ENGLISH ELECTRIC AVIATION LTD.

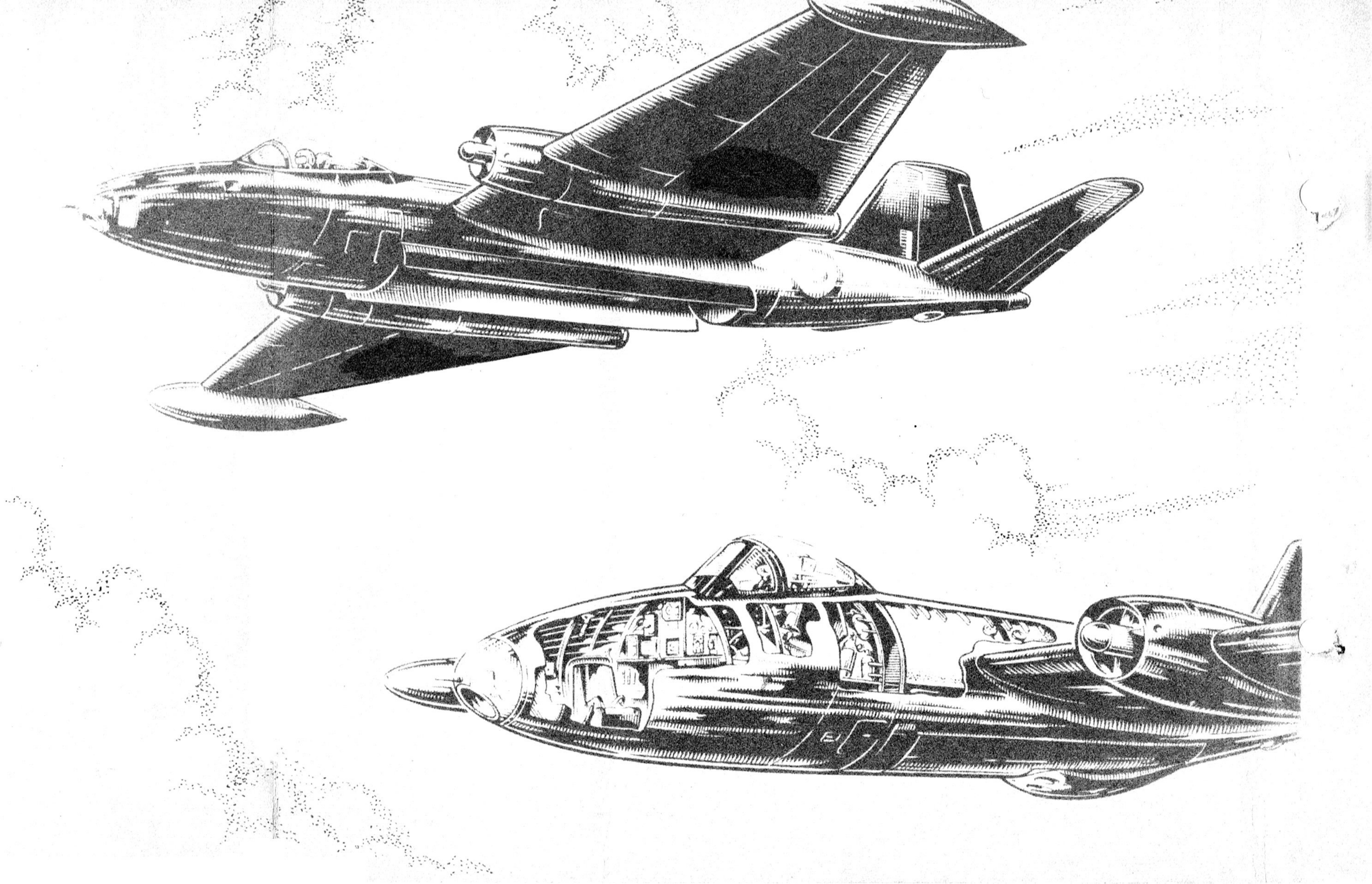
Canberra Service School

WARTON AERODROME

Lancashire

Lecture Notes

Canberra Variant Aircraft



AIRFRAME COURSE.

MK. 8.

No amendments are
issued for this Publication.

1. Newspapers and periodicals are forbidden in Lecture Rooms.
2. Table tops are not to be used as drawing boards: a supply of paper is always available on request.
3. The School does appreciate your efforts in maintaining a tidy Lecture Room.
4. The benefit that you derive from this Course depends upon your punctuality in attending Lectures.
5. When visiting the Works, always keep with your Instructor.
6. The Works are Out of Bounds to all personnel unless accompanied.
7. The afternoon of the last day is devoted to Examinations.
8. The School closes on the last Friday at 16.15 hrs.
9. The School is open to receive suggestions and answer queries.
10. The Student with a personal problem cannot concentrate, which does make study difficult.

    The Chief Instructor is always available as a confidante and adviser.

TABLE OF CONTENTS.

The empenage consists of a composite fin, variable tail plane, over-balanced elevators and rudder.

Armaments consist of a detachable gun pack mounted in the bomb bay containing four 20 mm. cannons.

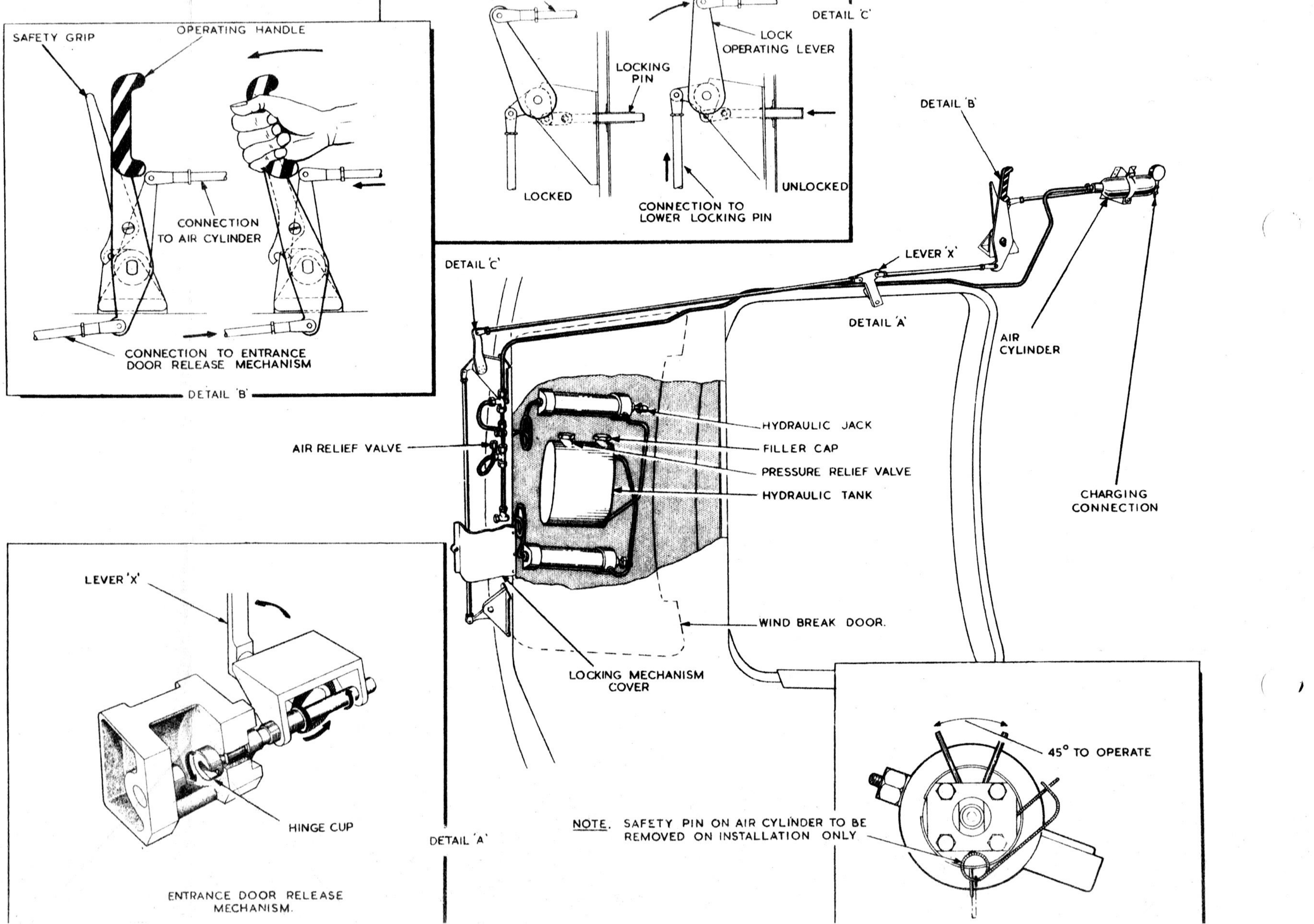
Rocket attachments are provided, one under each main plane.

The cabin is air conditioned and pressurised for high altitude flying.

The undercarriage, bomb doors, flaps and air-brakes are high pressure hydraulically operated.

The main planes are of metal construction, the mono-spar occupying 40% of the chord. Ailerons are pressure balanced. The flaps are of the split trailing edge type.

Flying controls operate on the torque-tube - blow-back rod principle.



SAFETY GRIP
OPERATING HANDLE
CONNECTION TO AIR CYLINDER
CONNECTION TO ENTRANCE DOOR RELEASE MECHANISM
DETAIL 'B'
DETAIL 'C'
LOCK OPERATING LEVER
LOCKING PIN
LOCKED
UNLOCKED
CONNECTION TO LOWER LOCKING PIN
DETAIL 'B'
LEVER 'X'
DETAIL 'C'
DETAIL 'A'
AIR CYLINDER
HYDRAULIC JACK
FILLER CAP
PRESSURE RELIEF VALVE
HYDRAULIC TANK
AIR RELIEF VALVE
CHARGING CONNECTION
WIND BREAK DOOR.
LOCKING MECHANISM COVER
LEVER 'X'
HINGE CUP
DETAIL 'A'
ENTRANCE DOOR RELEASE MECHANISM.
45° TO OPERATE
NOTE. SAFETY PIN ON AIR CYLINDER TO BE REMOVED ON INSTALLATION ONLY

WIND BREAK DOOR.

This door is forward of the main entrance door, and operated by an emergency lever mounted inside the cabin, above and to the right of the main entrance door.

This door is to deflect the air stream from the Navigator, enabling him to leave the aircraft during flight.

When closed the door follows the fuselage contour, and when opened reveals two jacks and a hydraulic reservoir.

Function.

When the emergency lever is operated, the first movement rotates the main door hinge pin assembly releasing the door, and withdraws the shoot bolts at the wind break door.

The final movement of the lever releases air from the storage bottle to the piston crown side of the wind break door jacks which opens the door approximately two inches; the air flow then takes over and opens the door to its fullest extent.

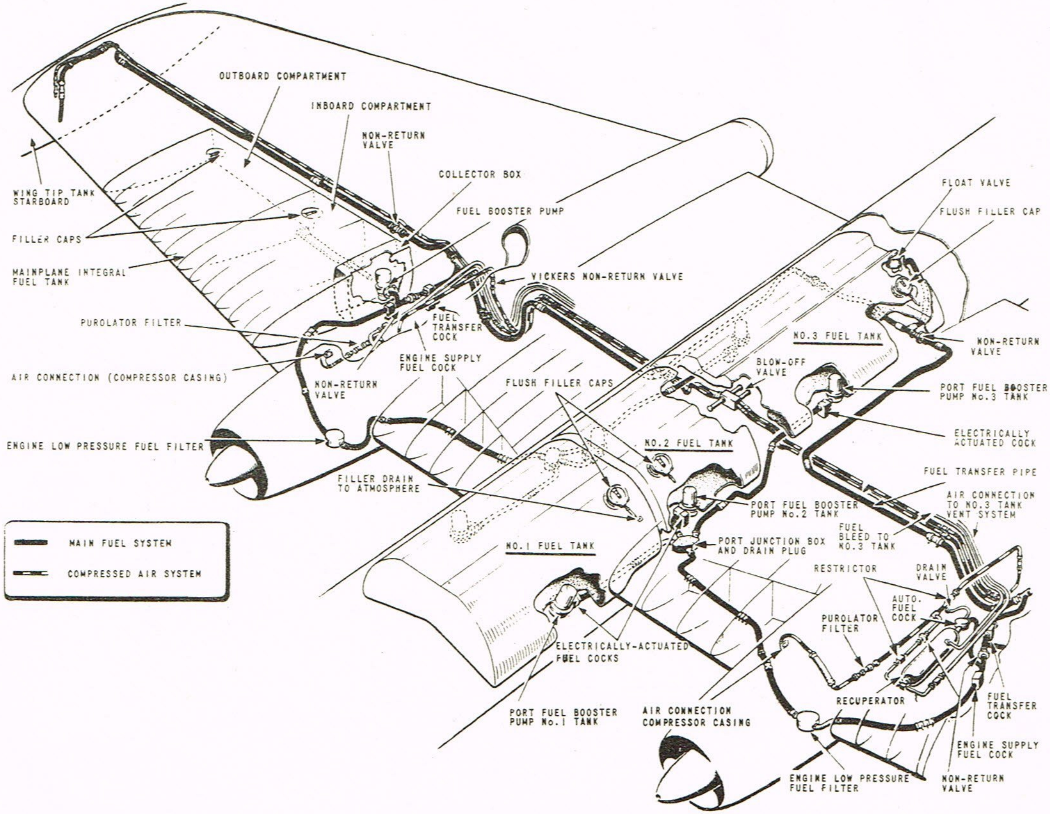
To dampen the sudden opening of the door, the hydraulic fluid on the piston rod side of the jack is returned to the internal reservoir.

ACTUATORS - MK. 8 AIRCRAFT.

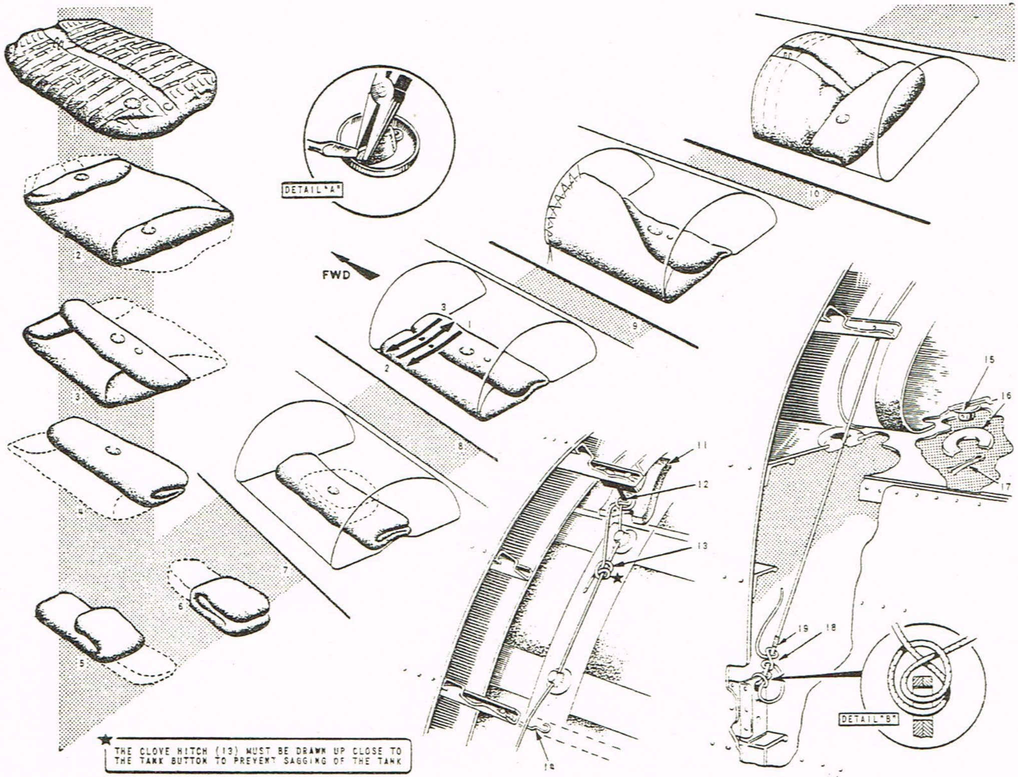
QTY.	TYPE	LINEAR or ROTARY	AIRCRAFT SERVICE.	POSITION of ACTUATOR.	POSITION of CONTROL SWITCH.
1	206	ROTARY	BOMB DOORS	BOMB BAY STBD. FWD	PILOT'S CONSOLE
1	204	ROTARY	UNDERCARRIAGE	BOMB BAY PORT FWD	U/C PANEL
6	201	ROTARY	FUEL COCKS FOR NOS. 1, 2 & 3, FUEL TANKS.	BOMB BAY 3 PORT 3 STBD	STBD. MID-REMOVABLE PANEL.
4	219	ROTARY	FUEL COCKS FOR INTEGRAL TANKS	2 PER MAINPLANE	STBD. MID-REMOVABLE PANEL
2	219	ROTARY	FUEL COCKS FOR OVERLOAD TANKS.	PORT AND STBD. REAR BOMB BAY.	STBD. MID-REMOVABLE PANEL
1	205	ROTARY	AIR BRAKES	BOMB BAY PORT	PILOT'S CONSOLE TUBE - PORT.
1	233	ROTARY	CABIN AIR MIXING VALVE.	PORT MAINPLANE	STBD. MID-REMOVABLE PANEL.
2	234	ROTARY	ENGINE GATE VALVES.	ONE INBOARD EACH ENGINE.	STBD. MID-REMOVABLE PANEL.

ACTUATORS - MK. 8 AIRCRAFT.

QTY.	TYPE	LINEAR or ROTARY	AIRCRAFT SERVICE.	POSITION of ACTUATOR.	POSITION of CONTROL SWITCH.
1	206	ROTARY	BOMB DOORS	BOMB BAY STBD. FWD	PILOT'S CONSOLE
1	204	ROTARY	UNDERCARRIAGE	BOMB BAY PORT FWD	U/C PANEL
6	201	ROTARY	FUEL COCKS FOR NOS. 1, 2 & 3, FUEL TANKS.	BOMB BAY 3 PORT 3 STBD	STBD. MID-REMOVABLE PANEL.
4	219	ROTARY	FUEL COCKS FOR INTEGRAL TANKS	2 PER MAINPLANE	STBD. MID-REMOVABLE PANEL
2	219	ROTARY	FUEL COCKS FOR OVERLOAD TANKS.	PORT AND STBD. REAR BOMB BAY.	STBD. MID-REMOVABLE PANEL
1	205	ROTARY	AIR BRAKES	BOMB BAY PORT	PILOT'S CONSOLE TUBE - PORT.
1	233	ROTARY	CABIN AIR MIXING VALVE.	PORT MAINPLANE	STBD. MID-REMOVABLE PANEL.
2	234	ROTARY	ENGINE GATE VALVES.	ONE INBOARD EACH ENGINE.	STBD. MID-REMOVABLE PANEL.



FUEL SYSTEM INSTALLATION



INSTALLATION OF NO. 3 FUEL TANK

FUEL SYSTEM.

Three fuel tanks are carried in the fuselage above the bomb bay. The front and centre tanks are internally braced, self-sealing and flexible, whilst the rear tank is a crash-proof collapsible fuel bag.

All three tanks are located within the tank compartment by their filler necks at the upper, and fuel pumps at their lower surfaces, which are secured to the fuselage skin and floor of the tank bay respectively.

No. 3 tank, which is the rear one, is supported in the fuselage by wire runners on the fuselage inner skin and studs on the upper surface of the tank, through which nylon cords are threaded, the cords being pulled tight and secured by cleats in the bomb bay. Similar studs on the base of the tank pass through holes in the floor of the compartment, these being secured by spreader plates and split rings front and rear, and by spreader plates and split pins in the intermediate positions.

The tanks are separated by a removable diaphragm fitted to the interior of the fuselage between tanks Nos. 1 and 2 and by the main plane centre section from between tanks Nos. 2 and 3. The front of the compartment is closed by the vertical bulkhead of the front transport joint, and the rear by a removable bulkhead.

Wing Tip Tanks.

Two wing tip tanks may be carried, one on the under surface of each main plane at the extreme wing tip. The tanks are rigid and of streamline form. Each is secured to the main plane structure by three bolts containing explosive detonators. The bolts screw into the attachment blocks on the upper surface of the tank and pass through bolt housings at the wing tips to which they are secured by nuts.

A navigation light is fitted at the extreme centre front of each tank, the electric wiring from the light being connected to two bolts mounted in an insulating block on the upper surface of the tank, which makes contact with the two contact studs on the lower surface of the wing tip when assembled. The tanks are jettisoned by firing the detonators within the attachment bolts which severs them and permits the tanks to drop free.

Main Fuel System.

