When at AUTO, blow is switched on automatically when the ailerons are drooped more than 5° (see Chapter 6), by operation of two micro switches. If the engine blow valves have not already been opened, operation of the micro switches also opens these, but this practice should be avoided (see para. 5 (*a*)). A guarded SUPPLY — NORMAL/EMERGY switch, adjacent to▶

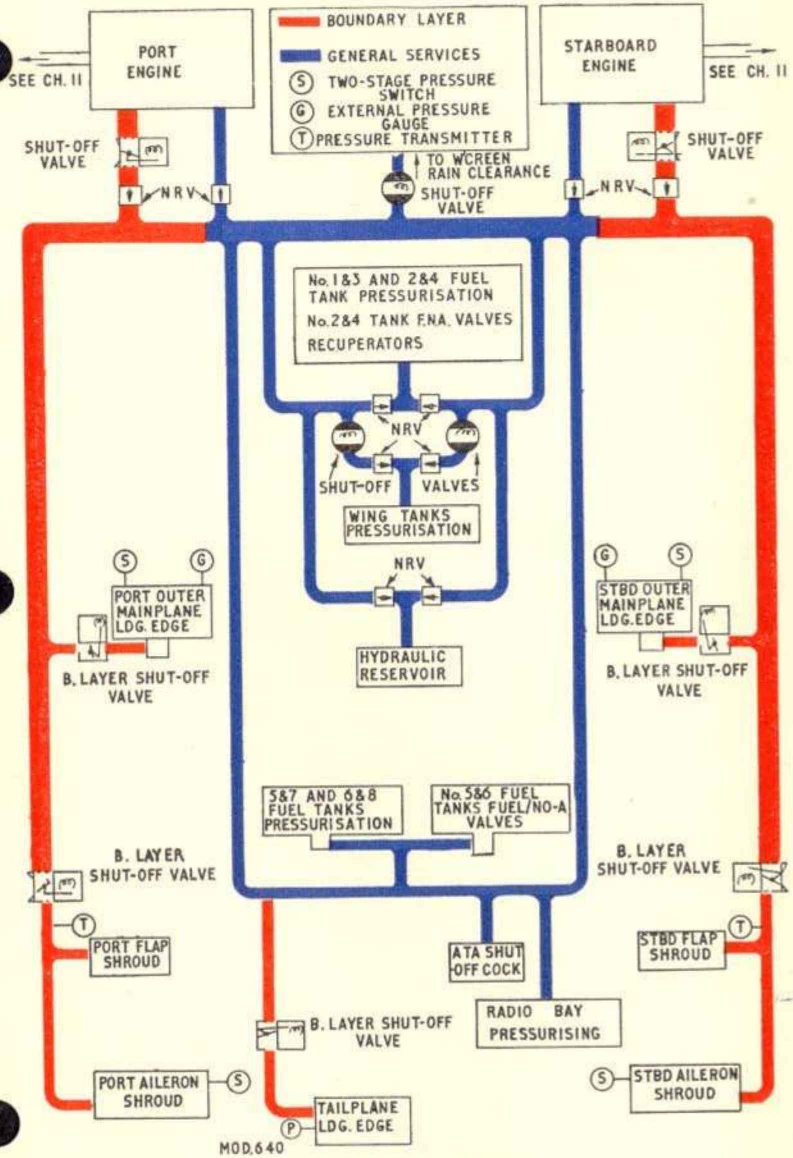


Fig. 1. Engine air bleed system

the BLOWING SYSTEM switch, selects the DC supply from the Normal or the Emergency busbars, respectively.

(*c*) *Pressure gauges/test connections*

Post-mod. 734 external pressure gauges are fitted in the mainplane tips at the leading edge, and test connections are at the mainplane tips trailing edge and the mainplane tips leading edge. Pre-mod. 734 all these positions had external gauges.

(*d*) *Magnetic indicator*

A BLOWING SYSTEM magnetic indicator on the port side of the instrument panel, shows LOW, HIGH, or cross-hatching. The latter indicates that the system is in-operative and HIGH indicates that there is at least the minimum take-off pressure in the system. LOW indicates that there is at least minimum landing pressure. The indicator is operated by four two-stage pressure switches, wired in series so that insufficient pressure at one surface is sufficient to change the indication. The pressure switches are one in each aileron shroud and one in each outer mainplane leading edge. Pressure transmitters, one in each duct to the ailerons, operate the BLOWING SYSTEM — PORT WING and STBD WING pressure gauges on the port wall, immediately aft of the wheel-brakes triple-pressure gauge.

(*c*) A tailplane blow magnetic indicator is adjacent to the blowing system indicator. It turns black when the pressure is at least the minimum required and at other times is cross-hatched.

WARNING: In some early aircraft with a black and white two-position indicator, it shows white when there is sufficient pressure and black at other times.

(*f*) *Test switches*

(i) Two BLOWING SYSTEM CIRCUIT TEST switches labelled MAIN — ON/OFF and STANDBY — ON/OFF, and spring-loaded to ON, are aft of the port console. If the blowing system is ON, holding the MAIN switch OFF de-energises the main solenoids of the blowing and turbine cooling valves and the fuel datum reset; this checks the standby valves. Operation of the STANDBY switch is similar. If the MAIN switch is held OFF and the DC SUPPLY switch is set to EMERGY, the standby solenoids emergency supply is tested.

(ii) Prior to mod. 828 being embodied, a single three-position MAIN/FLIGHT/STANDBY switch was fitted instead of the two two-position switches.

(*g*) Two ENGINE TURBINE COOLING — PORT/STBD. magnetic indicators are on the pilot's cockpit starboard wall, forward. Each indicator shows black when its turbine cooling valve is open, white when the valve is closed, and cross-hatching when the valve is in transit or the DC is disconnected.

5 Normal management of the air-bleed system

(*a*) The General Services, with the exception of windscreen rain clearance, are supplied with air whenever an engine is running, but to ensure that an adequate supply is maintained when the blowing system is selected the ENG BLOW VALVES switch must be set to OPEN at least 2 seconds before MANUAL is selected on the BLOWING SYSTEM switch or before aileron droop takes place, if the BLOWING SYSTEM switch is selected to ◀AUTO. For the same reason the engine blow valves switch must not be set to CLOSE until BLC has been switched off for 20 secs. or until the engine turbine cooling valves are fully closed. ▶

(*b*) If blow is selected when the wings are folded, deterioration of the wing-fold joint seals and a hazard to personnel will result.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 5 — GYRON JUNIOR Mk. 101 ENGINE SYSTEMS

Contents

1 Engines, general description

The two Gyron Junior Mk. 101 engines each have an 8-stage axial flow compressor and a two stage axial flow turbine. The incidence of the compressor inlet guide vanes and first row stator blades is varied according to engine speed and intake temperature. The engines are designed to provide a substantial flow of air for boundary layer control, engine de-icing, fuel tank pressurisation and various cockpit services in addition to its normal function. A Dowty spill-type fuel system controls each engine automatically and the only manual controls are the combined throttle and HP cock levers. For starting purposes an LP air starter on the front of each engine is supplied with air from a Palouste engine which is automatically controlled through the starting circuits.

2 Engine fuel system

Simply, control of an engine is obtained by controlling the flow of fuel entering the combustion chamber through the cone apex of each burner, by spilling fuel from the base of the burner and returning it to the low pressure side of the HP pump. Control is achieved through a spill valve, in the spill line, which increases or decreases the spill flow, thus decreasing or increasing the fuel flow into the combustion chamber. The fuel control system is comprised of sub-units, all housed together and known as the fuel metering unit, as follows: — HP pump, HP cock, maximum speed governor and top temperature control, all speed governor, spill valve and acceleration control, low pressure control valve, minimum pressure valve and high pressure and low pressure filter.

3 HP pump

The engine-driven plunger-type pump has a fixed stroke and delivers fuel to the burners at a rate proportional to engine speed. It also provides fuel pressure for operating the spill valve servo system. The pump supplies the spill-type burners via the HP cock and the minimum pressure valve.

4 Spill valve

The spill valve is in the spill line between the burners and the inlet side of the HP pump. Its function is to control the fuel flow into the combustion chamber as required by the settings of the throttle and the automatic controls. The spill valve is actuated by a piston whose position is determined by the relative values of high pressure fuel and servo pressure fuel, acting one on each side of the piston. The HP fuel has a smaller working area than the servo fuel and under steady running conditions the piston is held steady, positioning the spill valve to give burner discharge suitable for the selected engine speed. If the throttle is operated, or the automatic controls operate, servo pressure is modified, by increasing or decreasing servo flow past the ball valves, causing the spill valve to take up a new position, resulting in a change in burner discharge. Spill valve movement towards fully open, i.e. minimum fuel flow into the combustion chamber, is arrested by a minimum flow stop. This results in an increase in idling RPM above about 15,000 ft. and at about 35,000 ft. the idling speed will be in the region of 80% RPM.

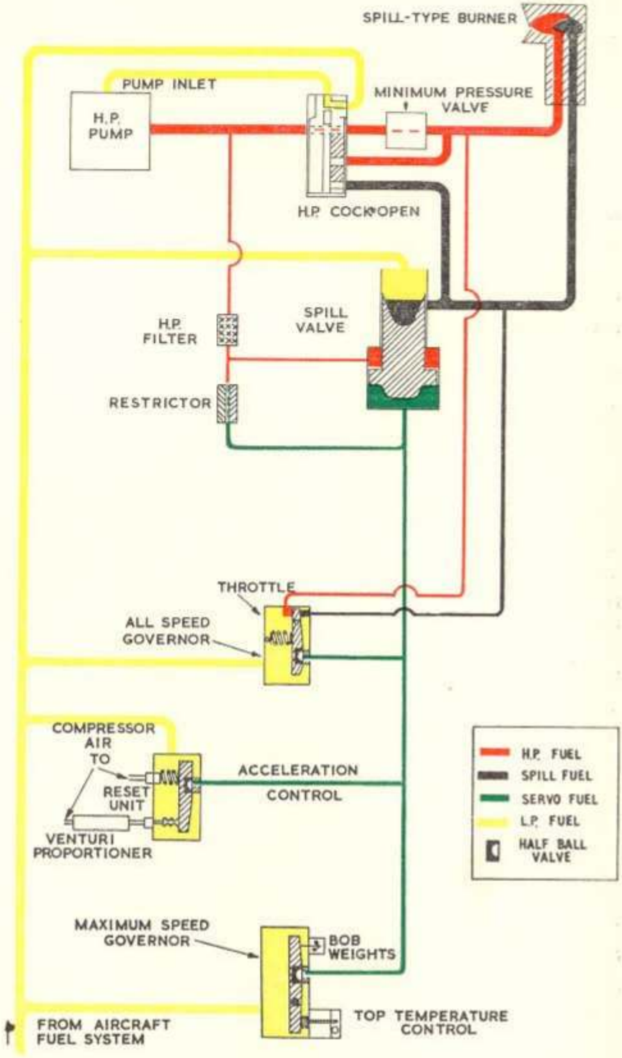


Fig. 1 — Engine fuel system servo control (simplified)

5. Acceleration control

The acceleration control is part of the spill valve unit and varies servo pressure according to compressor air pressure. To suitably reduce the operating air pressure and, at the same time, ensure that the working pressure is always proportional to compressor air pressure, a venturi proportioner is provided in the air line. When boundary layer control is in use, additional fuel is required in the combustion chamber (see Chapter 4). To provide this, an acceleration reset control resets the datum of the acceleration unit. When boundary layer control is switched on a double datum control valve is opened, allowing compressor air to enter the acceleration reset unit and increase the loading on the acceleration control arm, ensuring a greater movement of the spill valve (to close) before equilibrium is reached.

6. All speed governor

The all speed governor houses the throttle and maintains a constant engine speed at any given throttle setting (except minimum setting, see para. 4), irrespective of altitude. This is achieved by modifying servo pressure through opening or closing a servo ball valve. Opening the throttle spring-biases (to closed) the servo ball valve. This increases servo pressure, moves the spill valve towards the closed position, reducing spill and increasing burner discharge into the combustion chamber. As the engine speeds up the pump pressure increases and this, acting on the servo ball valve operating lever, tends to open the valve, reducing servo pressure until the RPM is the correct equivalent of the throttle setting.

7. Maximum speed governor and top temperature control

(a) The engine maximum speed is automatically restricted by bobweights driven from the HP pump drive. As engine speed increases, centrifugal movement of the bobweights is transmitted through a lever which allows a half ball valve to become unseated. This reduces servo pressure, increasing the opening of the spill valve and reducing burner flow into the combustion chamber.

(b) The top temperature control is housed in the above unit and acts on the same lever controlling the half ball valves. It is controlled by thermo-couples in the jet-pipe.

When buundary layer control is switched on, the temperature datum is automatically reset to allow an increased JPT to be reached, before the ball valve starts to open.

◀(*c*) Pre-mod. 1192 the datum reset is de-energised to low datum and, if DC fails the high datum is not selected when BLC is selected. Post-mod. 1192 the datum reset is de-energised to high datum which is then automatically set if DC fails. Micro switch failure can now result in the high datum being set with the turbine closing valves closed. ▶

8 HP cock

The HP cock on each engine is controlled by the first movement of the combined HP cock and throttle lever, on the port console. When a cock is open, low pressure fuel passes to the HP pump and high pressure fuel from the pump is passed to the burners. When a cock is shut, high pressure fuel from the HP pump is returned to the fuel tanks, the low pressure supply to the HP pump inlet is cut off and ports are opened to allow the HP pump to withdraw fuel from the high pressure line to the burners and from the burner spill lines. This ensure a clean cut and that no fuel dumping occurs.

9 Minimum pressure valve

The minimum pressure valve between the HP cock and the burners is a spring-loaded piston-type valve. Its function is to prevent the supply of fuel to the burners when HP pump pressure is insufficient to operate the servo system and supply the burners. When this valve shuts, on engine shut-down, a by-pass line allows the withdrawal of fuel from the burner line. See para. 8.

10 Variable incidence guide vanes

The incidence of the compressor inlet guide vanes and the first row of stator blades are varied automatically, depending on engine speed and intake temperature, in a possible range from 68 to 94% RPM, depending on intake temperature. A variable-stroke plunger-type fuel pump supplies fuel pressure to operate two hydraulic jacks attached to the operating mechanism and a follow-up movement ensures progressive movement of the vanes. The system is similar to the engine fuel system in that servo pressure, which controls the pump stroke, is used to oppose pump pressure on the jacks. The servo pressure is modified by a temperature unit and by a bob-weight control driven from the fuel pump. The position of the vanes is shown on an indicator on the instrument panel.

11 Air-bleed system

The air-bleed system provides a continuous supply of air for operation of the ATA, fuel tank pressurisation, etc., and, on demand, air for boundary layer control (see Chapter 4). When a demand for boundary layer control is made, additional fuel is fed to the combustion chamber by resetting the ACU and a higher top temperature is permitted, by resetting the top temperature control. The higher temperature requires increased turbine cooling and this is provided through a turbine cooling valve which opens automatically when the demand is made. Three-position magnetic indicators show black when the valves are open, white when shut and cross-hatching at other times.

12 Oil systems

(*a*) Each engine has its own self-contained oil system. A pressure pump in the sump draws oil from a reservoir located round the air intake casing and delivers it, via a filter, to the front and rear bearings, the centre housing, air starter, fuel pump and overspeed governor. All oil, except that supplied to the rear bearing, returns to the sump by gravity and is then returned to the top of the reservoir by a scavenge pump. A separate pump returns rear bearing oil to the reservoir.

(*b*) The reservoir has two sight-glasses, one on each side, which show the oil level; they are marked from 21 PINTS (MIN) to 24 PINTS (MAX). A pressure refuelling connection is at the lower port side of the engine and a gravity refuelling cap is at the top, starboard side. A pressure switch on the delivery side of the pressure pump operates an OIL PRESSURE magnetic indicator on the starboard side of the instrument panel. It shows black when the oil pressure is above 9½ PSI.

13 Engine starting, general

Each engine is turned by the LP air starter on the front of the engine, supplied with air from a Palouste engine. The air delivery hose connections and the electrical sockets are in the lower part of each engine cowling and once the Palouste has been started and connected to the engine it is under the control of the starting cycle. Starting is initiated by pressing the required ENGINE START — PORT or STBD. guarded pushbutton at the rear of the port console. Each engine has two igniter plugs, each one supplied by a separate high energy ignition unit.

14 Engine starting, operation

With the battery master switch on, pressing an ENGINE START pushbutton completes an electrical supply to: —

1. Wind up the time switch.
2. Operate the HE ignition units.
3. Energise an acceleration valve and open an air supply valve on the Palouste.

NOTE: There is no DC supply to the start button unless the battery master switch is ON, i.e. the isolating relay energised.

The LP starter is supplied with air and turns the engine, light-up occuring at about 17% RPM, i.e. after about 12 seconds. After 21 seconds the time-switch breaks the supply to the Palouste, closing the acceleration valve which causes it to reduce to idling speed, and the air supply valve. At the same time the supply to the HE ignition units is disconnected. If about 32% RPM is reached within 21 seconds, an overspeed switch opens, to terminate the starting cycle as above.

WARNING: If light-up does not take place at the first attempt to start, the time switch must be allowed to run its full 'cycle' of 32 seconds before a second attempt is made. If light-up fails to take place after 2 attempts the collector box in the base of the engine must be drained.

15 Engine relighting

An ENGINE RELIGHTING pushbutton is on the forward face of each throttle lever. Pressing a button completes the circuit to both HE igniter units. Both igniter units are also energised automatically when the armament firing trigger switch is operated, providing the armament selector switch is at ROCKETS or BULLPUP.

16 Engine instruments

(*a*) Two percentage RPM indicators, one for each engine, are on the starboard side of the instrument panel. 100% represents 9,200 RPM.

(*b*) Two jet-pipe temperature indicators, one for each engine, are below the RPM indicators. Each indicator is operated by four dual thermo-couples in the associated jet-pipe.

(*c*) Two inlet guide vane indicators, one for each engine, are below the JPT indicators. Each indicator is controlled by a Desynn transmitter connected by a lever to the guide-vane on the port lower side of the appropriate engine.

(*d*) Two oil pressure magnetic indicators, one for each engine, are below the inlet guide-vane indicators. Each is operated by a pressure switch on the delivery side of the oil pressure pump.

17 Engine starting considerations

(*a*) The engines are normally started by using the Palouste starting trolley, witb a ground electrical supply plugged in. However, if a Palouste pod is carried on a pylon, the parent aircraft's engines or the engines of another aircraft may be started using the pod in position.

(*b*) The battery master switcb must be ON.

(*c*) Unless a DC ground supply is plugged in, the type 107 inverter cannot be run and the fire warning system will then be inoperative.

18 Engine anti-icing systems

For engine anti-icing systems, refer to Chapter 10.

19 Engine fire-protection systems

For engine fire-protection, refer to Chapter 13.

20 Jet-pipe temperature/power indications

The jet-pipe temperature's indication of minimum power for take-off can vary considerably from engine to engine and the acceptable ranges for blown and unblown take-off are, therefore, marked on each JPT indicator. Factors affecting the JPT wbich are considered during the engine run before marking the gauge for a particular engine are: —

Idling and maximum RPM

Variation from ISA conditions

Relative wind

Whether engine has been opened up beyond 60% RPM in last 5 mins.

Slam acceleration time from 42% to max. RPM. The JPT reading must be taken within 5 secs. of reaching max. RPM.

Air-bleed conditions, ATA on-line and electrical loading, anti-icing and de-misting off

Cabin pressurisation off

BLC on or off as appropriate to type of take-off and engine turbine cooling valves in their correct position.

If BLC is on, both engines are run simultaneously so that one half air-bleed is from each engine.

21 Thrustmeters

A thrustmeter on the instrument panel indicates thrust in terms of pressure ratio. The meter is marked from 1 to 3·5 and the particular engine is selected by an ENGINE THRUST — PORT/STBD switch below the meter. Differential pressure is derived from a pitot head in each jet-pipe and a static vent in each intake casing.

Malfunctioning

22 IGV malfunctioning

(*a*) Failure of the IGV's to function satisfactorily is indicated by an incorrect setting for the RPM set, or by their failure to move during throttle operation within the IGV operating range. The engine fails to accelerate and the JPT rises rapidly.

(*b*) If the IGV's fail fully open in the range 84-88% (approx.) it may be possible to obtain maximum RPM and full thrust if the throttles are opened carefully. If the engine will not accelerate, maintain the highest RPM possible, but remaining within the JPT limitations.

(*c*) If the IGV's fail fully open at an RPM* below 84% (approx.) it will not be possible to accelerate the engine. Maintain the maximum obtainable within the JPT limitations. If the failure occurs at idling RPM, not more than 60% will be available, retain the engine in use for the services it provides.

(*d*) If the IGV's fail fully closed, maximum RPM will be available but this will not produce more than about 50% thrust. The JPT will be low.

conventional controls or, electrically hy the actuator, on signals from the autopilot system.

3 PFCU operation

(*a*) *Manual demand*
A control demand made hy the pilot is taken, mechanically, to the control valves, which open to admit fluid to the appropriate side of the jacks; movement of the jack then drives the appropriate control surface. A mechanical follow-up movement closes the valve when the correct control surface position is reached.

(b) *Autostabiliser system demand*
A signal from the autostabiliser system is taken electrically to the actuator which, in turn, moves the control valves. Although the mechanical follow-up movement is still operative an electrical feed-back is also provided to control the position of the actuator.

(*c*) *Autopilot system demand*
A control demand made by the autopilot system is also taken electrically to the actuator which, in turn, moves the control valves. In this mode the mechanical follow-up is inoperative and an additional electrical feed-back is provided to control the position at which the actuator returns to neutral and closes the control valves.

4 Artificial feel

(*a*) To provide feel during application of aileron, tailplane, or rudder, douhle-acting spring units are incorporated in the control linkages to the control valves of the PFCU's. As the pilot's controls are displaced from the neutral position an increasing force is required to overcome the springs.

(*b*) To give additional feel relative to airspeed, for the rudder and tailplane only, a hydraulically-operated feel unit is incorporated in each of their controls runs. This unit comprises a feel simulator control and a hydraulic jack. The feel simulator control meters fluid to the jack under the control of pitot and static pressure, so that movement of the jack resists the pilot's control movement. The resistant force increases in proportion to the square of the speed. To give additional resistance to control movement from neutral, on the ground, the feel simulator control passes a base pressure even when there is no pitot pressure.

5 Rudder and aileron trim

(*a*) Trimming of the rudder and ailerons is effected by two actuators, one connected to each control system by a lever and a double-acting spring link (see 4(*a*)). By altering the position of the spring link lever, the neutral position of each control can be moved, to give the necessary trim.

(*b*) The actuators are controlled by a RUDDER AILERON TRIM control on the port console. Rotary movement of the control operates two micro switches controlling the rudder trim actuator and lateral movement operates the two switches controlling aileron trim. The control is spring-loaded to the central position. Simultaneous operation of both trimmers is not possible.

(*c*) The rudder and aileron trim indicators are on the port console, forward of the throttles. The rudder indicator shows a plan representation of the aircraft relative to the fore-and-aft line, and the aileron indicator shows a pictorial representation of tbe aircraft (in roll) relative to the horizon.

6 Tailplane and tailplane trim

(*a*) (i) The incidence of the all-moving tailplane is varied through a maximum range of 28° by combined movement of the control column and a datum sbift trimmer. Its position is shown on a TAILPLANE indicator on the port console which has markings every two degrees from 8° NOSE DOWN to 20° NOSE UP. Note that the NOSE UP and NOSE DOWN markings refer to aircraft attitude and not tailplane incidence. A yellow sector between 2° and 4° nose-up indicates the nominal take-off limits. The authority of the control column is dependent upon the trim applied; the relationship is shown below:

Total movement of tailplane	8° nose down to 20° nose up.
Total movement by control column (with 4° nose up trim)	12° nose down to 10° nose up.
Total movement by trimmer	4° nose down to 13° nose up (pre-mod. 1123)

It follows tbat if the tailplane is trimmed to 13° nose up and the control surface can only move to 20° nose up, then the available nose up control column authority is $20° - 13° = 7°$. Similarly, if the tailplane is trimmed to 4° nose down, then the available nose-down control column authority is $8° - 4° = 4°$.

NOTE: With the control column in the neutral (no force) position, the applied trim is shown on the indicator.

◀ (ii) When mod. 1123 is embodied, although tailplane movement remains the same the maximum nose-up tailplane trim is reduced to 9° nose up, then the available nose up control column authority is $20° - 9° = 11°$. ▶

(*b*) The tailplane is trimmed by the datum shift metbod in which a twin-motor actuator, connected to the control run, varies the tailplane angle without moving the control column, i.e., the neutral (no force) position of the control column, indicated by a pointer on the control column slide, is constant, irrespective of the trim applied. The normal motor in the trim actuator is controlled by fore-and-aft movement of four single-pole linked switches on the control column. The integrity of the circuits can be tested by pulling out the outer actuating lever and then operating each lever independently; the actuator should not run.

(*c*) The auxiliary motor in the trim actuator is controlled by a STANDBY TAILPLANE TRIM — NOSE UP/NOSE DOWN double-pole switcb on the port console. The DC supply to this switch is from the emergency busbar.

(*d*) An oil-filled damper is also incorporated in the control run.

7 Aileron gear change unit

An aileron gear change unit in the aileron control run to the PFCU's, is controlled by an AILERON GEAR CHANGE, PULL FOR LOW SPEED control on the starboard console. When set (down) to high speed, full aileron travel of ± 12½° (post-mod. 793) is obtained with full stick travel; pre-mod. 793 full aileron travel of ± 17½° is obtained with full stick travel. When pulled up for low speed full aileron travel of ± 17½° is obtained with full stick travel pre- and post-mod. 793.

Autopilot System

8 Autopilot system, general

(*a*) (i) The autopilot system is fully integrated with the flying contol system. It provides sbort period autostabilisation of the aircraft in the pitch, roll and yaw axis (autostabilisation — manual mode) and this facility is normally in operation at all times, thus augmenting the aircraft's natural stability. To provide stability in yaw if the yaw channel fails, a yaw damper, not normally in operation, is provided (see para. 12).

(ii) The system also provides, in the autopilot mode, Mach and heading locks, a barometric beight lock.

(*b*) *Safety devices*

Four safety devices, one manual and three automatic, are provided to prevent autopilot run-away causing aircraft structural failure; operation of any safety device gives an AP warning on the SWP. The manual device is an instinctive cut-out button on the control column; automatic protection is provided by limit switches on tbe tailplane and aileron. Tailplane run-away is limited to $+\frac{3}{4}°$ to minus $1\frac{1}{2}°$ and aileron run-away is limited to $\pm 3°$ ($\pm 2°$ post-mod. 670); in addition single aileron run-away is prevented by two differential limit switches; if any of the safety devices operate both autopilot and autostabiliser modes will be disengaged.

9 Autopilot computer

(*a*) The autopilot computer is the heart of the autopilot system and its function is to effect all data storage and, after computation, to make the necessary switching required for the autostabilisation and autopilot modes, thus controlling the PFCU actuators. The power requirements are 28V DC from the normal busbar and 3-phase AC from the 200V busbars.

(*b*) The computer receives data from the following sources: —

Air data system
MRG
Compass

10 Autostabilisation/manual mode

(*a*) In this mode, three rate gyros, one each for tbe pitch, roll and yaw channels are employed. Signals produced by angular rate of movement are fed to a computer, where they are amplified and then fed to the actuators of the PFCU, as appropriate, to move the control surfaces. As

◀the control surface movement required is dependent on airspeed, provision is made for pilot selection of either high or low speed gearings in the yaw and roll channels. The normal flying controls remain operative when the auto-stabiliser channels are engaged.

(*b*) Channel selection is made from a panel under the instrument panel shroud, starboard side, containing three switches, one each for the YAW, ROLL and PITCH channels; the switches have three positions, APPROACH/OFF/HIGH SPEED. Providing the adjacent ICO RESET pushbutton has been pressed, operation of the auto-stabiliser channel selectors will engage their respective channels, except in the case of the pitch channel where switching to either HIGH SPEED or APPROACH engages the one pitch gearing available. The channels will be disengaged automatically if the ICO pushbutton on the control column is pressed.

11 Autopilot mode

(*a*) The autopilot mode provides three facilities additional to autostabilisation, namely height lock (barometric) or Mach lock and heading lock. Switching from Mach lock to height lock mode or vice versa with the autopilot engaged is not effective; if such changes of mode are desired, the autopilot must be disengaged and the required mode selected before the autopilot is re-engaged. The selection of heading lock can only be made after engagement of the autopilot in either height lock or Mach lock modes. Upon engagement of the heading lock mode, the roll and yaw autostabiliser HIGH SPEED channels automatically become operative irrespective of the autostabiliser channel selector position; as does the autostabiliser pitch channel when either height lock or Mach lock modes are engaged.

NOTE: The aircraft must be flown manually to the correct height, Mach No. or heading and then retrimmed, before the appropriate channel is engaged.

(*b*) The autopilot controller is on the pilot's starboard console and contains five toggle switches, one magnetic indicator and a pushbutton. In addition, three pushbuttons are on the control column aod a toggle switch is▶

◀on the port console. The function of the switches is as follows:—

Controller

ICO RESET pushbutton	Used as a power switch for the whole system and is also used to clear autopilot warnings on the standard warning system. In addition it is used to re-energise the circuits after operation of the instinctive cut-out or after operation of any of the automatic safety cut-outs.
AUTOPILOT switch ...	used as an ON/OFF switch for the autopilot mode. The switch must be on, before engaging the autopilot by pressing the engage pushbutton.
HEADING ON/OFF switch	To engage the heading lock.
HEIGHT/MACH switch	To select and engage the height or Mach channel.
PRIMARY ATTACK ON/OFF switch ...	Inoperative.
RADIO ALTIMETER ON/OFF switch ...	To engage radio altimeter monitoring of the height lock.
Autopilot magnetic indicator	Shows black when the autopilot is engaged and white at other times.

Control column

ICO pushbutton ...	Instinctive cut-out for disengaging the whole autopilot system, including the autostabilisers.
ENGAGE pushbutton ...	To engage the autopilot mode after appropriate switch selection on the controller.
DISENGAGE pushbutton	To disengage the autopilot mode but not the autostabiliser. ▶

Port console

AUTOPILOT HEADING ON/OFF switch ...	This switch, in addition to the HEADING switch on the controller, must be ON to engage the heading channel.

12 Yaw damper

A yaw damper is provided to improve damping of the lateral and directional oscillations of the aircraft when the autostabiliser yaw channel is inoperative. An electrical actuator, attached to the rudder control run, is controlled by a rate gyro which detects any change in rate of yaw and transmits a signal to the actuator via an amplifier. The actuator moves the rudder controls, applying a force in opposition to the oscillation. The yaw damper is controlled by a YAW DAMPER — ON/OFF switch on the pilot's instrument panel, inboard of the autostabiliser switches.

NOTE: There is no yaw channel failure warning, and it is extremely difficult to detect a failure on the ground.

13 Management of the autopilot system

(*a*) *Before flight*

After AC and DC power is available, operate the ICO reset button to apply power to the autopilot system; the AP warning on the SWP should clear. Engage the autostabilisation mode by setting the YAW, ROLL and PITCH switches to HIGH SPEED.

⧓

Set ON the AUTOPILOT switch.

NOTE: Autostabilisation normally remains engaged throughout the sortie; it will become disengaged, however, if the ICO button on the control column is pressed.

(*b*) *General handling*

(i) In all modes, the rate of application of bank must not exceed 10°/second.