Two submerged fuel booster pumps, Pulsometer 1003 Mk.3, are fitted into the base of each tank, the Port pumps are connected by fuel pipes to a collector box feeding the Port Engine. The Starboard pumps are similarly connected to a collector box feeding the Starboard Engine. Non-return valves at each inlet to the collector boxes prevent fuel flowing back from the boxes to the tanks not in use.

A low pressure electrically actuated fuel cock, located near each pump ; is provided to control the fuel supply from the tank.

The installation of separate switches for the individual pumps and their associated cocks permit free selection of the source of fuel.

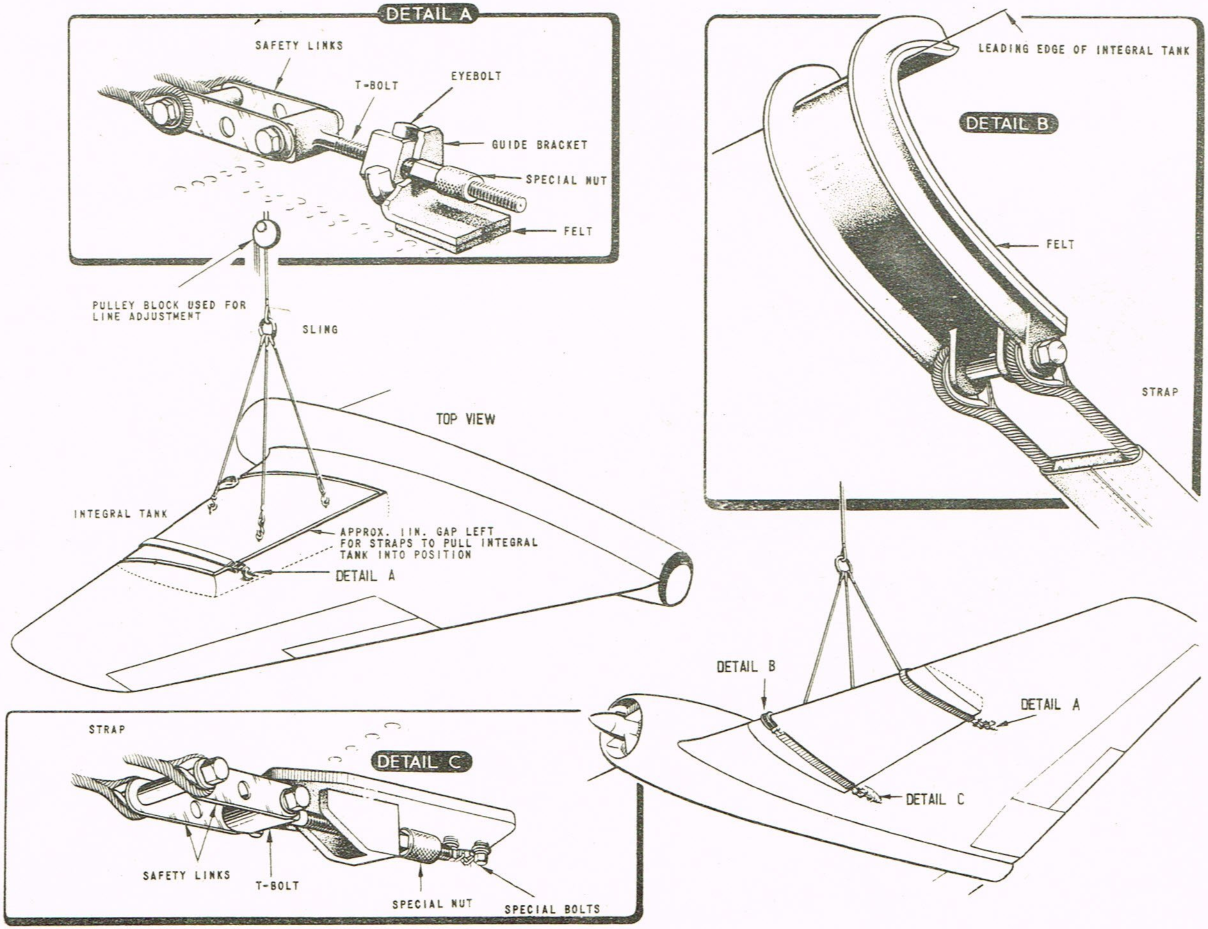
Electro-static fuel contents gauges are incorporated in all tanks.

The tanks are vented to atmosphere through a common pipe finally extending from the rear of No. 3 tank and exhausting through an aerofoil section tail pipe on the underside of the fuselage adjacent to the tail bumper.

Wing Tip Tanks Fuel System.

The fuel pipe inside each wing tip tank passes through the top of the tank and is joined to the pipe in the wing by a metal slip-release pipe and hose connexion.

The pipe continues through a non-return valve in the main plane structure to the fuselage where a further non-return valve is fitted to prevent tanks feeding each other. It then joins a common pipe, together with the opposite wing tip tank fuel pipe, connecting to a float valve at the rear of No. 3 tank through a filter.



MAIN - PLANE INTEGRAL TANKS INSTALLATION

Integral Main Plane Fuel Tanks.

The integral fuel tanks are located between rib No. 2 and rib No. 6 in each outer main plane section. They are held in position by a series of counter-sunk headed set screws around the edge of the tanks, and three shear load spigots at the rear. The recess spigots are bolted to the main spar, while the projection spigots are fitted to the rear wall of the fuel tanks.

These fuel tanks form the wing contour from the leading edge to the front of the main spar.

Internally there are two tank sections separated by a spill baffle, each tank section feeding into a collector box formed within the inner section; in this collector box are two non-return valves to prevent fuel feeding back to an empty tank section.

Installed in the collector box is a PUL 907 MK. 2 Fuel Pump, which delivers fuel to a "TEE" piece in which are fitted two electrically actuated fuel cocks, controlling the fuel either direct to the engine, or to a float valve at the rear of No. 3 tank.

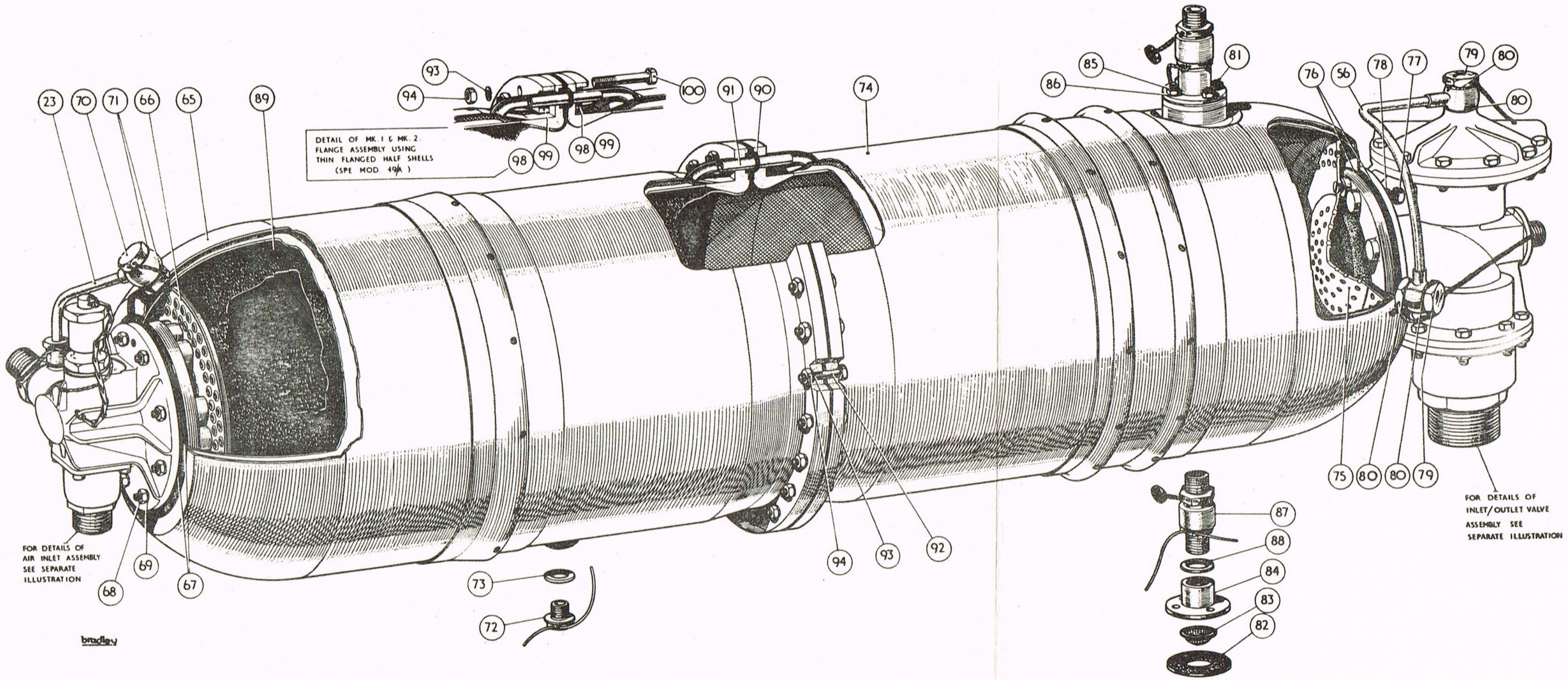
The switches for all fuel cocks are mounted on the "MID" removable panel. situated on the starboard side of the cockpit. The switches for the fuel pumps, together with the fuel contents gauges, are mounted on the "FUEL CONTROL PANEL" situated on the starboard side of the Pilot.

Fitted in the lowest part of the tank are four water drain valves, with the addition of a further one in the collector box. These valves are spring loaded in the closed position. The position of these valves is denoted by a small hole in the bottom of the tank section of the main plane, and must not be confused with the two filler orifice drain pipes which terminate in the lower skin. To release the trapped water it is necessary to push a piece of stiff wire upwards through the hole lifting the valve off its seat, therefore releasing fuel and water. Immediately the wire is withdrawn the valve will close. Access to these valves is through the inspection manholes in the rear face of the tank section, visible when the tank is removed.

Wing Tip Tank Air System.

Air pressure for transferring fuel from the wing tip tanks to No. 3 tank is ducted from No. 12 stage of each engine compressor. An air pipe from each engine passes to the rear, alongside the jet pipe, through a purolater filter and a restrictor to a non-return valve aft of the main spar, and then through the main plane structure to a pressure relief valve located in the bomb bay beneath No. 3 tank.

From the valve an air pipe is taken through the main plane structure to the wing tip where it is connected to the tank air pipe by a metal slip-release pipe and hose connexion. There is no separate control for the air system; fuel is transferred whenever the engines are running and the fuel level in No. 3 tank is low enough to allow the float valve to open. If wing tip tanks are not fitted, the ends of the air fuel lines must be securely plugged.



GENERAL ARRANGEMENT – TYPE PRC. 40 SERIES RECUPERATORS

FUEL RECUPERATORS.

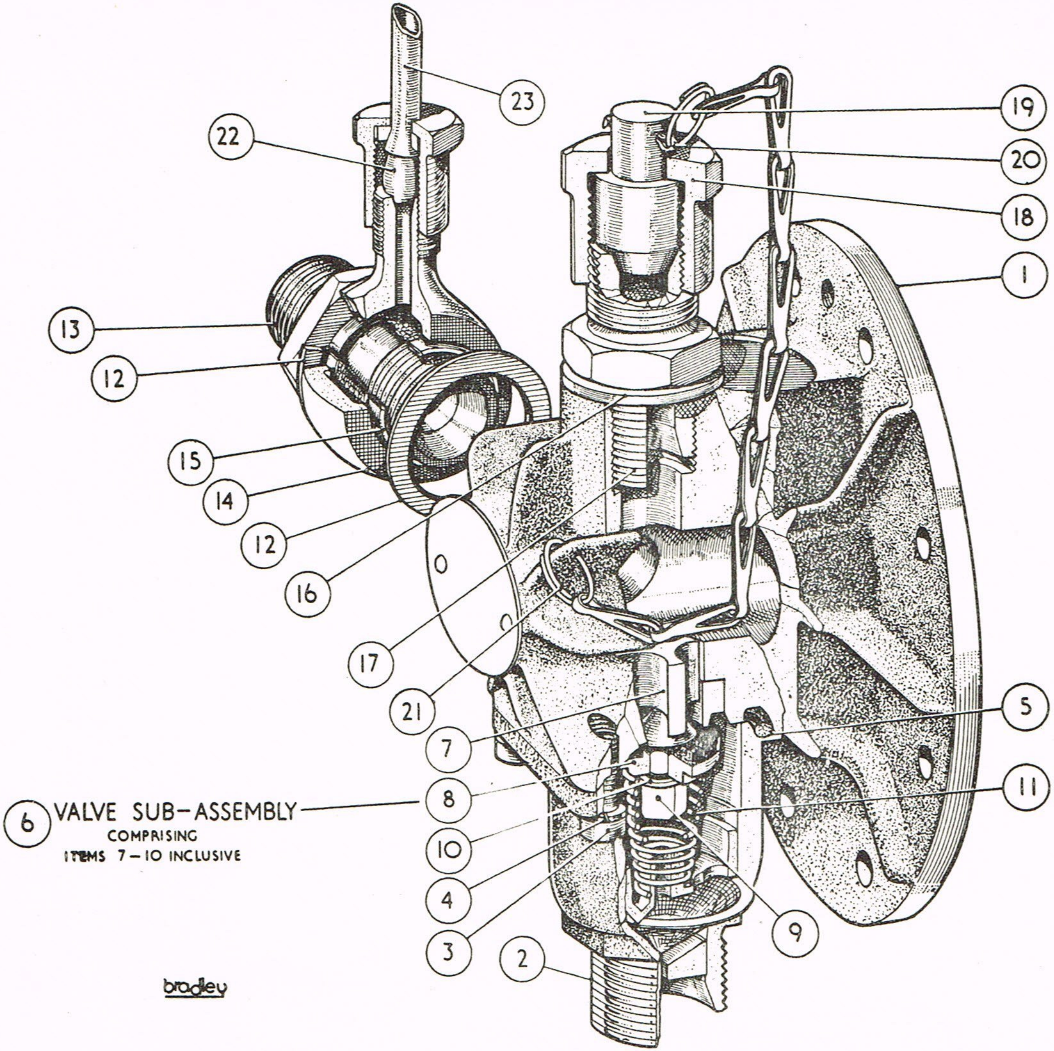
(Protected Type).

These fuel recuperators have been designed to deal with zero and negative 'G' conditions and Inverted Flight. The complete unit is installed in the fuel supply line, and teed into the delivery pipe between the fuel booster pump of the integral wing tanks and the engines.

The units are mounted in a horizontal position between the outboard engine ribs Nos. 1 and 2A Port and Starboard and comprise an outer metal cylinder, having within a flexible bag which is clamped securely in position between the two bolted flanged portions of the fuel recuperator casing. Between this and the outer shell is a jacket of compressed air, and should any damage be sustained in operation, thereby causing loss of air pressure due to the perforation of the outer shell, a spring loaded valve automatically prevents the flow of fuel through the inlet.

Function.

Each recuperator is Teed into the delivery line from the booster pump, the fuel under a pressure of 15.75 p.s.i.g. moves the flexible bag to its fullest extent and therefore charges the bag with 4 gallons, Kerosene 32 lbs., Avtag 31.2 lbs. of fuel which is sufficient for the maximum duration of Inverted Flight.



GENERAL ARRANGEMENT – TYPE PRC.40 RECUPERATORS

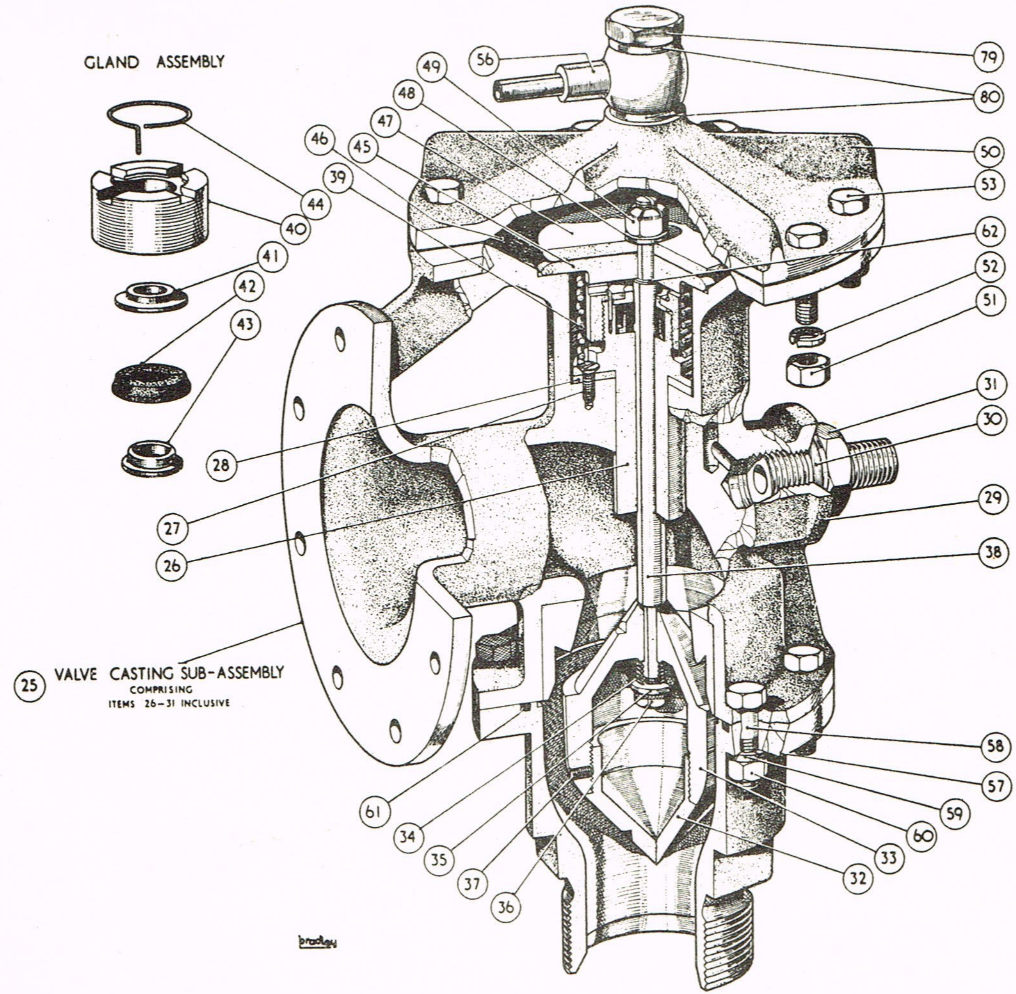
AIR INLET ASSEMBLY

Air at a constant pressure of 5 p.s.i.g. is fed up to the end of the recuperator from the Stage No. 12 of the engine compressors through a N.R.V. and Hymatic reducing valve to the end of the recuperator opposite the fuel inlet and outlet, the booster pump pressure being higher than 5 p.s.i.g. maintains the recuperator fully charged during flight.

On inversion of the aircraft or during negative 'G' conditions, the booster pump will fail to deliver fuel and the 5 p.s.i.g. air pressure on the recuperator will discharge or partially discharge the bag of fuel to the engine, a non-return valve situated in the fuel line between the recuperator and the booster pump closing off and preventing fuel being pushed back through the booster pump.

Air Pressure Relief Valve.

To maintain a constant air pressure of 5 p.s.i.g. around the recuperator bag a pressure relief valve is mounted on the outer casing opposite the fuel inlet - outlet connexions; this valve is regulated to blow off at $6\frac{1}{4}$ - $6\frac{1}{2}$ p.s.i.g. and is adjustable by alternative valve compression springs, this discharged air is piped to enter the fuel tank venting at the rear of No. 3 fuel tank diaphragm.



GENERAL ARRANGEMENT - TYPE PRC.40 RECUPERATORS

FUEL INLET ASSEMBLY

Operation of the Fuel Shut-Off Valve.

Mounted on the outer casing opposite the Air Pressure Relief Valve is the fuel inlet-outlet connexion and the fuel shut-off valve.

The shut-off valve comprises a diaphragm operated valve having recuperator air pressure on one side of the diaphragm (5 p.s.i.g.) and a spring pressure on the opposite side. Immediately the engines are started a reduced air pressure is delivered to the recuperator and thence to the diaphragm, which in turn overcomes the spring pressure opening the shut-off valve allowing fuel to enter the recuperator.

In the event of the outer casing becoming perforated, all air pressure will be lost, and, as the diaphragm requires air pressure to operate the shut-off valve, this valve will close under the action of the spring, and prevent the discharge of fuel through the perforated casing and bag.

Aeration of Fuel.

To prevent the aeration of fuel a non-return valve and metering orifice is mounted on the outer casing, allowing three changes of fuel per hour to be undertaken, the discharged fuel is piped into the rear of No. 3 fuel tank.

AUXILIARY FUEL TANK.

Provision is made for installing a 300 gallon fuel tank in the rear of the bomb bay. The tank is attached to the rear secondary bomb beam at two positions by strap and turnbuckle assemblies.

IMPORTANT.

The Avro triple carrier locating pegs must be removed from the rear secondary bomb beam and stowed before the tank is installed.

Fitted in the base of the tank are two fuel pumps TYPE PUL 1003 from which fuel pipes lead through non-return valves to electrically actuated cocks installed in the bomb bay.

The pumps and their associated cocks are controlled by two switches located in the starboard control panel at the Pilot's station.

A fuel pipe from each cock joins the wing tip tank fuel transfer pipe aft of No. 3 tank. The tank is vented to atmosphere by a vent pipe connected to the existing fuel tank venting system. A calcium chromate inhibitor cartridge is housed in a container in the base of the tank.

FUEL AND FLOW PRESSURE TESTS.

The following equipment is required for the fuel flow pressure tests:

1. Fuel Bowser.
2. A 50 gallon measuring cylinder.
3. A $1\frac{3}{4}$" Aircrafting Cock connected to the outlet from the fuel delivery pipe and to a length of $1\frac{1}{2}$" piping into the measuring cylinder.
4. An accumulator supply giving 24 volts at the pumps.
5. Voltmeter and Ammeter.
6. Pressure gauge reading up to 30 p.s.i.
7. Stop watch.

Fuel Quantities.

The free flow and pressure tests are to be made with the following quantities of fuel in the tanks at the commencement of the tests:

No. 1 Tank.	160 gals.	=	1280 lbs.
No. 2 Tank.	130 gals.	=	1040 lbs.
No. 3 Tank.	162 gals.	=	1296 lbs.

Pressure Test.

With the cock to the measuring cylinder shut off, the pump delivery pressure is to be measured for each pump separately. The voltage across each pump must be 24 volts.

Each pump should run for 5 minutes, and during this time the delivery system must be carefully inspected for leaks.

After 5 minutes running, the delivery pressure should be measured by a pressure gauge at a convenient position adjacent to the end of the flexible fuel delivery pipe and the current consumption of each pump noted. The delivery pressure should be 17.0 p.s.i.g. and the current consumption 11.0 amps.

NOTE: It is advisable at the commencement of each test to open the cock to the measuring cylinder for a few seconds to clear away accumulated air.

Free Flow Test.

The delivery from each tank (port and starboard) is to be gravity tested into the measuring cylinder with the outlet end of the flexible pipe supported at approximately the same height at the delivery connexion to the engine.

Make 3 tests, allowing 24 lbs. of fuel to flow into the measuring cylinder at each test.

These tests must be carefully timed.

<u>THE AVERAGE TIME FOR 24 LBS. OF FUEL</u>

<u>TO FLOW MUST NOT EXCEED 27 SECONDS.</u>

<u>NOTE:</u> Before the first timed flow is taken from each pump position, it is advisable to switch on the booster pump for a few seconds to clear away any accumulated air in the system.

Delivery Rate from the Pumps.

The procedure is the same as for the Free Flow Tests except that each pump is tested in turn by timing the flow of 24 lbs. three times.

The voltage at the pumps must be checked and should read 24 volts.

The time taken to pass 24 lbs. of fuel must not exceed $8\frac{1}{2}$ seconds.

TESTING INTEGRAL WING TANKS.

1\. (a) Trim contents gauge of integral tanks to zero.

(b) Fill each compartment separately and check that there is no leakage between the full compartment and the empty one. (See Note (2).

(c) Fill the tanks and record the amount of fuel to fill the tank and the amount registered on the contents gauge.

(d) With integral tanks full, drain off fuel into measure drum under gravity. The time taken to deliver 24 lbs. of fuel must not exceed 27 seconds. Take an average of three readings.

(e) Drain off fuel in increments of 400 lbs. and calibrate the contents gauge. Record the quantity of fuel.

(f) Unusable fuel is about 32 lbs.

2. Fuel Quantities.

The pressure tests are to be made with the following quantities of fuel in the tanks before commencement of the tests.

(a) Integral Tanks. 800 lbs. (Inboard compartment).
Integral Tanks. 480 lbs. (Outboard compartment).

(b) Operate each booster pump in turn and check that 24 lbs. of fuel are delivered in not more than 7.3 seconds.
Take an average of 3 readings.
The voltage is to be 24 at the pumps.

(c) For each integral tank operate the by-pass switch in the cabin to "Wing Transfer to Rear Tank" and check the flow from each integral tank to No. 3 tank which should be 400 lbs. in 165 to 180 seconds.
Take an average of 3 readings.

3. Pressure Tests. (No Flow).

Close the aircrafting cock; run each booster pump separately for 5 mins.

To check pump pressure at the engine inlet using gauge - see that all pump switches are "OFF" - plug ammeter in E.C.P. test socket and depress push button test switch to obtain a reading of 15.75 p.s.i.g. at 10.25 amps.

WING TIP TANK FUEL FLOW TESTS.

Test Equipment.

The following equipment is required for testing the fuel flow from the wing tip tanks to No. 3 Tank:

(1) An air supply of 75 p.s.i.g.

(2) A pressure gauge reading up to 100 p.s.i.g. fitted to a suitable adaptor to connect it to the air supply pipe.

(3) A stop watch.

NOTE: Before the commencement of the wing tip tank flow tests the fuselage should be supported with a testle at Frame 42.

Flow Tests - With Ground Air Supply.

Disconnect the air supply from each engine compressor casing and connect a ground air supply to each air pipe.

Apply an air pressure of 75 p.s.i.g. to the port and starboard air pipe.

(1) The time taken for 800 lbs. (measured on the No.3. tank fuel gauge) to transfer into No.3. tank.

THIS MUST NOT EXCEED 7 MINUTES.

(2) That the flow from the wing tip tanks is even. This should be checked by means of a dip-stick.

Disconnect the ground air supply from the starboard pipe, apply an air pressure of 75 p.s.i.g. to the port air pipes for a period of three minutes, and check by means of a dip-stick that the flow from each wing tip tank is even.

Reconnect the ground air supply to the starboard engine and disconnect the ground air supply to the port engine. Apply an air pressure of 75 p.s.i.g. to the starboard air pipe for a period of three minutes and check by means of a dip-stick that the flow from each wing tip tank is even.

Fill No.3. tank with fuel and with 800 lbs. in each wing tip tank apply an air pressure of 75 p.s.i.g. to the air pipes and check that the float valve prevents any further admission of fuel from the wing tip tanks.

Disconnect the ground air supply to the starboard engine and reconnect the air supply pipe to each engine compressor casing. Drain No.3. Tank until it contains 400 lbs.

Flow Tests - With Engines Running.

Run both engines at 5,500 r.p.m. and check the following:

(1) The time taken for 400 lbs. (measured on No.3. tank fuel gauge) to transfer into the No.3. Tank. 3 - 5 minutes.

(2) That the flow from each wing tip tank is even. This should be checked by means of a dip-stick.

Recuperator Tests.

1. (a) Disconnect the air pressure line at Stage No. 12 of the engines, and attach an air bottle to give 80 p.s.i.g.

   (b) Blank off the air line feeding the wing tanks blow-off valve, immediately aft of the recuperator air tapping.

2. Close the fuel cock, 'Transfer to Rear Tank'.

3. Disconnect the fuel line at the engine and place a measuring drum underneath, connecting the fuel line to the cock on the measuring device turned to the "OFF" position.

4. Switch on the integral tank booster pump; this will then charge the recuperator.

5. To check that the fuel bleed from the recuperator is functioning correctly, place the ear against the end of the bleed pipe where it enters No. 3 fuel tank.

6. To check the recuperator discharge, switch off the integral tank booster pump, open the cock at the measuring device and check that there is a discharge of 28 - 32 lbs. of fuel in 10 - 12 seconds, with a full bore flow.

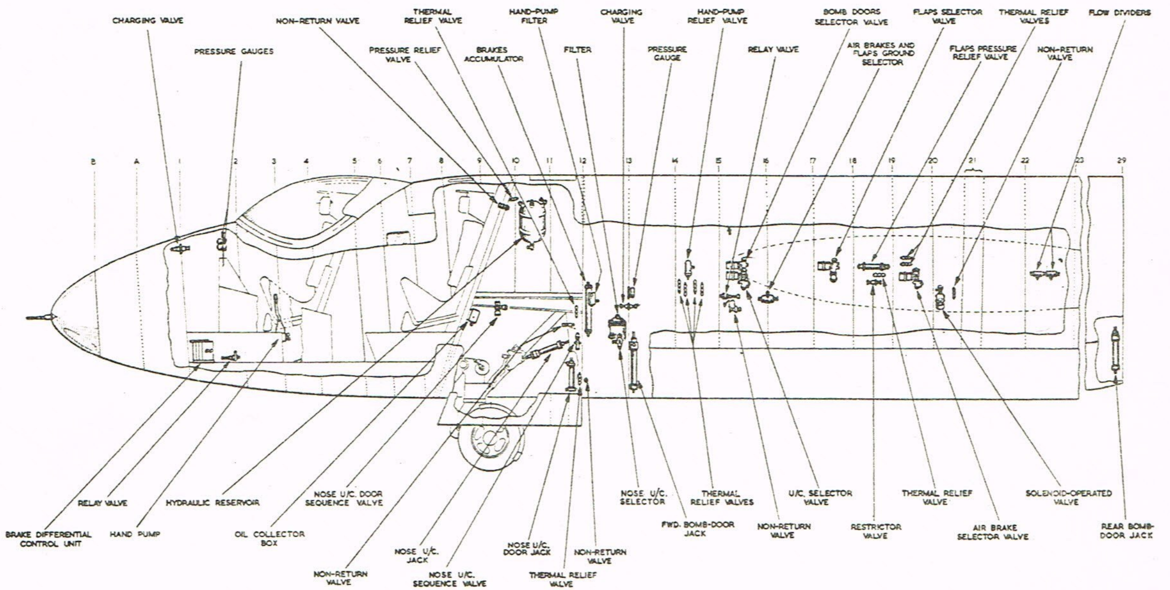
Engine Ground Run.

With No. 3. tank in operation, and the recuperator fully charged, switch off the fuel cock only, and check that the engine maintains a constant speed of 7750 r.p.m. over a mininium period of 10 seconds.

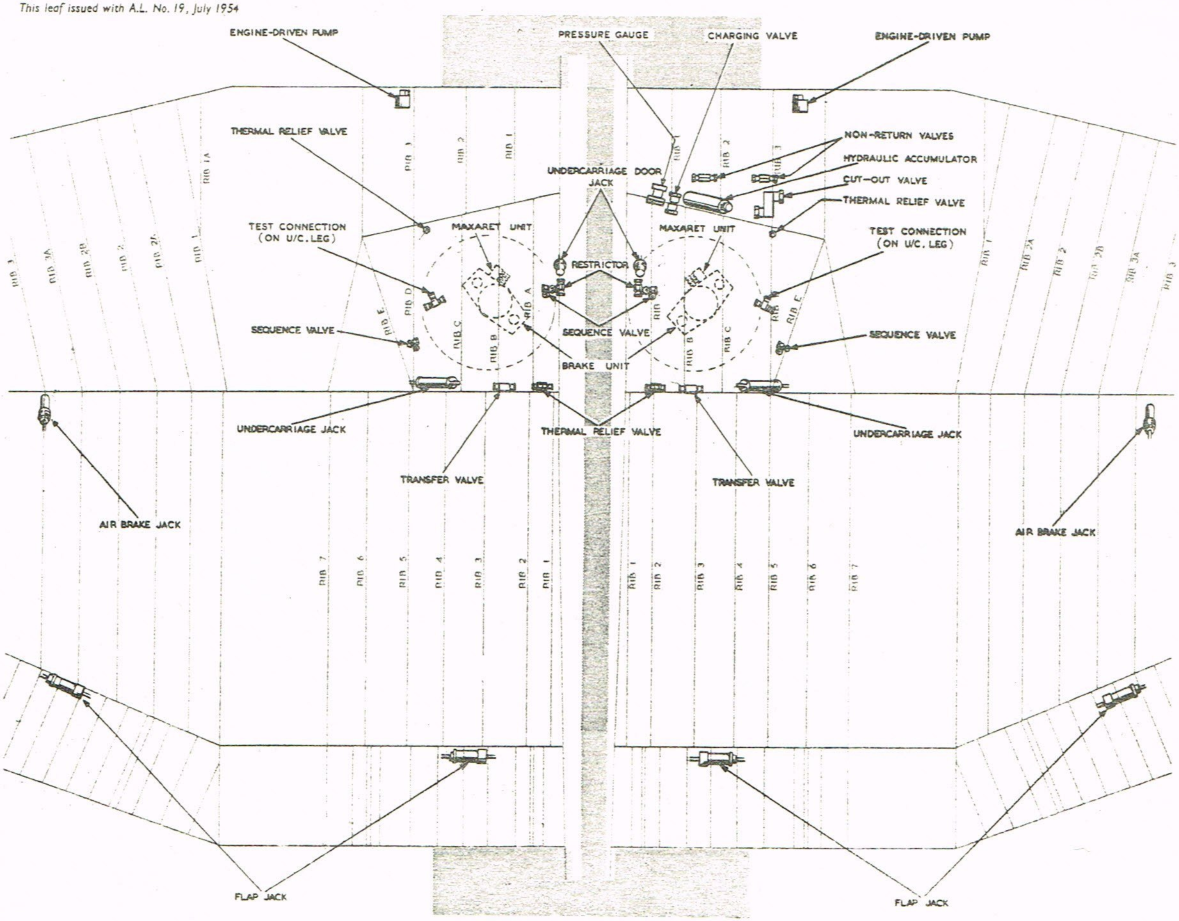
Auxiliary Fuel Tank Delivery Test.

Each pump separately	-	192 lbs. in not more than One minute.
Both pumps operating	-	480 lbs. in not more than Two minutes.

NOTES.



Location of hydraulic components in fuselage



Location of hydraulic components in main planes

HYDRAULIC SYSTEM.

The hydraulic system comprises a miscellany of components built up to form an efficient service.

Two Lockheed Mk. 7 hydraulic pumps are mounted - one on each engine driven gear box - to receive hydraulic fluid through a Vokes filter piped from the reservoir mounted in the equipment compartment with access to the filling orifice on the port side of the fuselage slightly aft of the cabin diagonal pressure bulkhead.

From the engine driven pumps, the fluid passes through two non-return valves to form a common pressure line entering a Lockheed cut-out valve, situated between ribs Nos. 2 and 3 in the leading edge of the starboard main plane.

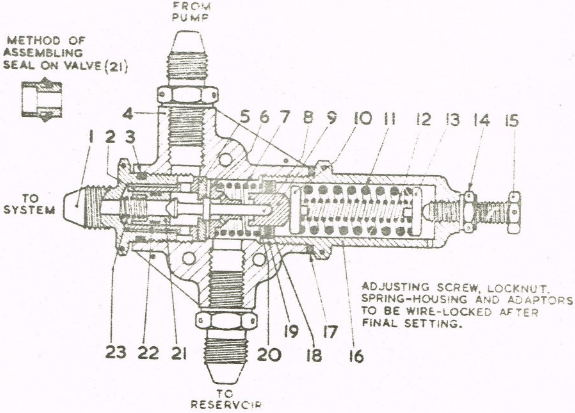
Leaving the cut-out valve at a controlled pressure of 2700 - 2750 p.s.i.g. a Lockheed accumulator is TEED into this pressure line, mounted at an angle in the root end of the starboard main plane leading edge, inflated to 1400 p.s.i.g. (with no hydraulic pressure in the system) the fluid continuing forward through a non-return valve to enter the main distribution system.

Hand Pump.

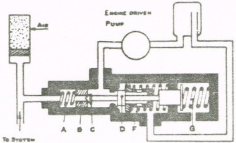
This is mounted on the starboard side of the Pilot, at seat level; of Turner manufacture, it draws fluid from the reservoir through a Dowty filter mounted on the first vertical bulkhead, with access in the battery compartment.

Leaving the hand pump, the fluid passes under pressure through a non-return valve to enter the main distribution system.

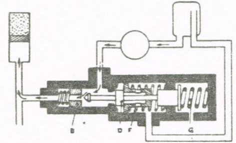
NOTES.



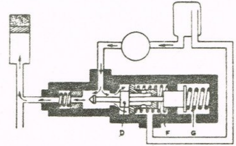
CUT-OUT VALVE. A.I.R. 41158.



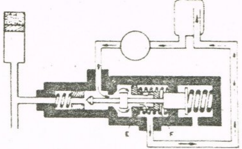
Nº 1. STATIC POSITION ENGINE-DRIVEN PUMP NOT WORKING AND ACCUMULATOR DISCHARGED SPRINGS (F, G) KEEP VALVE (D) SEATED AND SPRING (A) HOLDS VALVE (B) AGAINST VALVE STEM (C)



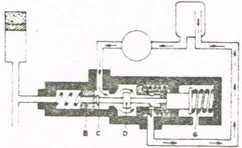
Nº 2. WHEN ENGINE-DRIVEN PUMP STARTS WORKING, FLUID LIFTS VALVE (B) AND FLOWS INTO ACCUMULATOR, COMPRESSING AIR AND STORING ENERGY. SPRINGS (F, G) KEEP VALVE (D) SEATED UNTIL ......



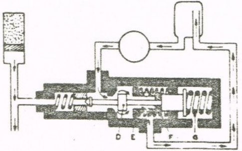
Nº 3. ACCUMULATOR PRESSURE REACHES 'CUT-OUT' FIGURE PRESSURE ACTING ON VALVE (D) THEN LIFTS IT SLIGHTLY AGAINST FORCE OF SPRINGS (F, G) SO THAT......



N° 4. PRESSURE ACTS ON FLUTTER PLATE (E) DISPLACING IT ALONG VALVE SPINDLE AGAINST SPRING (F); FLUID THEN ESCAPES TO RESERVOIR THROUGH HOLES IN FLUTTER PLATE AND



N° 5. DELIVERY PRESSURE OF PUMP FALLS ACCUMULATOR PRESSURE PUSHES VALVE (B) ON TO VALVE STEM (C) AND OPENS VALVE (D) FULLY AGAINST SPRING (G); FULL DELIVERY OF PUMP FLOWS THROUGH FLUTTER PLATE TO RESERVOIR THIS IS THE 'CUT-OUT' CONDITION



N° 6. AS ACCUMULATOR PRESSURE FALLS DURING OPERATIONS OF SYSTEM SPRING (G) PUSHES VALVE (D) TOWARDS ITS SEAT WHEN 'CUT-IN' PRESSURE IS REACHED VALVE (D) ENGAGES SEAT SPRING (F) RETURNS FLUTTER PLATE ON TO VALVE (D) AND CHARGING CYCLE COMMENCES AS IN DIAGRAM (2)

LOCKHEED CUT-OUT.

The function of this valve is to control the charging of the accumulator by the two engine driven hydraulic pumps, thereby enabling the pumps to circulate fluid round an idling circuit once the accumulator is fully charged.

The manner in which this is achieved is diagrammatically portrayed on the opposite page.

The unit consists of a body (4) in which a valve seat (5) is retained by an adaptor (1) containing a sleeve (2). Leakage is prevented by a seal (3) fitted in a groove in the adaptor. A slidable valve (21), carrying a seal (22) and loaded by a spring (23), is assembled in the sleeve.

The spring housing is screwed into the other end of the body and contains two springs (11, 12), the load of which is transmitted to a valve stem (8) by a plunger (9). The latter part passes through a seal (19) which is assembled between two washers (18, 20), these parts being housed within a recess at the inner end of the spring housing.

The valve stem enters the plunger and is formed with a flange and a conical face, the flange engages the seat (5) while the conical portion seats on the valve (21). A flutter plate (6) is carried on the valve stem and loaded by spring (7).

Wheel Brake Circuit.

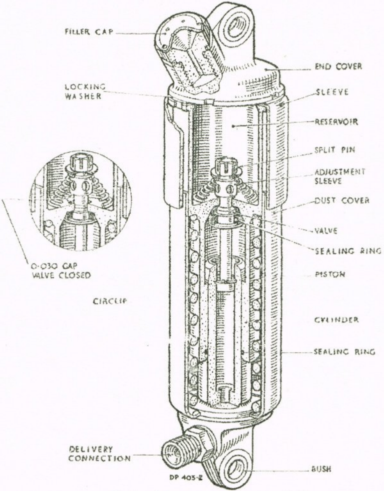
From the main distribution system fluid passes through a GROUND to FLIGHT manually operated control valve mounted on the starboard side in the bomb bay, to a Dunlop Reducing Valve mounted beneath the Pilot's platform, reducing the pressure from 2700 p.s.i.g. to 1500 p.s.i.g., continuing to enter a Dunlop MK.III Brake Control Unit mounted adjacent to the Reducing Valve.

Tapped into the pressure lines on leaving the main distribution system is a non-return valve and a Lockheed accumulator inflated to 1400 p.s.i.g. Both these are mounted on the same bulkhead as the Dowty filter.