(ii) Longitudinal trim (tailplane) must not be used in turning flight.

(iii) Longitudinal trim must be maintained within $\pm\frac{1}{4}°$ in straight flight below 5,000 ft.

(iv) The autopilot modes must not be used if the radio bay temperature exceeds 60°C. (70°C wben mod. 1019 is embodied.)

(v) *Heading hold*
A datum shift may occur on engagement. The hold is unreliable and may deteriorate, especially in low level, high-speed flight. The limiting bank is $22\frac{1}{2}°$.

(*c*) *Climb*

Select Mach lock by setting HEIGHT/MACH switch to MACH. Select heading lock by setting ON the HEADING switch and the AUTOPILOT HEADING switch on the port console.

NOTE: The leading lock cannot be engaged unless either the HEIGHT or MACH lock is engaged.

Trim the aircraft for stable flight between 0·75 and 0·85M and, at not less than 3,000 ft., engage the autopilot by pressing the ENGAGE button on the control column; MI turns black.

NOTE: The maximum height for use of Mach lock is 30,000 ft.

(*d*) *Height hold*

(i) *Barometric height lock between* 400 *and* 4,000 *ft*.
In VMC, by day only, over the sea, in the range 0·70 to 0·85M.
The autopilot must be disengaged for turns below 1,000 ft., except for minor turns of up to 10° bank for aiming during an attack.
Radio height lock not being available, great care is necessary in selecting the initial datum height.

WARNING: Atmospheric pressure changes will give a corresponding cbange in actual height bold, therefore continuous monitoring of height is essential.

(ii) *Barometric height lock between* 4,000 *and* 27,000 *ft*.
in the range 0·70 to 0·84M.
Limiting angle of bank 45°.
Speed variations should not exceed ± 30 knots.

NOTE: With the barometric height lock engaged, excursions greater than ±20 ft. (below 2,000 ft.) or ±5% (above 2,000 ft.) are failure cases. Disengage the autopilot.

(*e*) *Descent*

(i) With Mach lock engaged, 0·70 to 0·85M from 30,000 to 5,000 ft.

(ii) During descent in Mach lock, the flight path may be erratic.

(iii) Mach lock must be disengaged before levelling-out.

◀(iv) Limiting angle of bank is 45°. ▶

(*f*) *Checks before landing*

(i) Disengage the autopilot.

(ii) Select autostab switches to APPROACH.

(*g*) *After landing*

Press ICO button.
Switch off all switches if applicable.

Auxiliary Control Surfaces

14 Mainplane flaps, normal control and operation

Two flaps, one on each mainplane, are each operated by a single jack, powered from the normal side of the General Services hydraulic system. The flaps are synchronised by mechanically linking the port jack selector slide valve to the starboard jack. Pressure is applied continuously to the down side of the jacks and upward movement is only possible because of differential piston areas in the jacks. The flaps are selected by a FLAPS — UP/TAKE-OFF/DOWN switch, on the port control panel, which is additionally marked 0°, 15°, 30° and 45°. Each switch contact is connected to a corresponding contact on a drum switch which is linked to the starboard flap to ensure a follow-up movement. When a down selection is made, the drum switch makes the circuit to the down solenoid and the selector valve opens to connect the up side of the starboard jack to return. The continuous pressure on the down side of the jack piston moves the jack and the jack linkage rotates the drum switch to the correct position. When the desired movement has taken place, the contact is broken and the selector valve closes, stopping further movement of the jack. While this movement is taking place, the mechanical connection to the port jack selector slide valve completes a similar operation. When an up selection is made the up solenoid is energised and this feeds fluid to the up side of the jack pistons. Due to the larger piston area on this side, the pressure overcomes the continuous pressure on the down side and upward movement takes place.

15 Mainplane flaps, standhy control and operation

If the normal side of the general services hydraulic system is shut down, or the normal selector is inoperative due to a DC power failure, the flaps can be lowered once only by using a FLAPS — OFF/DOWN switch on the standby control panel. Selecting down on this switch energises an emergency selector valve which supplies fluid, from the emergency side of the General Services hydraulic system, to the down side of the starboard jack and to a release valve. The release valve, in moving, opens the up side of the starboard jack to return, allowing the continuous pressure on the down side of the piston to move it down. As the jack moves, the mechanical linkage to the port selector valve selects down for that jack and the emergency pressure moves the jack down.

16 Airbrakes, normal operation and control

(*a*) The airbrakes consist of two petals which are hinged at their forward end and extend beyond the rear fuselage, forming a fuselage tailcone, when closed. The brakes are hydraulically-operated by power from the normal side of the General Services hydraulic system and solenoids of a selector which controls a single jack are energised by selection of an AIRBRAKES — IN/OUT switch on the starboard throttle lever handle. The airbrakes can be stopped at any position between in and out by releasing the switch which is spring-loaded to the centre position. If it is desired to retract the airbrakes fully the switch can be moved past the IN position, in which case the spring return will be overridden. The position of the airbrakes is shown on an AIRBRAKES indicator on the instrument panel. When the airbrakes are in, a black disc is displayed but as the airbrakes are extended, an orange coloured sector of an equivalent angle to the airbrakes is displayed.

(*b*) When out is selected, the out solenoid in the selector valve is energised and fluid is fed to the jack which, in moving, extends the airbrakes to the maximum of 144°. An IN selector energises the in solenoid of the selector which feeds fluid to the in side of the jack, retracting the airbrakes.

(*c*) Two micro switches in the control circuit are normally closed. Inserting a safety pin in a hole on the starboard side of the tail, just forward of the airbrakes, opens these micro switches and prevents airbrake operation. This pin is a ground equipment item.

17 Airbrakes, standby control and operation

If the normal side of the General Services hydraulic system, or the normal selector fails, the airbrakes can be operated in both directions by an AIRBRAKES STANDBY — IN/OFF/OUT switch on the port instrument panel. Selecting IN or OUT on this switch has the same effect as the normal selector but in this case power for the emergency side of the General Services hydraulic system is fed through an emergency selector valve and shuttle valves. In addition to operating the jack, the emergency fluid is fed to a release valve, which opens the normal lines to the jacks, to return. The valve must be reset on the ground before the normal selector is again operative, but the General Services system will revert to normal once the airbrakes are in.

18 Aileron droop, normal control and operation

(*a*) Drooping of the ailerons and the compensating upward movement of the tailplane flap is controlled by a single AILERON DROOP — UP/TAKE-OFF/DOWN selector switch, on the port side of the instrument panel. The switch quadrant has four additional markings, in degrees, 0, 10, 20 (Take-off) and (25) (Down). The switch controls the main motor in each of two actuators, one for the ailerons and the other for the tailplane flap. The aileron actuator moves the control valves in the aileron PFCU's and the ailerons themselves are, therefore, moved hydraulically; the tailplane flap actuator, however, directly moves the flap. The actuators are designed so that angular movement of each surface is synchronised and this movement is indicated by AIL DROOP and TAILPLANE FLAP indicators, on the port side of the instrument panel.

(*b*) When selecting aileron droop, the indicators should be checked that both surfaces are operating. It is possible for an electrical fault to stop or prevent initial starting of either actuator. It is therefore recommended that if malfunctioning occurs, the normal selector be left in its selected position and either of the standby switches used immediately. Once either switch has been used, the normal selector will be inoperative.

19 Aileron droop, standby control

If, due to failure of the selector or the actuator main motors, a normal selection of aileron droop and tailplane flap cannot be made, the second motor in each actuator can be controlled separately by a TAILPLANE FLAP—IN/OFF/OUT switch and an AILERON DROOP—UP/OFF/DOWN switch, as appropriate. Operation of these switches disconnects the DC supply to its associated normal motor, ensuring that conflicting selections cannot be made. To restore the supply to the normal motor an AILERON DROOP AND T/P FLAP reset pushbutton, at the aft end of the port console, must be pressed.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 7 — LANDING GEAR AND ASSOCIATED CONTROLS

Contents

1. Undercarriage, general description

The undercarriage comprises the port, starboard and nosewheel units and the tailskid, all operated by hydraulic power from the normal side of General Services hydraulic system. The undercarriage is controlled by three selector valves, one for the leg jacks, one for the doors and up-locks and one for the tailskid jack. The wheelbrakes are operated automatically when the undercarriage is selected up.

2. Undercarriage, normal controls and indicator

(*a*) Normal selection of the undercarriage is by two of three pushbuttons on the port control panel. The buttons are interconnected to ensure that only one button at a time can be pressed in. A locking solenoid, controlled by two micro switches, one on each leg, prevents the UP button being pressed in when the weight is on the leg. This lock can be overridden by rotating a ring round the button through 60°. Normally the undercarriage cannot be retracted unless the nosewheel is centred, but this does not apply if an emergency up selection is made.

◀(*b*) *Catapult launch*

When mod. 689 is embodied, provision is made for *selecting* undercarriage up before the oleos have extended. Pressing a DECK TAKE-OFF button on the port wall, releases the locking solenoid and allows the UP button to be pressed in but does not make the hydraulic selection. The latter is made automatically when the weight comes off the undercarriage legs. A magnetic indicator, adjacent to the pushbutton, shows ON when the button has been pressed and reverts to black when the undercarriage legs have extended on take-off.

WARNING 1: This facility should not be used for take-offs asbore as pressing the button renders the emergency retraction facility (with weight on the undercarriage) inoperative.

WARNING 2: If the button is inadvertently pressed in, the system can only be reset by switching off the battery switch, and the generator switches if both engines are running.

(*c*) A standard undercarriage position indicator is adjacent to the pushbuttons. A red warning light on the instrument panel is on when the indicated Mach No. is less than 0·25 and the nosewbeel is locked-up; it is fed from the air data computer. When mod. 331 is embodied, a micro switch operated only when the throttle levers are fully OPEN, renders the light inoperative. ▶

3. Undercarriage, emergency down selection

(*a*) The port, starboard and nosewheel units only can be lowered, on failure of the normal selector or if the normal side of the General Services hydraulic system has shut-down (see Chap. 3, para. 4), by operating the third (EM DOWN) pushbutton on the port control panel. Pressing in this pushbutton energises an emergency selector valves and a door locks emergency selector valve. Selection of these valves provides power from the emergency side of the General Services hydraulic system to operate the jacks, through shuttle valves. Normal sequencing takes place.

(*b*) If any door-unlocked micro switch fails to sequence on a down selection, the undercarriage cannot be lowered by either a normal or emergency DOWN selection. For this case, a U/C EMERGY OVERRIDE—OFF/DOWN switch is provided on the standby control panel. Setting this switch to DOWN, *after first pressing the emergency down pushbutton,* by-passes all the sequencing micro switches and selects the emergency selectors simultaneously.

NOTE: The override switch is spring-loaded to OFF and is under a plastic cover. The cover must be broken and the switch held ON until the undercarriage is locked down.

4 Nosewheel steering

(*a*) The nosewheel can be turned through an arc of about 100°, i.e. from 50° on either side of centre, hy a hydraulic jack, powered by the normal side of the General Services hydraulic system. Control of the jack is by a drum switch, whose position is selected hy the position of the rudder pedals. A follow-up movement ensures step-hy-step operation of the valve. The service is selected hy pressing a red NOSEWHEEL STEERING pushhutton on the starboard throttle lever; holding pressed this hutton energises a hy-pass valve selector and the hy-pass valve is then closed to prevent free circulation of the fluid on either side of the steering jack, thus locking the jack until a steering selection is made by moving the rudder pedals.

NOTE: Nosewheel steering is not available when the General Services hydraulic system is on emergency.

(*b*) The following features are built into the system:—

1. On take-off, micro switches on both legs energise the by-pass selector valve and a centre contact on the drum switch. This will centre the nosewheel, providing it is within the self-centring range, i.e. within 50° of the centre line.
2. When the nosewheel is retracted, the hy-pass valve selector remains energised thus locking the nosewheel in the central position.
3. On landing, the hy-pass valve is de-energised thus allowing free castoring of the nosewheel until the steering pushhutton is pressed.
4. If, with the steering pushhutton pressed, the aircraft touches down with drift, a relief valve operates and allows the nosewheel to trail relative to the forward direction.
5. The relief valve will also operate on take-off when the stage is reached where rudder control overcomes the nosewheel steering selection.

5 Wheelbrakes

(*a*) The hydraulically-operated wheelbrakes on the main wheels are supplied with power from the normal side of the General Services hydraulic system. An accumulator, charged with air to 1,150 $^{+150}_{-50}$ PSI gives a reserve of power if the normal side of the General Services hydraulic system ◀becomes inoperative, the service not being supplied by the system when on emergency. A standard triple▶ pressure gauge on the front cockpit wall shows the pressure at each brake unit and the accumulator fluid supply pressure. The brakes may become inoperative as this pressure nears 1,300 PSI.

(*b*) The brakes are normally controlled by master cylinders, one on each rudder pedal, which operate a relay valve giving progressive and differential braking. The valve also restricts the pressure at the brake units to 1,700 PSI maximum. The minimum number of brake applications that can be made with a full accumulator and the hydraulic system failed, is twenty-one, providing anti-skid is switched off.

(*c*) A parking brake handle at the forward end of the starboard console in the front cockpit also operates the relay valve. This valve is also hydraulically operated by pressure from the undercarriage 'up' line when the undercarriage is selected up. It follows that the brakes will be on during flight. For normal parking, the foot pedals should be fully depressed before the parking brake handle is pulled out.

6 Anti-skid protection

Skid warning and protection against skid is effected electrically. The system is selected by a guarded ANTI-SKID —ON/OFF switch, on the front cockpit port console. Two solenoid-operated shut-off valves are located one in each line from the foot-operated relay valves to the brake units. The valves are controlled by signals from their respective wheel unit generators and as a skid condition is approached, the valve(s) is shut, thus releasing the pressure from the brake unit(s) irrespective of the position of the foot-pedal. As the skid condition recedes, the brakes are automatically re-applied.

WARNING: If a brake failure occura the anti-skid switch should be set OFF. This may restore the braking facility.

7 Arrester hook, normal operation and control

The arrester hook is operated hy power from the General Services hydraulic system and is controlled by an ARRESTER HOOK — UP/DOWN switch on the port control panel in the front cockpit. When a down selection is made, the down solenoid in a selector valve is energised and fluid is passed via a release valve and the selector valve, to the up-lock jack. At the same time fluid on the up side of the hook jack returns via the selector valve, allowing pressure, stored in an air-charged accumulator connected to the down side of the hook jack, to move the jack and lower the hook. A damping valve is provided in the system to prevent hook bounce on landing. When an up selection is made, fluid is directed via the release valve and the selector valve, to a recuperator, where it passes through the piston and the damping valve to the up side of the hook jack. As it retracts, this jack recharges the accumulator ready for lowering the hook when the next selection is made.

8 Arrester hook, standhy control and operation

If the Normal side of the General Services hydraulic system is shut down, or a hook selector failure occurs, the hook can be *lowered only*, hy using the emergency side of the General Services hydraulic system. If the ARRESTER HOOK—OFF/DOWN switch on the standhy control panel is set to DOWN, the release valve is energised. This cuts off the normal hydraulic supply to the selector valve and supplies fluid from the emergency side of the General Services hydraulic system to the up-lock jack, via a shuttle valve. This withdraws the up-lock and allows the accumulator pressure to lower the hook.

9 Hook light and deck approach light

Two lights are fitted. One is amber and is under the nose of the aircraft, to indicate to the ground crew the position of the undercarriage and the hook. The second light is green and is on the port control panel in the front cockpit. It indicates the position of the arrester hook. When the undercarriage is locked down the approach light shows a steady light. If the hook is then lowered a flashing unit is hrought into the approach light circuit and the ARRESTER HOOK light comes on.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 8 — FLIGHT INSTRUMENTS

Contents

INTEGRATED FLIGHT INSTRUMENT SYSTEM

1. IFIS general description

The IFIS consists of an air data system and a dynamic reference system which supply information to the flight and navigation displays of the crew members. It also forms the main source of information for other equipment in the integrated weapons system. It operates on 115 volt AC from the Essential Services busbar and 28 volts DC.

2. Air data system

The air data system provides information regarding the speed of the aircraft and the atmosphere through which it is flying. It involves centralised measurement, computation, correction and electrical transmission to the servo-operated presentation units and to other equipment. The system comprises the following main units:—

Pitot/static transducer
Static transducer
Height lock transducer
Air data computer
ADC power supply unit
IAS and Mach No. indicator
Height and TAS indicator

3. Air data computer

(a) The air data computer comprises a number of servo units each of which instantly resolve a mathematical equation when the initial value of any variahle is changed. In addition to providing the data for presentation on the flight instruments the computer also provides basic data for the strike sight, autopilot and Doppler navigation system.

(h) The computer provides a DC supply to an undercarriage warning light on the instrument panel when the Mach No. is below 0·25M with the nosewheel locked up.

4. Transducers

(a) The pressure head delivers pitot and/or static pressure to the transducers, each consisting of a capsule unit and a servo-operated gearbox. The transducers convert tbe pressure signals which are routed as required.

(b) *Pitot/static transducer*

Pitot and static pressures are fed to this transducer which converts them into two electrical outputs. One signal is fed straight throught the computer and drives the IAS indicator and the other is a factor of the Mach No. output. The transducer does not start transmitting until 65-70 knots is reached.

(c) *Static transducer*

Static pressure is fed to this transducer which converts it into three electrical outputs. Two of these outputs are representative of height, but one is more sensitive than the other and is fed straight through the computer, to drive the height sections of the height and vertical speed indicator and the height and TAS indicator in the front and rear cockpit respectively. The less sensitive output is processed for time, in the computer, and it then drives the VSI section of the height and VSI indicator. The third output, after suitable processing, is used to operate the Mach indicator and, after further processing by signal from a resistance temperature bulb, to drive the TAS section of the height and TAS indicator.

(d) *Height lock transducer*

The height lock transducer receives static pressure and, although considered part of the air data system, its electrical output is fed solely to the autopilot.

5. Air data computer power unit

AC and DC for operating the computer, the resistance thermometer and the transducers, with the exception of the height lock transducer, is supplied by the ADC power unit. The unit is itself supplied with AC at 400cps from the 115 volt Essential Services busbar.

6. Integrated instrument display

(a) The information provided by the computer and the transducers is presented on three instruments, each instrument presenting two outputs. The first two indicators (below) are on the pilot's panel; the third indicator is on the observer's panel.

(b) *ASI and Machmeter*

The ASI and Machmeter is a horizontal display using a single moving pointer, a fixed IAS scale and a moving Mach No. scale.

(c) *Height and vertical speed*

The height and vertical speed indicator comprises two dials, one above the other. The lower dial indicates rate of climb by a single pointer and the upper dial indicates height by a single pointer and a two-figure counter. One revolution of the pointer indicates 1,000 ft. and the counter indicates the number of revolutions of the pointer i.e. thousands of feet. The usual method of adjusting the altimeter setting is provided.

(d) *Height and TAS indicator*

The height and TAS indicator in the observer's cockpit presents the information on two vertical moving tapes, each of which is read against a fixed index.

7. Dynamic reference system

The dynamic reference system, which provides attitude and heading information for display to the pilot and to the autopilot, comprises the following units: —

Master reference gyro (MRG)

Detector unit

Attitude indicator

Navigation display

Navigation repeater.

8. Master reference gyro

(a) The MRG installation provides pitch, roll and heading information for the attitude indicator and the compass system of the navigation display. It comprises an earth gyro mounted on an inner platform which, in turn, is mounted on an outer platform. The inner platform is also used as a mounting for the azimuth gyro. The platforms are, in effect, gymbals and both can be rotated in their respective planes by servo motors, activated by signals from the earth gyro itself. This ensures that the gyro will not topple as the platforms are always in the same relative position to the gyro and the earth.

(b) The starting cycle operates as soon as DC is available and the 115 volt AC busbar is live. For the first 3 seconds the platforms are set rapidly to their datum positions and for the next 17 seconds fast erection of the earth gyro takes place. At the end of this perind the MRG is erected to within 1° of its datum.

WARNING: If it is necessary to disconnect the AC or DC supply within 4 minutes of it being switched on, a period of four minutes must elapse before it is again switched on or damage to the MRG will result.

(*c*) To allow the MRG to be switched off, while other servicing which requires an AC supply is carried out, an MRG — ON/OFF switch is fitted in the radio bay. If during cockpit checks, the OFF-flag in the attitude indicator is still showing, the position of this switch should be checked.

9 Detector unit

The detector unit is mounted in the starboard wing tip. It measures the horizontal component of the earth's magnetic field and its outputs are fed to the navigation display on the instrument panel. The output signals are compared with the compass card position and are resolved as one signal which represents the card mis-alignment. This signal is amplified and then fed to the azimuth gyro in the MRG where it precesses the gyro which, in turn, feeds back a signal to re-align the compass card.

10 Attitude indicator

(*a*) The attitude indicator (roller blind) is operated by signals from the MRG. It gives a continuous indication of pitch, by roller blind presentation, and of roll, by a pointer at the bottom of the blind frame. The hlind is half pale-grey and half black and the dividing line represents the natural horizon. Cruciform markings, whose larger limb points in the direction of the horizon, are at the zenith and nadir positions. On the face of the instruments are two circles which represent 20° and 40° of pitch respectively and, in the vertical plane only, there are additional marks which represent 10°, 30° and 50° pitch. In the centre a small circle represents the datum position. Roll markings are 10°, 20°, 30°, 60° and 90° port and starboard.

(*b*) A translucent orange disc bearing two white arrows is covered by a black disc when the normal power supplies are connected. If either an AC or a DC failure occurs, the black disc will move, revealing the arrows, one of which points to the navigation display as there is no separate power failure warning for that instrument.

(*c*) A bead, controlled by the flight director, and which moves only in azimuth, is superimposed on the attitude indicator. Its principal use is during a UHF homing and when in the central (datum) position indicates that the aircraft is on the correct homing course. Any deviation from datum is corrected by turning the aircraft (datum) towards the bead; i.e. if the bead is to port of datum, the aircraft must be turned to port. A ball-type slip indicator is at the top of the attitude indicator.
(*d*) A fast-erection ON/OFF switcb is to port of the flight instruments display.

11 Navigation display

(*a*) In addition to use as a conventional compass indicator, the navigation display also gives, by selection, direct Tacan and offset Tacan display facilities, by roller blind presentation. The roller blind is behind a central window around whicb the compass card revolves. A COMPASS CARD LOCK—ON/OFF switch is under tbe starboard coaming of the instrument panel. Selecting this switch to ON locks the compass card if the MRG malfunctions.

(*b*) Around the front face of the instrument are the following controls and indicators:—

RANGE N.M. veeder counters	For use in the Tacan modes. An obstruction bar is across the counters in other modes.
BEAM and GLIDE-PATH flags	For use with ILS. Shows OFF at other times.
Mode selector switch	
COMP	Compass only. The blind is black and inoperative.
ILS	Compass only. Unused.
TAC	Compass and offset Tacan.
DL	Compass and direct Tacan. In both Tacan displays the range is shown on the blind concentric circles representing 20NM intervals.

SYN knob ...	For synchronising the compass. A dot/cross annunciator is on the opposite side of the display. The compass card can only be precessed in the direction giving quickest synchronisation, thus preventing the setting of 'red on blue'.
ILS marker ...	Unused.
HDG knob ...	For setting the heading pointer.
COMP/DG pushbutton and DG flag	When the DG flag appears the torque motor in the MRG azimuth gyro is disconnected. This allows the compass card to be used as a directional gyro.

12 Navigation repeater

(*a*) This is similar to the navigation display and shows magnetic heading against the fixed lubber line and direct Tacan by roller-blind presentation.

(*b*) By using the Variation setting control, inputs of magnetic variation or grivation and compass deviation are set in, thus providing outputs of true or grid heading to the ◀Weapons system and roller map. ▶

(*c*) True or grid heading, is displayed by a pointer geared directly to the VSC shaft. The pointer should be displaced east or west, agreeing with the VSC window indication.

Standby Instruments

13 Gyro instruments

A Mk. 6D artificial horizon and a type FD1 direction indicator, on the instrument panel, are for use if the IFIS fails. The artificial horizon has a fast-erection button but this must not be used until power has been applied to the gyro for at least 30 seconds. The direction indicator has a combined fast-erection and card-setting knob. To set the card the knob is turned, but for fast erection the knob is pushed in. A blue light at the top right of the instrument comes on when the knob is pushed in but will go out when the knob is released unless the gyro is more than 15° from the vertical. In this ease the light will remain on while fast erection is taking place, which will be until the gyro is within 15°. Both instruments are supplied from a single control unit, supplied with AC direct from the

Essential Services 115 volt busbar and with DC from the Normal busbar. The AC supply is for operation of the gyro but if this supply fails, changeover to a DC-operated inverter in the control unit is automatic. The DC supply is routed through a DC SUPPLY — NORM/EMERGY switch above the artificial horizon. When the switch is at NORM, the supply is from the Normal busbar and when the switch is at EMERGY, the supply is from the emergency battery. If the normal supply fails, the gyros will continue to operate satisfactorily providing the switch is set to EMERGY within 30 seconds of the failure. To reduce running time on the ground, the DC supply is wired so that the changeover to DC operation will not take place unless the battery switch is on.

14 Pressure/static instruments

(*a*) An airspeed indicator and an altimeter are on the instrument panel, grouped with the standby gyro instruments, and are connected to ▶◀ two static vents, one each side of the nose, and a pressure head which also supplies the Q-feel. Anti-icing for the pressure head is by an element controlled by a PRESSURE HEADS — ON/OFF switch on the starboard switch panel.

NOTE: The pressure head switch also controls the heater elements for the artificial feel simulator pressure head and the airstream direction detector system probe.

(*b*) An ASI correction card holder is on the cockpit starboard wall.

15 E2B compass

An E2B compass is above the windscreen. Prior to mod. 478 there is no lighting switch and no Normal DC supply. (See Chap. 9).

Miscellaneous Instruments

16 Deck landing ASI

A deck landing ASI is on the coaming, to port of the strike sight. Pre-mod. 723 it is connected to the mainplane pressure/static system, but post-mod. 723 it is connected ◀to the standby instrument system. Post-mod. 1085 it is re-connected to the mainplane system. This instrument does not indicate less than 70 knots. ▶

17 Airstream direction detector system

(*a*) (i) The airstream direction detector system provides visual and audible indication of the aircraft's angle of attack. The system comprises a borizontal probe unit on the starboard side of the nose, a single pointer incidence indicator, with OFF flag, on the port side of the instrument panel and index lights to port of the attack sight. An audio signal is injected into the inter-comm. The system is controlled by an APPROACH AID — ON/Off switch, on the ADD controller on the cockpit port wall, and adjacent to it is a volume control. A DAMPING — ON/Off switcb is used in turbulent conditions to prevent oscillations of the signal. The probe has a heater element which is controlled by a thermostat and the pressure heads heaters switch.

◀ (ii) DC for the system is supplied from the Normal bus-bar when an ADD supply switch on the port side of the instrument panel is at NORM. Setting the switch to EMERG supplies DC from the emergency battery but in this case only audio signal is operative. ▶

(*b*) The detector probe is divided, horizontally, into upper and lower halves, each half having a row of slots which face into the airstream; these slots transmit air pressure through separate passages into opposite sides of a paddle chamber. The paddle is attached to the probe immediately adjacent to two potentiometers which transmit the rotational movement by varying the DC current they carry.

▶◀

(*c*) The index lights comprise three vertically mounted lamps behind a screen wbich has a central broken circle, above which is an open vee. Below the circle is an inverted open vee. The circle represents the optimum angle of attack and the vees indicate the direction in which the aircraft should be rotated to reach the optimum. A day/night screen is fitted to the lights and is controlled from the top of the fitting.

The indications are: —

Open vee	— Lower nose.
Open vee and circle	— Lower nose slightly.
Circle	— Correct attitude.
Circle and inverted vee	— Raise nose slightly.
Inverted vee	— Raise nose.

(*d*) When switched on for the approach, the audio signal is first heard as a high-pitched note, interrupted at a rate of 10 per second. As the optimum angle of attack is approached the rate of interruption decreases to 1 per second and is superimposed on a continuous medium-pitched note. As the optimum angle is reached only the medium note is heard. With further increase in the angle of attack a low-pitched note, interrupted at 1 per second, is superimposed on the medium note, which eventually ceases, leaving the low-pitched note. Interruptions of this note increase to 10 per second as the stalling angle is approached.

18 Accelerometer

A direct-reading accelerometer is on the instrument panel.

19 Air thermometer

An electrically-operated indicator in the observer's cockpit is controlled by a resistance bulb, forward of the nosewheel. The indicator covers the range −80° to +80°C. The electrical supply is from the Normal DC busbar.

20 Radio altimeter

For radio altimeter refer to Chap. 14.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 9 — GENERAL EQUIPMENT AND CONTROLS

Contents

1 Canopy, general description

(*a*) A single sliding canopy, mounted on two jettison rails, encloses the tandem cockpits. The canopy is normally opened and closed by an electric actuator controlled by a CANOPY MOTOR — TO CLOSE/OFF/TO OPEN lever on a canopy control box on the front cockpit starboard wall. The DC supply to the actuator is direct from the battery and is therefore independent of the battery master switch or the crash relays ((see Chapter 1). Provision is also made for declutching the actuator to allow the canopy to be moved by hand and if this proves to be impracticable an external hand-winding mechanism is also provided. Mechanical locks, one each side of the canopy, lock it in the closed or open position. A warning light adjacent to the control box is on when the canopy is unlocked. The filament of this lamp can be tested by pressing the lamp. Three canopy control levers are provided. One, on the pilot's control box, is labelled CANOPY — LOCKED/ UNLOCKED/DECLUTCH and is connected by teleflex cables to a PULL TO DECLUTCH CANOPY MOTOR lever on the starboard side of the observer's cockpit. The third lever, labelled CANOPY RELEASE is on the outside of the aircraft ahreast the internal control box. This lever is normally flush with the skin and disconnected from the control box hut it can be released hy pressing an adjacent hutton and, when released it engages with the control hox mechanism. The lever portions are indicated hy the words UNLOCK and DECLUTCH painted on the fuselage; the locked position is the stowed position. When the lever is moved to UNLOCK, it exposes a canopy motor control lever.

(*b*) A canopy seal is inflated by air pressure (see Chapter 11, para. 7). To prevent seal inflation when the canopy is unlocked or in the open locked position, a stop valve in the control hox is operated hy the "unlock" lever. When the stop valve is closed, the seal is vented.

2 Canopy, operating control lever

(*a*) When the main canopy control lever is moved from LOCKED to UNLOCK the teleflex cahles withdraw the canopy locks. The warning light comes on. At the same time, a cam in the control box operates the canopy seal stop valve, shutting off the air supply; a second cam operates a micro-switch, which completes the circuit to the canopy motor *open* and *close* micro switches.

(*b*) When the operating lever is moved from UNLOCK to DECLUTCH it disengages the actuator motor and breaks the circuit to the motor *open* and *close* micro-switches.

(*c*) *Observer's lever*

If the observer's PULL TO DECLUTCH CANOPY MOTOR lever is operated it completes the operation at (*a*) and (*b*) in one movement.

WARNING: If the motor is unclutched by the Observer it must be clutched-up again with the canopy returned to the position at which it was unclutched.

3 Canopy, normal operation

If the canopy control lever it at UNLOCKED, selecting TO CLOSE on the motor control lever operates a *close* micro-switch. This supplies DC via a *close* relay and reversing relay to the actuator and to an actuator brake release. When the canopy reaches the fully closed position, a limit switch breaks the circuit to the actuator and to the actuator brake release. Selecting TO OPEN energises, through a bi-metal strip, an *open* relay and the reversing relay. The bi-metal strip causes a 2-3 sec. delay, allowing the canopy seal to deflate before the canopy starts to move. To avoid overheating, a 6 minute period should elapse after one complete cycle of canopy operation.

4 Canopy hand-winding

The hand-winding gear is under a panel at the aft end of the canopy winding mechanism. It consists, simply, of a handle socket attached to a sprocket which engages with the winding mechanism. The actuator must be declutched by the external control lever before the handle can be turned. The handle is normally collapsed and strapped in a stowage just forward of the winding mechanism.

5 Canopy jettison, control and operation

The canopy can be jettisoned from three control positions, one above the instrument panel coaming, port side, one ◀on the observer's port console (both fitted with safety pins) and the third, an external handle, on the port side▶ of the nose. Pulling any one of these handles fires a cartridge in its associated primary breech. The resulting gas pressure is fed to a port main breech where it fires the main cartridge. Gas pressure from this cartridge acts on the pistons of two rail guns which unlock the canopy rails. As the pistons move forward, exhaust ports are uncovered and the escaping gas fires the cartridge in the starboard main breech. The gas from this cartridge passes to two jettison guns which force the canopy and rails upwards, allowing the airflow to carry the canopy clear of the aircraft. During the initial movement, the canopy is disengaged from the winding mechanism.

6 Wing and nose folding

(*a*) *Wingfold*

The outer mainplanes are folded or spread by power from the Normal side of the General Services hydraulic system, under the control of a WINGSPREAD/INTERRUPT/WINGFOLD lever on the starboard console. This lever is mechanically linked to the selector valve. A solenoid lock is fitted to prevent movement of the lever when the weight is off the undercarriage legs, or if jury struts are fitted. When WINGFOLD is selected, fluid is passed to two latch jacks, one to each mainplane, which withdraw the latches. The final movement of each latch opens a sequence valve which passes fluid to the fold side of the two wingfold jacks, one to each mainplane. Movement of the latch pins also operate micro-switches in the warning circuits (see sub-para. (*c*)). Selecting INTERRUPT during the folding or spreading operation centralises the selector valve, thus closing both the supply and return lines of the jacks. The resulting hydraulic lock prevents further movement of the mainplanes in the spread or fold directions, hut will not prevent one wing folding and the other spreading. Selecting WINGSPREAD reverses the sequence of operation and spreads and locks the mainplanes.

(*b*) *Nosefold*

The nose-section, forward of the cockpit, folds to port and is secured in that position by a huilt-in jury strut, which enters an anchorage on the port side of the fuselage. The nose, when closed, is secured hy three latches and these are locked by a handle on the starboard side of the nose. The handle is held flush with the skin hy a spring catch when the nose is locked. The locking mechanism operates ◀a micro-switch which is part of the standard warning system.▶

(*c*) *Indicators*

A WING AND NOSE FOLD LOCK magnetic indicator on the starboard console shows hlack when both mainplanes are locked spread and the nose is locked. If any of these are unlocked a WF warning is also given on the standard warning panel.

7 Windscreen wiper

A hydraulically-operated windscreen wiper is powered hy a self-contained hydraulic system. A twin electrically-driven hydraulic pump unit, each half having two horizontally opposed pistons, provides suction and pressure alternately to drive a rack and pinion assemhly to which the wiper arm is attached. The motors are controlled by a WINDSCREEN WIPER — OFF/SLOW/FAST rotary switch on the starboard wall. When FAST is selected, both motors are running and the wiper operates at 200 cycles/min. When SLOW is selected only one motor runs and the wiper operates at 100 cycles/min. When the switch is OFF, the airflow over the windscreen parks the blade to the starboard side of the windscreen. Supplied with 3-phase AC at 200 volts, one motor is fed from the Normal busbar. It therefore follows that, if an ATA failure occurs, one motor only will be available to drive the wiper.

8 Fatigue meter

A fatigue meter Mk. 3C is installed to record positive and negative accelerations in excess of 0·6G absolute, in flight. An airspeed contactor is employed to switch on the instrument when a speed of 145 knots is reached and to switch it off again when the speed is reduced to below 115 knots.

⧓

9 Emergency arrester barrier cutters

Emergency arrester barrier cutters are fitted to the folding nose in a central position, one each on the top and bottom surfaces of the nose. The cutters are designed to sever the horizontal nylon tension rope, allowing the vertical members to be deflected away from the engines.

10 Navigation equipment stowages

(*a*) When mod. 658 is embodied, a map stowage is on the side of the observer's port console.

(*b*) When mod. 1001 is embodied, a stowage on the observer's windscreen is provided for a navigation computer, a Hunt protractor and a Rally-master clock.

Lighting

11 Navigation lights

The usual navigation lights are controlled by a NAVIGATION LIGHTS — STEADY/OFF/FLASH switch on the pilot's switch panel. When the switch is at FLASH, a flashing unit is brought into circuit. The brilliancy of the lights is controlled by a NAVIGATION LIGHTS — BRIGHT/DIM switch, also on the switch panel.

12 Formation lights

Two lights, one in the outboard trailing edge of each aileron, and a third light, which is the second filament in the tail light, are used as formation keeping lights. They are controlled by a FORMATION LIGHTS — BRIGHT/OFF/DIM switch on the pilot's starboard switch panel.

13 Rendezvous lights

Two rendezvous lights are mounted one on the dorsal fin and the other below the fuselage on the accessories bay rear door. The lights each have separate DC supplies but are controlled by a single RENDEZVOUS LIGHTS—ON/OFF switch on the pilot's starboard switch panel. A twin-filament oscillator unit in each lamp causes it to flash at 80-90 flashes per minute.

14 IFIS lighting

The integrated flight instrument system is grouped on two panels; one is the pilot's instrument panel and the other is the observer's port auxiliary panel. The instruments are illuminated by integral low voltage lamps, supplied from the AC Normal busbar, and each group is controlled by a separate DC-operated control system. The pilot's lights are controlled by an IFIS LIGHTING—ON/OFF switch and an adjacent dimmer on the port console. The observer's lights are controlled from the starboard console in the rear cockpit.

15 Instrument panel lighting

(*a*) Lighting of the instrument panel is by miniature pillar lamps. Generally, each instrument has two lamps, each one fed from a different fuse, so that about half the lamps are from one fuse and the other half from another fuse. The lamps are supplied from the DC busbar and are controlled by an INSTRUMENT PANEL — ON/OFF switch on the port console. A second switch labelled NORMAL/EMERGENCY is left at NORMAL except on failure of the DC supply. If this occurs, selecting EMERGENCY on the switch provides DC from the emergency battery to the following lamps:

E2B compass, AC supply indicator, directional gyro, standby altimeter, standby airspeed indicator, No. 1 and No. 2

engine RPM indicators, No. 1 and No. 2 engine jet-pipe temperature indicators, artificial horizon switch, artificial horizon.

(*b*) When mod. 478 is embodied, the E2B compass light is supplied through the INSTRUMENT PANEL lights switch, and both positions of the NORMAL/EMERGENCY switch. In addition a STANDBY COMPASS—ON/OFF switch, to port of the E2B, is provided to switch off the light if it is not required.

16 General interior lighting

(*a*) Interior lighting for the accessories bay, the bomb bay and radio bay is provided by cockpit type lamps in the roof structure of each bay.

(*b*) *Accessories bay*

One lamp is fitted in the roof in each of the two compartments in the accessories bay and a further lamp is fitted adjacent to the main hydraulic reservoir to facilitate fluid level checks. All the lamps are controlled by a single ACCESSORIES BAY LIGHTS switch on the forward bulkhead.

(*c*) *Bomb bay*

Three lamps in the bomb bay are controlled by a special key inserted in the underside of the fuselage. When inserted and turned through 90° it actuates a micro-switch. This transfers the DC supply from the bomb door operating circuit, rendering it inoperative, to the lamps.

(*d*) *Radio bay*

Threc lamps in the radio bay are controlled by a RADIO BAY LIGHTS—ON/OFF switch on the mic/tel panel in the bay.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 10 — ICE-PROTECTION SYSTEMS

Contents

1 General description

The ice-protection systems prevent the formation of ice round the engine air-intakes and the intake cowlings, the windscreen, the auxiliary air-intakes and the pressure heads. Anti-icing of all the air-intakes is under the control of a single switch but the windscreen and the pressure heads each have their own switches. All three switches are on the starboard switch panel, in the pilot's cockpit. Ice protection for the engine air-intakes and the intake cowlings is provided by hot air tapped from the combustion chamber cooling supply. The windscreen, auxiliary intakes and the pressure heads are provided with electric elements. ▶

2 Air-intakes (engine)

The system for each engine is similar. Compressor air is tapped from the top of the combustion chamber entry and is fed through an electrically-operated valve to the inlet guide vanes and to the hollow spokes of the intake casing. At the inner end of the spokes the air passes forward through the double skin of the starter fairing and is discharged at the nose of the fairing. Part of this air is diverted to the three spokes of the intake extension where it escapes through holes in the leading edges.

3 Intake cowlings (airframe)

Combustion chamber cooling air is fed forward through two ducts which combine at an electrically-operated pressure regulating valve. From this valve the air is passed forward, to circulate inside the hollow front section of the cowling, and it eventually escapes to the inside of the cowling and passes to atmosphere via an extractor at the base of the cowling. Part of this air is diverted to the leading edge of the cowling from where it passes through the leading edge of the engine bay ventilation duct and the cabin air-conditioning ram-air duct.

4 Auxiliary air-intakes

The auxiliary air-intakes, one at the junction of each engine fairing on the mainplanes, are provided with spray-mat heating elements. These elements are under the direct control of a thermister and a thermal control unit, but the AC and DC supplies are routed through a relay, operated by contacts on an airspeed contactor, which close at 145 knots, and open again when airspeed falls to 115 knots. The DC supply is also routed through the anti-icing switch and, providing this switch is made, the spray-mats are automatically controlled at speeds above 145 knots.

5 Anti-icing control

The anti-icing control for the intakes is an ANTI-ICING —ENGINE, AUX INTAKE, SURFACES/ENGINE/OFF switch. With DC available and the switch at OFF, the air-intake valves (engine) and the intake cowling valves (airframe) are energised (closed). Setting the switch to ENGINE opens these valves and provides a flow of hot air as in paras. 2 and 3. If the switch is set to ENGINE, AUX INTAKE, SURFACES, the "ENGINE" valves ◀remain open and the auxiliary air-intakes spray-mats are placed under the control of the thermister.

NOTE: The inscription "SURFACES" is no longer relevant as aerofoil anti-icing is no longer connected.

6 Windscreen

The windscreen is provided with gold film AC heating elements between the laminations, for anti-icing and demisting purposes. Sensing elements control the heat which is kept sensibly above 0°C. providing a WINDSCREEN HEATING—ON/OFF switch, which provides DC to the▶

◀control system, is ON. An overheat sensing element which operates at 65°C is also provided. When there is no DC to the system, a W/S DE-ICING magnetic indicator on the instrument panel shows cross-hatching. The indicator shows NORM when the system is operating normally but if the overheat sensing element operates, the magnetic indicator changes to O/H.

NOTE: Full voltage cannot be applied to the elements until the aircraft is airborne.

7 Pressure heads

Two pressure heads, one for the capsule-type instruments and the other for the flying controls artificial feel simulator each have electric heater elements. The elements are controlled by a PRESSURE HEADS—ON/OFF switch on the starboard switch panel.

8 Ice-detector

(*a*) The ice-detector system comprises a resistance bulb, in the nosewheel door, which measures temperature, and a detector head (two bulbs) under the nose forward of the door, which measures humidity. A control unit receives these signals and, in icing conditions, energises a relay to supply DC to an ICE WARNING magnetic indicator, below the strike sight. The indicator shows ICE when energised and is black at other times.

(*b*) The DC supply to the system is through an ICE DETECTOR—ON/OFF switch on the Pilot's cockpit starboard wall and also through an airspeed switch which closes at 145 knots and opens at 115 knots. A TEST ON/AUTO/TEST OFF switch, spring-loaded to OFF, also on the starboard wall is normally at AUTO. To test the system, selecting TEST ON simulates icing conditions and the warning should be given. TEST OFF should be selected before the switch returns to AUTO. ▶

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 11 — PRESSURISATION AND CONDITIONING

Contents

1 General description

The cockpits are pressurised and air conditioned by air from both engines. The air is taken from the combustion chamber forward entry casing and is supplied through two shut-off valves, one for each engine, and then merges into a single stream to pass through a heat exchanger and a cold air unit. A temperature control system automatically maintains the temperature selected by the pilot. A number of subsidiary systems are fed from the cockpit system, these are the canopy seal, windscreen de-misting, anti-G;

ventilated suits, radome pressurisation and accessories bay cooling. The radio bay is conditioned by a separate system.

Pressurising and conditioning

2 Air supply

Air from both engines is fed through electrically-operated shut-off valves and non-return valves and then merges into a single stream, to pass through a pressure regulating valve. The line then separates, one line conducting air through a temperature control valve and the other line passing air through a heat-exchanger after which it separates to supply various services. The cockpit air passes through a cold air unit and joins with the hot air from the temperature valve, in a water extractor. The conditioned air then passes through a heat exchanger, where it conditions the ventilated suit supply, and thence to the cockpit, through a non-return valve. The first heat-exchanger and the cold air unit are both supplied with ram air from intakes inboard of the engines.

3 Temperature control

The required cockpit temperature is obtained by mixing hot air, at supply temperature, with air from the cold air unit. The required temperature is set on a control in the cockpit and, when automatic is selected, that temperature will be maintained by the temperature controller under the influence of a low limit and a high limit thermostat.

4 Pressure regulation

The cockpit pressure is regulated by a pressure controller and two discharge valves. Below 8,000 ft. the controller is inoperative and the discharge valves are fully open. At 8,000 ft. the controller becomes effective and progressively closes the discharge valve as altitude is increased, until at 25,000 ft. the pressure differential is 4 PSI. This value is then held irrespective of any further increase in height.

5 Safety and inward relief valve

If the discharge valve fails shut, a safety valve starts relieving pressure at a differential of 4¼ PSI and will control the differential so that 4¾ PSI is not exceeded. If the cockpit pressure is lower than ambient, the inward relief part of the valve opens and equalises the pressure. This is only likely to occur during a maximum rate descent with the engines idling.

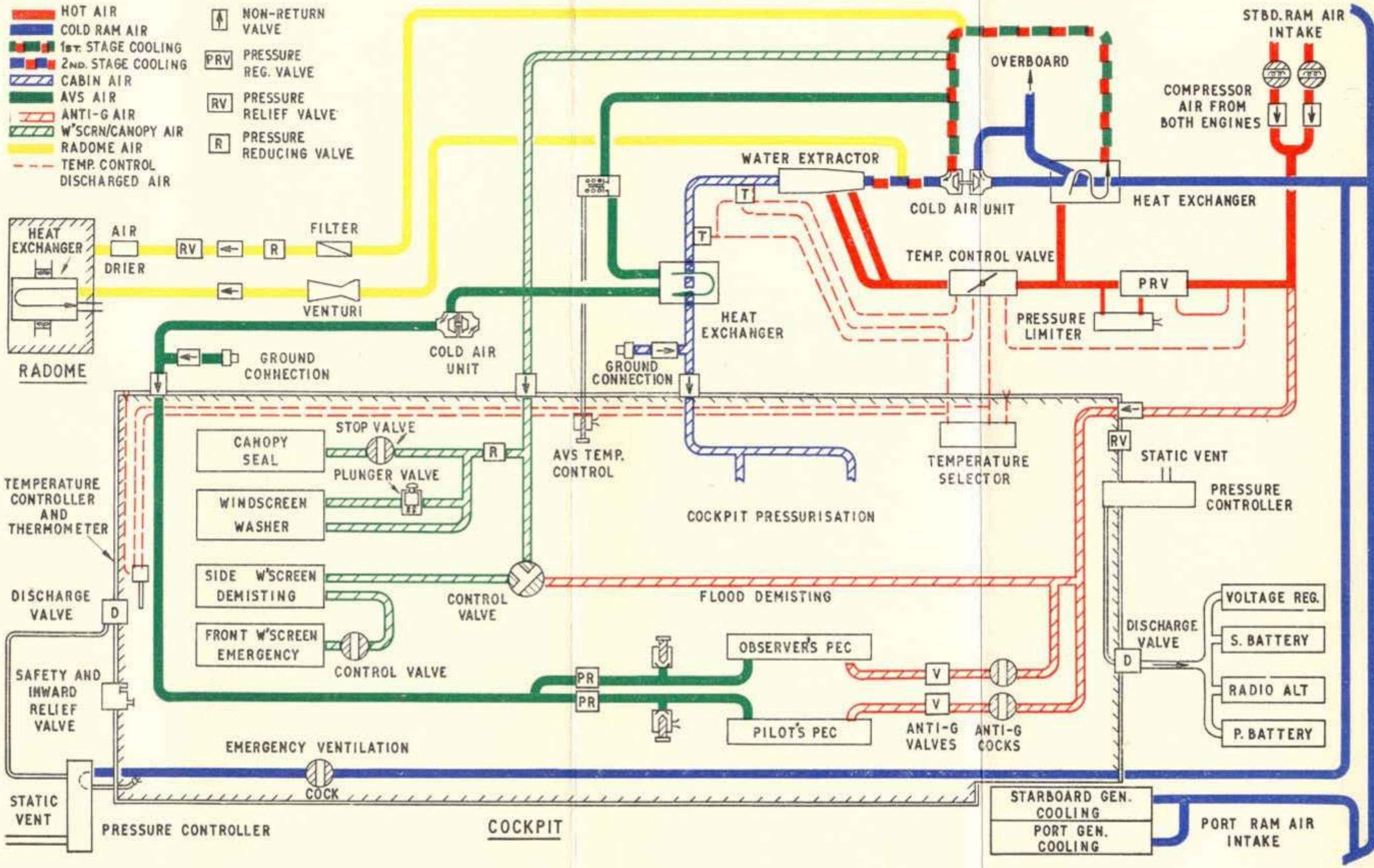


Fig. 1 — Air pressurisation and conditioning

6. Emergency ventilation

If malfunctioning of the system occurs, the normal operation of the pressure controller and the discharge valve can be over-ridden by opening an emergency ram air valve. When this valve is open, air at ram pressure is admitted to the cabin and the front discharge valve is opened fully.

7. Canopy seal and side windscreen de-misting

(a) A tapping from the cockpit air supply, between the first heat exchanger and the cold air unit, provides for inflation of the canopy seal and normal de-misting of the side windscreens and forward sides of the canopy. The air for the canopy seal is reduced to 8 PSI above cockpit pressure and is under the control of a stop valve incorporated in the canopy control (see Chap. 9, para. 1(b)). The de-misting air is under the control of a three-way cock which stops the supply, admits the normal supply, or admits the normal supply and an additional supply, according to the way it is set. The additional air supply is from the anti-G suit supply line and is at a relatively higher temperature.

(b) If the windscreen anti-icing system fails, front windscreen de-icing/de-misting is provided by ducting air from the side windscreen de-misting system under the control of an EMERGENCY DE-MIST—PULL AND TURN control on the cockpit coaming, starboard side.

8. Windscreen washer

A spray tube in front of the windscreen is supplied with liquid solvent from a reservoir, by air pressure tapped from the canopy seal supply. The system is controlled by a plunger valve which supplies air to a liquid control valve; the reservoir is pressurised whenever pressurisation is on. The plunger valve control protrudes through the starboard console and should be pressed and released immediately, as this will give a 15 second application of liquid to the windscreen, during which time the wiper should be in operation. The capacity of the reservoir is sufficient for approximately 15 such applications.

9. Anti-G supply

The supply for anti-G purposes is taken from the single air supply line from the engines, before it passes through the pressure controller. The air passes through a non-return valve and the line then divides, one going to the pilot's PEC and the other to the observer's PEC. An anti-G valve and a stop-valve are in each line.

10. Air ventilated suit supply

The supply for the ventilated suit is tapped from the cockpit supply line, between the first heat-exchanger and the cold air unit. The air is passed through a throttle valve, a heat-exchanger and a cold air unit, and then passes through a water extractor, a reducing valve and a non-return valve. The airflow is then divided, one half going to the controls in each cockpit and thus to the PEC. The temperature is controlled by the throttle valve which varies the mass flow through the heat-exchanger and cold air unit. An air-bleed in the throttle valve is controlled from the front cockpit.

11. Radome pressurising and conditioning

(a) Air for radome pressurisation is tapped from the cockpit supply, between the first heat-exchanger and the cold air unit. The air passes through a filter, pressure reducing valve, non-return valve, pressure relief valve, and an air drier. The air is automatically supplied whenever the cabin pressurisation switch is on.

(b) Pressurising air is fed through a heat-exchanger in the radome and its passage is assisted hy two electric fans. The fans are automatically switched on when the radar is switched on.

12. Accessories bay cooling

(a) The discharge valve on the cockpit rear hulkhead operates in conjunction with a pressure controller to cool electrical equipment in the accessories bay up to an altitude of 8,000 ft., above which height the bay temperature is naturally low enough to prevent over-heating.

(b) Two DC generators are cooled by ram air from an intake on the port side of the bay. The ram air is impelled

18 Anti-G system controls

The anti-G air supply to the pilot's PEC is controlled by an ANTI-G — ON/OFF cock on the starboard wall and an ANTI-G VALVE on the starboard console. The supply to the observer's PEC is controlled by similar controls on the starboard side of the observer's cockpit. The CABIN PRESSURE switch must be on.

19 Air ventilated suit system controls

The ventilated suit air supply to the pilot's PEC is controlled by an AIR VENT SUIT — OPEN/SHUT cock on the starboard console. The observer's control is at the forward end of the rear cockpit, starboard side. The CABIN PRESSURE switch must be on. A temperature control labelled AIR VENT SUIT TEMP. CONTROL is adjacent to the pilot's AVS cock.

Malfunctions

20 Malfunctioning of the cockpit pressurising system

If the cockpit altitude exceeds 32,000 ft., a CPR warning will be given on the SWP. A check should be made to ensure that pressurisation has been switched on. If it has then the pressure controller or the discharge valve is malfunctioning; reduce altitude to below 30,000 ft.

21 Malfunctioning of the radio bay cooling system (pre-mod. 852)

(*a*) If the radio bay temperature exceeds 75°C and the magnetic indicator in the observer's cockpit shows O/HT, then probable failure of the temperature controller or the cold air unit is indicated. Set the radio bay cooling override switch to OVERHEAT.

(*b*) If, after taking the action in (*a*): —

(i) the magnetic indicator fluctuates between NORM and O/HT, failure of the temperature controller has occurred.

(ii) the magnetic indicator remains at O/HT or returns to NORM, failure of the cold air unit is indicated.

22 Malfunctioning of the radio bay cooling system (post-mod. 852)

(*a*) If the radio bay temperature exceeds 75°C and/or the R/BAY warning is given and the magnetic indicator shows O/HT, additional action to that in para. 21(*a*) can be taken, namely, the pilot can select the CAU radio bay switch to ISOLATE. This closes the shut-off valve and isolates the cold air unit from the radio bay. If the magnetic indicator showed cross-hatching, it would indicate that the temperature control valve had not moved to the fully closed position.

(*b*) If the radio bay temperature gauge shows an excessive and increasing temperature without the CPR warning or the magnetic indicator changing to O/HT, it indicates flame-stat failure as well as CAU or temperature controller failure. In this case set the radio bay override switch to OVERHEAT; this will close the temperature controller shut-off valve, bring on the CPR warning and cause the magnetic indicator to change to O/HT. If it is suspected that the CAU unit has also failed, the CAU switch should be set to ISOLATE.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 12 — AIRCREW EQUIPMENT ASSEMBLY AND OXYGEN

Contents

1 General description

The aircrew equipment assembly (AEA) consists of the ejection seat and associated equipment (including the underwater escape system post-mod. (631), the flying and safety clothing and associated equipment including oxygen connections.

Ejection Seats

2 Ejection seats Type 4 MSA

(*a*) Two ejection seats are fitted. Each seat has a combined safety and parachute harness which is fastened by a single quick-release box. A back-type Mk. 37A parachute assembly of the horse-shoe type is fitted. The pack is secured by two restraining straps at the upper end and fitted with a headrest. The seat pan accommodates a personal survival pack type R. Two leg-restraining cords are fitted at the front of the seat pan. An emergency oxygen bottle is stowed behind the seat.

(*b*) The seat height may be adjusted electrically by operating the switch on the starboard side of the seat. The harness lean-forward release is the forward lever on the starboard side of the seat pan.

(*c*) *Combined-harness quick-release box*
The quick-release box, when fastened, secures the occupant to the seat. The box must not be operated when carrying out manual separation in the air since this will free the occupant from both seat and parachute.

3 Ejection gun and firing handles

An 80 ft./second ejection gun is fitted. The ejection gun is fired by pulling the face screen firing handle or the seat pan handle. The seat is fitted with canopy breakers on the drogue container and the seat pan, in case ejection through the canopy becomes necessary. If the seat pan handle is used, the occupant must sit upright and concentrate on forcing back the head throughout ejection. Both handles have a safety pin post-mod ES3209 but until this mod. is embodied, the seat-pan handle has a two-position (locked/unlocked) safety lock instead.

4 Barostat/G-stop time delay

(*a*) After ejection, at heights of 10,000 ft. (or approx 16,000 ft. if seat is suitably modified) and below, a barostat causes an automatic cycle to commence. After 1¼

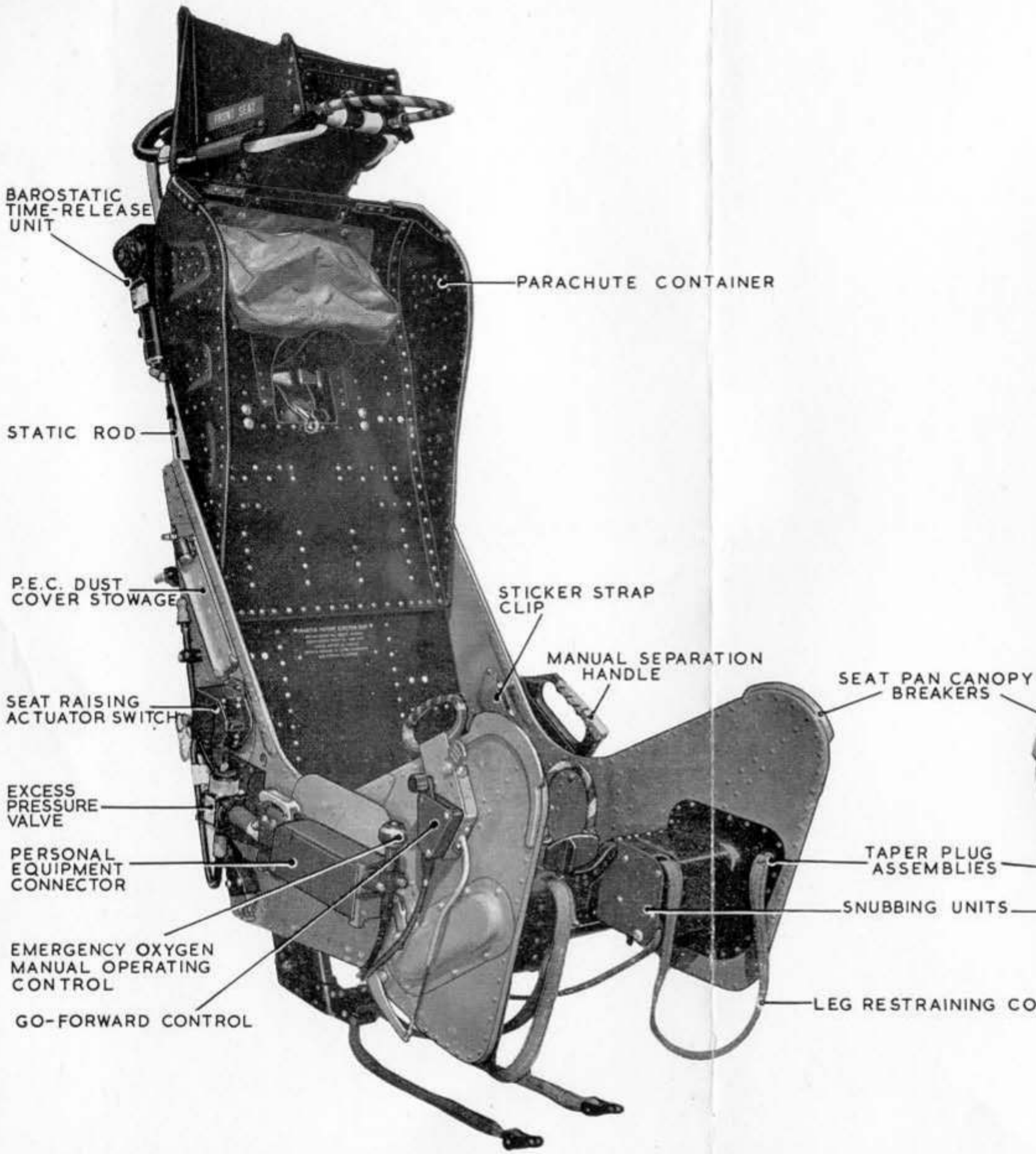


Fig. 1 — Type 4 MSA Mk. 3 ejection seat, starboard front

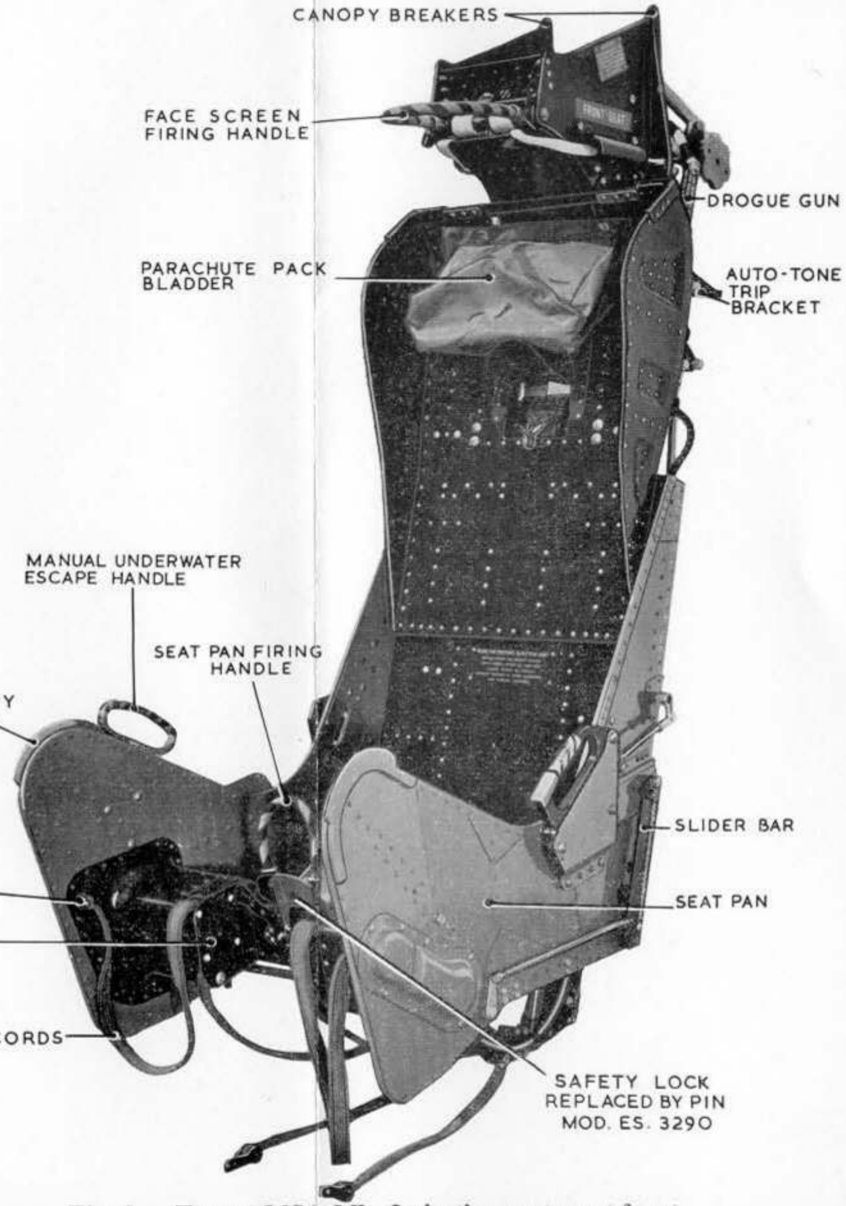


Fig. 2 — Type 4 MSA Mk. 3 ejection seat, port front

secs., if the G-stop has not operated (see (*b*) below), the safety harness is released from the seat, as are the face screen, firing handle and headrest pad.