A further tapping is introduced to accommodate a Gauge Relay, with the gauge mounted on the forward panel in the starboard side of the cockpit to indicate the available brake pressure.

Toe braking is employed, and the foot motors are mounted on the rudder bar with flexible lines to the Brake Control Unit whilst the parking brake lever is mounted on the edge of the Pilot's console, forward of the throttle box. Leaving the Brake Control Unit with two separate lines, fluid passes to the port and starboard wheel brakes.

Dunlop Plate type hydraulic brakes are fitted, each Unit having four cylinders; each cylinder is provided with a bleeding point.



Sectional arrangement of master cylinder

DUNLOP MASTER CYLINDER.

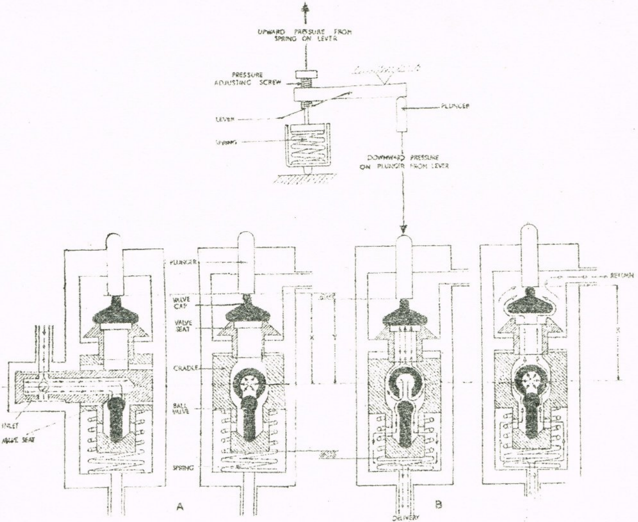
Introduction.

Operation of the Unit provides the fluid pressure necessary to operate the brake control valve and allow the aircraft main hydraulic system pressure to pass to the brake unit. A master cylinder is mechanically linked to each rudder control foot pedal and the pressure produced is fully progressive with the load applied.

Principle of Operation.

When the master cylinder is fully extended the action of the supporting spring holds the base of the reservoir against the underside of the adjustment sleeve. In this condition a pre-set clearance exists between the valve seal and the lower face of the reservoir base, thus, any fluid loss sustained during operation of the unit, is immediately replenished from the volume of fluid in the reservoir.

When a load is applied to the foot pedal the reservoir and cylinder unit compresses the main spring and telescopes on to the piston. Immediately this movement is in excess of the pre-set clearance dimension the valve closes under the influence of its spring.



UPWARD PRESSURE FROM SPRING ON LEVER
PRESSURE ADJUSTING SCREW
LEVER
SPRING
PLUNGER
DOWNWARD PRESSURE ON PLUNGER FROM LEVER
PLUNGER
VALVE CAP
VALVE SEAT
CRADLE
BALL VALVE
SPRING
INLET
VALVE SEAT
RETURN
X
Y
DELIVERY
A
B

DUNLOP MK. III. PRESSURE-REDUCING VALVE.

Introduction.

The function of the MK.III Pressure Reducing Valve is to deliver hydraulic fluid at a pre-set pressure to a hydraulic control system.

Principle of Operation. (See functional diagram).

The function of the Unit is to maintain a fixed pressure at the delivery side irrespective of the main system pressure present at the inlet connexion. This delivery pressure can be adjusted by means of the adjusting screw.

Diagram 'A' shows the relative position of the internal components of the valve as they would be in a pressurised system, with main system pressure applied at the inlet barrel, and with the required delivery pressure present in a closed delivery circuit. This condition is maintained by the upward thrust of valve spring loading, plus delivery back pressure, balancing the downward thrust of the pressure setting spring applied through the lever and plunger.

Pressure drop on the delivery side due to the operation of a service destroys this balance; the pressure setting spring tilts the lever, thrusting the plunger, valve cap, exhaust valve seat and cradle downwards against the valve spring. Supply fluid pressure is transmitted past the ball valve to supplement the drop in delivery pressure.

This condition is shown in diagram 'B'. As pressure on the delivery side rises, the back pressure applied over the exhaust valve area again supplements the thrust of the valve spring to overcome the setting spring, and the cradle moves upwards to re-seat the ball valve. At this position, further increase of pressure on the delivery side is prevented, and the Unit is again balanced.

In practice, the movements and time factors are very small. Any slight drop in delivery pressure results in immediate compensation by the opening of the valve which immediately tends to close again. Thus the valve maintains a steady pressure at the delivery side.

Should pressure in the delivery circuit rise above the pre-set figure (as for example pressure rise due to thermal expansion while the system is at rest) the excess back pressure will lift the exhaust valve as shown in diagram 'C' permitting the excess to be dissipated into the return line.

Dunlop Maxaret Automatic Brake Control Unit.

The Maxaret Unit is designed to permit maximum brake application to either wheel without fear of wheel locking, either in straight or bounce landing. One Unit is fitted to each brake torque plate driven by the main wheel dished rim, and shimmed under the mounting bracket to maintain a flat of 1" on the Maxaret drive wheel.

These Units are handed =

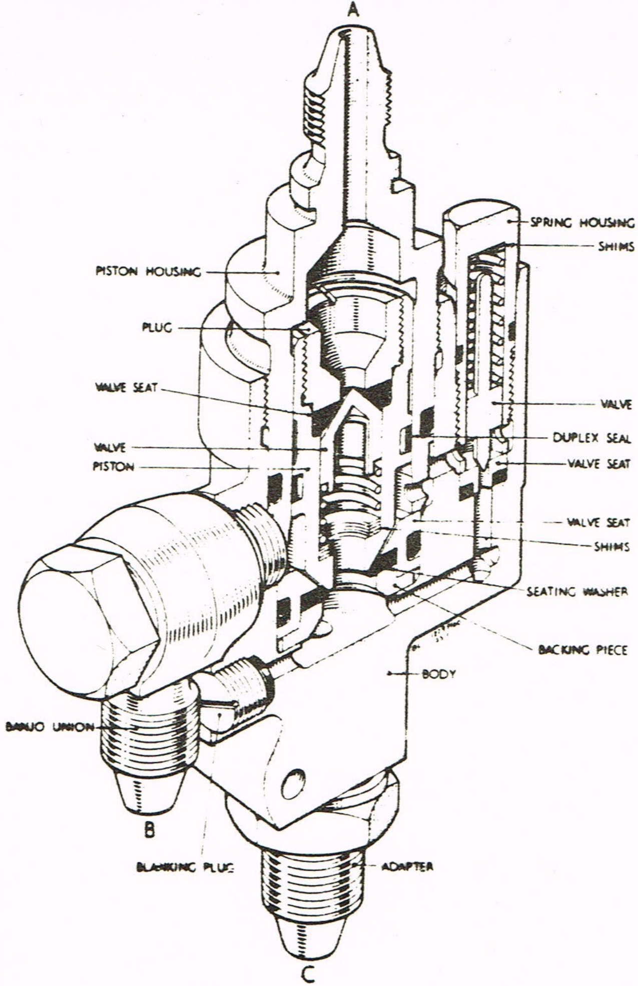
L.A.M. for the port wheel.

R.C.M. for the starboard wheel.

L.A.M.	Left hand	- Anti-clockwise	- mineral oil.
R.C.M.	Right hand	- Clockwise	- mineral oil.

On the opposite face to the Maxaret drive wheel will be noted the exhaust valve seat. Below and a little to the right is the indicator rod, to indicate that the internal mechanism of the unit is correctly adjusted. When the main landing wheel is stationary the rod should be flush with the casing, when the brakes are either "ON" or "OFF".

To check the action of the indicator rod it would be necessary to spin the wheel rapidly and apply the brake, when the follow up action of the Maxaret internal flywheel would momentarily allow the rod to protrude 0.060".



DOWTY TRANSFER VALVE

Undercarriage Circuit.

The control valve is fitted on the port side of the bomb bay forward, and operated by an electrical actuator with press button switching ct mounted on the Pilot's console. The valve has four hydraulic connexions.

Dowty jacks are employed throughout in this circuit. Pressure is fed from the control valve to either side of the pistons, depending upon the direction of the undercarriage, while to accelerate the lowering of the undercarriage, Dowty transfer valves are incorporated, which transfer fluid from the ram side to the piston crown side of the jacks.

These transfer valves are fitted on the forward face of the main spar, one in each wheel well, and consist internally of a sliding piston having a conical valve formed at one end, while within the piston at the opposite end another solid conical valve is fitted spring loaded in the closed position.

For the retraction of the main undercarriage, fluid is fed into the transfer valves, forcing the solid conical valve off its seat and passing through the hollow piston direct to the ram side of the main jacks; pressure on top of the piston valve keeps the hollow conical valve in the closed position.

Fluid expansion is controlled by a thermal relief valve fitted within the transfer valve.

For the extension of the undercarriage, fluid is fed direct from the control valve to the piston crown side of the main jacks, and the return fluid from the piston ram side of the jacks, forces the hollow conical valve off its seat closing the solid conical valve, thus allowing the escape fluid to enter the fluid line to the piston crown side of the jacks, accelerating the lowering of the undercarriage.

Included in the circuit are sequence valves which are operated mechanically, allowing one part of the circuit to complete its final movement before the other part will operate.

In each undercarriage door circuit two one-way restrictor valves are piped; these valves oppose each other to regulate the opening and closing speed of the doors.

Two branch lines go forward to feed the nose-wheel and doors, through a manually operated control valve mounted in the battery compartment, and during flight wired to the "FLIGHT" position.

When the valve is selected to "GROUND" the nose-wheel and doors can be retracted independently of the main undercarriage by using the aircraft hand pump.

NOTE:

The nose jacking spigots must be fitted to each side of the nose and the jacks in position before operating this control valve.

Eight external thermal relief valves are fitted to compensate for fluid expansion, adjusted to relieve at 3350 - 3550 p.s.i.

NOTES.

Undercarriage Selection Control.

The undercarriage is hydraulically operated, and the controlling of the "UP" and "DOWN" movements is by a rotary control valve electrically actuated.

The actuator is operated by a "TWO-BUTTON" type switch arranged so that pressure applied to either button will eject the other. It also incorporates a safety device on the "UP" side to prevent accidental "UP" selection with the aircraft on the ground.

This switch is fitted on the vertical panel which is a continuation of the Pilot's control.

WARNING:

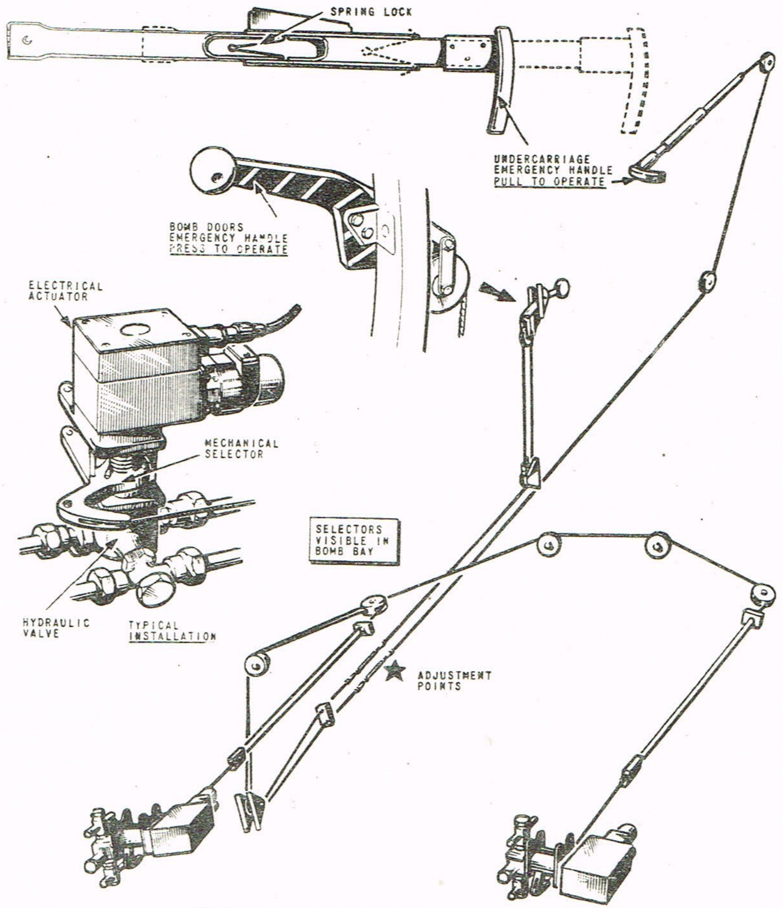
When the aircraft has been on jacks, and lowered slowly on to the ground, the aircraft must be rolled or rocked to allow the undercarriage oleo legs to settle. The maximum extension for oleo legs is $9\frac{1}{2}$; any measurement above this figure renders the micro-switch mounted on the starboard leg inoperative.

When the aircraft is on the ground, the "UP" push button is inoperative unless the emergency position has been selected, by virtue of the micro-switch fitted to the starboard oleo leg which is in the open position.

When the weight of the aircraft is removed from the undercarriage, the oleo leg extends, and with this action the torque links, through their scissors-like movement, close the micro-switch, energising a small coil within the "TWO BUTTON" switch.

This small coil (Electro-Magnet) draws the armature forward, allowing the "UP" push button to be depressed, ejecting the "DOWN" button.

NOTES.



Alighting gear and bomb doors emergency selectors

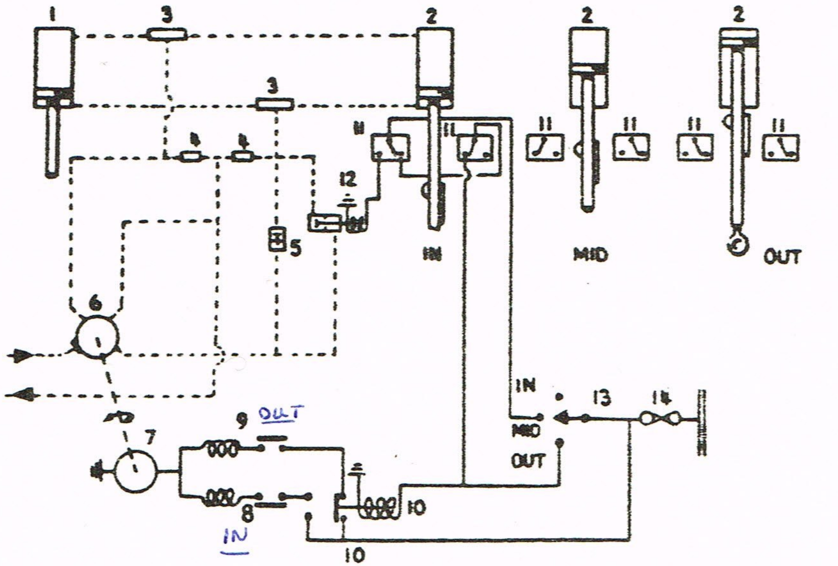
Emergency Operation.

To select the undercarriage "UP" whilst the aircraft is on the ground, the over-ride handle must be turned 90° to the right, and the "UP" button pressed in; this over-rides the locking coil (Electro-Magnet).

Should the actuator fail, the undercarriage can be lowered by pulling on the "RED" umbrella handle, mounted above the "TWO BUTTON" SWITCH. The operation of this handle returns the rotary control valve to the "DOWN" position by the medium of a cable control.

WARNING:

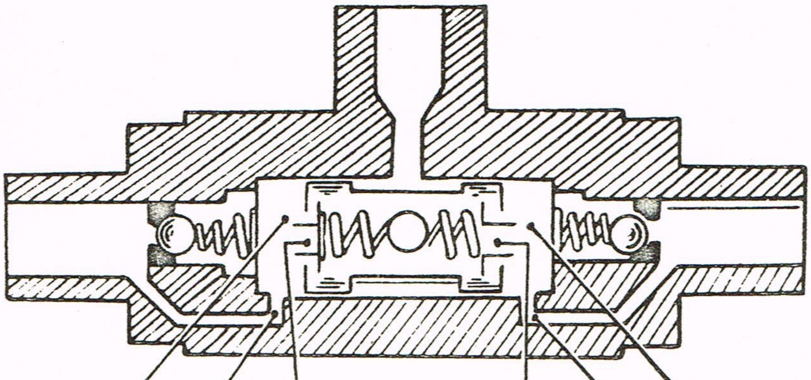
The Umbrella Type handle must not be returned to the normal position until the aircraft is placed on jacks and the nose-wheel locked, or sleeves fitted over the jack rams and the nose-wheel locked, otherwise the undercarriage will fold up if parked on uneven ground.



1. PORT HYDRAULIC JACK
2. STBD. HYDRAULIC JACK
3. FLOW-DIVIDER VALVE
4. THERMAL RELIEF VALVE
5. NON-RETURN VALVE
6. HYDRAULIC SELECTOR VALVE
7. ACTUATOR
8. ACTUATOR 'IN' FIELD
9. ACTUATOR 'OUT' FIELD
10. RELAY
11. MICRO-SWITCHES
12. MESSIER SOLENOID VALVE
13. PILOT'S SELECTOR SWITCH
14. FUSE

3-POSITION AIR BRAKES

MESSIER FLOW-DIVIDER VALVE (Schematic) TYPE 8076.



The fluid enters the central shuttle assembly and flows through two calibrated orifices A.1 and A.2 to the chambers B.1 and B.2, past a second set of variable orifices C.1 and C.2 to the two output branches of the system. When the flow is equal, the pressure drops across A.1-C.1 and A.2-C.2 are equal, and the pressure on the chambers B.1 and B.2 remain equal ; the forces on the ends of the shuttle are thus in balance. If the back-pressure drops in, say, the left hand branch, the flow through A.1 will tend to increase ; this increases the pressure-drop across it and reduces the pressure drop in the chamber B.1. The shuttle moves over to the left, throttling the flow through C.1, until the balance of flow is restored and the pressure in B.1 and B.2 again balance.

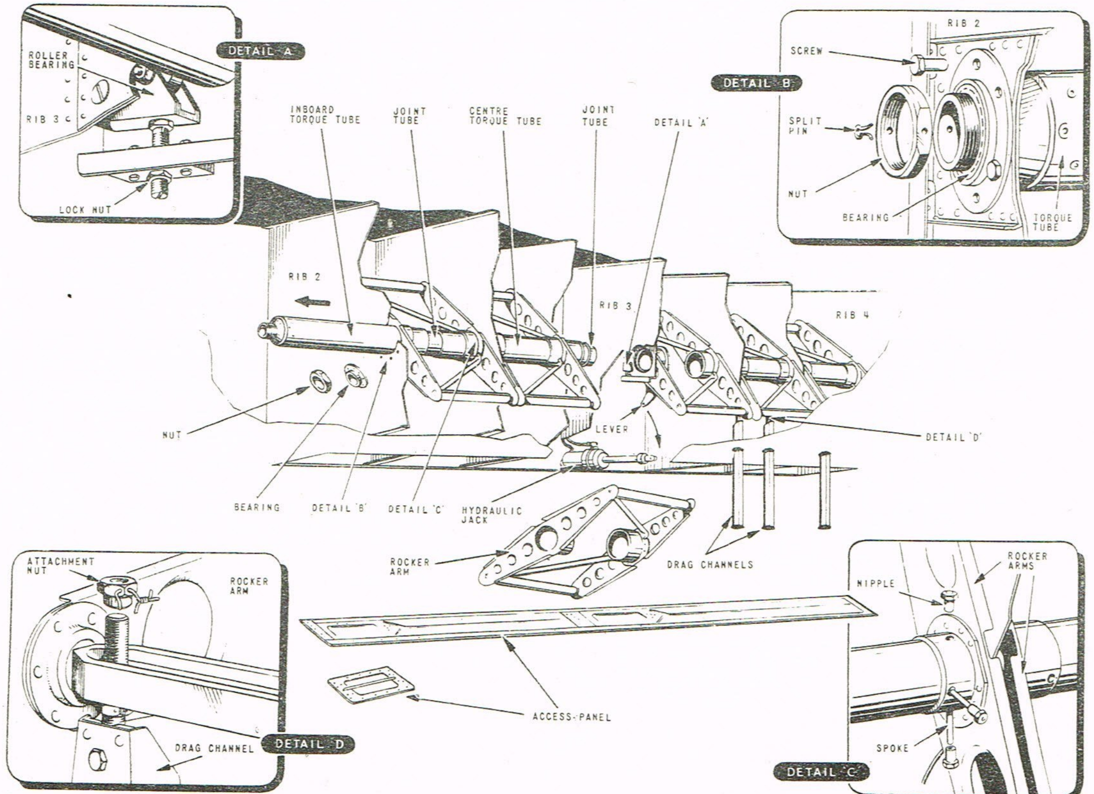


FIG. 9. AIR BRAKES REMOVAL

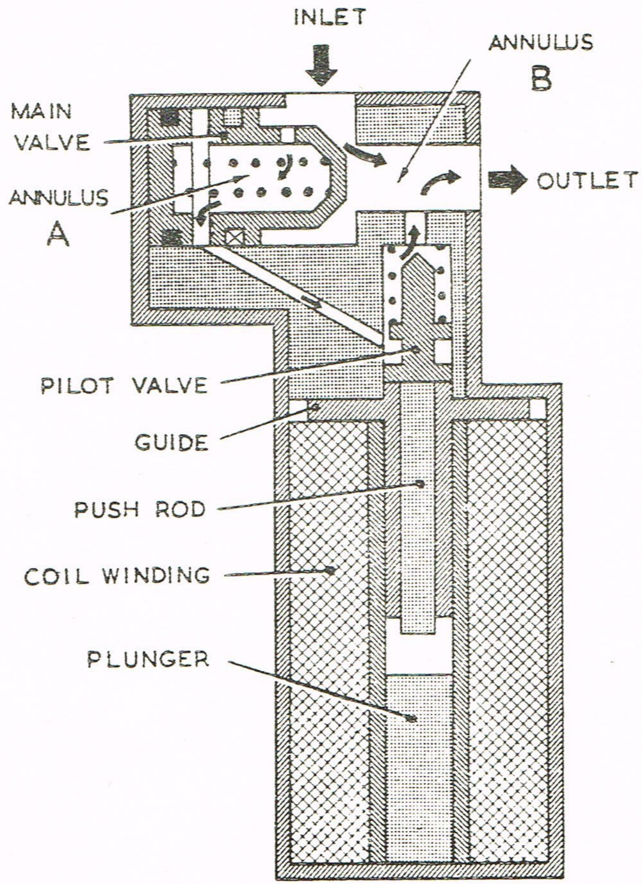
Air Brake Circuit.