(*b*) A G-stop is incorporated to prevent the opening of the main parachute if the speed of the seat after ejection is too high for safe deployment. The stop prevents the operation of the barostatic time-delay unit until the speed of the seat has fallen to a safe figure. The seat has a ground level ejection capability provided that the aircraft's flight path is parallel to the ground and the speed is a minimum of 90 knots. If the aircraft is descending or nose-down more than the minimum altitude will be required.

5 Lean-forward harness release

A lean-forward type harness release is controlled by a lever on the outside of the starboard thigh guard. The harness is released only while the lever is held forward and a spring-loaded drum takes up the slack during backward movement of the occupant.

6 Manual separation handle

The handle at the port side of the seat pan has a thumb press safety lock. When it is removed and the handle is pulled up it withdraws the sear in the guillotine (Mk. 1 seat only) which fires and severs the drogue link-line, separating the parachute from the seat. In addition, by linkages, the parachute harness locks, the man component of the PEC, and the leg restraint cords, are all released. A safety pin is provided for the guillotine sear.

NOTE: In the Mk. 3 seat the handle does not withdraw the guillotine sear; it is subsequently removed by static line.

7 Leg restraint cords

The leg restraint cords ensure that the occupant's legs are drawn back automatically and restrained close to the seat pan during ejection, thus providing leg clearance and preventing the legs being blown apart after ejection. The cords pass through snubbing units on the front on the seat pan, through the rings on the garters, and are then inserted into the thigh guard socket. The snubbing units allow the cords to pass freely *down* through the unit, but prevent them passing upwards. A push-up plunger is provided under eacb snubbing unit to allow the occupant to adjust the cords to give comfortable leg movement in the aircraft. An interconnection between the restraining cord sockets and the PEC makes connection of the cords impossible until the man component or the dust cover of the PEC is mated with and locked to the seat component.

8 Personal equipment connectors

(*a*) To enable the aircrews' main oxygen, emergency oxygen, ventilated suit, anti-G suit connections and the mic/tel lead to be connected or disconnected from the aircraft in one action, a PEC is fitted to the starboard side of the seat pan. The conector comprises three components, the aircraft component, connected to the cockpit floor, the seat component, bolted to the seat pan and the man component, attached to the flying clothing.

(*b*) The man and seat components are mated by sliding the nose of the former into hooks at the front of the seat component and then pressing downwards the handle at the rear. To release the man component, press the thumb button in the handle and lift the handle.

(*c*) An excess pressure valve at the rear of the PEC prevents build-up of excessive pressure at the mask when the emergency oxygen supply is in use.

(*d*) When the man component of the PEC is removed, a dust cover must be fitted in its place. The cover is stowed on the starboard side of the seat.

9 Safety pin stowages

The seat face screen firing handle safety pin, the guillotine sear safety pin and the canopy jettison handle safety pin, for each cockpit, are stowed on the starboard wall of their ◀respective cockpits. When mod. 1198 is embodied a stowage for the seat-pan firing handle pin is also provided. ▶

Underwater Escape System

10 Underwater escape system, general description

(*a*) When mod. 631 is embodied, provision is made for a fully automatic underwater escape system. This is capable of ejecting an unconscious occupant from the aircraft, separating him from his seat and supporting him on the surface by his fully inflated LSW, without any action being necessary on his part.

The main components and their functions are shown in the following sub-paras.

(*b*) *Water pressure sensing unit*

Stainless steel pipes lead from a static pressure hole, in the port cockpit skin, to the pressure sensing diaphragm assembly of a compressed air bottle firing unit at the base of each ejection gun. When the sinking aircraft reaches a depth of approximately 13 ft. the pressure on the valve diaphragm moves the restraint on the firing pin, allowing it to descend under spring pressure and fire the cartridge in the head of each main air bottle.

(*c*) *Main air bottle*

A main air bottle charged to 3,000 PSI is behind each seat, integral with the pressure sensing diaphragm assembly. Pipes from the assembly lead to the base of the ejection gun via a two-way cock and the drogue gun trip rod release unit. A pressure gauge is provided on the bottle.

(*d*) *Auxiliary CO2 bottle and bladders*

The auxiliary CO2 bottle is mounted on the starboard side of the seat, above the harness release lever. When fired by rotation of the harness release lever, gas is piped to two inflation bladders, one behind the parachute pack, and the other underneath the dinghy pack. The action of these bladders, on inflation, is to force the occupant forward and upwards.

(*e*) *Modified LSW*

The LSW inflation bottle in the starboard side of the LSW, is modified so that it is actuated by air from the main air bottle, via the drogue gun trip rod release unit and PEC. In addition it is increased in capacity from 34 to 86 grammes of CO2 to ensure correct LSW inflation when subjected to water pressure. To prevent a build-up of excessive internal pressure, a pressure relief valve, set to 3 PSI, releases excess gas when on or near the surface. Manual operation of the LSW and the oral inflation facility are still available.

(*f*) *Modified PEC*

The personal equipment connectors are modified to include the air line to the LSW inflation bottle and incorporates a spring-loaded ball valve in the aircraft portion, held open when the seat and aircraft portions are connected and automatically closed to conserve the air when they separate during ejection.

(*g*) *Ejection gun*

Each ejection gun has a plug fitted to the lower end of the inner piston tube and held in position by two shear rivets. This reduces the volume of air required and also prevents the compressed air from bursting the diaphragm of the primary cartridge and possibly causing it to fire. A non-return valve is fitted into the base of each ejection gun to prevent any loss of cartridge gas into the underwater escape system during normal ejection. In addition, a modified type of sear is fitted to the firing unit in the ejection gun breech, which allows the firing cable to disconnect when the ejection gun extends, thus preventing the firing of the primary cartridge.

(*h*) *Underwater escape selector handle*

◀The underwater escape selector handle, to port of the seat, has two positions: SAFE and UNDERWATER.▶ When safe is selected, the handle is in the up position and a slide valve is moved so that it blanks off the delivery ports to the base of the ejection gun and the drogue trip rod release unit. The same movement opens a port so that compressed air would exhaust to atmosphere outside the cockpit should the main air bottle inadvertently discharge. Upon selection of UNDERWATER by depressing the locking knob in the end of the handle and pushing the handle down, where it relocks, the slide valve is moved so that the vent to atmosphere is closed and the bottle contents, upon release, initiate the ejection sequence.

(*j*) *Manual firing handle*

A manual firing handle is fitted to the starboard thigh guard. The action of pulling the handle up withdraws a sear from a breech unit mounted on the compressed air bottle diaphragm assembly. When the striker fires the cartridge, the gas pressure impinges on the valve diaphragm which removes the restraint on the main air bottle firing pin, thus initiating the escape sequence.

11 Automatic underwater escape

When the sinking aircraft reaches a depth of approximately 13 ft. the pressure on the valve diaphragm removes the restraint on the firing pin, allows it to descend under spring pressure and fire the cartridge in the head of the bottle. The compressed air is thus released and is piped to two places, the base of the ejection gun and the drogue gun trip rod release unit. The air entering the bottom of the ejection gun forces the piston tubes upwards, unlocking the seat and ejecting it from the aircraft without firing the ejection gun cartridges. The air to the drogue gun trip rod release unit forces a plunger out of its housing, and this releases the drogue gun trip rod, preventing the gun from being fired. At the same time the plunger strikes a linkage which withdraws the guillotine sear, thus severing the link line between the drogues and parachute. The movement of the plunger uncovers a port in the unit, allowing the air to proceed to the modified LSW inflation bottle, via the PEC. The bottle is thus actuated and the LSW inflated. As the seat rises on ejection, the time-release unit is tripped and runs for its normal period of 1¼ seconds, when the plunger descends and strikes the harness release lever. As the harness release lever rotates, it releases the harness lock and at the same time operates the auxiliary CO_2 bottle which inflates the seat-man separation bladders. The occupant is thus forced from the seat, and is free to rise to the surface where he floats, supported by his LSW.

Anti-G and Air Ventilated Suit Systems

12 Anti-G system

(*a*) The purpose of the system is to provide air at low pressure for the aircrew's anti-G suits, a connection for which is on each PEC.

(*b*) Air for inflation of the suits is provided by the cockpit pressurising system (see Chapter 11). A set of controls is in each cockpit. With air pressure available and an ANTI-G — ON/OFF cock on the starboard wall ON, when applied G in excess of approximately 1½ is applied, an anti-G valve on the starboard console operates and allows air to pass and inflate the anti-G suit. The amount of inflation depends on the amount of G applied. The valve has an H and L setting, and when H is selected the suit is inflated, at 1·0 PSI/G. With L selected, inflation is at 0·8 PSI/G.

(*c*) The suit may be tested, with tbe cock ON, by pressing the ANTI-G TEST button on the top of the valve, as gently as possible to avoid severe discomfort due to too rapid inflation.

13 Air ventilated suit system

The air ventilated suit system provides low pressure air for aircrew cooling; a connection is on eacb PEC. The pilot's control is aft of the anti-G valve and the observer's control is on the side of the starboard console.

Oxygen System

14 Oxygen system general description

(*a*) Liquid oxygen is carried in two bottles in the radio bay. Normally one bottle supplies the pilot and the other bottle supplies the observer, but a two-way cbeck valve ensures that one bottle will automatically supply both crew members, if the other bottle is empty. Each crew station has a Mk. 17E or Mk. 17F regulator, two remote blinkers, one for each crew supply, and a contents gauge. Each contents gauge normally shows the contents, in litres or eighths, of its associated bottle but the pilot's gauge will show the contents of the observer's bottle on operation of a pushbotton, forward of the gauge. Two pressure gauges and the filling connections are on the starboard side, adjacent to the radio bay.

◀NOTE: Transmitting on HF or Tacan may cause fluctuations in the contents gauges. ▶

(*b*) When mod. 917 is embodied a LOX pack wbicb is removed from the aircraft for re-charging is fitted. Because of the time taken for the pressure to stabilise after the pack is refitted, the following restrictions are imposed.

There is no restriction if a 5-hour stabilisation period has elapsed. If less than this period has elapsed, then only the "airmix" setting should be used.

Manoeuvres

If, during manoeuvres, the regulator pressure drops below 95 PSI, the manoeuvres must be terminated and the pressure allowed to regenerate to 160 PSI in steady level flight. If pressure does not recover, select EMERGENCY oxygen and reduce height to below 10,000 ft.

(*c*) When mod. 994 is embodied the LOX pack is fully stabilised and there are no restrictions on use.

15 Mk. 17E or Mk. 17F regulators

(*a*) The regulator has an ON/OFF valve which controls the flow of oxygen, an air inlet NORMAL — 100% OXYGEN switch, a pressure gauge, an emergency three-position switch and a magnetic indicator. This shows black when oxygen is not being used or when electrical power is not available and a vertical white line when oxygen is being demanded.

(*b*) When the ON/OFF valve is on and the inlet switch is at NORMAL, an air/oxygen mixture is fed to the pilot's mask, up to a height of 32,000 ft., at which height 100% oxygen is automatically delivered. When the inlet switch is at 100% OXYGEN, no air is added, irrespective of the height. The emergency switch when moved to either right or left admits oxygen under greater pressure.

(*c*) The mask may be tested before flight by deflecting the emergency switch sideways and holding the breath. If the magnetic indicator on the regulator remains black there are no leaks around the mask. If the indicator changes to white the mask requires to be tightened.

NOTE: The difference between the Mk. 17E and Mk. 17F regulators is that the latter will continue to operate satisfactorily at a lower supply pressure.

16 Emergency bottles

(*a*) The emergency oxygen supply for each seats is contained in a Mk. 8C bottle mounted on the rear of the seat pan. The bottle remains with the seat after separation has occurred, following ejection.

(*b*) A manual control on the right of each seat pan is pulled up to turn on the emergency oxygen bottle.

(*c*) A safety pin for the bottle is normally removed and stowed in a bag on the port wall of the front cockpit (starboard wall rear cockpit).

17 Cockpit checks

Safety pins: —

Face-screen firing handle safety pin	In
Guillotine safety pin ...	In
Underwater escape selector (mod. 631)	SAFE (ashore) UNDERWATER (afloat)
Underwater escape safety pin	In (ashore) Out and stowed (afloat)
◀ Seat-pan firing handle safety lock (pre-mod. ES 3209)	Engaged (Pin in post-mod. ES 3209) ▶
Canopy jettison handle safety pin	In
Drogue withdrawal line	Routed over and clear of other lines
Drogue link line ...	Outside parachute restraining strap
Firing cables	Connected to sear
Drogue gun and barostatic time release unit static rods	Connected
Top latch plungers ...	Flush
Sticker straps	Connected
Manual separation handle safety lock	Engaged

18 Strapping-in procedure

Strap-in in the following order: —

(*a*) Connect dinghy lanyard to LSW, passing it outside thigh. Connect dinghy side attachments to LSW and LSW hose to man component of PEC (mod. 631).

(*b*) Remove and stow PEC dust cover.

(*c*) Connect man component of PEC, check correct locking.

(*d*) Pass right leg-restraint cord through rings on front of right garter and engage taper plug in right thigh-guard socket. Pull sharply on the cord to check locking. Connect left leg-restraint cord in a similar manner.

(*e*) Adjust lumbar cushion to correct position.

(*f*) Check QRB locked.

(g) Slip lap strap lugs through negative-G loops and then connect harness lap straps, ensuring that the negative-G straps are clear of the seat-pan firing handle (QRB has to be held rotated past locked position before harness lugs are inserted) Straps to be:

1. As tight as comfort permits, then tighten negative-G straps.

2. With QRB as low as possible.

3. Right strap to pass *outside* PEC hoses.

4. Allow small bight in hoses, between lap-strap and PEC, to avoid strain under negative G.

(*h*) (i) Pass each leg loop through its respective lap-strap ring, and engage the loop over the shoulder harness lug.

(ii) Engage the shoulder harness lugs in the QRB (push the leg loops well down on to the lugs).

(iii) Ensure shoulder harness passes under LSW stole.

(*j*) (i) Tighten the parachute (blue inner) harness shoulder straps.

(ii) Tighten the seat safety (khaki outer) harness shoulder straps.

(*k*) (i) Operate the lean-forward lever, lean forward and then release lever.

(ii) Ground crew folds rucks in harness behind back.

(iii) Lean back and check snubbing unit, check finally locked.

(iv) Check tighten the shoulder straps but do not overtighten.

(*l*) Put on the flying and protective helmets and fasten the chin straps.

(*m*) (i) Connect oxygen mask tube to supply hose.

(ii) Connect clip ring to LSW.

(*n*) Connect mic/tel lead.

19 Checks after strapping-in

(*a*) Raise and lower seat through its complete range once only. Reposition to correct height so that face-screen firing handle can be reached by both hands together.

(*b*) Move the body to the left and right through the maximum range, ensuring that no strain is imposed on PEC.

(*c*) Set the oxygen mask toggle to the low-pressure position and adjust it until there is no leakage when the regulator is set to EMERGENCY. Select 100% oxygen.

(*d*) Place the seat-pan firing handle lock in the flight ◀ position (pre-mod. 1198).

(*e*) Seat occupant removes guillotine and canopy jettison handle (and underwater manual firing handle mod. 631) and seat-pan firing handle (mod. 1198) safety pins and ground-crew removes face-screen firing handle safety pin. Seat occupant stows all three (four — mod 631 or five, mods. 631 and 1198) pins. ▶

20 Normal exit procedure

When leaving the aircraft after landing, the following procedure should be used: —

(*a*) Engage the seat-pan firing handle safety lock or insert the pin. Remove the remaining safety pins from their stowage, fit the appropriate pin through the canopy jettison handle and hand one pin to the ground crew who fits it through the face-screen firing handle lock. Fit the remaining pins in the guillotine sear (and the underwater manual firing handle — post-mod. 631). Return the underwater escape handle to SAFE.

NOTE: If no ground crew is available, the aircrew members *must* fit all safety pins before leaving the aircraft.

(*b*) Operate the harness QRB, free the straps and return the fitting to the locked position.

(*c*) Disconnect the oxygen mask tube from the oxygen supply hose.

(*d*) Disconnect the mic/tel lead.

(*e*) Disconnect the chain and remove the man component of the PEC from the seat component and refit the dust cover. Free the leg-restraint cords from the garters. Pass the helmet and PEC component to the ground crew.

(*f*) Disconnect the dinghy lanyard and the two side connections from the lifejacket.

(*g*) Climb out of the aircraft.

21 Crash into sea (pre-mod. 631)

(*a*) Whether the aircraft is to be ditched immediately after take-off or at any later stage in flight, the following drills should be used, as the aircraft's ditching characteristics are poor. If time permits, abandon by ejection while still airborne, if not, jettison canopy.

⧓

(*b*) Deflect the oxygen regulator emergency toggle switch sideways; this will enable the oxygen system to be used as an underwater breathing apparatus if the aircraft submerges before escape is effected.

When the aircraft has stopped:—

(*c*) Operate the harness quick-release fitting and free the straps. Brace against cockpit side to prevent floating away from the PEC.

(*d*) Disconnect the man component of the PEC from the seat component and free leg-restraint cords.

(*e*) Leave the aircraft as quickly as possible. Inflate the life jacket when clear of the cockpit coaming and remove oxygen mask.

(*f*) If, as is normal, the rescue craft approaches almost immediately, there is no need to inflate the dinghy; if, however, it appears unlikely that rescue craft will be quickly on the scene, the personal survival pack side quick-release couplings to the life jacket should be operated and the dinghy inflated.

(*g*) If, following ditching, the aircraft sinks with the hood still in place, it will not be possible to jettison the canopy until the cockpit is at least two-thirds full of water. It is, therefore, recommended that, when No. 4 Mk. 3 seat cartridge is fitted, an underwater ejection be carried out as soon as possible using the following drill:—

(*h*) Grasp the face-screen firing handle with both hands, palms facing aft and elbows as close together as possible.

(*j*) Pull the firing handle and attached face-screen down firmly over the face, at the same time blowing out strongly (see sub-para. (*l*)). *It is most important to keep the hands close to the chest during the latter part of this movement.*

(*k*) As soon as possible after ejection, operate the harness quick-release box, free the straps, free the leg-restraining cords from the garters, push clear of the seat and inflate the lifejacket. The man component of the PEC should release automatically from the seat; if it does not, it will be necessary to disconnect it from the seat component, otherwise the occupant will remain secured to the seat by the hoses.

(*l*) It is essential to blow out continuously on the way to the surface. Failure to do so will result in damage to the lungs, due to the expansion of air in the lungs during the ascent. The aim should be to regulate the ascent so that the bubbles of exhaled air are not overtaken; this will ensure that the ascent rate is not too bigb.

(*m*) If with No. 6 Mk. 1 ejection seat cartridges fitted the aircraft enters the water with the canopy still in position, ejection must be made without delay. An underwater ejection is bazardous under these conditions, but nevertheless it is the only means of escape.

◀22 Crash into sea (post-mod. 631)

Whether the aircraft is to be ditched immediately after take-off, or at any later stage of the flight, the following drills are to be used, as tbe aircraft's ditching characteristics are poor.

Abandon aircraft

If time permits, abandon by ejection while still airborne.

Jettison canopy

If airborne ejection is not possible: jettison canopy while still airborne if possible, or before aircraft sinks.

Operate underwater escape system

Whether canopy had jettisoned or not, and wbether aircraft has sunk or not, brace the head and shoulder and then operate the underwater escape system firing bandle. After escaping remove oxygen mask, release QRB and free harness straps before disconnecting PSP side attachments and inflating life-raft.

If underwater escape system fails to operate

With canopy off

Release QRB and free harness straps.

Release PEC.

Climb out, inflate LSW, remove oxygen mask and inflate life-raft.

With canopy on

If necessary, wait until canopy is submerged, brace head and shoulders and then use oormal face-screen firing bandle. Remove oxygen mask, inflate LSW, release QRB and free harness straps before disconnecting PSP side attachments and inflating life-raft.

WARNING: To avoid damage to lungs, it is essential to hlow out continuously during ascent. It may also be necessary to partially deflate the LSW through the oral inflation valve, to facilitate boarding the life-raft. ▶

23 Crash landing immediately after take-off

(*a*) The drill to be used when crash landing immediately after take-off is as follows: —

When the aircraft has stopped: —

(*b*) Disconnect the man component of the PEC from seat component and free the leg-restraint cords.

(*c*) Operate the harness quick-release box and free the straps.

(*d*) Leave the aircraft as quickly as possible.

(*e*) If, after a reasonable time, there are no signs of fire, return to the aircraft and *insert the ejection seat safety pin in the hole in the ejection gun sear.*

24 Action when entering the landing circuit

In addition to the normal cockpit cheeks, ensure that 100% oxygen is selected on the regulator when entering the landing circuit.

▶◀

25 Crash landing in the landing circuit

The drill to be followed when crash landing in the landing circuit is similar to that given in para. 23. It should be noted that the ejection seats may be used at ground level provided that the aircraft's flight path is parallel to the ground and the speed is at least 90 knots. If therefore, it is considered that crash landing may be unduly hazardous, ejection should be considered as an alternative.

26 Ejection, considerations

Normally the canopy should be jettisoned before ejection. If speed cannot be reduced to below 230 knots before the canopy is jettisoned, the observer must use the seat-pan firing handle. If ejection through the canopy is necessary, it is essential to adopt an upright sitting position and concentrate on forcing the head back throughout ejection. The seat may be used at ground level provided that the aircraft's flight path is parallel to the ground and the speed is at least 90 knots.

WARNING: At speeds above 230 knots with the canopy off, the observer's arms may be forced back by the airflow when trying to use the blind handle. It is recommended, therefore, that if the canopy is jettisoned the seat-pan firing handle is used.

27 Ejecting

The aircraft should not normally be abandoned until the canopy has been jettisoned. Proceed as follows: —

1. Jettison the canopy.

2. Ensure that the harness is locked fully back; normally this will occur as the occupant reaches for the face-screen firing handle.

3. Grasp the face-screen handle with both hands, palms facing aft and elbows as close together as possihle.

4. Pull the firing handle and the attached face-screen down firmly over the face, keeping the head pressed well back against the headrest cushion. *It is most impartant to keep the hands close to the chest during the latter part of this movement.*

◀28 Sequence of events during ejectiou

(*a*) As tbe seat ascends the guide rail, the following sequence occurs: —

(*b*) The leg-restraining cords tighten until the rivets shear in the dead-eyes securing the cords to the cockpit floor.

(*c*) Initiates auto-tone transmission (post-mod. 395).

(*d*) The time-delay mechanism for the drogue gun is actuated, the gun being fired after a delay of ½ sec.

(*e*) The time-delay mechanism for the barostatic time-release unit is actuated. The actual delay before parachute withdrawal commences is variable and depends upon aircraft height and speed at the time of ejection. If ejection takes place above approx. 10,000 ft. the barostat delays parachute withdrawal and separation from the seat until the seat has ılescended to that height. A 'G'-stop is fitted to the time-release unit to prevent parachute withdrawal taking place until the seat has slowed to a speed suitahle for development; when the seat has slowed to this speed and is below 10,000 ft., there is a further delay of 1¼ sec. before parachute withdrawal occurs.

(*f*) The seat component of the PEC is separated from the aircraft component, disconnecting the main oxygen hose, anti-'G' suit and air-ventilated suit air supply hoses and▶

◀the mic/tel lead.

(*g*) The seat raising/lowering actuator lead is disconnected.

(*h*) The emergency oxygen is turned on whether required or not.

(*j*) As the parachute develops, the occupant is snatched from the seat. If, following ejection, it is suspected that▶ the automatic separation mechanism is not functioning, the action in the following paragraph must be taken.

NOTE: Separation from the seat may not occur immediately due to the delays imposed by the 'G'-stop and the barostat.

29 Manual separation

(*a*) Discard the face-screen.

◀(*b*) Operate the manual separation handle, by▶ depressing the safety catch and pulling the handle upwards.

WARNING: Do not operate the harness quick-release fitting as this will release the occupant from the seat and the parachute harness.

(*c*) Push clear of the seat, exerting pressure on the rim of the seat-pan to disengage the harness sticker straps from their clips.

(*d*) Grasp the parachute rip-cord handle in the right hand and pull it across the body.

30 Manual bale-out, considerations

If the seat fails to eject, pull the firing handle downwards still further; if the seat still fails to eject pull the seat-pan firing handle. If this fails, a manual bale-out must be made. As the emergency oxygen cylinder is clamped to the rear of the seat-pan, no oxygen supply will be available after a manual bale-out. If, therefore, it is not essential to abandon the aircraft immediately, it may be advisable to remain in the aircraft until it has descended to below 15,000 ft. This will remove the danger of anoxia and exposure to extreme cold and may enable additional distress messages to be transmitted, thereby enhancing the chances of a speedy rescue. The decision whether to abandon immediately or to stay with the aircraft until it is somewhat lower must be made by the captain after assessing all the factors involved. The aircraft should be cleaned-up and, in particular, the airbrakes should be in.

31 Baling-out

(*a*) The procedure to be used during a manual bale-out is as follows: —

(*b*) Jettison the canopy if it is still in place.

◀(*c*) Operate the manual separation handle, by▶ depressing the safety catch and pulling the handle upwards.

WARNING: Do not operate the harness quick-release fitting as this will release the occupant from the seat and the parachute harness.

(*d*) Abandon the aircraft.

(*e*) When clear of the aircraft, grasp the parachute rip-cord handle in the right hand and pull it across the body.

Emergency Use of the Oxygen System

32 Toxic fumes

If the cockpit becomes contaminated with toxic fumes, set the air-dilution switch on the regulator to 100% OXYGEN and deflect the EMERGENCY switch to one side, to prevent inward leaks on the mask.

33 Regulator indicator failure

(*a*) If the magnetic indicator ceases to operate check that the main tube is correctly connected, that the pressure on the regulator gauge is normal and that the main oxygen contents gauge is indicating that oxygen is still available. Select 100% oxygen.

(*b*) If the above indications are satisfactory, depress the regulator EMERGENCY switch, when in the central position. A supply of oxygen under increased pressure indicates that the regulator is serviceable but that the indicator is defective.

34 Regulator failure

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

Excessive delivery of oxygen with difficulty in exhaling and oxygen streaming into the eyes,

or

No delivery of oxygen with the inability to inhale, the mask being sucked on to the face.

(*b*) In either event, the emergency procedure is as follows: —

(1) Turn on the emergency oxygen supply.

(2) Turn off the regulator.

(3) *Commence an immediate rapid descent to a cabin altitude of below* 10,000 *ft*.

NOTE: Where the regulator failure results in excessive delivery of oxygen, making exhalation difficult, the pressure may be relieved by lifting the lip of the mask with a finger.

35 Cabin pressure failure

(*a*) If, following the loss of cabin pressure, the cabin altitude exceeds 40,000 ft., the regulator will automatically deliver oxygen under pressure. The emergency procedure is as follows: —

(*b*) Set the oxygen mask toggle harness to the 'high-pressure' position.

(*c*) *Commence an immediate rapid descent to below* 40,000 *ft*.

(*d*) If the mask fails to seal the pressure delivered by the regulator, hold it against the face by hand.

(*e*) Within 15 minutes of reaching 40,000 ft., commence a slow descent to a cockpit altitude of 30,000 ft. to avoid suffering from decompression sickness.

36 Use of the emergency oxygen bottle

(*a*) If it is necessary to use the emergency oxygen bottle through failure of the regulator or because of exhaustion of the main supply, pull up the emergency control on the right of the seat.

(*b*) The duration of supply from the emergency bottle cannot be accurately guaranteed and may vary from 6 to 10 minutes, therefore the descent to 10,000 ft. cabin altitude should be made within 5 minutes. Upon exhaustion of the bottle, breathing will become difficult because the inward relief valve is blanked off. Check that NORMAL is selected and, if desired, unplug the mask tube.

(*c*) On ejection the main supply tube to the PEC seat portion is automatically released and the emergency set brought into use. In all high altitude ejections the duration of the set will last until the seat has reached 10,000 ft. and separation occurs. The emergency oxygen set then remains with the seat and the PEC man component is automatically disconnected from the seat component. If descending into water the oxygen mask should be removed.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 13 — STANDARD WARNING AND FIRE-PROTECTION SYSTEMS

Contents

Standard Warning System

1 General description

(*a*) The standard warning system provides visual and audio warning of an emergency, and visual warning of the particular service concerned. Warnings given are of excessive temperatures in the vicinity of the engines, fuel tanks or bomb bay, or failure of the following services: —

Autopilot
Cabin pressurisation
Flying controls hydraulic systems
Generators
Wing and nose fold locks

(*b*) Visual warning, in general, is by two attention getter lights, one each side of the pilot's cockpit, and a light in a cancel pushbutton on the standard warning panel (SWP). Visual warning in particular, is by illumination of a service light on the SWP. Audio warning (fire-bell) is given ◀ through the mic/tel circuits. The audio warning and attention-getter facility can be rendered inoperative by setting to OFF, a LIGHTS and AUDIO WARNING — ON/OFF switch on the starboard console. ▶

(*c*) The system is supplied from the emergency battery except for the test circuit which is supplied from the DC Normal busbar. When mod. 497 is embodied, control of the audio warning and attention getter facility is transferred to the M (mute) switch, when pulled up. The LIGHTS & AUDIO WARNING switch is then deleted. Mod. 497 also introduces automatic cancellation of the warning caused by a fault of short duration.

2 Standard warning panel

The SWP, on the starboard console in the pilot's cockpit, contains the following service lights and switches: —

Service lights

OXY — Inoperative (pre-mod. 852)
or
R. BAY — Radio bay cooling (post-mod. 852)
C. PR — Cockpit pressure
GEN. P. — Port generator
GEN. S. — Starboard generator
CON. P. — Powered flying controls — port
CON. S. — Powered flying controls — starboard
AP — Autopilot
WF — Wing and nose fold locks
FIRE. P. — Fire in port engine
FIRE. S. — Fire in starboard engine
FIRE. F. — Fire in fuel tanks bay
FIRE. B. — Fire in bomb bay

Switches	*Function*
T (Test) pushbutton ...	For testing the whole warning system.
M (mute) push switch	Inoperative (pre-mod. 497). Post-mod. 497 the switcb, when pulled up, renders inoperative the audio warning and attention getter facility. A light in the top of tbe switch is then on.
C (cancel) pushbutton)	For cancelling a warning but will not extinguisb the service lights which will remain on until the cause of warning is removed.