The control valve is mounted in the roof of the bomb bay, mid-way on the port side, and operated by an electrical actuator controlled by a three-position switch mounted on the coaming ring port side.

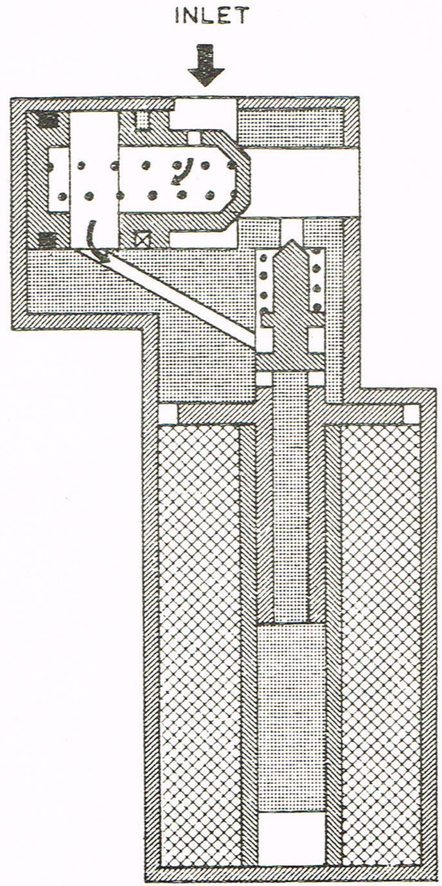
Two Messier jacks are employed, fitted in the port and starboard main plane respectively. Mounted on the starboard jack ram is a twin cam assembly to operate two micro-switches which energise a Messier Solenoid Valve and de-energise an 'S' type relay; they in turn determine the mid position of the air-brakes when the appropriate selection is made.

To synchronise the opening and closing of the brake fingers, two Messier Flow- Divider Valves are fitted; these are mounted on the port side of the bomb bay aft of the control valve.

Two Thermal Relief Valves are fitted to compensate for fluid expansion, and adjusted to relieve at 3350-3550 p.s.i.



FUNCTIONAL DIAGRAM



FUNCTIONAL DIAGRAM

MESSIER SOLENOID COCK.

(Air Brakes).

Coil de-Energised.

In this condition fluid under pressure entering at the inlet acts upon the area of the shoulder on each side of the main valve, but because pressure can escape (via the pilot valve) from Annulus 'A' faster than it can from Annulus 'B' the main valve opens and remains open until the pilot valve is closed by energization of the solenoid coil.

Coil Energised.

With the pilot valve shut, fluid from Annulus 'A' can no longer escape to the reservoir through the outlet and therefore builds up a pressure over an area greater than in Annulus 'B'. This with the assistance of the spring is sufficient to close the main valve. No further flow through the valve takes place until the coil is de-energised.

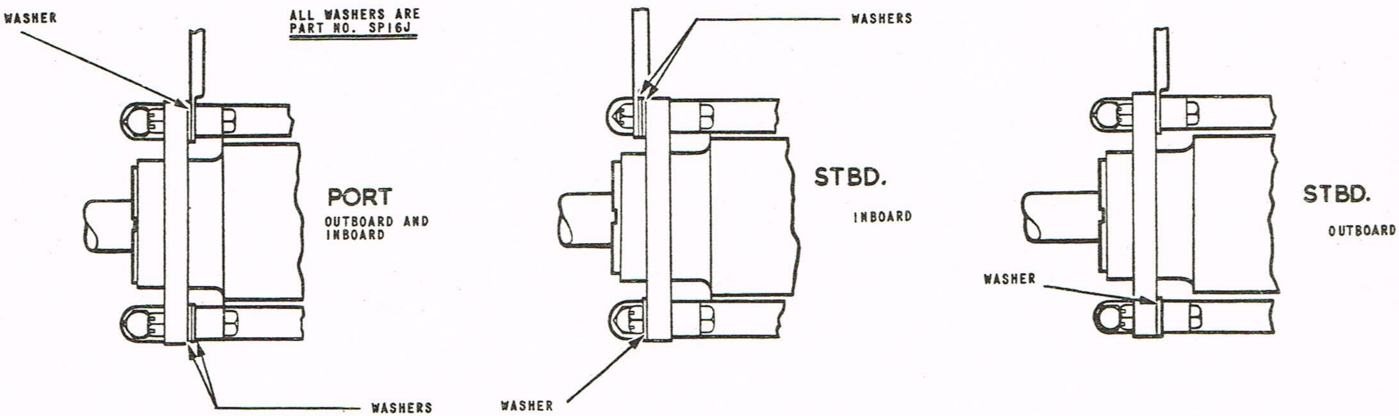
Bomb Door Circuit.

The control valve is fitted in the bomb bay on the starboard side forward, operated by an electrical actuator, with the switch mounted on the Pilot's console.

The control valve is provided with a cable control to over-ride the actuator in the event of an electrical failure. The lever for the operation of the over-ride is mounted on the port wall of the Pilot's cockpit.

Two Dowty jacks are employed in this circuit, one at the front of the bomb bay and the other at the rear. The rear jack is of larger diameter than the front jack to compensate for the increased volume of air accumulating at the rear, when the doors are open for ground flight. To maintain the jack rams in good condition, and to prevent them from becoming dust laden when the doors are open for ground checking, they operate in reverse phase, i.e. when the doors are open, the jacks are retracted, and when closed the jacks are extended.

Two thermal relief valves are fitted in the circuit to compensate for fluid expansion, adjusted to relieve at 3350 - 3550 p.s.i.g.; these are fitted adjacent to the control valve.



Flap jack assembly

Flap Circuit.

The four trailing edge flaps are controlled independently, by four double-ended Dowty jacks, which are fed by one pressure and one return line. The electrically actuated hydraulic control valve is mounted in the roof of the bomb bay, while the actuator control switch is mounted on the Pilot's console immediately below the undercarriage retraction button.

There is no interconnexion mechanically between flap units; air flow during flight is utilised for synchronisation. To safeguard the flaps when lowered above the recommended air speed, a pressure relief valve (blow-back valve) is fitted in the "DOWN" line of the circuit; in the same line a two-way restrictor valve is fitted to ensure gradual movement of the flaps in each direction.

One thermal relief valve is fitted in the "UP" line of the circuit to compensate for fluid expansion.

Manually Operated Control Valve.

Opposite the front pick-up point for the main plane, in the bomb bay on the starboard side, a two-position control valve is piped into the circuit; this is annotated "FLIGHT" and "GROUND".

In the former position the undercarriage, bomb doors and wheel brakes can be operated by the hand pump, and when turned to the latter position all hydraulic services can be operated by the hand-pump .

NOTES.

ALIGHTING GEAR.

The fully retractable, hydraulically operated alighting gear consists of two main wheel units retracting into the main planes and a nose-wheel unit retracting into the fuselage aft of the pressure cabin. Mechanical locking devices and electrical indicators are provided for the "UP" and "DOWN" positions of all three services. The main wheels only are fitted with Dunlop hydraulically operated brakes and Maxaret Units.

Nose-Wheel Unit.

The nose-wheel unit consists of a levered suspension, liquid spring shock absorber strut, fitted with a spring loaded self-centring device, a radius rod, stay link, hydraulic jack, fully castoring dual wheels, and locking and latching mechanism.

Shock-absorber Strut.

Two bearing brackets on the rear face of the pressure bulkhead provide a suspension and pivoting point for the strut main trunnion, whilst lugs on the strut outer cylinder pick up with the stay links and so connect the strut to the retraction mechanism.

The wheels are carried on a beam pin, jointed to the shock-absorber strut piston rod and to the forked end of the strut outer casing.

Shock-absorber.

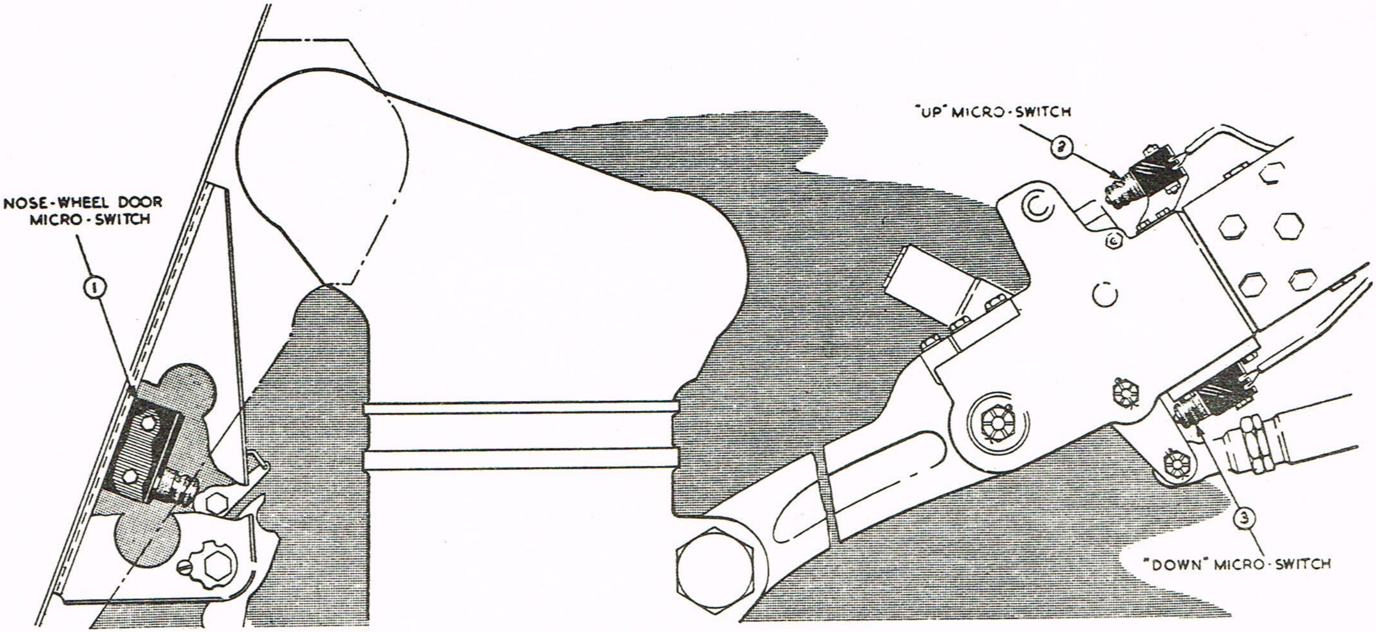
The shock absorber is a liquid spring unit of Dowty manufacture and consists of a smooth bored cylinder and hydraulic ram. The cylinder is drilled and tapped at the closed end of the bore to house a bleeder plug and charging valve.

The hydraulic ram is machined at the outer end to form an eye end fitting, whilst the inner end is bored and counter-bored to form a housing and associated fluid ways for a non-return valve assembly.

The hydraulic ram head is drilled to provide a transfer passage for fluid, and the periphery of the head is machined to receive a piston ring.

Compression of the shock absorber under load causes the ram to enter the cylinder, and fluid is now further compressed due to the introduction of the ram; a quick transfer of fluid has to take place which opens the non-return valve in the head of the ram piston, transferring the fluid to the other side of the head.

When a load has been absorbed, the compressed fluid has a tendency to eject the ram at high speed, necessitating the reverse flow of fluid, as the fluid is unable to pass through the non-return valve in this direction, it is restricted to the drilling in the piston head (transfer passage), thus regulating the speed of the recoil action.



Micro switches—nose landing gear

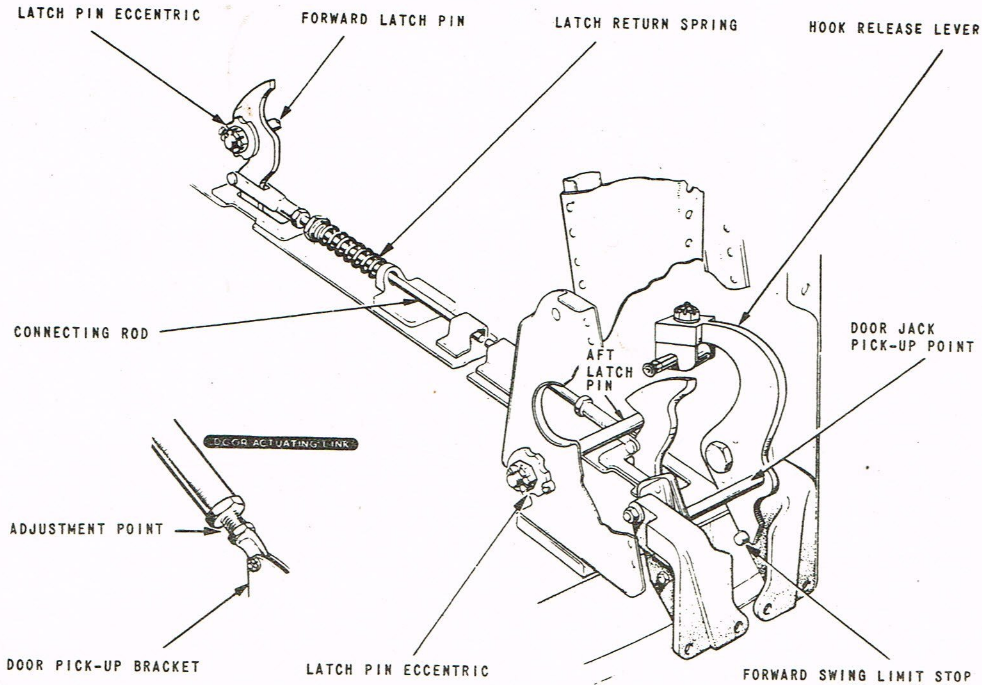
Self-centring Device.

A spring loaded, self-centring unit is provided as an integral part of the outer casing. It is housed in a dash pot at the top of the outer casing and consists of two horizontally opposed springs actuated by a cam working in a double ended piston between the springs. The cam is effective for a distance of 25° in either direction, within which limits the units act as a partial damper.

The chief fitment is to centralize the wheels for retraction purposes. On the wheels being turned in excess of the 25° the cam slips free of the piston and the wheels may castor in a full circle, the cam re-engaging in the piston as the wheels are again turned in line with the aircraft.

Radius Rod.

The radius rod pivots in a block held between two heavy support beams on the underside of the wheel well roof and is pin jointed to the stay link which connects it to the strut outer casing. It carries a spring loaded catch which engages when the gear is in the "DOWN" position, and a lock lever, an up-latch hook pin and "UP" and "DOWN" micro-switches.



Nose undercarriage door latching mechanism

Retraction Jack.

The jack is slung below the radius rod and is extended when the gear is retracted.

Door Jack.

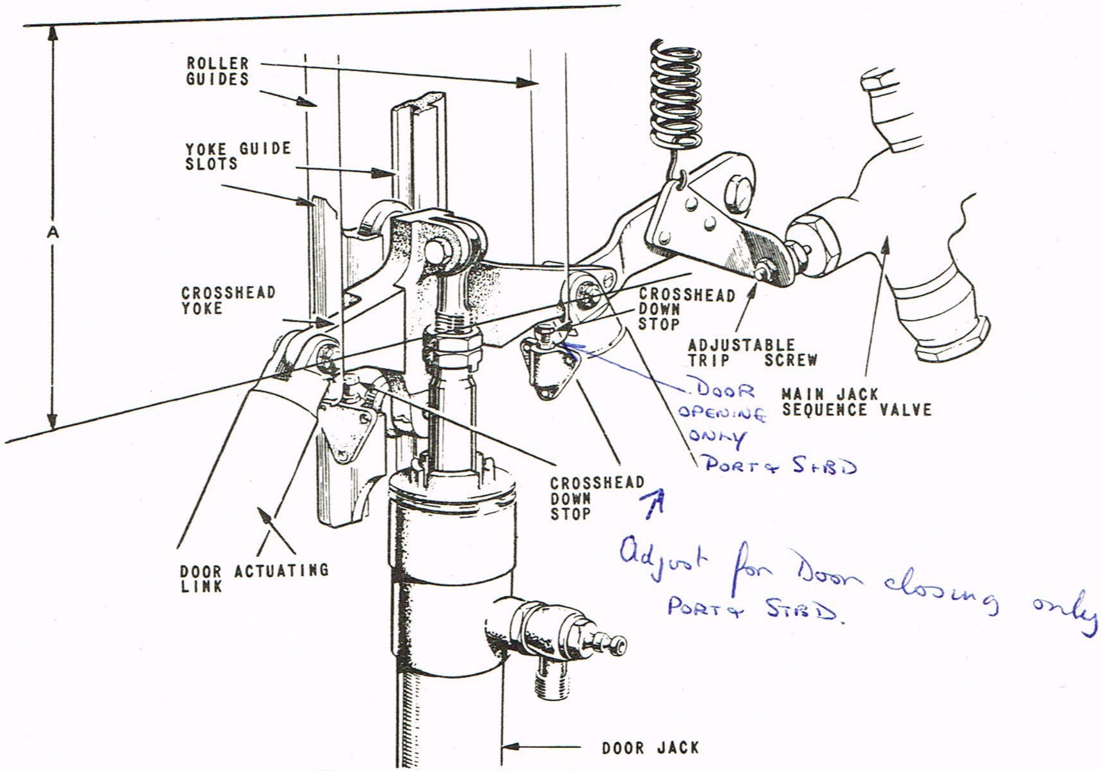
The door jack is mounted vertically on the rear bulkhead of the nose-wheel well. The jack is coupled to a yoked cross-head running in roller guides provided in the bulkhead, and the doors are operated by means of links pinned to the cross-head yoke. The jack is extended when the doors are closed.

Nose-Wheel Doors.

The flush fitting nose-wheel doors are provided with shimming for adjustment purposes, under the up-stop packing and abutment faces at each end of the Port door, and at the rear end of the Starboard door. The doors are warped in such a manner that the front end closes before the aft end.

Door-Latching Mechanism.

Latches are provided in the starboard door and are inter-connected by a 2 B.A. rod; they are spring loaded to the latched position.



Nose undercarriage door crosshead

Up-Lock Mechanism.

The up-latch hook engages with the latch-pin provided on the radius rod. When the gear is lowered, the lock lever displaces the hook and frees the radius rod.

Sequence Valves.