GT (Ground test) pusbbutton	For testing the warning system when a ground DC supply is plugged in.
	NOTE: To avoid excessive lamp temperatures all warnings, other than fire and wing and nose locks, are automatically disconnected when a ground supply is plugged in, unless the battery master switch is ON.
Two F (fire) pushbuttons	One for each engine's fire-extinguishing system. A warning light is in the head of each pushbutton.

3 Standard warning system, operation

Excessive temperatures in the vicinity of the engines, fuel tanks or bomb bay, or failure of any system listed in para. 2, cause a warning circuit in tbe appropriate system to operate. This connects DC to a flasher and excitation unit and the appropriate lamps in tbe standard warning panel. The flasher and excitation unit provides a steady DC supply to the audio warning unit and an intermittent supply to the two attention getters and tbe cancel pusbbutton.

Fire-Protection Systems

4 General description

(*a*) Three fire-protection systems are provided, identical systems for each engine and one combined system for tbe fuel tanks and bomb bays. The systems detect and give warning of fire or bigh temperature round the engines or in tbe fuel and bomb bay and provide for either manual or automatic extinguishing. The normal electrical requirements are, 115 volts AC from the Essential busbar and 24 volts DC from the emergency battery. For test purposes a 24 volt supply from the Normal busbar is substituted for the emergency battery supply when the test button on the standard warning panel is pressed.

◀(*b*) *Triple* FD *systems*

(i) When mod. 613 is embodied, FFFD firewire systems are installed. The layout is similar to the layout in sub. para. (*a*) but the possibility of spurious warnings is reduced.

(ii) When AC and DC is available, the control unit supplies periodic current pulses to the firewires; the periods between the pulses are used by the control unit to monitor the electrical charge accepted by the firewires. This charge increases with firewire temperature and if anywhere around the loop a critical temperature is reached, the monitoring circuit operates a detection relay within the control unit.

(iii) The relay contacts complete a DC circuit to the standard warning system, causing the fire caption, the attention-getters and the audio warning to operate. The attention-getters and audio warning are cancelled by pressing the C button on the warning panel; the fire caption does not go out until the firewires cool sufficiently to permit the detection relay to reset.

(iv) *Functional test*
The testing facility, controlled by the test button on the standard warning panel, checks the serviceability of the whole engine fire detection system. Pressing the test button energises a test relay in the control unit to add a capacitator to the firewire loop, the capacitor circuit being completed through the firewire's central conductor. The capacitor simulates the effect of overheat; the monitoring circuit responds, closes the detection relay and hence operates the fire caption, attention-getters and audio warning. Unserviceability of the fire detection system is indicated by the fire warning lights either not illuminating on pressing the test button or failing to extinguish when the test button is released. Unserviceability may be caused by moisture contamination of the firewire through a fracture in the outer conductor or a loose coupling between sections. It is therefore important that the test is made when such contamination is likely to be present, namely:

Prior to engine start — particularly if the aircraft has been parked for some time in moist conditions.

NOTE: After a prolonged stand in moist conditions, a defective firewire may initiate a warning immediately the battery is switched on.

After flight — since the aircraft may have descended through cloud and the rising ambient pressure will have assisted any cootamination. Delaying the test beyond engine shut-down nullifies this test, since the heat from the cooling engine dries out any moisture.▶

Engines

5 Engine fire, detection and warning

A set of four firewires are looped round each engine and jet-pipe and are wired in series. One wire passes round the compressor and continues below the engine to encircle the accessories, including the fuel control unit; the remaining wires are round the comhustion chamber, jet-pipe and the jet-pipe extension. If, anywhere along the fire-◀wires, a critical temperature is reached it operates the▶ standard warning system. The fire warning will remain in force until the firewires have cooled sufficiently to de-energise the relay.

6 Engine fire, extinguishing

A 6 lh. bottle of methyl-hromide on the inside of each engine intake cowling has a dual operating head. One head supplies a spray-ring round the engine intake and a spray nozzle which discharges into the intake. The second head supplies a pipeline which passes aft along the top of the engine and discharges into the cooling airflow which passes between the jet-pipe and the jet-pipe heat shield. The first head is operated when the appropriate fire-extinguisher pushhutton is pressed and both heads are operated automatically hy operation of the crash relay.

7 Engine fire-protection, controls and indicators

(*a*) Two fire-extinguisher pushhuttons, one for the port engine and the other for the starboard engine, are aft of the standard warning system panel. Each hutton has a warning light in its centre. In addition FIRE P and FIRE S warning lights are on the panel.

(*b*) The firewires and the warning system are tested when the standard warning T (test) pushhutton is pressed.

Fuel Tanks and Bomb Bay

8 Fuel and bomb bay, fire detection

Two firewires are provided. One is clipped to the spray-pipes of the extinguisher system and the other projects into the lower half of the bomh bay at the aft end. ◀Each firewire is connected to a relay unit in the radio bay.▶

9. Fuel and bomb bay, fire-warning and extinguishing

◀If a critical temperature is reached in either of the fire-▶ wires it energises its associated relay in the relay unit which operates the standard warning system and gives the fuel bay or homb hay fire-warning as appropriate. Energising either relay will also operate two 12 lb. methyl-hromide fire extinguishers in the radio bay, one port and the other stardhoard. A spray-pipe from each of the bottles is carried along their respective sides of the homh and accessories bay and the fuel tanks, and nine connections to each pipe carry the fluid upwards between the fuel tanks. The warning will be cancelled when the firewires have cooled sufficiently.

10 Fuel and bomb bay fire, controls and indicators

A FIRE F (fuel hay) light and a FIRE B (bomh bay) light are on the standard warning panel. The complete fire-detection and warning system is tested when the T (test) pushhutton in the standard warning system is pressed. A ◀relay and, post-mod. 613 four diodes, in this circuit▶ prevents operation of the fire-extinguishers.

Explosion Suppression

11 Internal and external fuel tanks

(*a*) When mod. 79 is embodied, an explosion suppression system is incorporated in the fuselage tanks, although in peace-time the system is rendered inoperative. The system utilises the time interval between commencement of a flame and development of an explosion, to fill the tank with a mixture of fuel and an extinguishing agent, thus preventing development of tbe explosion. Simply, each tank has two suppressor units, fitted with detonators wbich are fired on receipt of a signal from a photo-electric cell. The system is supplied with AC at 115 volts from the Essential busbar and DC from the Normal busbar.

(*b*) When AC is first applied, a neon MAIN TANKS EXPLOSION SUPPRESSION — RESET indicator on the pilot's starboard console is illuminated. Pressing an adjacent PRESS TO RESET guarded pushbutton, resets tbe system and extinguishes the light. Eigbt indicator fuses, in the starboard wheelbay, show if the system has operated.

(*c*) The external tanks system is similar to the internal tanks system except that it is only operated by the crash relays. There are no indicators or controls in the cockpit ◀ but an indicator fuse is in the fairing of eacb tank. Only a DC supply is required and this, pre-mod. 1067, is provided from the emergency battery; there is thus a permanent drain from this battery. When mod. 1067 is embodied the supply is taken from the DC normal busbar hut relay action, if the crash relays operate, provides a supply from the emergency battery.▶

NOTE:- THE SYSTEM IS RENDERED INOPERATIVE BY STI/BUCC/151B

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 14 — RADIO AND RADAR

Contents

Radio

1 Radio, general description

The radio installation provides multi-channel voice communication on UHF (main and standby) and HF, and intercomm. through the audio frequency stages of those sets. It also provides UHF homing facility, using the main set, and bearing and distance information using Tacan and provision is made for connecting telebriefing circuits. A radio selection HF/UHF/TB switch, a P to T, an intercomm./mute switch and a telebriefing light are in each cockpit and an emergency P to T, for use with the standby set only, is in the pilot's cockpit. All sets are supplied with DC from the Normal busbar and the HF is also supplied with AC at 200 volts. The Tacan also receives AC at 115 volts. If the normal DC supply fails, the standby UHF set can be supplied from the emergency battery. If the AC 200 volt Normal busbar becomes de-energised an emergency supply for the HF can be obtained from the Essential Services busbar.

WARNING: If the HF is used on the ground all personnel and equipment must be well away from the aircraft, owing to the high voltages in the airframe structure during transmissions.

2 Radio, controls and indicators

(a) Pilot's cockpit

(i) A radio facilities panel on the port console bouses the UHF controller and the following control switches, reading from the outboard to inboard: —

◀P TO T EMERG — TRANS/OFF switch
UHF HOMER — MIN/MAX switcb
STANDBY UHF
CHAN — GUARD/ALTVE switch
POWER — NORM/EMERG switch
UHF
T/R — NORM/STANDBY switch
AERIALS — UPPER/LOWER switch

(ii) The pilot's radio selector is a TB/UHF/HF switch, outboard of the LP cocks. ▶

(iii) A T/B ON light is on the cockpit port wall.

◀(iv) A mute switch, labelled P to IC/OFF IC and spring-biased to OFF, is on the cockpit port wall. ▶

(v) The pilot's P to T pushbutton is on the starboard throttle handle, above the airbrakes switch.

(*b*) *Observer's cockpit*

(i) A UHF radio facilities panel on the port console contains: —

T/B ON light

Radio selection TB & RADAR WARNING/UHF/HF switch

P to T switch

◀(ii) A foot-operated mute switch on the starboard side is similar in operation to the pilot's mute switch. ▶

(iii) The HF control box is on the starboard console.

(iv) An HF POWER change-over switch is on the starboard wall.

(*c*) The ground crew have a mic/tel socket and a call switch in both port and starboard wheelbays and, for servicing purposes, a socket on the port wall of each cockpit and one in the radio bay.

3 Intercomm.

For normal use between aircrew, and aircrew and groundcrew the radios provide direct intercomm., providing one set is switched on and is selected on both radio selection switches. If the observer has a different selection, operating either of the I/C mute switches connects all mic/tels to the pilot's selected radio, and mutes all radios except the main UHF set guard receiver and the standby UHF set. The system, however, allows a large number of combinations, not all of which are secure as they require use of a P to T pushbutton, therefore the following table is given as a guide.

T/B connected or discon-nected	*Selection switch position*		*Set switched on*		*Ground-crew connected or discon-nected*	Aircrew to — (via I/C/mute, P to T or direct)		
	Pilot	*Obs.*	UHF	HF		*Each other*	*Groundcrew*	*Control*
C	T/B	T/B	OFF	OFF	C or D	P to T	No	P to T
C	T/B	T/B	ON	ON or OFF	C	I/C/mute	I/C/mute	P to T
C	UHF	UHF	ON	ON or OFF	C	Direct	Direct	P to T
D	UHF	UHF	ON	ON or OFF	C	Direct	Direct	—
D	UHF	HF	ON	ON	C	I/C/mute	Pilot direct Obs.I/C/mute	—
D	UHF	T/B	ON	ON or OFF	D	I/C/mute	—	—
D	HF	HF	ON or OFF	ON	D	Direct	—	—
D	HF	UHF	ON	ON	D	I/C/mute	—	—
D	HF	T/B	ON or OFF	ON	D	I/C/mute	—	—
D	T/B	T/B UHF or HF	ON	ON or OFF	—	I/C/mute	—	—

WARNING: With a radio set switched on and selected on the selection switch, pressing the associated P to T for intercomm. will also transmit on the selected set.

4 Telebriefing and groundcrew call

A telebriefing plug is in the starboard wheel well. When telebriefing is connected the white T/B ON lights are on. If a groundcrew call switch is made, the lights are occulted. When telebriefing is disconnected the white lights go out but will come on (steady) if a groundcrew call switch is made. In this case the UHF receiver is connected to the pilot's mic/tel when T/B is selected.

5 Main UHF set

(*a*) An ARC52/TR5 set, controlled from the pilot's radio facilities panel, provides multi-channel (225-399·9 mc/s) voice communication. It provides a total of 1,750 frequencies of which 19 may be pre-set; one of the pre-set frequencies is always guard. A separate receiver within this set operates on the guard frequency only, when the main control switch is set to T/R + G, and signals received on this frequency will be superimposed on whatever other frequency is selected, and cannot be muted. Either of two aerials, one on the central dorsal fin and the other on the lower fuselage, below the pilot's cockpit, may be used and they are selected by an AERIAL — UPPER/LOWER switch.

(*b*) The controls of the set are as follows: —

Switch	*Function*
Function switch ...	... A four-position switch selecting,
OFF —	No power supplied.
T/R —	Permits reception and transmission on a selected frequency after a 20 secs. warm-up period.
T/R + G —	Permits reception and transmission on a selected frequency and reception on the guard channel.
ADF —	Switches in homer, for presentation on attitude indicator. Normal communication facility is retained.

Channel selector switch ... A three-position switch selecting,

M — Manual tuning.

G — Selects guard channel.

1 - 18 — Selects the preset channels as required.

Manual tuning controls ... Four controls, with associated indicator windows which show the selected frequency. They are read from left to right.

Volume control ... ... Controls audio output to inter-comm. and audio output of the ADD.

(*c*) The mic/tels and the P to T's are connected to the main set through a relay, when it is energised. Setting a ◀UHF T/R switch from NORM to STANDBY de-energises the relay (see para. 6), but does not switch off the main set.

(*d*) Provision is made for an automatic interrupted▶ tone transmission of 1000 c/s when either ejection seat is fired. An AUTOTONE/CANCEL switch on the pilot's port console enables the pilot to cancel the transmission if, after the observer has ejected, he decides to land the aircraft. If the standby UHF set is in use the transmission will emanate from that set and will be in the range 800-1200 c/s.

6 Standby UHF set

(*a*) The standby UHF set provides two-channel voice communication. One channel is pre-set to 243 m/cs, the guard channel; the other is pre-set to 243·8 m/cs and is normally used for test purposes. A single aerial is on the dorsal fin forward of the main UHF aerial. The set is ◀controlled by the UHF T/R switch which, when at STANDBY, connects a DC supply, and also de-energises a relay, which then connects the mic/tels and the normal P to Ts to this set. The emergency P to T is always connected to the standby set and can only be used with this set. The channel is selected by a CHAN GUARD/ALTVE switch. The power supply is controlled by a POWER — NORM/EMERG switch which at NORMAL is supplied from the Normal DC busbar and at EMERG is supplied from the emergency battery.

WARNING: The power output of the standby set is▶

lower than the main set, therefore a reduced range should be expected.

◀(*b*) When mod. 1117 is embodied the standby set is transistorised and has a lower current consumption (see Ch. 1 para. 17(*b*)). ▶

7 UHF homer

The UHF homer uses the main UHF receiver and the lower aerial, and displays the bearing of any transmission on the frequency in use. The display, in azimuth only, is shown as a bead on the attitude indicator. The main UHF set controller switch must be at ADF and the sensitivity of the display is controlled by a UHF HOMER—MAX/MIN switch.

8 HF set

The HF set provides multi-channel (2·5 - 20 m/cs.) voice communication up to 1,500 miles. It provides a total of 1,750 frequencies of which 12 are pre-set. The power required is supplied from the Normal DC busbar and the 200 volt Normal AC busbar; an emergency AC supply is available from the Essential Services busbar. A notch-type aerial is in the dorsal fin and an automatically controlled heating unit is provided for the unit. Control of the set is from an HF control unit on the starboard console of the observer's cockpit. The functions of the controls and indicator are: —

Control	*Function*
Function switch	A four-position switch selecting: —
OFF —	No power supplied.
OVEN —	DC power to the crystal oven and valve heaters. Approx. 8 mins. are required to warm-up.
R —	Full power supplied — allows reception on selected channel.
T/R —	Allows reception and transmission on selected channel.
OVEN magnetic indicator	Shows black when oven is at required temperature.
Channel selector A to M ...	Selects any of the 12 preset channels.
Channel magnetic indicator	Shows black when the selected channel is set up.

Control	*Function*
RX GAIN control	... A volume control.
AE TUNE control	... Allows fine tuning of the aerial to the signal being received. NOTE: The aerial is automatically tuned to the selected transmitter frequency.
AE TUNE RX push-button	... A button which must be depressed while the AE TUNE control is being operated.
HF POWER SUPPLY — NORMAL/EMERGY switch	... Controls the AC supply to the set. If the ATA fails, load shedding must be carried out before the switch is set to emergency.

9 Tacan

(*a*) The Tacan installation provides a continuous indication of bearing and distance from a beacon in both the Pilot's and Observer's navigation display of the IFIS (see Chapter 8). A separate facility allows an offset position on the pilot's display. The set is controlled from the pilot's port console where a controller has the following switches:—

Power switch ...	... An ON/OFF switch
BRG/DIST.BRG switch	... When BRG is selected no aircraft transmission is made, and only bearings are indicated. When DIST. BRG is selected both range and bearing are indicated.
Channel selectors	... Four pushbuttons and a single selected channel window, for selecting any one of the 126 available channels. Pushing the top buttons increases the channel number and pushing the bottom buttons decreases the number. In each case the left bottom moves the tens.

WARNING: Care must be taken not to turn the channel numbers below 01 or above 126, as damage to the selector mechanism may result.

DISPLAY STATES FOR ALTERNATIVE MODE AND CONTROL SELECTIONS (TACAN)

Switch positions	
POWER ON/OFF	BRG
	TAC selected on navigation display
ON	Compass display on both instruments
	Beacon identity tone
OFF	Compass display on both instruments
	DL selected on navigation display
ON	Valid direct Tacan display (bearing only) on both instruments
	Beacon identity tone
OFF	Meaningless Tacan display (with zero range) on both instruments
	COMPASS or ILS selected on navigation display
ON	Compass or ILS (inoperative) display on pilot's instrument
	Compass display on repeater
	Beacon identity tone
OFF	Compass or ILS (inoperative) display on pilot's instrument
	Compass display on repeater

DISPLAY STATES FOR ALTERNATIVE MODE AND CONTROL SELECTIONS (TACAN)

Switch positions	
POWER ON/OFF	DIST/BRG
	TAC selected on navigation display
ON	Valid offset Tacan display on pilot's instruments
	Valid direct Tacan display on observer's instrument
	Beacon identity tone
OFF	Meaningless Tacan display on both instruments
	DL selected on navigation display
ON	Valid direct Tacan display on both instruments
	Beacon identity tone
OFF	Meaningless Tacan display (with zero range) on both instruments
	COMPASS or ILS selected on navigation display
ON	Valid Tacan display on repeater only
	Compass or ILS (inoperative) display on pilot's instrument
	Beacon identity tone
OFF	Meaningless Tacan display on repeater
	Compass or ILS (inoperative) display on pilot's instrument

Volume control ... ... Controls the audio output to the intercomm.

Two aerials under the fuselage, one by the nosewheel bay and the other aft, are selected by a FWD./AFT switch adjacent to the controller.

(*b*) A computer, required for offset Tacan, is controlled from the observer's port console. A controller forward of tbe IFIS navigator's repeater has the following: —

Range control and window ... ... For setting the target distance from the beacon.

Bearing control and window ... ... For setting the target bearing from the beacon.

10 Operating the radios

(*a*) In all cases, the operator's radio selection switcb must be set to the facility being used.

(*b*) *Main UHF*

To operate the main UHF: —

Set the function switch as required
◀ Set the UHF T/R switcb to NORM ▶
Select required aerial
Select channel or frequency required
Adjust volume

(*c*) *Homer*

Operate the main set as in (*b*) but set the function switch to ADF. Select min. or max. sensitivity as required.

(*d*) *Standby UHF*

To operate the standby UHF: —

◀ Set the UHF T/R switch to STANDBY ▶
Set the POWER switch as required
Select channel required

(*e*) *HF*

To operate the HF: —

Set the HF power switch to NORMAL
Set the function switch to OVEN
Select required channel
Set AE TUNE control to zero

When the OVEN magnetic indicator shows black and the ATA is on-line: —

Set the function switch to T/R
Check that both magnetic indicators are black.

NOTE: The function switch should be set to R until it is required to transmit, if a policy of radio silence exists.

On receipt of a signal: —

Adjust RX gain control
Depress AE TUNE switch and adjust AE TUNE control to give maximum signal.

11 Radio failures

(*a*) *Failure of the main UHF*

If the main set fails, switch on the standby set by setting the T/R switch to STANDBY. This does not switch off the main set.

(*b*) *Failure of intercomm.*
If the intercomm. fails set the radio selection switches to the set(s) not previously used and switch on the selected set, if necessary. Intercomm. should then be available through the new set.

(*c*) *Failure of the P to T's*
If both the normal P to T's fail, switch on the standby UHF set and use the emergency P to T. If a P to T jams on, set both selector switches to T/B to avoid spurious transmissions.

(*d*) *Failure of the DC supply*
If the normal DC supply fails, or if both generators fail, switch on the standby UHF set and set the POWER switch to EMERG. The normal P to T's can be used.

(*e*) *Failure of the ATA*
If the ATA fails, AC for the HF set can be restored, after load shedding, by setting the HF switch to EMERG.

Radar

12 Blue Jacket Doppler radar, general description

Blue Jacket is a twin-beam pulsed Doppler radar equipment operating in the X band, which is used to indicate position, wind, track and ground speed and to drive a roller map. It consists of four units, the aerial, transmitter/receiver, navigational computer and the indicator. The power supplies are DC from the Normal busbar and AC from the 200 volt Essential Services busbar.

13. Aerial and transmitter/receiver

(a) The aerial is below the radio bay. To prevent false inputs to the computer it is stabilised in pitch by the MRG, between the aircraft angles of 7° dive and 13° climb and a roll cut-out operates when 6° of roll is reached.

(b) The transmitter/receiver is in the radio bay. A signal cannot be received below 150 ft. AGL.

14. Navigational computer

The computer has two units, the tracker unit and the computer unit. The tracker unit locks on to Doppler information and computes aircraft groundspeeds along and across the heading. A TAS and compass bearing input allows computations of windspeed and direction. The along and across heading speeds are passed to the roller map and the computer unit. The computer unit computes drift angle and groundspeed for Blue Parrot radar (target marker computer) and for presentation of track and ground speed on the indicator. Northing's and Easting's or changes in latitude or longitude are also computed.

15. Indicator

(a) The indicator is in the observer's cockpit starboard side forward, below the roller map. It displays either track and groundspeed or windspeed and direction, as selected, by means of two pointers. Veeder counters display present position in either grid or lat/long co-ordinates, as selected. Jumping of these counters up to 1 mile or 6 mins. of longitude may occur when first switched on. The indicator also houses the controls and secondary indicators.

(b) The system has a memory mode which operates when the transmitter is off, the aircraft is below 150 ft., the signals received are too weak for use or the roll cut-out operates. In this case the computer continues to compute present position using TAS and the last calculated wind; the wind may be corrected by using the inching controls. When in the memory mode a memory light will come on and will remain on until normal operation is resumed. If a signal is received but is too weak for the tracker to lock-on, the memory light will be intermittent.

16. Doppler controls and secondary indicators

The Doppler controls and secondary indicators are: —

Main ON/OFF switch ...	Controls the power supply.
HT ON/OFF switch ...	Controls the power to the transmitter.
GRID/Lat-Long switch ...	Selects mode of veeder counters.
Counters ON/OFF switch	Starts the veeder counters.
Manual control	Allows manual setting of veeder counters. Counters switch must be off for this operation.
LAND/SEA	When at the SEA position adds 1% correction factor for signal losses over the sea.
Memory light	See para. 15(b).
AGC indicator	Indicates strength of received signals (short = strong).
WIND SPEED/TR.GR ...	Selects pointer display
Wind direction } Wind speed }	Inching controls for wind settings when on "memory".

17. Operating Doppler

To operate Doppler, set the controls as follows: —

Main ON/OFF switch ...	ON, a 5 min. warm-up period is required before the equipment is functional.
GRID/LAT-LONG switch	As required.
Veeder counters	Set to position.
LAND/SEA switch ...	As required.
WIND SPEED/TR.GR switch	WINDSPEED. Inch windspeed to zero and then to display local wind.
AGC indicator	Check that full bar is showing.
Memory light	On.

At unstick speed switch on counters, noting counter jump. When airborne switch HT to ON.

WARNING: Do not switch on counters before take-off as the minimum TAS output (about 60 knots) may be applied giving spurious ground-speed and counter movements.

18 Doppler malfunctioning

Unexpected wind display

Cause — failure of TAS input.

With HT-ON

Computation of present position, track and ground-speed will continue correctly. Wind displayed will be of sufficient strength and direction to combine with the false TAS and balance the computed groundspeed and drift angle. If the equipment goes on to memory when the TAS input has failed, present position indication will no longer remain correct.

19 Roller map, general description

The roller map is Doppler driven and consists of a coupling unit in the radio bay and a display head in the observer's cockpit, above the Blue Jacket indicator. The power supplies are 28 volt DC from the Normal busbar and AC at 200 volts from the Normal busbar.

20 Coupling unit

The coupling is fed with along and across heading ground-speeds direct from the Blue Jacket tracker unit, and with compass bearings. A correction for chart angle is applied at the display head and from these inputs the along and across chart movements are computed. This information is passed to the display head.

21 Display head

The display head is held in position by a quick-release bracket. The map is held between two rollers and gives a 5 in x 5 in. display. Approximately 12 ft. of map can be held on the rollers and the speed of movement of the map up or down the display is kept proportional to the ground speed by the along chart input. A monitoring system corrects any tendency to vary the speed due to build-up of map on one roller. Movement of the aircraft across the chart is displayed on a tape. The chart angle (i.e. the true centre-line track of the cut chart) is set in by a knurled knob marked TRACK. Two scales (½m. and ¼m.) are provided. Movement of the aircraft off the map coverage, up to 10in., is possible (e.g. 75 miles on ½m. scale) and on returning to the map no accuracy should be lost. To allow maps to be changed the top roller is removeable.

22 Roller map, controls and indicators

The roller map has the following controls and indicators: -

Scale selector/OFF switch	... A three-position switch for selecting ½m. or ¼m. with a central OFF position. Also provides power to the display head when set to either of the side positions.
Chart angle veeder counters (TRACK)	... Displays selected chart angle.
Chart angle selector	... For setting chart angle on veeder counters.
Aircraft position indicator tape ...	... A vertical black arrow on the transparent tape shows the aircraft position. The tape is marked at 1 mile intervals (¼ million scale) on either side. Horizontal arrows show the direction of the aircraft when off the map.
Tape control ...	... Allows manual control across the chart.
Rapid movement pull-wires	... Two wires allow rapid manual movement of the chart, up or down the display. The fine control should be used to maintain accurate monitoring.
Fine chart control ...	... Allows fine electro-manual chart control, when the scale is selected.

Back track marker ... A small marker on the upper perspex guard which may be placed on the track when back-tracking, to allow more of the chart to be viewed.

Lamp dimmer control ... For controlling the illumination.

23 Operating the roller map

To operate the roller map, first check that Blue Jacket is switched on. Blue Jacket main on/off switch also controls power to the roller may coupling unit. Then: —

Set chart angle.
Set up chart and tape display starting position.

When over starting position: —

Select chart scale.
Reset chart by fine control, as required.

24 Roller map, malfunctioning

(*a*) *Temporary ATA failure*

The AC supply will be disconnected. When the ATA returns on-line, operation of the roller map may be impossible unless Blue Jacket is switched OFF for a few seconds.

(*b*) *Failure of Blue Jacket*

Most Blue Jacket failures affect the roller map.

25 Radio altimeter, general description

(*a*) The Mk. 7 radio altimeter provides direct height indication in two ranges, 0 to 500 ft. and 0 to 5,000 ft. ▶◀ The equipment primarily consists of transmitter/receiver, power pack, two aerials, indicators, controller and limit lights. A test (confidence) circuit is provided.

(*b*) At a height of 20,000 ft. a pressure switch automatically renders the equipment inoperative until the aircraft is again below that height.

◀(*c*) (i) *Mk. 7*

No reliance should be placed on the accuracy of the equipment in the 0 to 5,000 ft. range. In the 0 to 500 ft. range, accuracy should be within ± 15%.

(ii) *Mk. 7B*

Mod. 1146 introduces the Mk. 7B altimeter. The accuracy of this equipment in the 0-500 ft. range is ± 3 ft. or 3%, whichever is greater, and in the 0 to 5,000 ft. range is ± 30 ft. or 3%. This accuracy is dependent upon the aircraft not exceeding 20° in roll or 17° in pitch.

(iii) The altimeter over-reads if angle of bank or pitch exceeds 20°. ▶

26 Radio altimeter, controls and indicators

(*a*) The controller is on the pilot's port console and has three toggle switches and a rotary switch, as follows:—

ON/OFF switch ... ... Selecting ON provides DC to the equipment. After switching on there is a 40 to 60 second delay for warming-up, before the equipment starts operating.

LIMIT SELR switch ... A twelve-position rotary switch with adjacent window which shows OFF, 50, 100, 200, 300, 400, 500, 1,000, 2,000, 3,000, 4,000 and 5,000 (ft.) as selected for the operation of the limit lights.

TEST switch ... ... A spring-loaded confidence switch. Selecting TEST inserts a known delay into the circuits. Providing the equipment is serviceable, the indicator will read 60 ft. irrespective of aircraft height.

RANGE — 500/5,000 switch ... ... Selects either the 0 to 500 ft. or 0 to 5,000 ft. range.

(*b*) *Indicator*

The indicator on the instrument panel is a single pointer instrument with an OFF flag and a scale having figure markings at 0, 1,000, 2,000, 3,000, 4,000 and 5,000 ft.

When the 0 to 500 ft. range is selected on the controller, a base plate is rotated and this deletes one nought from each of the figure markings except zero, thus making the indicator direct reading on both ranges.

(*c*) *Limit lights*

Three limit lights operate as follows: —

Red light — Indicates that aircraft is 5% or more below the selected limit.

Green light — Indicates that the height set on the limit selector has been obtained.

Amber light — Indicates that the aircraft is 5% or more above the selected limit.

The light filaments can be tested by pressing the fitting. Dimming facilities are provided by rotating the fitting.

27 Management of the radio altimeter

(*a*) *Switching on*

On/off switch ... ... ON
Limit switch ... ... As required
Range switch ... ... 500 ft.

Allow equipment to warm up (up to 1 min.), then operate TEST switch.

Check indicator shows approx. 60 ft.

(*b*) *Climbing*

Check hold-off height is more than 1,500 ft.

NOTE: The hold-off height is the height (barometric) at which the radio altimeter indicator pointer starts to fall back from the hard-over position when climbing. It should not be less than 1,500 ft. when set to low speed range over the sea.

◀ (*c*) *High speed, low level*

Before starting high speed, low level flight check the hold-off height. ▶

28 IFF with SIF, general description

(*a*) The IFF installation is a secondary radar system which provides automatic identification of aircraft when interrogated by radar. The system also provides for identification of specific friendly aircraft and has a distress signal. The installation has three operational modes and also incorporates an identification of position (IP) facility, as follows: —

Mode 1 — For general identification, selected on the SIF controller.

Mode 2 — For individual identification, code is pre-set before flight.

Mode 3 — For aircraft classification; selected on the SIF controller.

◀IP — For identifying position; normally provides for rapid identification on Mode 1 irrespective of mode in use. Can be set up for use with Mode 3.

Emergency — For emergency use, provides a readily identifiahle distress signal on interrogation, irrespective of mode selected.

NOTE 1: Neither IP or Emergency are available on Mode 2.

NOTE 2: IP and Emergency are available on Mode 3 only by pre-flight adjustment of links within the coder unit, hut will only be seen on displays when the interrogator is operating on the aircraft's correct Mode 3 code. ▶

(*b*) Two sharks-fin aerials are fitted, one below the fuselage, forward of the accessories bay door and the other on the tailplane upper fairing. The electrical supplies are DC from the Normal husbar and 115 volt single-phase AC from the 200 volt Essential Services husbar.

29 IFF with SIF, controls and indicator

(*a*) The whole installation is under the control of an IFF MASTER switch and two control units, both on the observer's starboard console.

(*b*) The IFF master switch controls the DC to the installation.

(*c*) The IFF control unit has one rotary switch aod three toggle switches, as follows: —

Rotary switch

Positions:	OFF ...	No power supplied.
	S/BY ...	In standby position. Only the heaters are warmed-up and about one minute is then required before the equipment will function.
	LOW ...	Low sensitivity. The equipment will only respond to strong interrogation signals.
	NORMAL...	The normal operating position. The equipment will respond to any signal received.
	EMGY ...	The emergency position which can only be selected after pressing a red button.

Toggle switches (two)

Select modes 2 or 3 respectively. Mode 1 is naturally selected when both switches are OFF.

◀*IP/OUT/MIC switch*

The MIC position is unused and the switch is spring-biased to OUT. Selecting IP operates Mode 1 (or Mode 3 if set up), for 15 seconds after the switch is released. ▶

(*d*) *SIF*

The SIF control unit has two double rotary switches, one pair selecting the codes for mode 1 and the other pair selecting the codes for mode 3. The outer ring of the pair selects the first digit of the code, and the inner ring selects the second digit.

30 Wide Band homer, general description

(*a*) The Wide Band homer is a detection device of pulsed radar transmissions. These transmissions may originate from any source whose frequency is within the receiver band-width and lies within about 100° of the aircraft heading. It is capable of operating at any altitude and provides the observer with a visual indication in the form of a bright orange line on a CRT. This display gives either port, starboard or dead ahead bearing information; the dead ahead information is correct within about 5°. An audio warning, the pitch of which is determined by the PRF of the transmitter, is also provided. This audio signal should be heard by the observer on the intercomm. irrespective of the position of the Radio Selection switch.

(*b*) When mod 5020 is embodied two pods are carried, one under each wing, and an indicator is situated on the port side of the observer's cockpit. The indicator displays, as stated above, the approximate bearing with relation to aircraft heading and an indication of the strength of the received signal. All the controls are mounted on its face.

◀(*c*) When Tacan is operating it provides a suppression pulse to switch off the homer receiver during transmission. ▶

(*d*) Power supplies required are 200 volts and 400 cycles, single-phase AC and 28 volts DC from the Normal supply.

31 Wide Band homer, controls and indicator

(*a*) *ON/OFF attenuator switch*

This switch has seven positions, as follows: —

OFF

In this position power supplies are not provided. To prevent inadvertent switching off in flight a stud must be pressed on the guard pillar to allow the switch to be placed in the OFF position. A few seconds are required after switching on before the equipment is fully operational.

Position 1

In this position noise flickers on the display and audio clicks are provided at the rate of about one per second. This position is used to check that the homer is operating and to set up the trigger bright-up controls. It is the most sensitive position which is normally used when searching.

Position 2 - 7

Attenuation of the received signal is provided by a step control. This effectively increases or reduces the trace length of the displayed signals. This control does not affect the audio volume but gives some indication of signal strength. The channel gain control is set up with this position selected. The signal should only be attenuated when a full scale deflection is observed.

(*b*) *Trigger bright-up control*

This controls the overall sensitivity of the equipment. It is set up with the ON/OFF attenuator switch on position 1. It may occasionally be necessary to readjust the trigger rate while airborne to approximately one click per second.

(*c*) *Brilliance control*

This controls the brilliance of the display and should normally be kept at a practical minimum to avoid hurning the CRT face. It is set up on position 1.

(*d*) *Audio volume control*

This controls the volume of noise being passed to the observer. It is set up on position 1.

(*e*) *CRT display*

This displays bearing only in the horizontal plane.

(*f*) *Pre-set control*

These are covered by small plastic covers and must not be touched in flight. Two are used to balance aerial channels.

32 Management of the Wide Band homer

(*a*) Confirm ATA is on-line.

(*b*) Switch Radio Selector Switch to T/B and Homer for improved listening.

(*c*) Switch ON/OFF to position 1.

(*d*) When warmed-up check that the display brightens on the peaks of noise, and that approximately one 'click' per second is heard. If these conditions do not obtain proceed as follows: —

Rotate trigger bright-up control fully anti-clockwise.

Adjust the brilliance control until the spot is extinguished.

Rotate the trigger bright-up control until one 'click' per second is heard.

(*e*) Set volume control high.

(*f*) The performance of this equipment is seriously affected if the Type 107 inverter is in use.

33 Blue Parrot

For Blue Parrot refer to Chapter 15.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 15 — WEAPONS SYSTEM

Contents

FIRE CONTROL SYSTEM

1. General description

(a) The Fire control system consists of two main parts; the radar and the sighting systems. The radar provides the Observer with a means of locating the target and subsequently provides the sighting system with target range and bearing, together with other information set in by the Observer. The sighting system computes and displays to the Pilot the information that is required for aiming, and completing the necessary manoeuvre for correct release of the selected store. This manoeuvre can, in certain cases, be carried out by either the Pilot or autopilot; the release is automatic in all modes except depressed sight line attacks.

(b) The complete system is made up of nine different units. To function, it receives constant information on roll, pitch, compass bearing, true airspeed and rate of climb from the IFIS. The Blue Jacket Doppler radar provides drift angle and ground speed.

(c) One of the units, the weapon system recorder, may be fitted optionally for attack recording purposes only. It then becomes part of the sighting system.

(d) The power supplies required are 28 volt DC and 3 phase AC at 200 volts and 400 c/s. The main AC supply is taken from the Normal busbar and is not available on ATA failure, but the heaters are supplied from the Essential Services busbars and will be supplied by the Type 107 inverter if the ATA fails.

(e) The power supply to the whole system is DC controlled through an ON/OFF switch and timing relays ensure a 5 minute warm-up period.

RADAR

2. Blue Parrot

(a) The radar is primarily designed for long range detection of surface vessels, using X-band. An integrated target marker enables blind TMB attacks to be made on either radar visible or non-discrete targets.

(b) A monopulse system is employed which gives the radar additional facilities for visual dive attacks and low flying. These facilities provide three modes of use: —

Normal
Radar ranging
Terrain warning.

(c) The radar system consists of four units: —

(i) *Radar main set*. This is the largest unit and is housed in a cannister in the hinged nose, pressurised to cockpit altitude. It consists of the scanner, TX and RX, a dead reckoning navigational computer called the target marker computer (TMC), display and range servo, and lock-on circuitry.

(ii) *Indicator azimuth range* (IAR). This is a CRT in the port forward corner of the cockpit, displaying to the Observer the information derived from the radar set. Either sector PPI 'B' scan or 'Z' scope displays, with ranges out to 240 nm are used. The video information is provided by a logarithmic receiver which allows a wide range of echo signal strength to be simultaneously displayed. A target marker is also displayed. There are controls beneath the CRT, selecting range scales and controlling the display quality.

(iii) *Control radar set* (CRS). This has a joystick for marker control and a number of other switches and controls affecting the radar set. It is situated outboard of the Observer's right knee.

(iv) *Control indicator* (CI). This has controls and switches affecting the use of both the radar and sighting systems, such as the Radar and the target marker mode switches, wind and target data controls. It is situated directly in front of the Observer below the chartboard.

(d) The scanner movement is physically limited by its construction in two directions: —

(i) In azimuth up to 50° either side of heading.

(ii) In elevation from 10° elevation to 30° depression.

(e) The scanner may be stabilised by the MRG in two planes: —

(i) Bank, in all radar modes, up to 110° of aircraft bank.

(ii) Elevation, in the normal mode only, at the required angle to the MRG horizontal between the scanner limits. (NOTE: In the event of MRG failure, aircraft axes data may be substituted).

3. Radar normal mode

(a) The normal mode is further subdivided into three phases. The first two, Search and Acquisition, are available on all range scales and displays. The third, Track, is available only on the ½ m. (short range) scale.

(i) *Search*. An azimuth scan on a wide sector, 50° either side of the aircraft heading.

(ii) *Acquisition*. An azimuth scan on a narrow sector, 10° either side of the target marker bearing. This provides a higher data rate than Search.

(iii) *Track*. This phase provides automatic lock follow of a discrete radar target. The target marker must be carefully placed about the target using the Acquisition phase. The scanner is, on selection of Track, at first automatically directed at the target marker position. The radar then searches the area within the marker boundaries and locks on to the strongest signal in this range and azimuth bracket. Provided lock is held the scanner is then controlled in azimuth and elevation by servo-systems driven by error signals derived from the mono-pulse scanner through a linear 3-channel receiver. These three channels receive signals of range, elevation and azimuth, respectively, and then produce the error signals required. This receiver is totally unaffected by the display controls. While lock is held the radar thus automatieally derives target range and bearing in azimuth and elevation. This target information is the most accurate available. If after two seconds no satisfactory lock is obtained the radar should automatically revert to the target marker information. Consequently, it is most important to place the marker accurately before attempting to lock-on. While locked on to a target a lock-light illuminates above the display. It is possible to obtain a false lock-on to heavy clutter, nearby land or shipping. In most cases the radar bearing will be seen to drift away from the target marker bearing and the range gate may be seen to wander in its search for a discrete signal; the lock-light remains lit. Noise-jamming may also provide a false lock, the radar bearing and elevation may be correct hut the range will almost ◀certainly be false. An anti-counter measure switch allows target marker range information to be passed to the sighting system while retaining the use of radar bearing and elevation. ▶

(*b*) The Display scales provided on Search and Acquisition are as follows: —

Sector PPI displays of ½M. 0-30 miles.
1M. 0-60 miles.
3M. 0-180 miles.

A "B" scan from 60 to 240 miles

Expanded "B" scans from 80-140 miles.
130-190 miles.
180-240 miles.

A "Z" scan display on the ½M. scale.

The expanded "B" scans are designed to improve ship detection capabilities while the "Z" scan provides improved azimuth discrimination at short ranges. All the displays are heading stabilised only.

(*c*) In the Normal mode, the scanner elevation is tied, unless lock is achieved, to the MRG horizontal datum. There are two main methods of control and one additional ◀facility, either:

1. Manually (hy the calibrated scanner depression wheel *or*

2. By use of fixed depression angles. These are 2½° depression at long range scales, normally used at high altitude: 1° depression at short range scales (½M. or 1M.) at low altitude; *and*

3. A two bar nod scan sweeping ½° above and below▶ the desired scanner elevation angle which may be selected and superimposed on either of the above. This is to improve the vertical coverage for intermediate altitodes and small errors in MRG pitch datum.

NOTE: *MRG fast erection.* A switch allows fast erection when in steady level flight to restore the datum.

4 Radar ranging mode

◀(*a*) Radar ranging is available for visual dive attack,▶ but accuracy may not be achieved with dive angles below about 15°. The scanner, after rotation through 90° to improve elevation discrimination, is slaved to the pilot's aiming mark: it remains roll stahilised. The correct target slant range is presented on the pilot's display unit when his ◀aiming mark is about the target. The lock circuitry for▶

◀radar ranging is started by the pilot 'accepting' at the top of the dive, causing the range gates to hunt from 5 miles to ½ mile and lock-on to the ground returns.

(*b*) An additional facility, DTM, is selected by depressing the red button, on the right of the control indicator, after initial radar ranging has been achieved in the dive. This gives more accurate range information by looking to the radar discrete target. The pilot must reject after the attack to enable the system to return to the simple radar ranging mode. ▶

5 Terrain warning mode

Terrain warning is for low-level use overland. The scanner is again rotated 90° and depressed 2° to the aircraft datum, pointing directly ahead: it remains roll stabilised. No warning signals are at present provided.

6 Target marker system

(*a*) The target marker system employs a DR navigational computer providing a variety of tactical facilities. The resulting marker range and bearing are displayed on the Indicator Azimuth Range and are tied-in accurately with the radar time bases and scanner control circuits, so that a radar discrete object can be accurately marked.

(*b*) The movement of the marker is controlled in three ways:—

(i) Along or across heading (i.e. up and down or across the CRT when using PPI displays) by manual rate control of the CRS joystick.

(ii) The true bearing and range, by manually controlled position offsets on the CI. The range and bearing are displayed on veeder counters.

(iii) By automatic ground stabilisation.

NOTE: No allowance is made for target movement.

(*c*) The marker range and bearing are produced in the Target Marker Computer. This computer receives the inputs, manually fed-in as in sub-para. (*b*) (i) & (ii). These control movements are resolved into marker distances north and east of the aircraft. The ground stabilisation (sub-para. (*b*) (iii)) is provided by resolving and integrating the inputs of drift angle and ground speed from Blue Jacket and true heading from the Variation setting control. The resulting miles flown north and east may be constantly subtracted from the initial marker distance to provide present marker distances. These present distances are resolved and displayed as range and relative bearing from the aircraft.

(d) The marker range and relative bearing are displayed on the IAR and can be passed to the sighting system where it may be displayed to the Pilot by a target spot denoting bearing and, when inside 12 miles, by a range circle. True bearing information is also available to the scanner control circuits for acquisition and track phase, to direct the scanner towards the target. When in Track phase, the range is used by the 3-channel receiver to denote the target area in which to search for lock-on.

(e) The marker display consists of a bearing line, painting about 10 times a second, originating at zero range. Two arcuate range lines, painting with the display sweep, mark the inner and outer limits of a gap in this bearing line. This gap is either 1 or 4 miles wide, depending on the scale selected.

(f) There are five main modes of use controlled by a single switch; and one subsidiary controlled by a spring-loaded pushbutton:—

(i) *Search*. The Marker remains at a fixed compass bearing and range from the aircraft. It is positioned by the CRS only.

(ii) *Normal*. The Marker is ground stabilised and is positioned by the CRS only.

(iii) *Offsets*. By using the offset range and bearing controls the marker is placed about a displayed object. The range and true bearing from the aircraft of this object may be read off counters.

(iv) *Offsets plus Doppler*. The marker is ground stabilised about a point known with reference to a radar identified object. The true bearing and range of this point from the previously marked object is displayed on veeder counters. The radar identified object is marked with the switch to Normal. On selecting O & D the marker jumps to the offset position and remains ground stabilised. The marker is then controlled by all three methods.

(v) *Identification points*. The marker may be ground stabilised about a point known with reference to a visual landmark. Before reaching the landmark the range and bearing of the point are set on the veeder counters.

Selecting IP runs the ground stabilisation to zero, and displays the marker at the selected range and bearing. On passing overhead the landmark, the Pilot presses the accept trigger. The marker, which at that moment is lying about the target's position is ground stabilised. It is now controlled by all three methods as in O & D.

(vi) *Track marker*. A separate pushbutton displays aircraft track by deflecting the marker bearing line from the aircraft heading by drift angle. The arcuate lines remain about the target. This only affects the IAR, the sighting system and scanner control circuits continuing to receive the target marker bearing.

(g) The operation of the marker is entirely independent of radar transmissions. A display is required only for sufficient time to mark discrete targets.

7. Radar system information available to the sighting system

(a) Information of target range, bearing and elevation is available in two forms; that manually set in by the Observer by using the position control, and that which on selection, automatically passes up-to-date information to the sighting system.

(b) *Manual position controls (on CI)*

(i) *Wind speed and direction.* Two controls allow wind speeds up to 60 knots to be applied from any direction, for a closing speed of 560 knots. The across-heading component is used to offset the Pilot's aiming mark so that a collision course is made to a stationary object.

(ii) *Target speed and direction.* Two controls allow target speeds up to 60 knots to be applied for any true course, for a closing speed of 560 knots. The across-heading component is used to offset the Pilot's aiming mark for a collision course to a moving target. The along-heading component is applied to the Doppler ground speed to provide target closing speed to the Sighting system.

(iii) *Height above burst.* A control allows height of TMB burst to be set in above, or below, approach altitude. This affects the release point of the weapon.

(*c*) *Information provided automatically*

(i) *Target marker*. The range and bearing of the marker is available to the sight in both Normal and Terrain warning modes. In elevation, the Pilot's Target spot is tied to the MRG, therefore it is not harmonised with the target in pitch. The accuracy of range and bearing is dependent on the TMC and its use. This information cannot be jammed.

(ii) *Radar*. Locked-on radar range, bearing and elevation are available when lock-on to a discrete target has been achieved, in the Track phase of the Normal code only. It can be jammed.

(iii) *Target marker range and radar bearings*. This combination can be provided if jamming breaks the lock-on range lock. The scanner can still point at the jammer but Target marker range is substituted for a false radar range.

(iv) *Radar range*. By use of radar ranging, range to a visual object which is depicted by the Pilot's aiming mark, is obtained. It can be jammed. No directional information is available.

Sighting System

8 General description

The sighting system is designed to provide the Pilot with information to complete blind and visual TMB attacks using a Long-Toss manoeuvre, and visual TMB attacks using an over-the-shoulder manoeuvre against ship, shore and inland targets using either the target, an offset technique, or an IP. Blind conventional bomb attacks are possible against ships but visual attacks only are possible against shore or inland targets; a Dive-Toss or depressed sight line attack being used. In all these attacks the store is automatically released. When rocketing, only visual attacks with manual release are possible, using a depressed sight line technique. The sighting system consists of six units: —

Control and release computer
Gyro unit
Display waveform generator
Pilot's display unit
Weapon system recorder
Recorder display, supply and control unit

and four switches: —

Armament selector switch
Accept trigger
Reject button
Manual/Auto switch

It is used in addition to the control settings made by the Observer (see para. 7).

⧓

9 Sighting system units

(*a*) *Control and release computer* (*C & RC*). This is the main unit. It is situated on the vertical bulkhead, exposed when the hinged nose is opened. The computer receives target range and bearing automatically from the radar system. Wind and target movement and aircraft height above bomb burst are set in by controls in the Observer's cockpit. Aircraft flight information is received from the Blue Jacket Doppler, the Integrated Flight Instrument System and the Gyro unit. Store ballistics and method of delivery are selected by switching. The computer solves the necessary computations for three modes (Long-Toss, OTS and Dive-Toss) to:—

(i) Provide aiming mark deflections, to correct for cross-wind, and target movement and aircraft incidence, to facilitate tracking and collision course.

(ii) Initiate pull-up and provide appropriate warnings.

(iii) Provide a programmed pull-up at 7° per second rate of pitch (Long-Toss, OTS and locked-on Dive-Toss).

(iv) Provide control of the pull-up plane by aiming mark deflections. These correct for cross-wind, target movement and, during pull-up, changes in cross-wind but not changes in target movement.

(v) Initiate weapon release.

(*b*) *The Gyro unit*. This is sited adjacent to the C & R computer. It contains two gyros; the taget spot is tied to one and the aiming mark to the other. In addition there are two accelerometers for measuring aircraft movement through space, vertically and horizontally to the airframe. This unit provides essential information during approach and pull-up.

(*c*) *Display waveform generator*. This is sited in the port nose access bay. It provides the Pilot's display and the Weapons system recorder with the information produced in the C & RC.

(*d*) *Pilot's display unit* (PDU). This is situated in the Pilot's forward view. A semi-transparent glass displays, by reflection, the information from a bright CRT. The display is collimated to infinity within a 16° cone of vision, this being the limits of the gyros before toppling. It presents the information required for approach, tracking

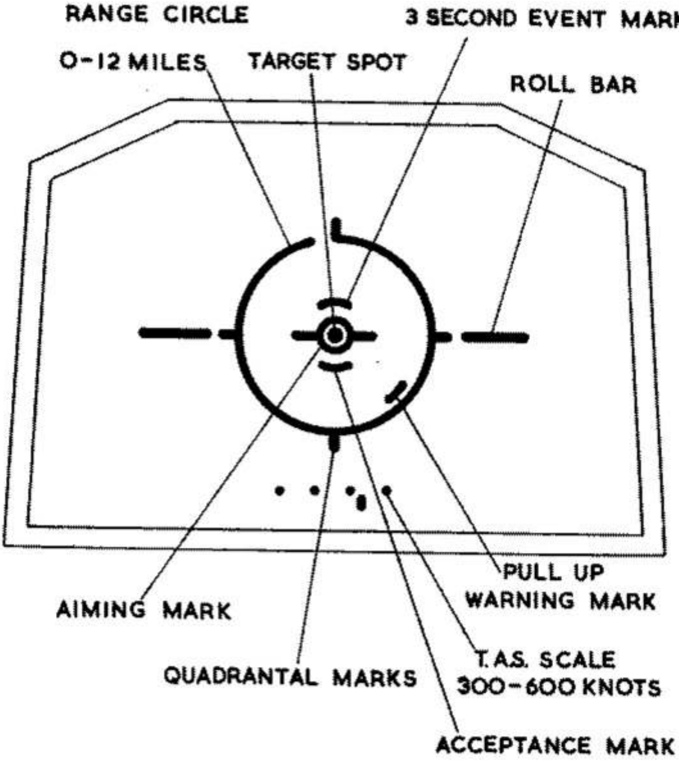
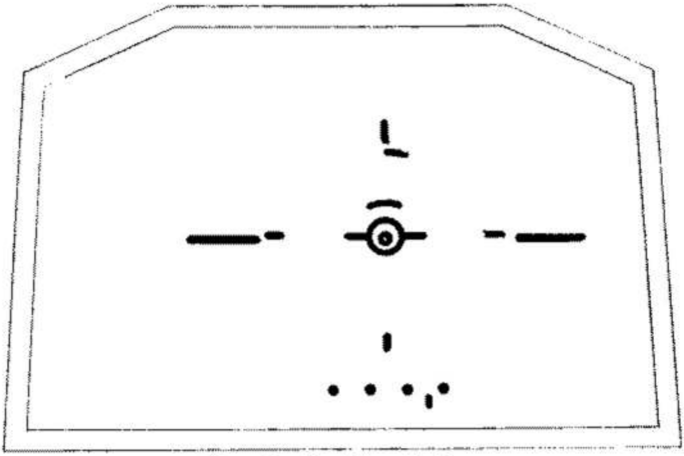


Fig. 1. Strike sight display symbols



Over-the-shoulder attack
Running-in to target at low level
Target visual any moment
Set target course and speed
Radar locked-on
Wind set

Fig. 2. Typical display on sight

and pull-out, the information is shown in the diagram and comprises:—

The symbols tied to the target spot gyro, i.e.
- Target spot
- Roll bar.

The symbols tied to the aiming mark gyro, i.e.
- Aiming Mark (may be offset in azimuth to allow for wind and target movement. It is automatically compensated in pitch for some measure of aircraft incidence).
- True Airspeed Scale.
- Quadrantal Marks.
- Range Circle.
- Pull-up warning mark.
- 3-sec. event mark.
- Acceptance mark.

NOTE: The roll bar is tied to the Aiming mark gyro in a radar ranging attack.

(*e*) *Weapon system recorder*. This 16 mm camera is situated under the nose in the hinged portion. It automatically records on film a picture of the outside world with a superimposed sight display. The speed of filming is either 1 frame every 15 seconds or 15 frames per second. It is controlled by the C & R Computer. The accept warning signal starts the fast speed which is continued until release, or until the reject button is pressed.

10 Sighting system switches

(*a*) *Armament selector switch*. This is situated on the Pilot's port console. It selects both the type of store to be released and its methed of delivery. It consequently selects the type of calculations to be made by the C & R Computer. The practice positions of the TMB modes allow the release signal to be passed to wing stations, for use with practice bombs.

(*b*) *Accept trigger*. This is sited on the forward side of the Pilot's control column. Pressing the trigger allows: —

The C & R Computer to provide a programmed manoeuvre at the pull-up point.

The release circuit to provide automatic release at the computed point.

And initiates: —

The ground stabilisation of the Target Marker Computer when overhead the IP.

Tachometric tracking for conventional bomb attacks.

Radar ranging when selected.

Store release when Manual is selected.

The programmed pull-up when OTS is selected.

Speed-up of the Weapons system recorder.

(*c*) *Reject button*. This is a red button on the starboard throttle. It cancels any computed manoeuvre initiated by the accept trigger and prevents release being signalled by the computer at any time up to release point. It also slows down the Weapon System recorder.

◀ **WARNING:** To prevent inadvertent release of a second weapon, the reject button should be pressed after each attack. ▶

NOTE: It may be necessary to press this button to obtain a display.

(*d*) *Manual / Auto switch*. Selects manual or automatic release. Normally this should be wire-locked to Auto as, when at manual, no use of the computed manoeuvres, IP or radar ranging facilities, is safe if the appropriate bomb station is selected. Manual is selected when rocketing or bombing with a depressed sight line.

Sighting System Functions

11 Sighting system functions, general

During various modes the whole system functions on two main phases (approach and tracking and then pull-up and release).

12 Long Toss (TMB)

(*a*) *Approach and Tracking*

(i) Target bearing and range information, from either the target marker computer or the radar set, when locked-on, is supplied by the radar. The Pilot must take care not to track in elevation as level flight may not be maintained. Height lock would normally be used. The target itself should be tracked if possible.

NOTE: When IP is selected the Pilot must press the accept trigger overhead the IP before target information can be supplied.

(ii) The target closing speed is calculated by ground speed from Blue Jacket and along heading component of target speed (set in by the Observer on CI). The pull-up point is based on a fixed time to go, which is displayed by the pull-up warning mark close to the range circle on the Pilot's Display Unit (PDU). At 12 miles the range circle appears and is wiped off as the range closes; the distance to target is read like a clock face. ▶◀ A 3 sec. event mark is displayed on the PDU directly above the aiming mark.

(iii) The aiming mark is offset in azimuth by wind and target movement controls on the CI to ensure a collision course is flown towards the target. It is automatically compensated in pitch for some measure of aircraft incidence, to facilitate tracking.

(iv) The aircraft must approach as level as possible. Rate of climb from the Air Data System and the accelerometers in the Gyro unit calculate the flight vector.

(b) Pull-up and release

(i) At the appearance of the 3 sec. event mark the pilot must accept, if he wishes to continue the attack. On acceptance an event mark appears directly below the aiming mark.

(ii) At pull-up the target spot and aiming mark gyros are caged and centralise on the display. They remain stationary for ½ second. Range circle, pull-up warning, marker roll bar and quadrantal marks disappear.

(iii) One half second after the gyros are caged the target spot starts to rise on the display. The pilot must enter the pull-up manoeuvre immediately and attempt to keep the target spot central within the aiming mark.

(iv) If a cross-wind is present a banked pull-out is ensured by deflection of the AM. It is particularly important at the early stages of pull-up to track the target spot carefully in azimuth, using aileron control only.

(v) During pull-up the accelerometers calculate the aircraft's vector; the computing system becoming purely inertial. The C & R computer automatically compensates ◀for an error of up to 1°/second in the pull-up rate. ▶

(vi) During this period there may be changes in crosswind. Consequently an MRG monitoring system is incorporated in the C & R computer, which attempts to correct their effect by aiming mark deflections. No allowance is made for errors in azimuth tracking.

(vii) When the aircraft has reached the correct point in space the store is released. The complete display, except for TAS scale, is removed.

13. Over-the-shoulder (TMB)

NOTE: Selection of OTS overrides the Observer's computer IN/OUT switch.

(a) Approach and tracking

(i) Since OTS manoeuvres are initiated visually on top of the target (at zero range) no calculation of pull-up point is required. On selection of OTS the range servo therefore runs down to zero. This may be seen on the display; the pull-up warning mark is at zero range. The 3 second event mark appears when the computer is ready.

(ii) Steering signals may be used.

(*b*) *Pull-up and release*

On passing overhead the pilot accepts. The manoeuvre is identical in this phase to the Long Toss. However, release is not obtained until about 105° of the loop have been completed.

14. Dive Toss (conventional bombs)

(*a*) This mode can be subdivided into two. One, when the radar is locked on to a discrete target, enahling hlind attacks to be carried out; the other when visual attacks allow radar ranging to be used.

(*b*) *Radar locked-on* (*Blind attacks*)

(i) *Approach and tracking*

The range circle appears at 12 miles but it is not wiped off until 4 miles from the target. The quadrantal marks represent miles to target. In other respects the display is identical to that of Long-Toss. Autopilot is not used. At the start of the dive the pilot accepts. This: —

1. Increases the sensitivity of the aiming mark gyro (5 secs.) to provide tachometric lead.
2. Displays the accept mark.

NOTE: The aiming mark can be compensated, in azimuth, for wind and target movement. An approximate collision course dive is carried out, and 5 seconds tracking is required.

(ii) *Pull-up and release*

The appearance of the display at pull-up point is identical to that of Long-Toss or OTS. However, the pull-up is very short before release is obtained. The pilot pulls up, maintaining his wings at the same bank angle to provide the extra lead required. Release is signalled when sufficient pitch-up has been ohtained for the correct gravity drop. At release the TAS scale only is left.

(*c*) *Radar ranging* (visual attack)

(i) *Approach and tracking*

The range circle appears at 2½ miles (range scale as in blind attacks) and the target spot is removed. The roll-bar is tied to the aiming mark gyro. In other respects the display is normal. The autopilot is not used.

NOTE: Dive angles greater than about 15° are required for accurate radar ranging.

At the start of the dive the Pilot accepts. This increases the sensitivity of the aiming mark gyro for tachometric tracking, displays the accept mark, and allows the range servo, hitherto held at 2½ miles, to search for the range cross-over (denoting the earth's surface). The range circle then displays the correct target slant range once the aiming mark is about the target. The range servo may run out to 5 miles in its search. Ahout 2 seconds are required for the range servo to correctly lock-on to the cross-over. The aiming mark is compensated in azimuth hy wind and target movement as in the locked-on dive attack. An approximate collision course dive is carried out.

(ii) *Pull-up and release*

A 3 sec. event mark is displayed.

At the pull-up point only the aiming mark, event marks and TAS scale remain.

The Pilot pulls up, maintaining his wings at the same bank angle. Release is not signalled until sufficient pitch-up has been ohtained for the correct gravity drop. At release the TAS scale only is left.

15 Depressed sight fine

(Rockets, and as a standby mode for conventional bombs).

(*a*) The Ohserver selects either bomh or rockets and the required aiming mark depression, by a switch and a control on the CI. This control is marked 0 to 7½°; it is depressed in the true vertical. This is in addition to the incidence correction made in the airframe vertical.

(*b*) The Pilot must select manual release.

(*c*) No use of the C & R computer is made and there is no ranging. Therefore there is no target spot or range circle. The pull-up warning mark is at zero range.

(*d*) The aiming and release is manually judged hy the Pilot.

Controls and Indicators

16 Radar system

◀(*a*) *Control radar set*

NOTE: Whether or not the alternatives quoted below are fitted will depend upon the modification state of the set.