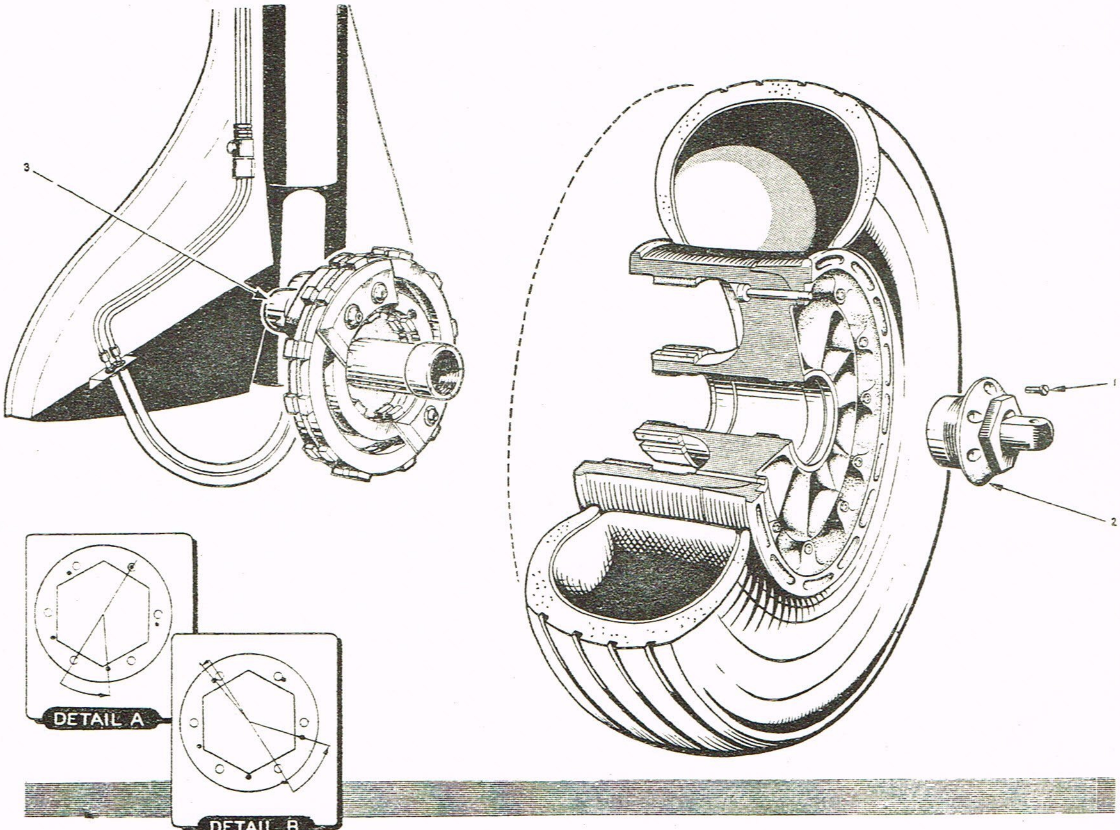
The door jack sequence valve is mounted in the roof of the wheel well, lever operated and tripped by the radius rod. The nose-wheel jack sequence valve is mounted on the rear bulkhead and operated by the door cross-head yoke.

Mechanism Operation.

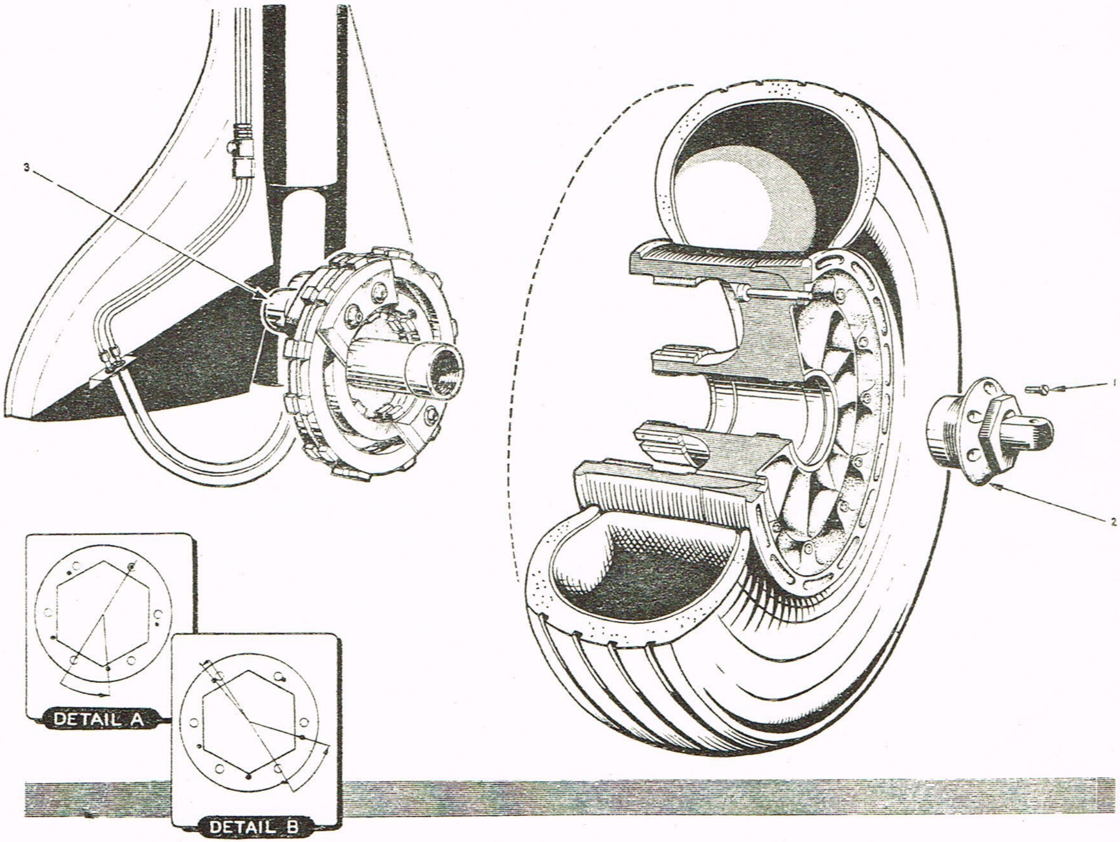
On selecting the undercarriage "DOWN" hydraulic pressure is applied to the ram side of the door jack; initial movement of the jack causes it to pivot on its bottom mounting pin, actuating the latch hook release lever which disengages the latch against the latch return spring.

The continued movement of the jack ram opens the doors and trips the nose-wheel sequence valve, thus releasing hydraulic fluid from the piston crown side of the main jack. Movement of this jack causes the lock lever to pivot disengaging the up-latch hook.

Further movement of the jack ram lowers the undercarriage strut which is locked down by means of the spring loaded latch pawl and jack under-ride.



MAIN UNDERCARRIAGE WHEEL REMOVAL



MAIN UNDERCARRIAGE WHEEL REMOVAL

MAIN WHEEL UNITS.

Each main wheel unit consists of an oleo-pneumatic shock-absorber of English Electric design, a side-stay link, a hydraulic jack and a single wheel mounted in cantilever.

Shock-absorber Strut.

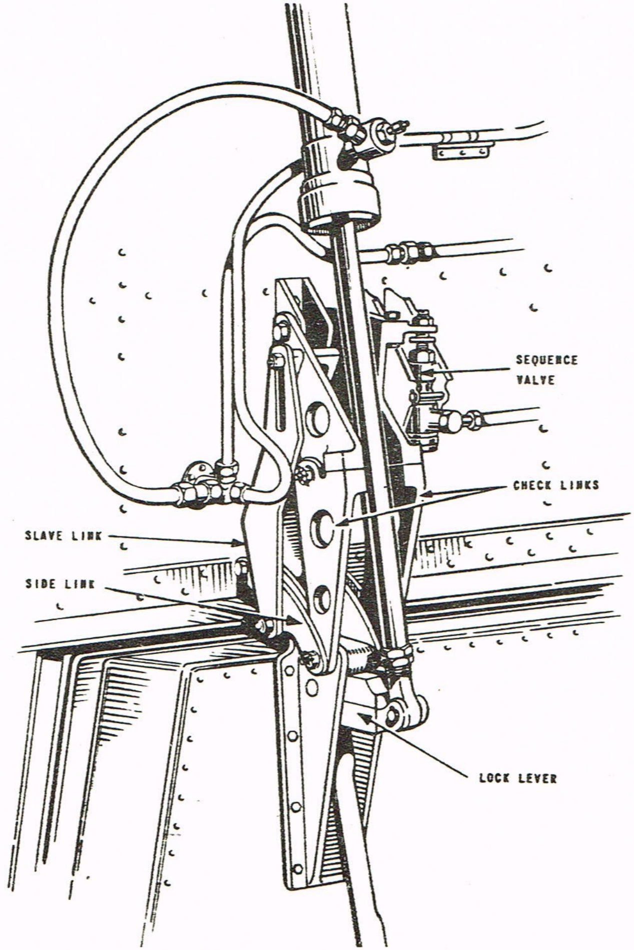
The shock-absorber strut is suspended by its main trunnion from two large bearing brackets on the front face of the main spar, one on each side of the inboard engine rib. A lug on the strut outer cylinder is ball jointed to the side stay link.

The torsion links, forming a scissors-like connexion between the inner and outer cylinders of the strut, transmit loads from the wheel to the outer cylinder.

A spat type undercarriage door fairing is attached to the strut at four points.

Shock-absorber.

The main components of the shock-absorber are a high tensile light alloy outer casing, an inner plunger tube, a sliding tube and axle of machined nickel-chrome steel, and torsion links of light alloy.



Main undercarriage door operating mechanism

Fitted to the top of the sliding tube is a piston carrying one piston ring; the piston has a series of drilled holes, whilst under the head an orifice plate valve is fitted with leak holes to allow the rapid filling of the re-bound control chamber.

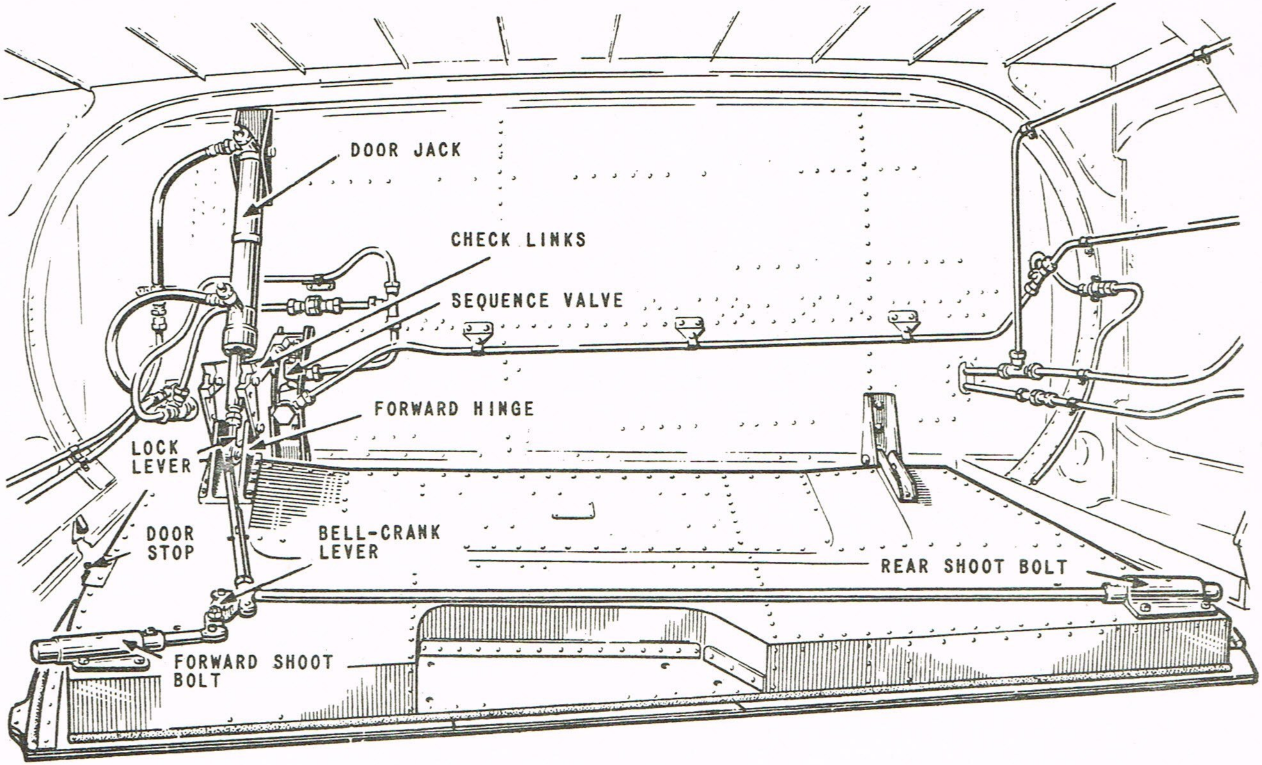
The inner plunger tube carries a piston fitted with one piston ring; the piston is drilled with one hole to provide the main orifice, and, on the underside a clack valve is fitted with a leak hole. The compression stop is a simple abutment on the sliding tube, whilst the extension stop is a screwed collar butting on to a fibre ring.

Side Stay.

One end of the side-stay is attached by a spherical joint to a bracket on the front face of the main spar. The other, which is pin jointed to the side-stay link, picks up the hydraulic jack ram and also carries a micro-switch, uplatch roller and a trip lever which operates the door jack sequence valve.

Doors and Operating Mechanism.

The main undercarriage door jack is slung vertically between brackets on the fuselage side with the jack ram attached to a lock-lever between the lugs of the door forward hinge.



Main undercarriage door

Doors and Operating Mechanism (cont.)

These lugs are also attached to jointed check-links which butt when the door is fully open.

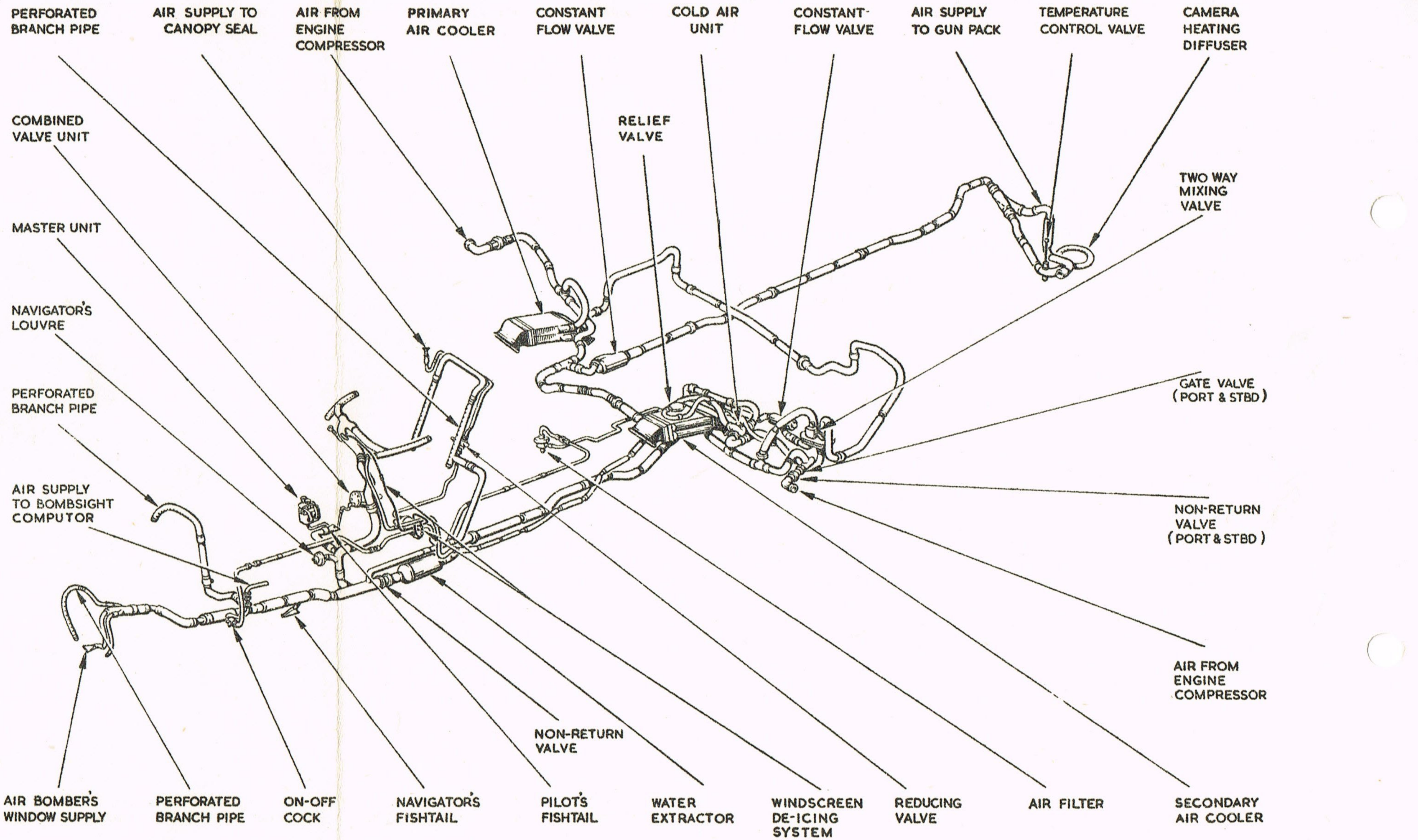
A trip lever on the after check-link operates the undercarriage "DOWN" sequence valve.

The lock-lever rotates as the jack is operates and by means of a tie-rod and a bell crank lever operates the door-latch shoot bolts.

In the event of failure of the check-links, a slave-link is incorporated to ensure that the "DOWN" sequence valve will be tripped.

The undercarriage "DOWN" sequence valve is so situated as to ensure that the door is fully open before pressure is delivered to the main jack.

A small flap door in the engine cowling is mechanically operated.



PERFORATED BRANCH PIPE
AIR SUPPLY TO CANOPY SEAL
AIR FROM ENGINE COMPRESSOR
PRIMARY AIR COOLER
CONSTANT FLOW VALVE
COLD AIR UNIT
CONSTANT-FLOW VALVE
AIR SUPPLY TO GUN PACK
TEMPERATURE CONTROL VALVE
CAMERA HEATING DIFFUSER
COMBINED VALVE UNIT
RELIEF VALVE
TWO WAY MIXING VALVE
MASTER UNIT
NAVIGATOR'S LOUVRE
GATE VALVE (PORT & STBD)
PERFORATED BRANCH PIPE
AIR SUPPLY TO BOMBSIGHT COMPUTOR
NON-RETURN VALVE (PORT & STBD)
AIR FROM ENGINE COMPRESSOR
NON-RETURN VALVE
AIR BOMBER'S WINDOW SUPPLY
PERFORATED BRANCH PIPE
ON-OFF COCK
NAVIGATOR'S FISHTAIL
PILOT'S FISHTAIL
WATER EXTRACTOR
WINDSCREEN DE-ICING SYSTEM
REDUCING VALVE
AIR FILTER
SECONDARY AIR COOLER

AIR CONDITIONING.

General Description.

The installation provides temperature controlled air to the pressure cabin by taking hot air from the engine compressors and passing it direct into the Cabin; passing it through heat exchange Units and a Godfrey Cold Air Unit, if cold air is required, or cooling a proportion of the air and mixing the delivery to the desired temperature.

Main components of the system are a Godfrey Cold Air Unit (C.A.U.) type A.C.R.E. (Air Cycle Refrigeration Engine), two Heat Exchange Units and a Teddington electrically-actuated Temperature Control Valve. All air to be cooled passes through both heat exchange Units and the C.A.U.

The primary heat exchange Unit is installed in the leading edge of the starboard main plane, whilst the secondary heat exchange Unit, the C.A.U. and the temperature control valve are located in the leading edge of the port main plane.

A Teddington Electrically-actuated Gate Valve is installed close to the inboard engine rib in the leading edge of each main plane. These valves control the initial supply of hot air and are operated by switches Nos. 1 and 2 mounted on the Pilot's starboard instrument panel.

A non-return valve is fitted between each gate valve and the engine casing.

COLD AIR UNIT. (A.C.R.E.9).