Main ON/OFF	Switches power to the fire control system.
TX/SBY	Switches power to the radar transmitter.
Phase change switch ...	Selects search, acquisition or track in sequence as required. It is electrically connected to the Radar Mode Switch and only functions when Normal mode is selected.
Clutch lever	Releases handle assemhly. The first pressure allows lateral, the second fore-and-aft movement of the handle.
or	
Clutch lever	Controls speed of movement of the marker. First pressure is slow, second pressure is fast.
Across heading marker control	Lateral movement of the handle moves the marker in an across heading direction.
Along heading marker control	Fore-and-aft movement moves the marker in an along heading direction.
Elevation control switch	Up — selects fixed depression angles. Down — selects manual control of the scanner.
or	
Elevation control switch	Selects fixed or manual depression of the scanner. When manual is selected, the depression scale is illuminated.
Manual elevation control	Forward movement of the handle depresses the scanner when manual elevation control is selected. ▶

or	
◀Manual elevation control	Manual elevation / depression can be set by using the calibrated scale.
1 or 2 bar scan	Up — selects single bar scan.
Track marker button ...	When depressed the bearing line displays track while arcuate lines remain about the target.
Manual gain control ...	Controls the gain of the log receiver supplying tbe CRT display.
ACM switch	When aft, selects Radar locked-on bearing and target marker range, when Radar input is selected to the sighting system by the Target Marker/Radar switch. It functions only during Track phase.
or	
ACM switch	Selects Radar locked-on bearing and target marker range. It functions only during Track phase. ▶

(*b*) *Indicator azimuth range*

CRT display	Displays video, target and track marker as selected.
Range scale selector ...	A rotary switch selecting:—
½ M.	Either 30 miles sector PPI or "Z" scope, depending on position of expanded scale switch.
1 M.	60 miles sector PPI.
3 M.	180 miles sector PPI.
"B"	60-240 "B" scan.
Exp. B	Allows use of expanded scale switch.
Expanded scale switch ...	When Exp.B selected on rotary switch:
1. gives	180-240 mile "B" scan
2. gives	130-190 mile "B" scan
3. gives	80-140 mile "B" scan
	When ½ M. selected:
1. gives	30 mile "Z" scope.
2. & 3. gives	30 mile sector PPI.

Brilliance control ...	Controls brilliance of CRT display.
Differentiation switch	
OFF	No differentiation.
Short	A short time constant is introduced to reduce land clutter.
Long	A long time constant is introduced to reduce sea clutter.
Sensitivity control ...	Controls the threshold above which video signals are displayed.
Lock light	An amber light above the CRT illuminates:— 1. During warm-up until HT is present. 2. When the radar has locked-on during track phase or has locked-on during a radar ranging dive-toss attack.

(*c*) *Control indicator*

C/N. C = Caged ...	Scanner is rotated 90° and depressed 50°.
N = Normal ...	Allows normal usage of scanner in the three radar modes.
MRG out/in	Switches either MRG or, in the event of MRG failure, aircraft datums of roll, pitch and azimuth to the fire control system. (In conventional attack 15° depression is applied to the C&R computer allowing dive attacks to be made at about 25° dive angles).
ROC out/in	Switches either rate of climb or zero input to the C & R computer in the event of an Air Data System failure.
ST sign out/in	IN position switches steering signals (Target marker or Radar) to the sighting system. OUT position provides a zero signal, centralising the target spot in azimuth but leaving the remainder of the display unaffected.

Comp out/in	When OUT, inhibits C & RC switching signals and removes all pilot's display symbols except TAS.
Radar mode switch (RR/N/TW)	RR selects Radar ranging. N selects normal mode. TW selects Terrain warning.
Radar input switch TM/R	TM allows target marker range and bearing only to be passed to the sighting system. R allows locked-on radar or target marker information to be passed.
◄ *or*	
Radar lock pushbutton DTM/RR	Ordinary discrete echo radar lock circuits can be selected for greater accuracy after radar ranging lock has been achieved, by pressing button. A red light on the side of the CI will illuminate. The pilot must reject after the attack to enable the system to return to simple RR mode.
Bombs IN/OUT switch	OUT selects computed automatic release Dive Toss attack display. IN selects depressed sight line manual release attack display.
or	
Bombs IN/OUT switch	As above. In addition the depressed sight line manual release attack display is incorporated automatically with the AM depression, when depressions greater than 3° are selected. ►
Target speed } ... Target course } ...	Provides sighting system with target information in true course and speed up to 60 knots.

Wind speed / Wind direction ...	Provides sighting system with wind information in true direction and speed up to 60 knots.
Height above burst ...	Sets aircraft approach height above required bomb burst height.
Offset range selector ...	0-50 allows fine short range settings (offset attacks). 0-250 allows long range settings. (Navigational fixing). The appropriate window is uncovered.
Offset range control ...	Controls position of counters uncovered by offset range selector. Push in for rapid movement.
Offset range counters ...	Display selected range.
Offset bearing control ...	Controls position of bearing counters.
Offset bearing counters	Display selected bearing.
Aiming mark depression control	◀ Selects aiming mark depression for rocket or bomb attacks. Marked 0-3½°, 6½-7½° in one half degree steps on early controls. ▶
Target marker computer mode switch	Selects: — IP (Identification Point), S (Search), N (Normal), O & D (Offsets plus Doppler) or O (Offsets), as required.
HT reset button ...	For use on HT failure.

17 Sighting system

(*a*) *Armament selector switch.* Selects as required: —

Off
Cameras
Dive Practice
Bombs
Rockets
Bullpup

Long Toss Practice O.T.S. Practice Long Toss Normal O.T.S. Normal	TMB

NOTE 1: OTS position overrides Comp OUT/IN switch on Control Indicator so that the Pilot may attack without the aid of the Observer.

NOTE 2: Practice positions select normal computer functions but allow release signal to be passed to different wing or bomb bay stations.

Accept trigger	Pilot's mode initiation or firing trigger.
Manual/Auto switch ...	Selects either manual by the Pilot or automatic release by the C & R computer.
Reject button	Cancels the mode accepted and may be used to reset a display.

(*b*) *Pilot's display unit*

Brilliance control ...	Controls the display brilliance.
The reflector glass displays:—	
TAS scale	Displayed at all times when the fire control system is switched on. Speed marks are 3, 4, 5 and 600 kts. From left to right.
Target spot	Displays target bearing. Controlled in pitch by MRG, except when radar inputs are switched in. Not displayed when Radar ranging or rockets are selected.
Roll-bar	Displays bank angle through 360° (See Note 1).
Aiming mark	When placed about the Target spot the system is aimed. It may be deflected left or right by wind or target movement controls, to provide a collision course to steer, and vertically by an incidence term.
Quadrantal mark ...	Provides four datums for the range circle.
Range circle	1. Represents 12 miles (clock form) in Normal attacks.

	2. Appears at 12 miles hut does not being to disappear until 4 miles (quadrantal form) in conventional locked-on attacks. 3. Appears at 2½ miles (quadrantal form) when radar ranging is selected.
Pull-up warning indicator	Provides an early indication of pull-up range.
3-sec. event mark ...	Appears 3 secs. before calculated pull-up, immediately above the Aiming mark.
Accept mark	Appears when the pilot accepts the attack immediately below the Aiming mark.

NOTE 1: During normal TMB or locked-on conventional attack the roll-bar is tied to the target spot gyro.

NOTE 2: During radar ranging or rocket attacks the roll-bar is tied, as are the remaining symbols, to the aiming mark.

(c) *Terrain warning light*. Illuminated when echoes are received within a fixed range. (4,000 to 4,500 yds.)

Management

18 Switching-on

Observer

CRS ◄ 1. Main ON/OFF switch to ON. Lock light illuminates.
2. TX/SBY to SBY.
3. Gain to min.
4. Select fixed elevation control.
5. 1 or 2 bar scan, as required.
6. ACM to OUT.

CI 7. C/N to N.
8. MRG to IN.
9. ROC to IN.
10. ST sign to OUT.
11. COMP to OUT.
12. Radar mode to N.
13. TM/R to R (early sets).
14. Tgt. speed to zero.
15. Wind speed to zero.

Pilot

1. Set Armament selector to OFF.
2. Set Manual/Auto as required.

►

Observer	*Pilot*
16. TMC mode to search.	
17. Height above burst, as required.	
18. Aiming mark depression control as required.	
19. B/DSL, as required.	
IAR 20. Select display scale as required.	
21. Sensitivity max. (clockwise.	
22. Differentiation OUT (up).	
23. Brilliance min. (anti-clockwise).	

Half a minute before the fire control system is fully warmed up the lock light goes out. When fully warmed up the complete system is functional.

NOTE 1: *Warm-up Cycle* (*5 mins.*); Timing relays prevent any damage occuring to the fire control system after switch ON, whatever the switch positions may be (see note on HT reset button). The sequence is as follows:—

1. Switch ON ...	Power supplied to the full system, warm-up begins, lock-light illuminates, TAS scale displayed.	
2. 4½ min. later (+4½)	Warm-up complete.	lock-light goes out.
3. ½ min. later (+5)	EHT signal, transmitter ready.	

The HT reset button sbould not be pressed during the initial warm-up period.

NOTE 2: With the ATA off-line the system will only warm-up to a 3 min. 50 sec. position. Consequently a further 1 min. 10 sec. is required after the ATA comes on-line, to complete the full 5 min. cycle.

19 Switching-off

Observer	*Pilot*
1. SBY/TX to SBY.	1. Set Armament Selector to OFF.

2. Brilliance to min. (anti-clockwise).	2. Brilliance to min. (anti-clockwire).
3. Main ON/OFF to OFF.	

NOTE: No damage will result to the system but it is advisable to leave the other switches in the ON position.

Malfunctioning

20 ATA failure

(*a*) This is indicated hy complete loss of both displays, and the AC power supply indicator on the Pilot's front panel.

(*b*) Within 700 millisecs after ATA failure the Standhy Inverter will be fully run-up, if not already running. This inverter is unable to provide sufficient power for full use of the system but will maintain heaters. However, this time delay may be too long and the switching circuits may return to zero. In this case, pressing the HT reset hutton will rapidly revert the system to the 3 min. 50 sec. position. The lock-light will illuminate.

(*c*) When the ATA returns on-line the HT reset hutton should once more he pressed. This will bring the system to the 4 min. 30 sec. position. A further ½ min. is required before full use is availahle.

21 Transmitter failure

◀This is indicated hy loss of display video. If the transmitter trips and resets continuously it will tben be switched off automatically; in this case set the TX/SBY switch to SBY for a short period. On resetting the switch to TX, the transmitter should function normally. Transmitter▶ failure may, however, be caused hy a failure of tbe main radar cannister pressurisation which is part of the cockpit pressurisation system. In this case the equipment should function correctly below 3,000 ft. Above 3,000 ft. the TX/SBY switch should be to SBY.

22 Failure of scanner stabilisation, roll-bar and target spot, or dynamic flight instruments

(*a*) Failure of the above may indicate a failure or partial failure of the MRG input. The MRG IN/OUT switch should be made to OUT.

(*b*) The OUT position provides fixed airframe datums of roll, pitch and azimuth.

1. Full use of the scanner is still available.
2. The target marker system is relative to aircraft heading and will only be ground stabilised over a steady track. Offset attacks are practically impossible.
3. Target and wind direction settings are relative.
4. The MRG monitoring system no longer functions.
5. Full use of the C & R Computer is available (with the exception of the monitoring system).
6. Conventional Dive Toss attacks should be made at dive angles around 25°.
7. The roll-bar and aiming mark are locked to the airframe horizontal.

23. Failure of rate of climb indicator, or dubious Air Data information

(a) Failure of the above may indicate a failure or partial failure of the Air Data inputs of the airspeed and rate of climb. The rate of climb input switch should be made to OUT.

(b) When the switch is at OUT, a zero rate of climb is provided and the pilot must take care to approach as level as possible to a Long Toss or OTS attack.

PART I — DESCRIPTION AND MANAGEMENT OF SYSTEMS

Chapter 16 — ARMAMENT AND PHOTOGRAPHIC EQUIPMENT

Contents

Armament Equipment

1 General description

(*a*) The armament system makes provision for the carriage, fuzing and release of the various armament stores and includes built-in safety factors which prevent stores being released on the ground or until the bomb bay door is locked open. Stores can be carried at stations 5 to 9 in the bomb bay in the fuselage and at stations 1 & 3 under the port wing and 2 & 4 under the starboard wing. Release of stores is initiated either automatically or by the pilot. An armament panel, on the port console in the pilot's cockpit, contains most of the pilot's switches; controls for fuzing and distribution are in the observer's cockpit.

These latter controls are either on the role panel on the port console, or above it on the port wall.

(*b*) The fuzing systems are EP, EL/EA, EM, and VT. EP fuzing is associated with the TMB, EL and EM with conventional bombs, and EA with Bullpup. EM fuzing has a lanyard which withdraws the arming pin as the bomb is released and the VT (variable time) is a proximity fuze.

2 Bomb bay, description

(*a*) The bomb bay has a rotating door to which the stores are attached at five different stations. The door is operated by a hydraulic jack and is locked in both the open and closed positions by four lock-jacks. Provision is made for both normal and standby selection of either position.

◀(*b*) A thermometer bulb in the bay controls the temperature indicator in the observer's cockpit when the adjacent switch is set to 3 BOMB B (see Ch. 11, para. 13(a)).▶

3 Bomb door, normal operation

(*a*) Selecting the door to open energises the normal solenoid of a locks selector valve allowing fluid to pass to the unlock side of the four lock-jacks. As the locks disengage, final movement of each lock operates micro switches connected in series to complete an electrical circuit to energise the open solenoid of the door jack selector valve. Fluid thus extends the jack, rotating the door to the open position. On reaching this position the door jack operates a micro switch to reselect the locks selector valve, which then passes fluid to extend the lock jacks. Pressure is then maintained on both the door jack and the lock jacks until a 'close' selection is made.

(*b*) Selecting the door to close initiates a reverse sequence to opening the door. Fluid pressure is also maintained on the jacks after completion of the operation.

(*c*) Fluid for normal operation of the bomb door is supplied from the General Services system, through a release valve. A DC supply is provided from the Normal busbar for operation of the control circuits and these circuits are so arranged that they prevent the door responding to a reverse selection until it completes its travel in the selected direction; in this case the locks will not engage until the final movement is complete.

(*d*) To prevent operation of the bomb door during servicing, a pin can be inserted into a hole in the underside of the fuselage, forward of the bomb door, and turned through 90°. This, through a torque tube and cams, operates two safety switches which isolate the normal and emergency DC supplies to the control circuits and switches the normal supply to the bomb bay lights. In addition, a second pin can be inserted inside the bomb bay and this prevents the torque tube from turning, ensuring that the external pin cannot be removed. The internal pin is stowed adjacent to the torque tube but the external pin is an item of ground equipment.

4 Bomb door, emergency operation

(*a*) If due to hydraulic or electrical failure, the bomb door fails to respond to normal selection, the standby selector must be used. A standby selection operates the door as in a normal selection except that the emergency solenoids of the selector valves are sequenced, instead of the normal solenoids. Shuttle valves are fitted to all jacks to permit emergency operation. In addition emergency pressure is fed to the release valve which then opens all the normal lines to "return", thus preventing a hydraulic lock. ◀In the emergency case the GS system reverts to normal as soon as the door locks are fully engaged and pressure is not maintained at the jacks, providing the system is not on automatic emergency or another system is not being operated on emergency. The standby selector should, therefore, remain in the OPEN or CLOSED position so that if application of G partially withdraws the locks, the GS system will immediately revert to emergency and supply the pressure to re-engage the locks fully.

NOTE: After the standby selector has been used the bomb door cannot revert to normal operation until the release valve has been reset on the ground. ▶

(*b*) A DC supply for emergency operation is provided from the emergency busbar. As in the case of normal operation the circuits are arranged so that the door will not respond to a reverse selection until it completes its travel in the selected direction, but in this case the operation is completed, i.e. the door locks will engage, before the door responds to the second selection. The General Services three-position magnetic indicator will show EMGY while the selector is at either the open or closed position.

WARNING: Although it is possible to complete more than one cycle of the bomb door using the emergency system it should not be done if the system is on automatic emergency or if the flying controls interconnection valve(s) have been opened, as it will seriously affect the operation of other services. (See Chapter 3.)

Pilot's Controls

5 Bomb door, controls and indicator

(*a*) *Normal control and indicator*
The bomb door normal control is a BOMBDOOR—CLOSED/OPEN switch on the port console, aft of the throttles. An adjacent BOMBDOOR POSITION magnetic indicator shows white when the door is locked open, cross-hatching (de-energised) when the door is unlocked and black when the door is locked closed. Failure of the normal DC supply or the fuse in the circuits to the indicator causes the indicator to turn cross-hatched.

(*b*) *Standby selector*
The bomb door standby control is a BOMBDOOR—CLOSED/off/OPEN switch on the starboard wall. The magnetic position indicator does not function with stand- ◀by operation, after failure of the normal DC supply, and▶ will remain cross-hatched (de-energised).

6 Armament selector switch

The ARMAMENT SELECTOR switch is on the armament control panel, on the port console. In addition to selecting the store, this switch also selects the computer mode and, consequently, switches the C & R computer in the Weapons System to resolve the equation for the appropriate attack. The selector has ten positions, annotated as follows:—

Pre-mod. 751		*Post-mod.* 751	
OFF		OFF	
CAMERA		CAMERA	
DIVE PRAC		DIVE PRAC	
LOW DRAG and MKS 6, 9 and 10		BOMBS	
ROCKETS		RP	
BULLPUP		BULLPUP	
NORM PRAC	TMB	NORM PRAC	TMB
OTS PRAC	TMB	OTS PRAC	TMB
NORM	TMB	NORM	TMB
OTS	TMB	OTS	TMB

WARNING: To prevent release into tbe bomb bay if the safety circuits fail, a bomb bay stores position should not be selected until the bomb bay has rotated open.

7 Release, manual/auto switch

The RELEASE—MANUAL/AUTO switch is on the port console, aft of the throttles. In the MANUAL position it routes the output from a firing trigger switcb to the stores release circuits. In the AUTO position the output from the firing switch is routed to the C & R computer to initiate the programmed release. The switch is wire-locked in the AUTO position.

8 Firing trigger switch

(*a*) The firing trigger switcb is on the front of the control column and is protected by a mechanically-locked SAFE/FIRE (forward) safety catch. The switcb has several functions which are dependent on the position of the armament selector switch and the release manual/auto switch. With the release switch at MANUAL, the trigger switch initiates the release of the conventional stores or the operation of the cameras, as appropriate to the position of the armament selector switch. In the AUTO mode the trigger switch's function is to accept a target for TMB, or to 'fix' an offset navigational landmark.

(*b*) Pressing the firing trigger switch when the armament selector switch is at ROCKETS or BULLPUP, also energises the engines automatic relight facility.

◀ (*c*) The bomb door stores cannot be released unless the bomb door open lock is fully engaged. ▶

9 Target reject button

The target reject button is in the end of the starboard throttle lever handle, below the airbrakes switch. Its function is to enable the computer release programme, which has been accepted by the trigger switch, to be cancelled and it is effective right up to the actual time of release.

10 TMB release unit and safety lock

The TMB is at No. 9 station and is held in position by the release unit. An inflight safety lock, to prevent inadvertent release of the TMB, is a twin motor actuator which inserts a pin to prevent the release jaws opening. The controls and indicators are: —

LOCK/UNLOCK switch	Controls the pin actuator
LOCKED indicator light	Indicates that the pin is in
UNLOCKED indicator light	Indicates that the pin is withdrawn
Two indicator lights ...	One or both lights on, indicates that the release is cocked.

NOTE: The locked and unlocked lights indicate the operation of one motor in the actuator. If the lights are pressed, they will indicate the operation of the second motor.

WARNING: If the safety-lock pin is not withdrawn before an attempt to release is made, release will not take place. If the pin is subsequently withdrawn, release will take place immediately, without further operation of the release trigger.

◀11 Jettison selector switch

The jettison selector switch has the following positions: —

Pre-mod. 751		*Post-mod.* 751
OFF CLEAR WINGS (ALL post-mod. 780) OUTER INNER	WINGS	OFF ALL OUTER INNER
5 and 6 7 and 8 TMB	INTERNAL	5 and 6 7, 8 and 9

▶

12 Jettison pushbutton

The stores jettison guarded pushbutton is to port of the instrument panel. It initiates the appropriate ejector or EM release unit, as determined by the selector switch. In the case of overload fuel tanks being carried in initiates operation of the pneumatic ejector.

NOTE: When mod. 780 is embodied, all stores can be jettisoned from a single jettison selection. With the selector at ALL, pressing the jettison pushbutton releases the wing stores. When the bomb door has been rotated a second press on the pushbutton jettisons the bomb bay stores with a suitable delay between stations 5 and 6 and 7 and 8.

WARNING: The jettison pushbutton must not be pressed a second time until the bomb door has rotated, or structural damage will result.

13 Jettison supply change-over switch

The JETTISON SUPPLY — NORMAL/EMERGENCY switch, on the port console aft of the throttles, makes provision for an alternaive DC supply to the jettison circuits. In the NORMAL position the supply is from the Normal busbar but when EMERGENCY is selected, the supply is from the Emergency busbar.

14 Bullpup

(*a*) When mod. 5030 and its associated mods. are embodied, provision is made for operating Bullpup missiles. The electrical supplies are 28 volts DC, and 15 volts 3-phase AC and 115 volts single-phase AC.

(*b*) The system is live when the armament selector is at Bullpup, but a warm-up period of 5 minutes is required before firing a missile, or reduced guidance range or complete guidance failure may result. The warm-up period is again required if the selector is moved from the Bullpup position.

◀(*c*) The weapon is fired by operating the firing trigger switch. Guidance is through a four-position switch in a control handle on the armament panel on the pilot's port console. ▶◀ The guidance system uses the UHF homing▶ aerial to transmit the signals, but this is not connected if the UHF controller function switch is at ADF and will result in an uncontrolled firing.

(*d*) The particular missile to be fired is fuzed and selected by the observer (see para. 16).

14A Practice bombs

(*a*) Up to eight 28 lb. or 25 lb. practice bombs may be carried in pairs at stations 1 to 4. Each carrier consists of an adaptor which locates directly to the pylon ERU and mounts two small pylons, side by side. Each bomb is held on its pylon by a release unit. 28 volt fuzing is used for 28 lb. bombs but no fuzing connections are required for 25 lb. bombs. The normal fuzing system (EP or EL/EA) is not used. A four-position autoselector is mounted in each carrier, two positions only being wired, one for each bomb station. The wiring of the four auto-selectors is such that, on rotating after release of the first bomb(s), the firing circuit moves to the second bomb. The pylon ERU is inhibited, except for jettisoning the carrier, by selecting each pylon NORMAL/PRACTICE switch to practice before fitting the carriers. Jettisoning of the bomb carriers may be carried out in the normal manner, bombs alone cannot be jettisoned, except by dropping normally.

(*b*) *2000 lb. HEMC practice*
Two carriers are fitted, with up to four bombs. The armament selector switch should be selected to either NORM PRAC or OTS PRAC to correspond with the required attack. One bomb will be released in each attack. The bomb distributor is not used.

(*c*) *1000 lb. practice*
Up to four pylons with eight bombs may be carried. Selecting the armament selector to DIVE PRAC permits the bombs to be dropped as required by the settings on the bomb distributor.

Observer's Controls

15 EP fuzing

(*a*) The EP fuzing control unit, on the port wall, has a seven-position channel selector switch, and two press-to-test indicator lights labelled STANDBY and BOMB ON STN, respectively. Only the first four positions of the selector are used.

(*b*) The standby light will not come on until a channel is selected or the equipment is at standby. Pressing the light tests the filament and detects DC in the system. The BOMB ON STN light is self explanatory and it too, when pressed, tests the filament and tests the indicator circuit.

(*c*) When mod. 824 is embodied, detection of AC supplies to the system is provided by two AC SUPPLIES neon lamps, adjacent to the fuzing unit. When the STANDBY channel is selected on the fuzing unit, one lamp will glow. Selecting a further channel causes both lights to glow, indicating that AC is available at the fuzing and charging units.

NOTE: The AC supply is routed through the circuit protection relays and is not normally available at the units until the undercarriage is up.

16 EL/EA fuzing

(*a*) This is an alternative to EP fuzing and both systems cannot be fitted together. A STATION & FUZING selector switch on the port wall has five positions as follows: —

Bombs	... ...	EL fuzing
Station 1 Bullpup	...	EA fuzing
2 Bullpup	...	EA fuzing
3 Bullpup	...	EA fuzing
4 Bullpup	...	EA fuzing

(*b*) A fuzing and arming selector switch on the console has eleven positions, channels A to L inclusive, which are used for EL fuzing. The first four channels are also used for EA fuzing.

(*c*) *Bullpup master switch*

A BULLPUP — ARMED LAUNCH/OFF/UNARMED LAUNCH selector switch on the port console is the master switch for the Bullpup installation. The weapon is launched by pressing the firing trigger, providing the master switch is selected to one of the launch positions and providing Bullpup is selected on the armament selector switch.

17 EM fuzing

The EM FUZING SELECTOR is a three-position double-pole switch on the port wall. Its three positions are NOSE/NOSE & TAIL/TAIL and is operative only when the bomb distributor is in use.

18 Bomb distributor

(*a*) The 8-way bomb distributor, on the port wall, is for use with conventional bombs. It has a four-position interval selector, giving spacings of 30, 45, 60 and 350 m/sec., and stop/start switches which determine the first and last bomb to be released. These switches are electrically interlocked.

(*b*) A four-position mode switch has the following positions: —

OFF
SINGLES
PAIRS
ALL

When OFF is selected, the EM fuzing circuits are de-energised, and it follows that tbe switcb sbould be in this position when the stores are jettisoned. If PAIRS is selected they are from the pairs 1 & 2, 3 & 4, 5 & 6, 7 & 8 and are dropped in sequence with the same intervals as selected for singles. In the ALL position, two groups of four bombs are released, the groups being separated by 30 m/sec. interval. This is necessitated by a structural limitation.

19 Rockets

(*a*) The 2″ and 3″ rocket role panel is interchangeable ◀with or (with NSM 3024 embodied) is incorporated in,▶ the photographic role panel, on the observer's port console; it has three switcbes, as in the following sub-paras:

(*b*) 2″ *RP six-position switch*
This switch gives a choice of the four wing stations separately, both outer stations collectively, and all stations collectively.

NOTE 1: When NSM 3023 is embodied, the observer can operate the cameras without a selection on the armament master switch being made.

NOTE 2: When NSM 3024 is embodied, the F97 facility is deleted and the F97 altitude meter and altitude setting knob are replaced by the rocket role switches.

(*c*) 3″ *RP four-position switch*
This switch gives a choice of a salvo of 2, 4, 6 or 8 rockets, but does not select the station to provide them as this is predetermined.

(*d*) 3″ *Ripple/Normal switch*
In the NORMAL position the salvo selected by the switch in (*c*), above, will be fired on operation of the finger trigger switch on the control column. Witb the switch at RIPPLE, the salvo will be repeated as long as the trigger is held operated, and rockets remain.

Photographic Equipment

20 Photographic equipment, general

(*a*) The photographic equipment makes provision for both day and night photography. The daylight facility comprises three F95 cameras mounted vertically and three F95 cameras mounted obliquely, one to port, one forward and one to starboard. Night photograpby is limited to one vertically mounted F97 camera and illumination is provided by a pyrotechnic photoflash unit. The cameras and the photoflash unit are carried in two crates on the bomb door the camera crate is provided with an automatically controlled heating and window demisting system. DC and AC is supplied from the 28 volt and 200 volt normal busbars, respectively the latter supply is for the two blower/heater units in the camera crate.

(*b*) The interchangeable role panel on the observer's port console, contains all the controls necessary for operation of the equipment, except for the armament selector switch and, for pilot control of the cameras, the firing trigger switch. Relays in the control circuits prevent operation when the bomb doors is closed. Operation of the cameras by the firing trigger switch is through the circuit protection relays, preventing pilot operation of the cameras until the undercarriage oleos have extended after take-off.

21 Mk. F95 camera installation

(*a*) *Vertical camera controls*

Up to three vertical cameras can be fitted, and they have the following controls: —

VERTS — ON/OFF selector switch	A single selector switch for all vertical cameras, which operate together.
VERTICALS film indicator	A single indicator showing the quantity of unexposed film. The dial is marked F, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$, and 0 and the indicator can be reset by rotating the indicator pointer clockwise.

◀

NOTE: When mod. 5085 is embodied, three indicators, one for each camera, are provided.

IRIS SELECTOR — OPEN/2/3 switch ... Allows the observer to set the irises of all F95 cameras to any one of three pre-set apertures, as light conditions may require. The OPEN position corresponds to the largest pre-set aperture; the smallest aperture is obtained by selecting position 3.

NOTE: On pre-production control panels this switch is a two-position ON/OFF switch. Normally at OFF, the ON position allows the observer to select a pre-set alternative aperture; this selection is irreversible in flight.

INTERVALOMETER selector ... ... A six-position selector which controls the camera speed to give 8 or 4 frames/sec. or a single frame at $\frac{1}{2}$, $\frac{3}{4}$, 1 or 2 sec. intervals, as selected.

NOTE: On pre-production control panels the single frame intervals are $\frac{1}{2}$, 1, 2 or 3 seconds.

CONTROL SWITCH—CONT/OFF/INTERRUPT ... ... The observer's control switch. It is spring-loaded from INTERRUPT to OFF and the former period is for short term operation. The CONT position is for continuous operation.

NOTE: On pre-production control panels this switch is labelled FIRING SWITCH. ▶

CAMERA SELECTOR — F95/F97 ... ... Selects F95 or F97 cameras as appropriate.

CAMERA HEATER

F95—ON/OFF switch ...	Controls the DC heaters in the camera gearboxes.

◀(b) *Oblique camera controls*

Three oblique cameras can be fitted and eacb bas a cboice of three angles 10°, 15° or 20° from the vertical, except that the forward camera, if fitted with a 12 in. lens, is restricted to 5°, 10° or 15°. Tbe controls are as follows: —

PORT, FORD and STBD selection	Three selector switches, allowing independent operation of each camera.
PORT, FORD and STBD film indicators	One for each camera.

The CONTROL SWITCH, the F.95 CAMERA HEATER switch and tbe IRIS SELECTOR are common to both vertical and oblique installations. All six positions of the intervalometer are relevant to the forward camera, but only the 8 and 4 frames/sec. positions are relevant to the port and starboard cameras.

(c) *Camera crate blower/heater units*

Two camera crate blower/heater units are operated by AC and controlled by a BLOWER MOTORS & HEATERS — AUTO / OFF / MANUAL switcb. When selected to MANUAL, tbe port and starboard blower motors run continuously and each heater element is thermostatically controlled. When AUTO is selected, both blower motors run only during the period when one or both heater elements are switcbed on tbermostatically. Two BLOWER HEATER — PORT and STBD. magnetic indicators show cross-hatching when the blower motors and heaters switch is selected OFF; they sbow black when the switch is selected to AUTO or MANUAL. If the heater element in one of the blower/beater units becomes overheated, it is isolated by an overbeat thermostat; this will also cause the associated magnetic indicator to revert to cross-hatching. If both blower/heater units become isolated, tbe blower motor will continue to run only if the switch is at MANUAL.