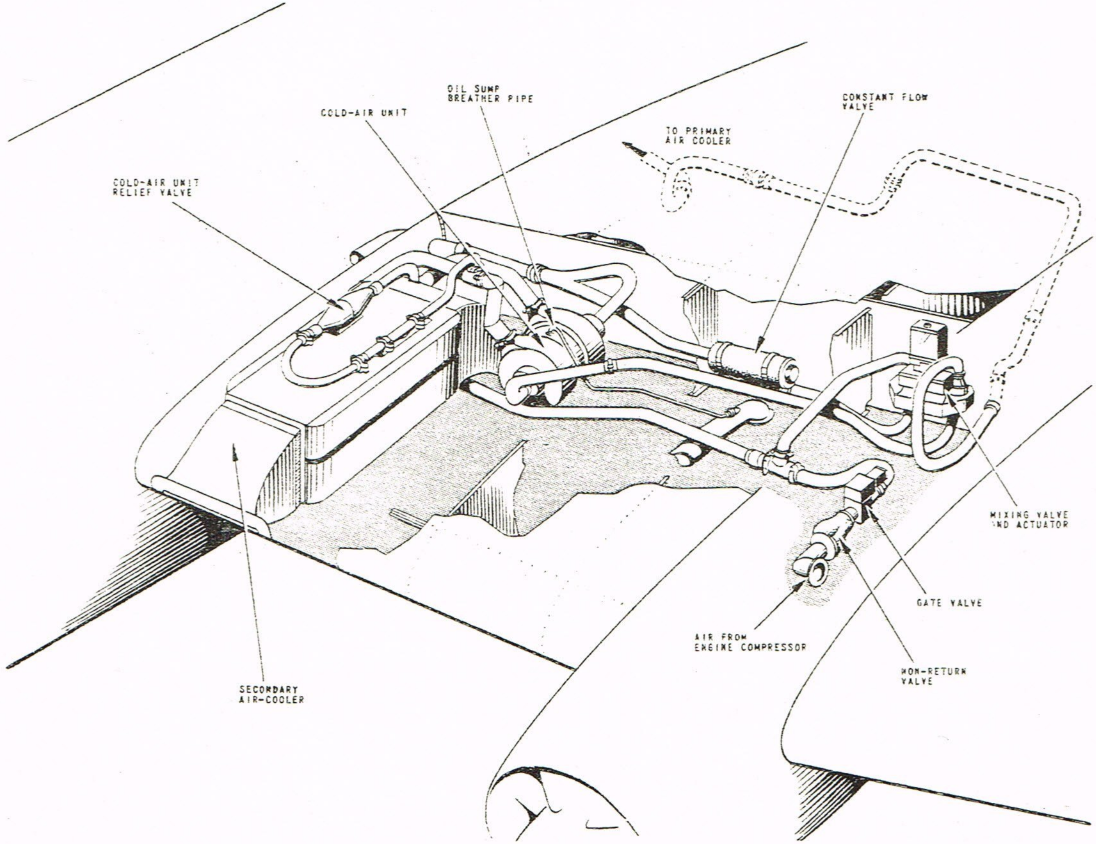
A.C.R.E. (Air Cycle Refrigeration Engine) is a system of cooling ventilating air supplied to the aircraft cabin.

The cold air unit consists of two separate volute casings, enclosing an inward flow turbine driving a centrifugal compressor through a common rotor shaft, and operates in conjunction with a heat exchange unit situated between its compressor and turbine elements. The air is supplied by bleeding off a supply from Stage No. 12 of each engine compressor.

OPERATION.

The air supply (charge air) then enters the eye of the cold air unit compressor, when the air is now compressed as it passes from the multi-cellular centrifugal rotor through the diffuser ring, the compression increasing the temperature of the air.

From the compressor the hot air flows through the secondary heat exchange unit, and is partially cooled by ram air passing through the matrix. From the heat exchange unit the cooled air under pressure from the compressor re-enters the cold air unit through the turbine volute. The power absorbed by the turbine to drive the compressor is obtained by the expansion of the charge air through the nozzle ring and turbine, which results in a further lowering of the air temperature, accompanied with a pressure loss. Thus, air under pressure at a suitably reduced temperature is supplied by the turbine to the cabin ducting.



AIR CONDITIONING SYSTEM—PORT INNER WING LEADING EDGE

HEAT EXCHANGE UNITS.

The term "heat exchanger" is used in a general sense and refers to all forms of heat extractors using ambient air for cooling purposes.

The primary or pre-cooler is mounted in the leading edge of the starboard main plane to reduce the charge air temperature before entering the eye of the compressor of the cold air unit.

The secondary or inter-cooler is mounted in the leading edge of the port main plane to reduce the expanded air temperature from the compressor before entering the turbine volute.

Action of Heat Exchange Units.

The charge air enters the inlet duct and passes seven times across the cooler through the charge airways connected in series and mounted between eight cooling airways.

The ram air flows direct through the cooling airways. In both the charge airways and the cooling airways, corrugated metal strips are positioned parallel to the lines of air flow in each airway.

The corrugated strips are secondary surfaces, and assist in cooling the charge air.

These heat exchangers are of the cross-flow secondary surface type and constructed of aluminium alloy.

To extract the maximum of heat from the ventilating system and to increase the flow of ram air through the cooling airways, divergent and convergent ducts are used, the former reducing the velocity of ram air with an increase in pressure and a consequent heat rise expanding the air, whilst the latter duct increases the velocity with a reduction of pressure and temperature.

Selecting Cabin Heating.

NOTE: No air will be supplied to the cabin unless the gate valve switches (numbered 1 and 2) are set to "ON".

To select cabin heating, switch the gate valve switches to "ON" and the temperature control switch to "HOT". This opens the gate valves and hot air from each flows, via the non-return valves, to the common pipe-line and the hot side of the temperature control valve. From the temperature control valve, the supply passes through the constant flow valve to the water separator and non-return valve to enter the pressure cabin.

Selecting Cabin Cooling.

To obtain a supply of cooling air in the cabin, set the gate valve switches to "ON" and the temperature control switch to "COLD". The cold side of the temperature control valve then opens and allows partly cooled air from the primary heat exchange unit to pass to the compressor stage of the C.A. U. Upon leaving the compressor the air is ducted to the secondary heat exchange unit (between the compressor and heat exchange unit a pressure relief valve is fitted) to the turbine stage of the C.A.U. and afterwards, now very cold, through the water separator and non-return valve to enter the cabin.

Intermediate Temperature Selection.

The HOT/COLD switch may be operated to give any intermediate cabin temperature which may be required. It has a centre-off position and when in use should be held to the "HOT" or "COLD" position, whichever is required, long enough to give the desired temperature which is shown by the indicator on the starboard instrument panel.

NOTE: In the event of a fault developing in the supply from an engine, an engine fails, or is on fire, the gate valve switch to that engine should be set to "OFF".

Servicing.

Access to the equipment in the leading edge of the wings is obtained by removing the leading edge panels used for servicing the accessory gearboxes and generators. Servicing of the Godfrey Cold Air Unit is covered in A.P.4340.Vol.1.

Control or Escape Valve.

This valve and its associated warning horn circuit is part of the normal cabin pressurisation system whose functioning is not affected except for the following:

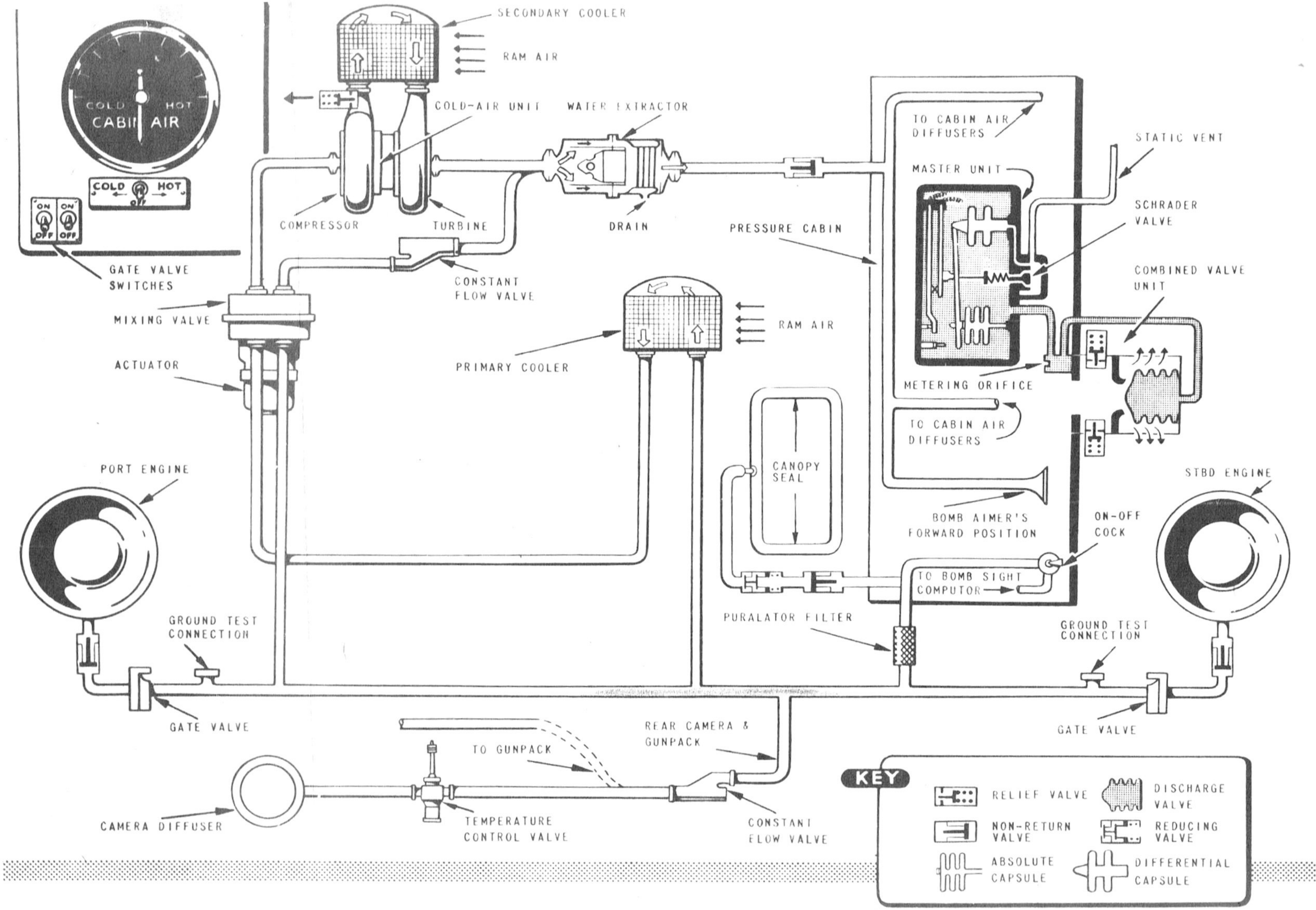
IT IS VERY IMPORTANT THAT THE CONTROL OR ESCAPE VALVE FILTER GAUZE BE KEPT CLEAN.

Testing.

When the aircraft is on the ground there is no cooling air flow through the primary and secondary heat exchange units and prolonged ground running is to be avoided.

With the engines running at idling r.p.m. it is not advisable to operate the C.A.U. longer than 10 minutes during any one test period, but it is quite in order to use the C.A.U. whilst taxying.

WARNING: Prior to the stopping of the engine or engines, the Temperature Control Valve must be selected to the "HOT" position.


SECONDARY COOLER
RAM AIR
COLD
CABIN AIR
HOT
COLD
HOT
OFF
ON
OFF
ON
OFF
GATE VALVE SWITCHES
COLD-AIR UNIT
WATER EXTRACTOR
COMPRESSOR
TURBINE
DRAIN
CONSTANT FLOW VALVE
MIXING VALVE
ACTUATOR
PRIMARY COOLER
RAM AIR
PRESSURE CABIN
TO CABIN AIR DIFFUSERS
MASTER UNIT
STATIC VENT
SCHRADER VALVE
COMBINED VALVE UNIT
METERING ORIFICE
TO CABIN AIR DIFFUSERS
CANOPY SEAL
BOMB AIMER'S FORWARD POSITION
ON-OFF COCK
TO BOMB SIGHT COMPUTOR
PORT ENGINE
STBD ENGINE
GROUND TEST CONNECTION
PURALATOR FILTER
GROUND TEST CONNECTION
GATE VALVE
GATE VALVE
REAR CAMERA & GUNPACK
TO GUNPACK
CAMERA DIFFUSER
TEMPERATURE CONTROL VALVE
CONSTANT FLOW VALVE
KEY
RELIEF VALVE
DISCHARGE VALVE
NON-RETURN VALVE
REDUCING VALVE
ABSOLUTE CAPSULE
DIFFERENTIAL CAPSULE

CABIN PRESSURISATION.

P.S.I.D. = Lbs. per sq.in. differential.

P.S.I.A. = Lbs. per sq.in. absolute.

The units for pressurisation are manufactured by Normalair Ltd., Yeovil, Somerset, and consist of a Master Unit and a control or escape valve.

Master Unit.

This is mounted inside the cabin on the starboard side of the Navigator's "TAKE-OFF" seat.

Internally the Unit contains an absolute capsule, differential capsule, a rocker beam controlling a Schrader Valve, a pair of electrical contacts, a plunger for checking the contacts, and an altitude stop.

Capsules.

The absolute capsule is a three stack capsule, designed to expand below an external pressure of 14.7 p.s.i.a.

The differential capsule is a two stack capsule, having atmospheric pressure within the capsule and a cabin pressure around the outside, and will contract or expand only when a pressure of 3.5 p.s.i.d. is applied.

Rocker Beam.

This is hinged to the top of the differential capsule by a split pin, and encircles the absolute capsule at the top to continue forward to act as a platform for the altitude stop.

Midway along the beam is a small cam, to operate the electrical contacts when the pressure falls to a dangerous level.

On the underside of the beam opposite the cam is the stem of the Schrader Valve.

Control or Escape Valve.

This is bolted to the back of the pressure bulkhead with an opening to the inside of the cabin behind the Navigator's "TAKE-OFF" seat.

Internally it consists of a bellows valve, two pressure relief valves, and an inward venting valve.

Pressure from the cabin operates the opening or closing of the bellows valve, through a small bleed washer and the capsules within the Master Unit.

Operation of Units.

From sea level to 10,000 ft. the Schrader Valve within the Master Unit is open, therefore no pressure can be built up within the bellows valve of the control unit, thus allowing the incoming air from the engine compressor to be spilled to atmosphere past the seat of the bellows valve.

Around 10,000 ft. the atmospheric pressure falls to 10.1 p.s.i.a. and this pressure (now inside the cabin) feeds through the 0.02" bleed washer via a pipe line to the Master Unit. The absolute capsule now expands due to the low pressure around around the outside of the stack, moving the beam upwards, which then allows the Schrader Valve to close. No air can escape from the Master Unit, therefore a pressure commences to build up inside the bellows valve, closing the valve.

With the continued increase of pressure, the absolute capsule will commence to contract, and due to the difference of pressures around and inside the differential capsule, the beam will move downwards, opening the Schrader Valve, which releases the pressure inside the control valve bellows, discharging to atmosphere through the static vent plate; the bellows valve now offers no resistance to the cabin pressure and opens to release cabin air to atmosphere.

This action is taking place up to an altitude of 25,000 ft. When this is reached, the absolute capsule has expanded until the beam is resting on the altitude stop, although with increased altitude the absolute capsule will continue to expand, compressing the spring between the beam and the capsule. Above this height the pressurisation continues on a pressure of 3.5 p.s.i.d. i.e. pressure within the cabin being 3.5 p.s.i.a. above atmospheric pressure, and controlled only by the differential capsule.

Control Unit Pressure Relief Valves.

Two pressure relief valves are fitted within this Unit, whose purpose is to relieve any pressure build-up inside the cabin of between 3.7 - 4 p.s.i.d. These valves act as safety valves, and come into operation when a rapid climb has to be made from sea level, and/or where the master unit and bellows valve cannot respond quickly enough.

The inward vent valve balances the pressure within the cabin and atmosphere when a rapid descent from high altitude has to be undertaken, and/or when the master unit and bellows valve cannot respond quickly enough.

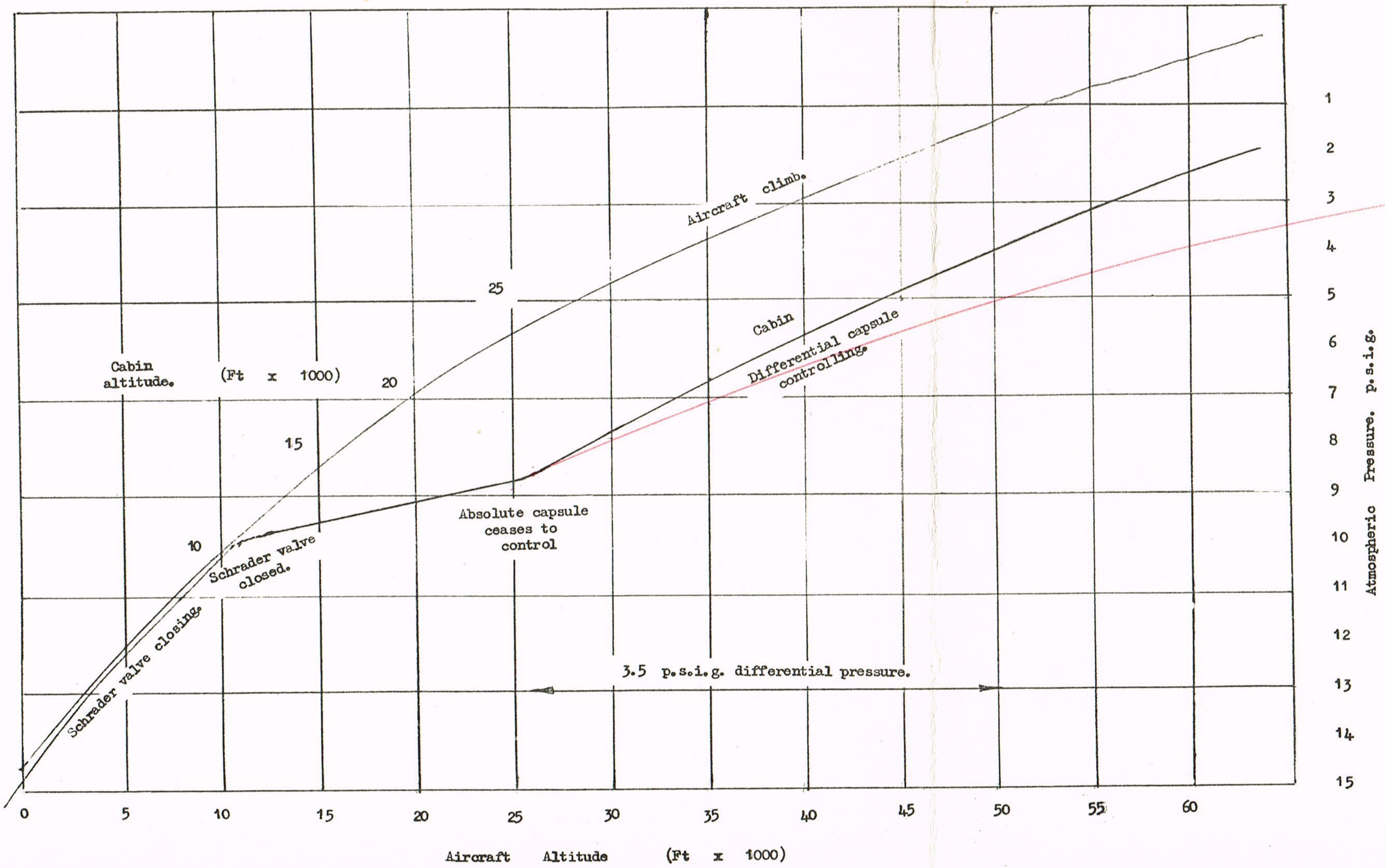
Atmospheric Pressures.

Sea level.	14.7 p.s.i.a.
10,000 ft.	10.1 "
15,000 ft.	8.3 "
20,000 ft.	6.7 "
25,000 ft.	5.4 "
30,000 ft.	4.3 "
35,000 ft.	3.4 "
40,000 ft.	2.7 "
45,000 ft.	2.1 "
50,000 ft.	1.6 "

Cabin Press. are 3½ lbs higher in each case

PRESSURISATION GRAPH.

Canberra Mk's 2. 3. 4. 6. 7. 8. 11. 12. & 13.



CABIN PRESSURE TEST.

Ground Testing using Test Rig.

The pressure cabin should be tested in the following manner, using a pressure testing trolley.

1. Disconnect and blank-off the pipe from the control valve to the control unit (behind the Navigator's "TAKE-OFF" seat.)

2. Ensure that the air supply adaptor is fitted to the delivery hose from the ground test trolley, and connect the delivery hose to the ground connexion on the rear face of the pressure bulkhead. Access to this is in the nose-wheel bay.

3. Connect the external pressure gauge to the $\frac{1}{8}$" British Standard Pipe thread connexion which is adjacent to the ground test connexion and inside the plastic nose hang a boost gauge that can be read from outside.

4. Close the main entrance door, inflate the cabin and note the pressure at which the safety valves open. The pressure should be between 3.75 and 4 p.s.i.g. with an airflow of 8 lbs. per minute.

<u>WARNING:</u> Pressure in the cabin must not exceed 4.7 p.s.i.g. When this figure is reached the test rig must be closed down immediately.

5. Check the structure for distortion and note major air leaks.

6. Close down the rig and note the time of pressure drop from 3.5 to 1.75 p.s.i.g. This should not be less than 70 seconds.

<u>WARNING:</u> Do not attempt to open the door until the external gauge connexion has been broken.

7. Remove the test rig connexion, and refit the blanking caps on the external connexions.

8. Reconnect the pipe to the control or escape valve.

PROCEDURE FOR PRESSURE TESTING

WITH ENGINES RUNNING.

1. Disconnect and blank off the pipe from the control valve to the control or escape valve, behind the Navigator's "TAKE-OFF" seat.

2. Close the main entrance door.

3. With engines running at 5,500 r.p.m. and the gate valves open, select the temperature control valve to the "HOT" position and check the time of pressure rise to 3.5 p.s.i.a. This should be less than 50 seconds.