22 Mk. F97 camera installation

The single F97 camera is vertically mounted in the centre section of the camera crate, forward of the photoflash crate. ▶

◀The controls are: —

CAMERA SELECTOR —F95/F97 switch ...	For selecting the appropriate camera.
F97 IND light	A green light which flashes, indicating that film is passing through the camera. Except on pre-production panels, the light has press-to-test and rotate-to-dim facilities.
GROUND SPEED selector ALTITUDE SETTING knob ALTITUDE meter	Used in conjunction with one another, to obtain the correct camera speed in relation to aircraft height and ground speed.▶

PART 1 — DESCRIPTION AND MANAGEMENT OF SYSTEMS

COCKPIT ILLUSTRATIONS

Key to Fig. A

Pilot's cockpit — port side

1. Starboard engine start pushbutton
2. Port engine start pushbutton
3. Starboard engine LP cock lever
4 Port engine LP cock lever
5. Bomb release safety lock isolating switches (two)
6. Aileron droop and tailplane flap reset pushbutton
7. Blowing system test switches (two)
8. Telebriefing/UHF/HF selector switch
9. Autotone on ejection cancel switch
10. Tacan aerials selector switch
11. Main UHF/VHF set controller
12. Lighting Control Panel comprising:
    Instrument panel lights switch and dimmer
    Cockpit floodlights switch and dimmers (two)
    IFIS lighting switch and dimmer
    Cockpit emergency lights switch
13. I/C ground test mic./tel. socket
14. Telebriefing light
15. Blowing system pressure gauges
16. Intercomm. P to IC switch
17. Wheelbrakes pressure gauge
18. ADD controller comprising:
    On/Off switch
    Volume control
19. Rudder and aileron combined trim switch
20. Tailplane trim standby switch
21. Radio P to T pushbutton
22. Airbrakes selector
23. Target reject pushbutton
24. Engine relight pushbuttons (two)
25. Emergency oxygen safety-pin stowage
26. Deck take-off pushbutton and warning light
27. Wheelbrakes anti-skid switch
28. Autopilot heading switch
29. Aileron trim position indicator
30. Tailplane position indicator
31. Rudder trim position indicator
32. Throttle levers
33. Throttle friction control
34. Bomb door position indicator
35. Nosewheel steering pushbutton
36. Bomb door selector switch
37. Armament release selector
38. Canopy jettison gun sear with safety-pin inserted
39. Armament jettison power supply change-over switch
40. BRSL unlocked lights (two)
41. BRSL locked and cocked lights (two)
42. BRSL switches (two)
43. Armament selector switch
44. Bullpup controller (location)
45. Armament jettison selector switch
46. UHF switch panel comprising, outboard to inboard:
    Emergency P to T switch
    Homer sensitivity switch
    Standby UHF channel selector switch
    Standy UHF power selector switch
    UHF set selector switch
    Main UHF aerial selector switch
47. Tacan controller
48. Radio altimeter controller

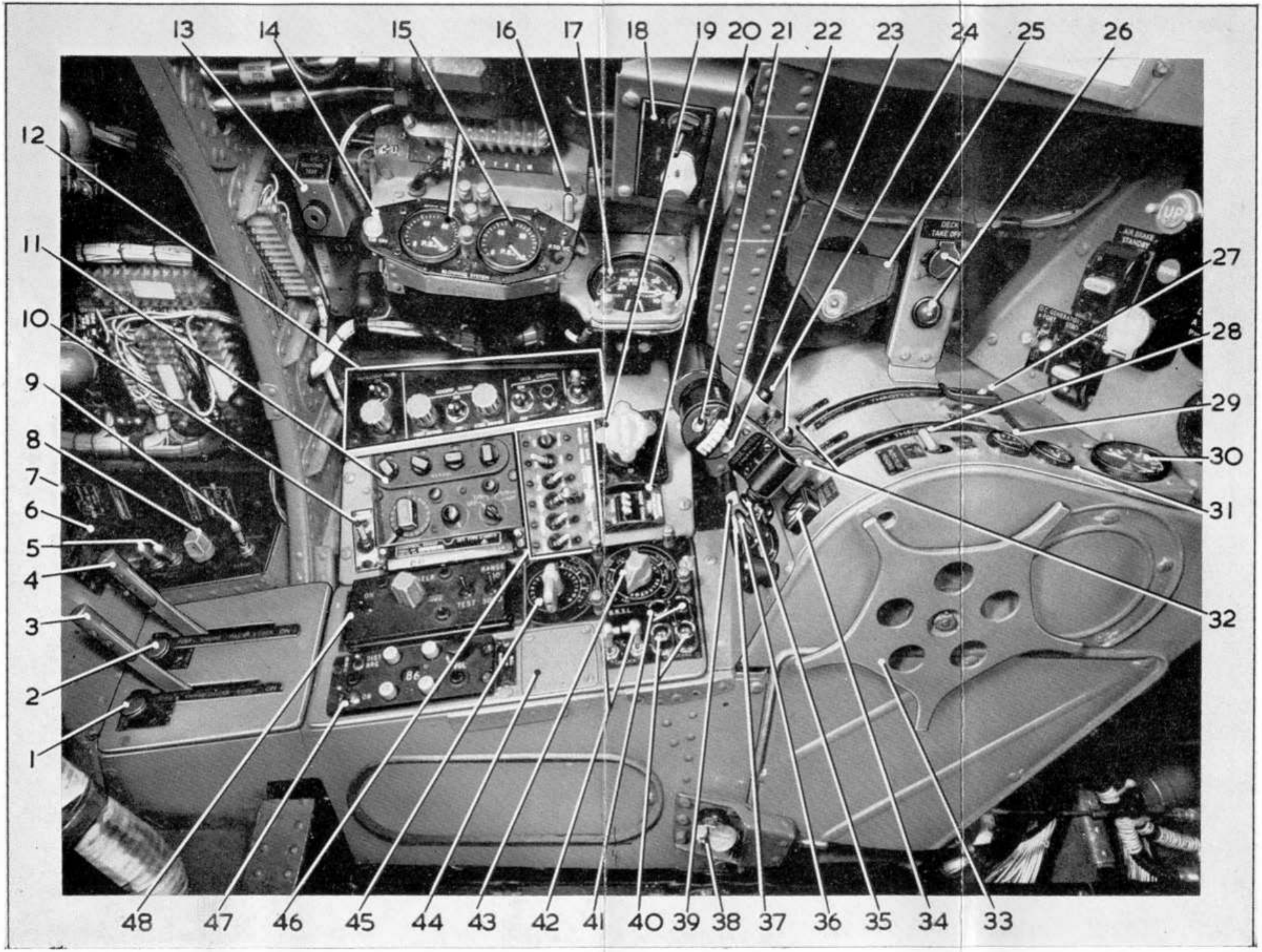


Fig. A. Pilot's cockpit, port side

Key to Fig. B

Pilot's cockpit — forward view

1. DC generator switches (two)
2. Airbrakes standby switch
3. Undercarriage selector comprising:
   Up-button, down-button and emergency down-button
4. Blowing system DC power selector switch
5. Oxygen magnetic indicators (two)
6. Arrester hook light
7. Stores jettison pushbutton
8. UHF frequency card
9. Attention-getter
10. Tailplane blow magnetic indicator
11. Airbrakes position indicator (partly hidden)
12. Aileron droop and tailplane flap position indicator
13. Blowing system magnetic indicator
14. Tailplane flap position indicator
15. Canopy jettison handle
16. ADD DC supply switch
17. Angle of attack indicator
18. Radio altimeter
19. Deck landing ASI
20. Ice-warning magnetic indicator
21. Terrain warning light
22. ADD index lights
23. Strike sight
24. Windscreen de-icing magnetic indicator
25. Undercarriage warning light
26. Compass card lock switch
27. Mk. 6 horizon DC supply switch
28. Radio altimeter limit lights
29. Accelerometer
30. Mk. 6 horizon
31. Direction indicator
32. Standby ASI
33. Standby altimeter
34. AC supply magnetic indicator
35. Standby yaw damper switch

Autostabiliser switches comprising:

36. Yaw channel switch
37. Roll channel switch
38. Pitch channel switch
39. Engine cooling valves magnetic indicators (two)
40. Attention-getter
41. Thrustmeter
42. Thrustmeter, engine selector switch
43. Flying controls integration valves switches (two)
44. Arrester hook standby switch
45. Flaps standby switch
46. Tailplane flap standby switch
47. Undercarriage emergency override switch
48. Bomb door standby switch
49. Fuel flowmeter
50. Pounds remaining fuel indicator and reset
51. Engine RPM indicators (two)
52. Starboard engine oil pressure magnetic indicator
53. Starboard engine IGV position indicator
54. Engine JPT indicators (two)
55. Port engine oil pressure magnetic indicator
56. Port engine IGV position indicator
57. Tailplane trim control
58. Firing trigger switch safety catch
59. Autopilot engage button
60. Autopilot/autostabiliser instinctive cut-out button
61. IFIS display comprising:
    Airspeed indicator/machmeter
    Altimeter
    RCDI
    Attitude indicator and slip bubble
    Navigation display
62. Attitude indicator fast erection switch
63. Undercarriage position indicator
64. Arrester hook selector
65. Flap/aileron droop/tailplane flap selectors (two)
66. Battery master switch

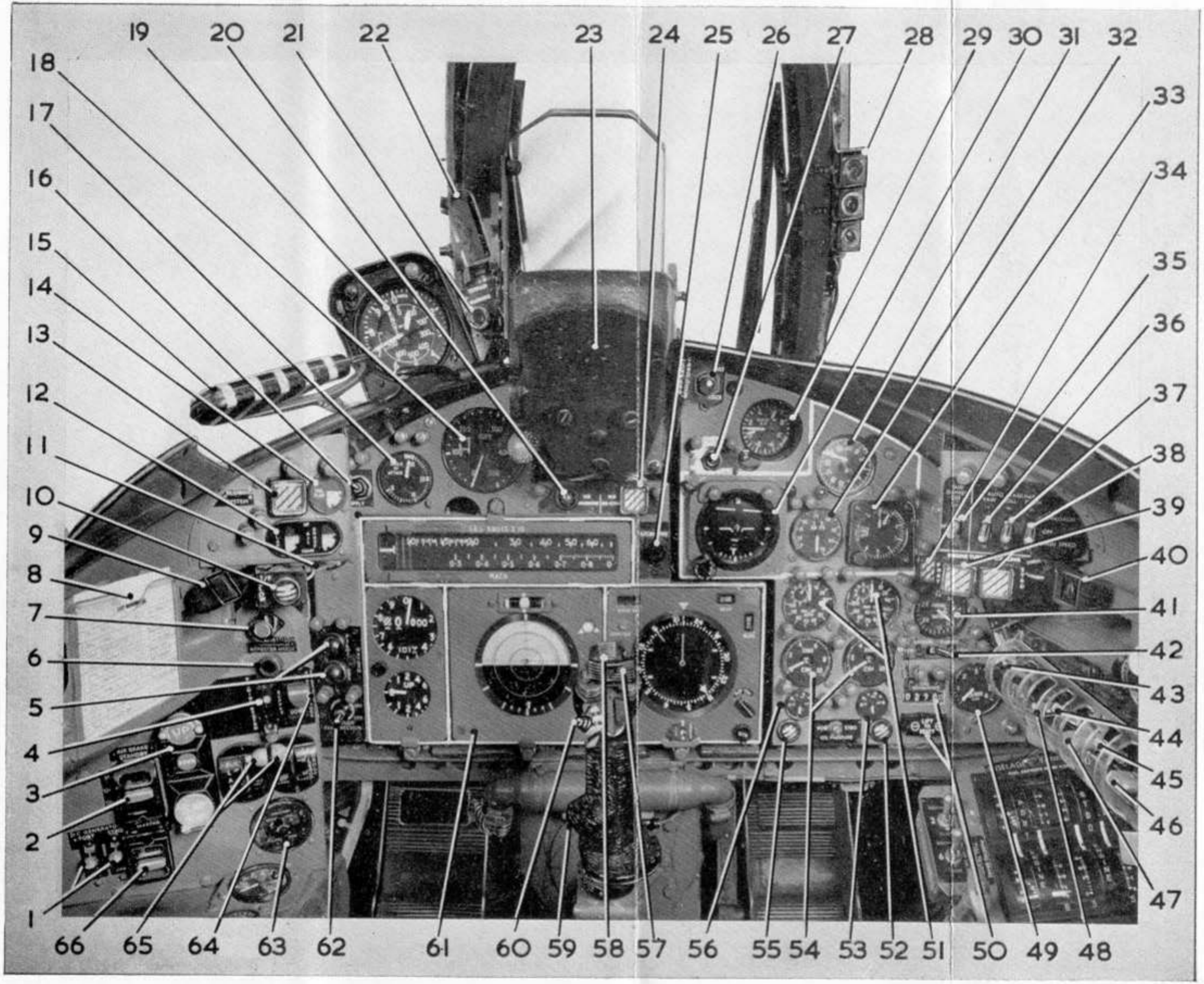


Fig. B. Pilot's cockpit, forward view

Key to Fig. C

Pilot's cockpit — starboard side

1. HP fuel pumps inlet pressure magnetic indicators (two)
2. Fuel tanks pressurisation magnetic indicator
3. Fuel cross-feed cock switch
4. Fuselage inter-tank transfer valves switch
5. Cross-feed cock magnetic indicator
6. Port fuel proportioner magnetic indicator
7. Starboard fuel proportioner magnetic indicator
8. Wheelbrakes parking handle
9. Fuel gauges supply change-over switch
10. Master fuel tanks contents gauges, nos. 2, 6, 3 and 5
11. Slave fuel tanks contents gauges, nos. 4, 8, 1 and 7
12. Flight refuelling master switch
13. Fuel-no-air valves switches (two)
14. Recuperator check pushbutton
15. Arrester hook standby switch
16. Undercarriage emergency override switch
17. Emergency ventilation control
18. Flaps standby switch
19. Tailplane flap standby switch
20. Aileron droop standby switch
21. Windscreen washer control
22. Windscreen wiper control
23. Louvre
24. Canopy lock warning light
25. Blowing system control switch
26. Inverter switch
27. ATA reset switch
28. ATA valve switch
29. Canopy motor control lever
30. Engine blow valves switch
31. Canopy declutch control
32. Cabin pressurisation switch
33. Pressure heads switch
34. Ice-detector switch
35. Ice-detector test switch
36. Windscreen heating switch
37. Flying controls hydraulic pressure gauges
38. Engine de-icing switch
39. Safety pins stowage
40. Navigation lights bright/dim switch
41. Navigation lights steady/flash switch
42. Rendezvous light switch
43. Ventilated suit air temperature control
44. Anti-G system cock
45. Ventilated suit air control
46. Anti-G valve
47. Side windscreen demisting control
48. Cockpit temperature controller and auto/manual switch
49. Oxygen regulator
50. Formation lights switch
51. Cold air unit isolating switch
52. Wingfold lever
53. Downward identification light switch
54. E2B compass deviation card holder
55. Aileron gearchange control
56. Autopilot controller
57. ASI correction card holder
58. Windscreen clear air jet switch
59. Oxygen contents gauge
60. Standard warning panel
61. Wing and nose-fold lock magnetic indicator
62. Oxygen contents gauge pushbutton
63. Fuel jettison control
64. General services hydraulic systems magnetic indicators comprising, inboard to outboard:
    Port engine pump magnetic indicator
    Valves position magnetic indicator
    Starboard pump magnetic indicator
65. Deviation card holder and map case.

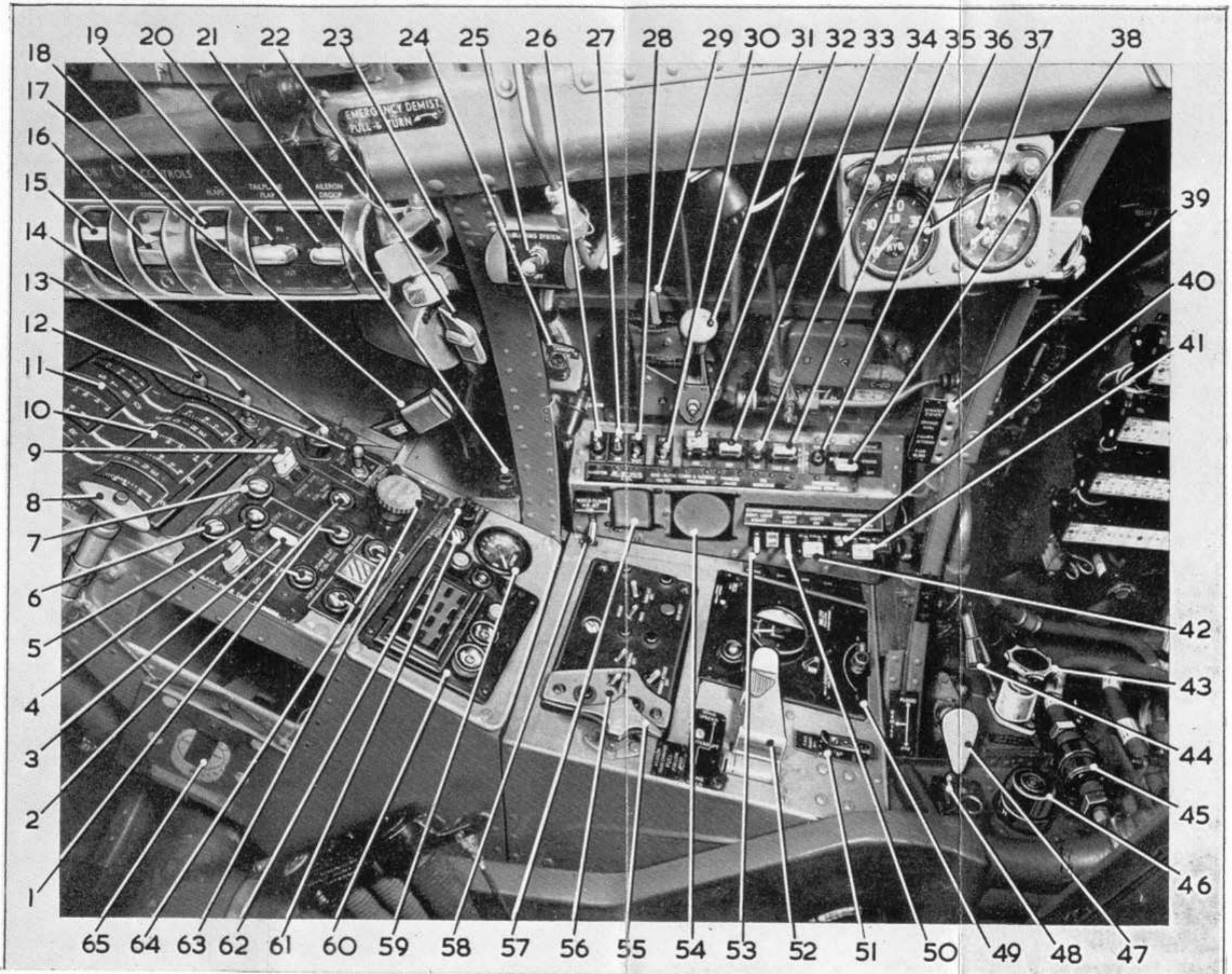


Fig. C. Pilot's cockpit, starboard side

Key to Fig. D

Observer's cockpit — port side

1. Role control panel (location)
2. Bomb distributer
3. Fire extinguisher
4. EL/EA fuzing unit
5. Wide-Band homer (location)
6. Miscellaneous temperature indicator
7. Cockpit altimeter
8. Overload fuel tanks contents gauges (two)
9. Oxygen remote magnetic indicators
10. Overload fuel tanks transfer switch
11. Tacan offsets controller
12. Navigation display
13. Canopy jettison handle safety pin
14. Radio bay cooling override switch
15. P to T switch
16. Radio bay overheat switch
17. Radio selection switch
18. OAT indicator
19. Miscellaneous temperature indicator selector

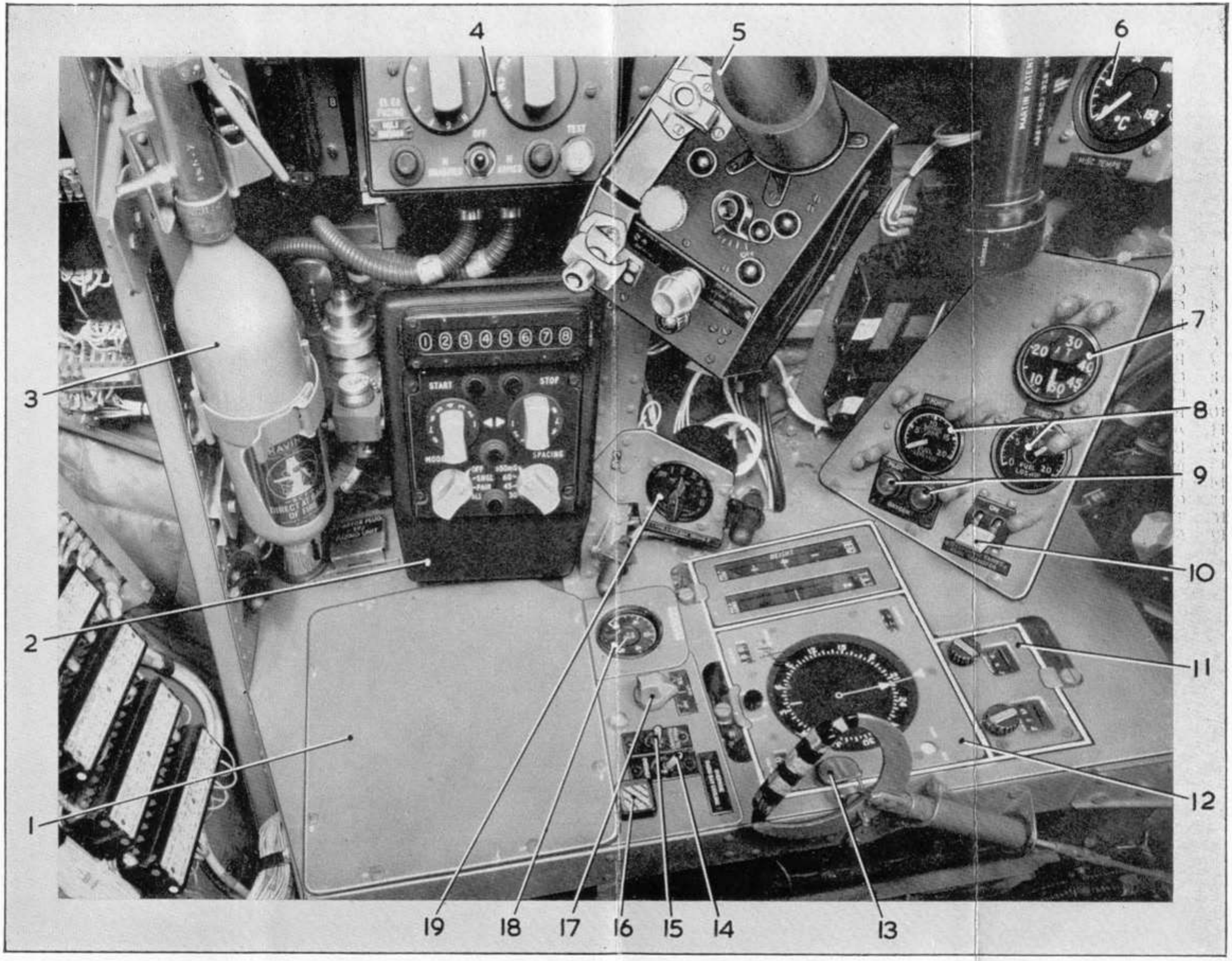


Fig. D. Observer's cockpit, port side

Key to Fig. E

Observer's cockpit — forward view

1. Overload tanks fuel transfer switch
2. Oxygen remote magnetic indicators
3. Overload fuel tanks contents gauges
4. Cockpit altimeter
5. Blue Parrot display
6. Miscellaneous temperature indicator
7. Blue Parrot controller
8. Chartboard stowage
9. Canopy declutch handle
10. Blue Parrot control handle
11. Air ventilated suit control
12. Blue Jacket (location)
13. Mute switch
14. Holdall stowage
15. Canopy jettison handle safety pin
16. Tacan offsets controller
17. Navigation display

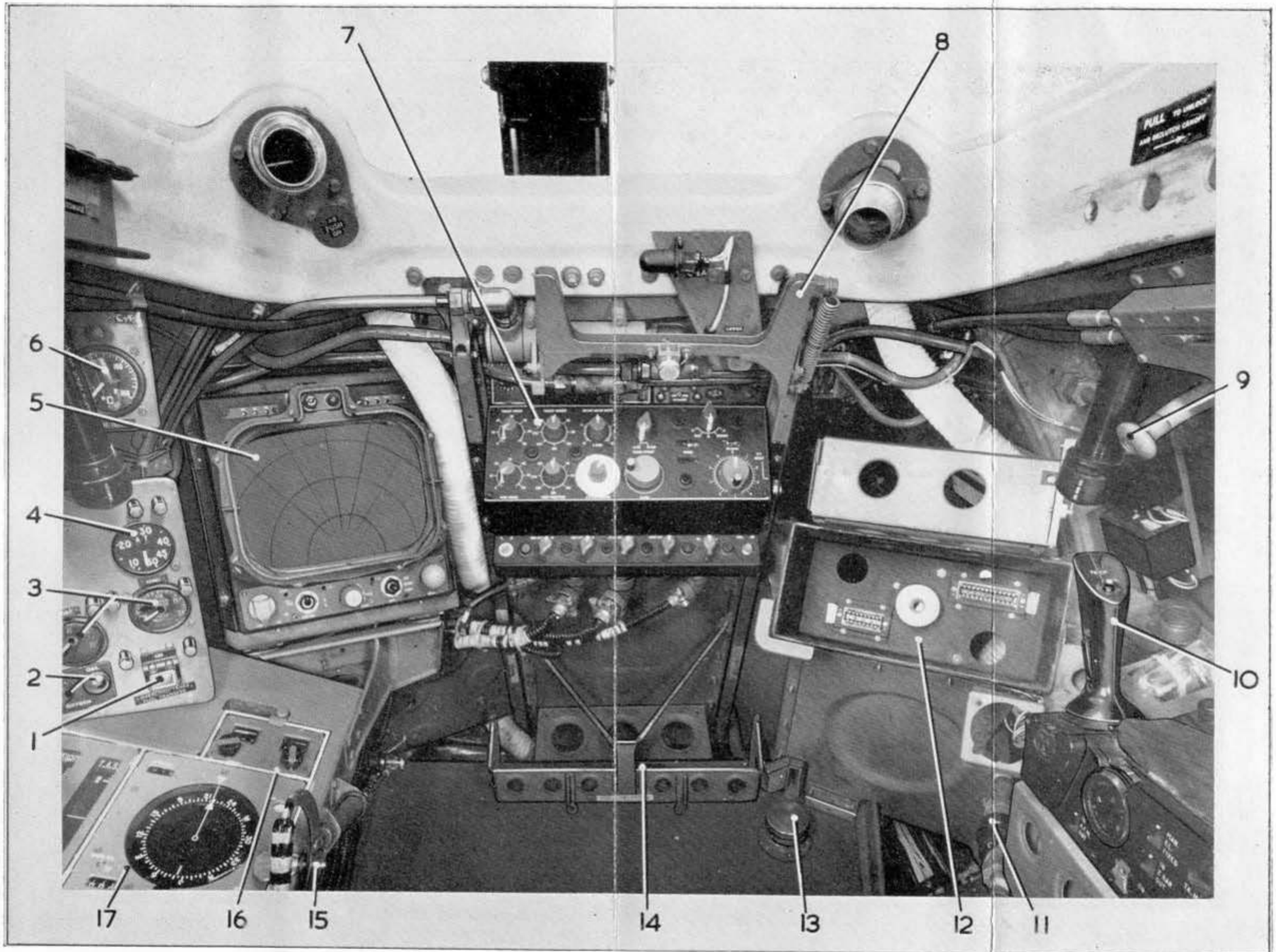


Fig. E. Observer's cockpit, forward view

Key to Fig. F

Observer's cockpit — starboard side

1. Blue Parrot controls
2. Blue Parrot control handle
3. Roller map (location)
4. Canopy declutch handle
5. SIF controller (location)
6. IFF controller
7. Safety pins stowage
8. HF power supply switch
9. Lighting panel comprising:
   Three toggle switches
   Three dimmer controls
10. Anti-G cock
11. Anti-G valve
12. Oxygen regulator
13. HF controller
14. Oxygen contents gauge
15. Air ventilated suit control

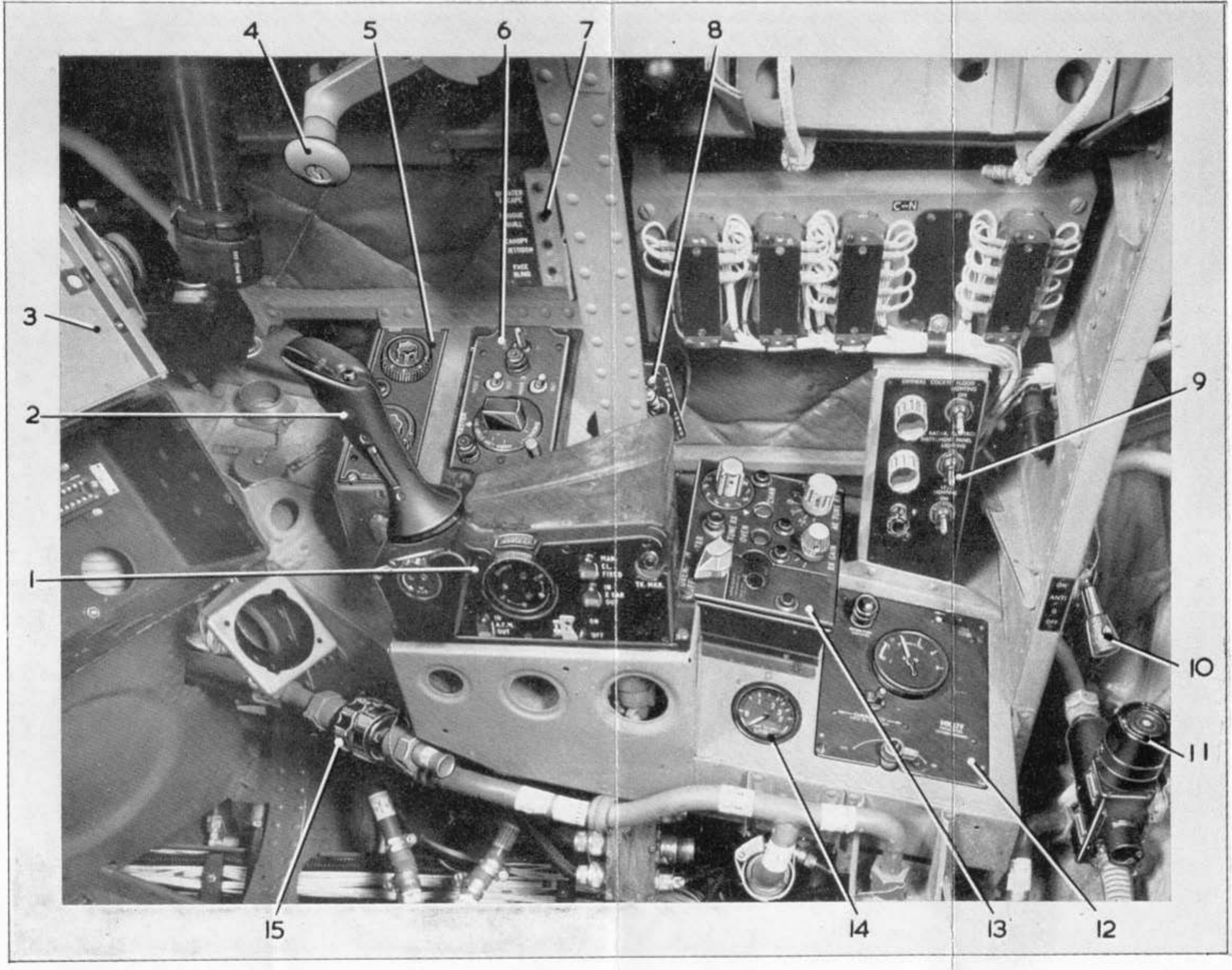


Fig. F. Observer's cockpit, starboard side