4. Select the temperature control valve to the "COLD" position, and check as No. 3.

5. With the Port engine idling and the Starboard engine running at 5,500 r.p.m. check that the cabin pressure can be maintained for 3 minutes. Repeat with the Port engine running and the Starboard engine idling.

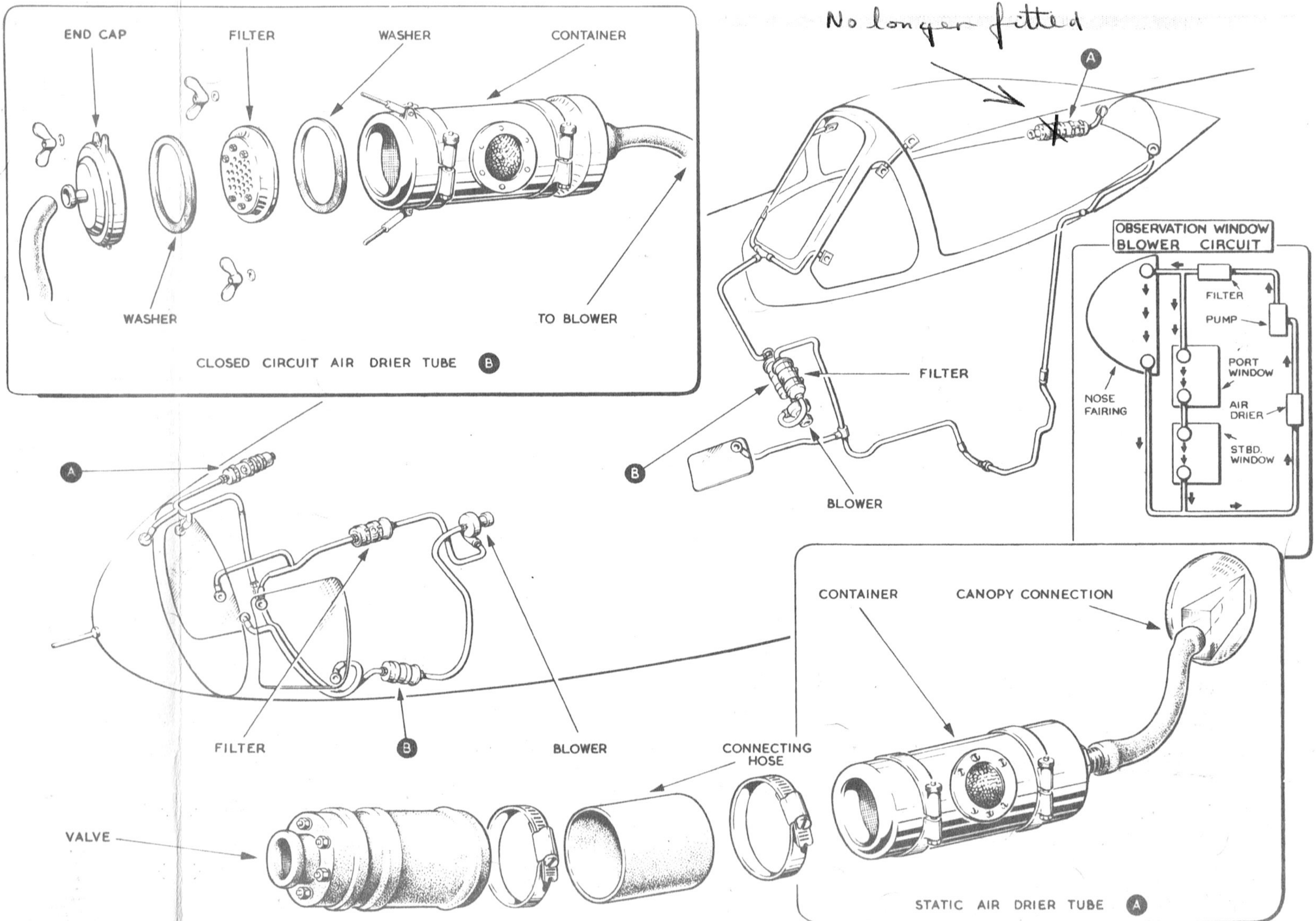
6. With both engines idling, close the gate valves (2) and check the pressure drop from 3.5 p.s.i.a. to 1.75 p.s.i.a. This should not be less than 70 seconds.

7. When the temperature control valve is moved from the "HOT" to the "COLD" position note the change in temperature.

8. Re-connect the pipe at the control or escape valve.

9. The "HOT" test and the "COLD" test must be regarded as two entirely separate tests.

<u>WARNING</u>: The main entrance door must not be opened until two minutes after the gate valve switches are moved down to the "OFF" position; the pilot to signal to the ground crew at the end of the two-minute period.



END CAP
FILTER
WASHER
CONTAINER
WASHER
TO BLOWER
CLOSED CIRCUIT AIR DRIER TUBE B
No longer fitted
A
FILTER
B
BLOWER
OBSERVATION WINDOW BLOWER CIRCUIT
FILTER
PUMP
PORT WINDOW
AIR DRIER
STBD. WINDOW
NOSE FAIRING
A
FILTER
B
BLOWER
CONTAINER
CANOPY CONNECTION
CONNECTING HOSE
VALVE
STATIC AIR DRIER TUBE A

DE-MISTING.

The Pilot's canopy and side observation windows, the nose, and its side observation windows, are of sandwich construction, and demisted on the closed circuit principle.

Each circuit is separate and electrically controlled, consisting of an air suction and blower unit combined, driven by an electric motor.

Function. (Canopy).

Immediately the motor blower is switched on, air is drawn from the hood of the canopy cavity and the side window cavities, through a moisture removal container to the suction side of the blower unit, passing through the unit, the air is now blown through a filter to enter the canopy cavity, and observation window cavities, as dry filtered air.

To compensate for the variations of pressures between the canopy and the cabin with altitude, a double diaphragm valve is incorporated to balance out the pressure within $\frac{1}{2}$ p.s.i.g.

Cabin de-misting of the Pilot's side windows is controlled by two manually controlled plunger valves, which direct hot air from a diffuser to the appropriate window.

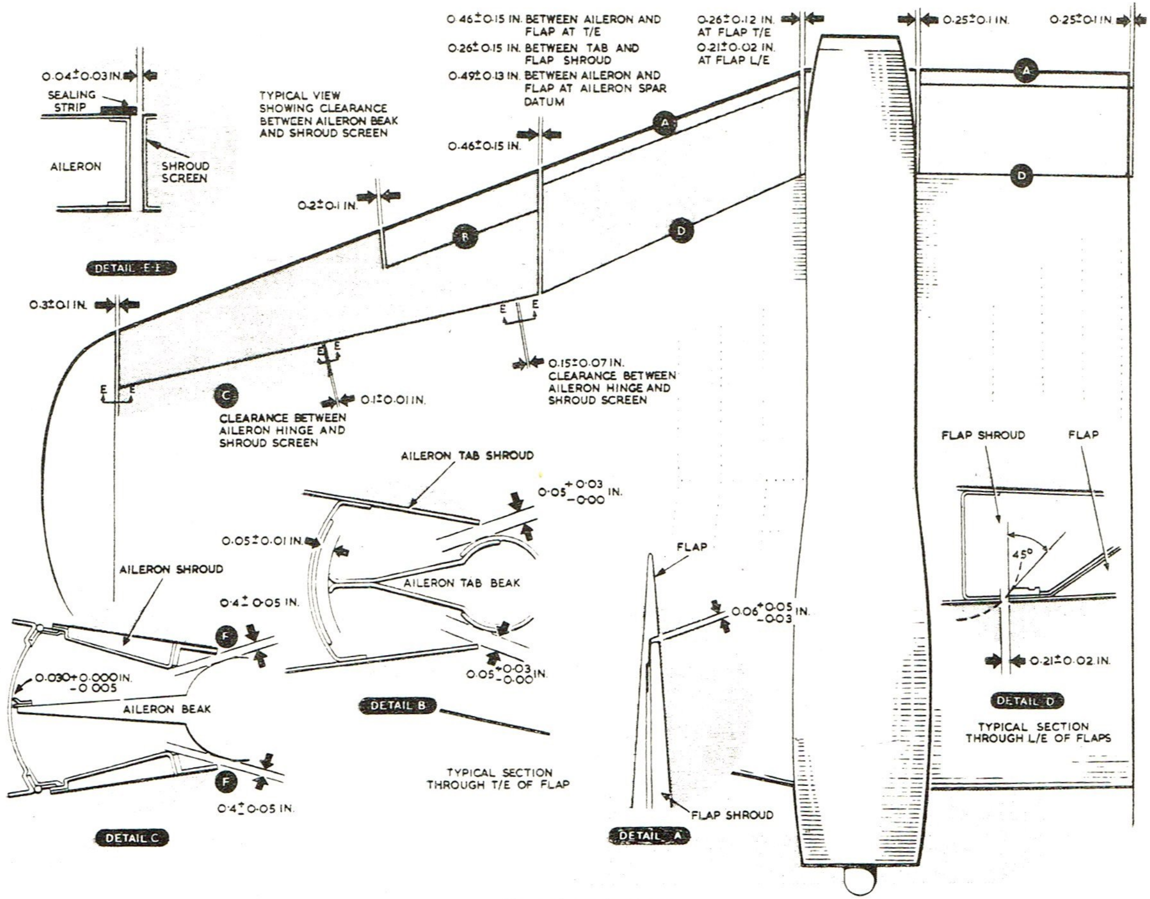
The plastic nose and observation windows operate on the same principle as the canopy.

Windscreen de-Misting.

The Pilot's windscreen is of a sandwich construction and the de-icing is automatic.

The medium employed is hot air taken from the cabin heating line in the bomb bay, through a diaphragm valve to the windscreen cavity.

Fitted in the cavity is a bimetal bleed valve which controls the diaphragm valve, regulating the temperature of air to the windscreen cavity, the exhaust air passes to atmosphere through a small scoop on the Port side of the canopy.



Main plane clearances.

EFFECTS OF MANUFACTURING ACCURACY ON THE CANBERRA.

Flight tests on the Canberra have shewn that it equals or exceeds specification figures in all respects, that it has outstanding qualities, and that the stall is innocuous. The high standard of manufacturing accuracy and finish which has been achieved, is an essential factor in realising these qualities, and the purpose of including this in the "SCHOOL NOTES" is to indicate the parts of the aeroplane most critically sensitive to accuracy.

Speed and Range.

These naturally depend on general cleanness and freedom from bad joints, leaks and the like, but by far the most important area is from the leading edge of the wing back to the main spar.

The main reason for the very good range figures is the laminar flow which exists over the whole of the area, at high altitudes and speed, and this can only be maintained if this part of the wing is free from roughness, and, in particular from "WAVINESS".

The basic profile in this area is not critical to, say 0.01", except in the immediate leading edge region (see under "Stall"), but if the manufactured profile departs from the nominal form it must do so steadily and smoothly; there must be no local sudden changes of curvature.

On other parts of the aircraft skin a certain amount of waviness can be tolerated so far as performance is concerned, but it is, of course, highly undesirable on the control surfaces and the leading edges of the fin and tailplane for other reasons.

Handling.

Here again a high standard has been realised in terms of controllability, rate of roll, single engine behaviour, and landing and take-off.

In general, the control surfaces should have good tight skins free from blemish, but the most critical area is the last few inches of chord at the trailing edge. It is most important that the trailing edge angle should be maintained at not more than the specified figure, and that there should be no suggestion of bulge in this region. This applies equally to the main controls and the tabs.

Another important feature is the alignment of the shrouds with respect to the control surfaces, and a straight edge laid fore and aft over a control surface or tab and its corresponding shroud would show no appreciable step in either direction. It is more important that the shroud should not be proud.

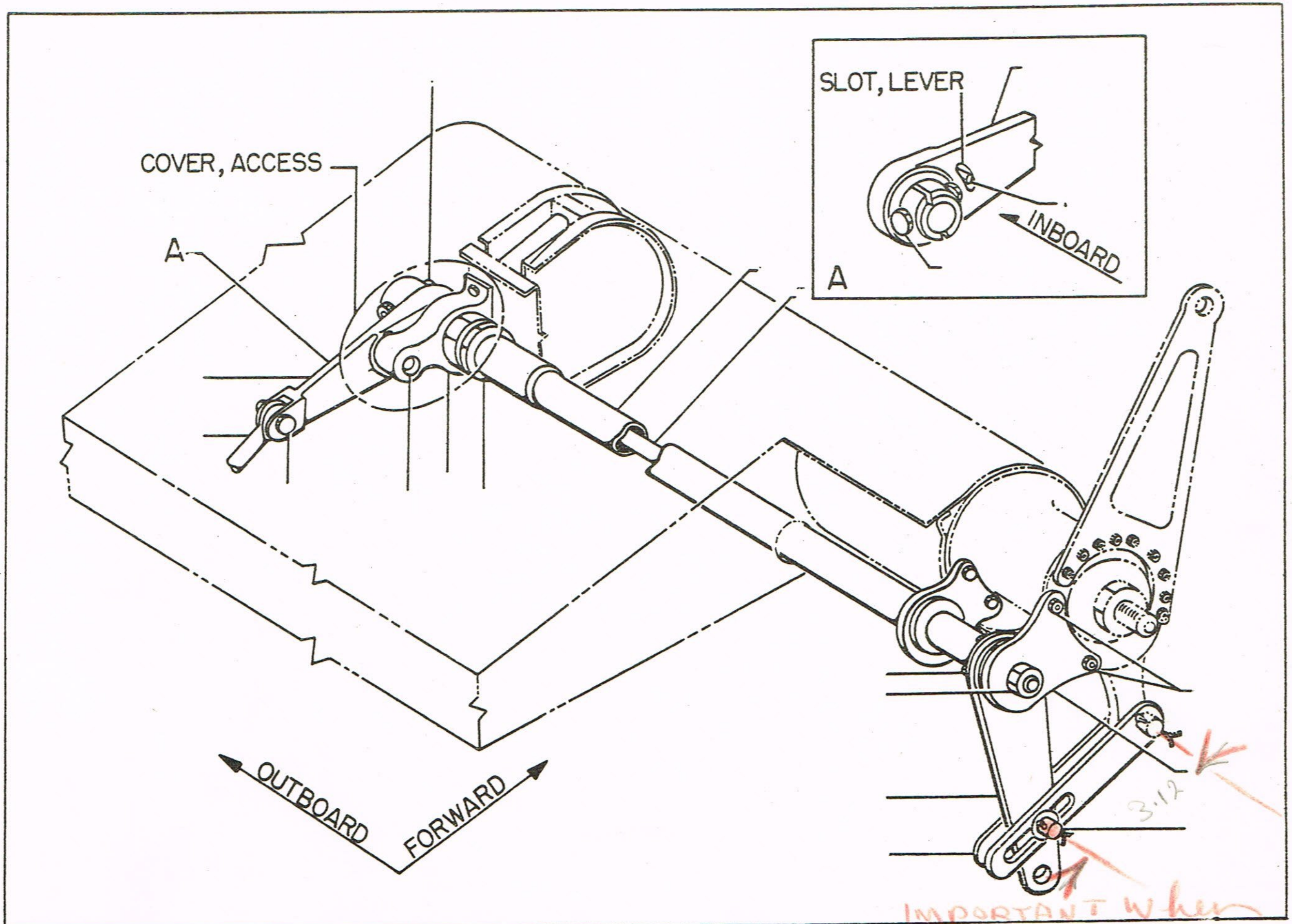
The heaviness of the ailerons is largely dependent on the gaps between the beak and the fixed shroud, and between the shoulders of the ailerons and the hinged shrouds.

The beak gap should be maintained within the specified limits in both directions. These are set by heaviness in one direction and by freezing or jamming in the other. The gaps between the shoulders and the hinged shrouds should not be less than the specified figure; too small a gap here make the ailerons unduly heavy.

Stall.

The stalling qualities are determined by the first few inches of the leading edge of the wing. It is therefore important that this area should be maintained accurately both in following the basic contour and in being free from waviness.

In particular there should be no suggestion of kinks with their ridges running in the spanwise direction. This criterion applies to the first four inches or so measured aft from the leading edge along the chord line.



Left Elevator Torque Tube and Blow-Back Rod Installation

FLYING CONTROLS.

General.

The flying controls are operated in the normal manner. Aileron, elevator and rudder controls are of push-pull rod and lever type with adjustable ends fitted to the rods in each control run.

Tabs in the trailing edges of the ailerons, port elevator and rudder are operated automatically through torque tubes and blow-back rods incorporated in the control surfaces.

The starboard elevator tab can be ground set and an electrical control permits the rudder tab to be set in flight.

The variable incidence tailplane is electrically actuated and controlled. Aileron Bias is effected electrically.

Elevator Controls.

The elevators are inter-connected and installed as a single unit, the push-pull rods being connected to the port elevator which is fitted with a spring tab with blow-back rod and torque-rube mechanism.

Adjustable limit stops are provided on the starboard connecting link. They are accessible when the rear cone fairing is removed.

Mass-balance bob weights supported on cranked tubular arms project them from the elevator nose into the tailplane interior. They are provided with removable top plates for adjustment and are accessible when the rear cone fairing and the adjacent box structure are removed.

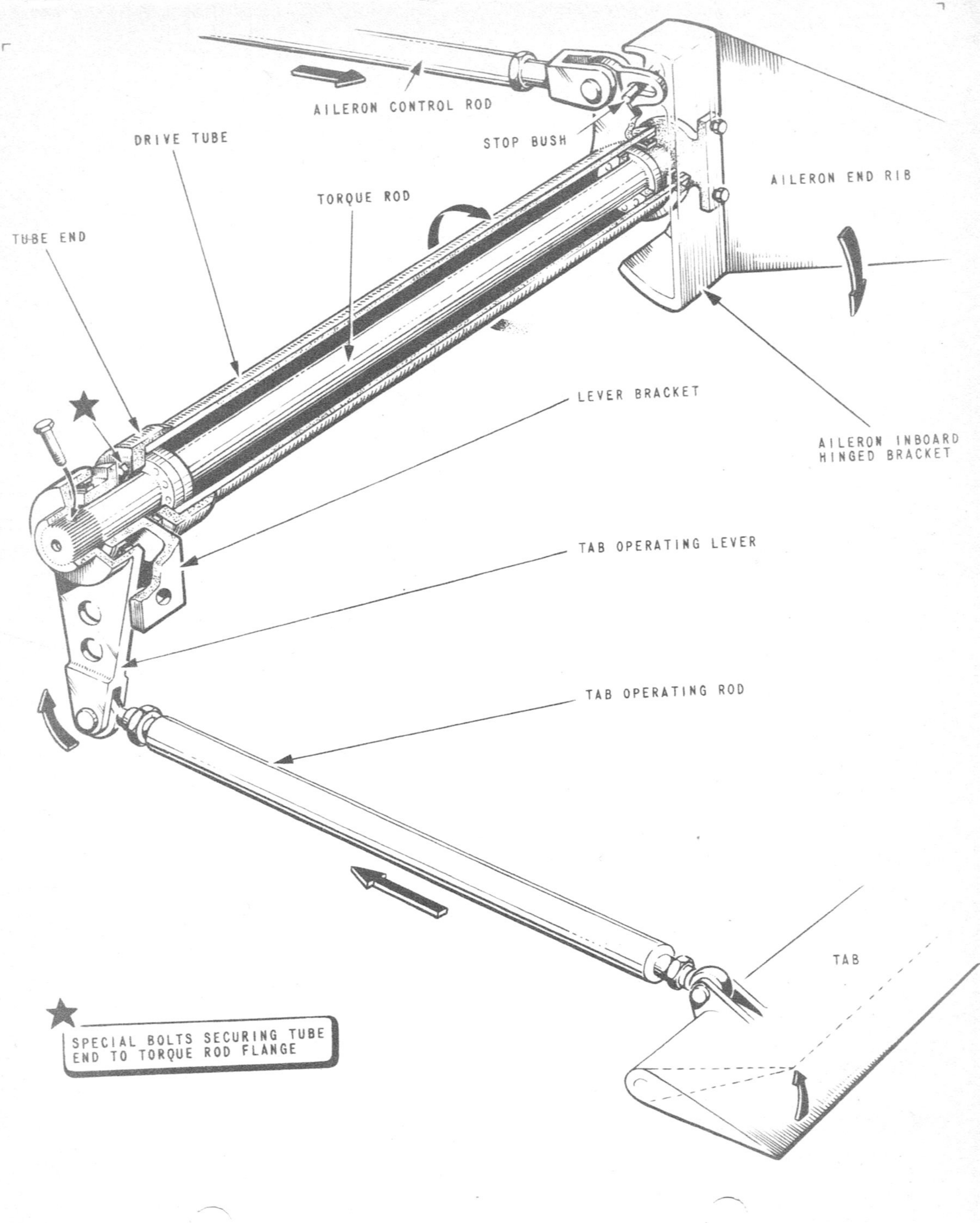
Rudder Controls.

The rudder is operated by push-pull control tubes and levers and incorporates a spring tab with blow-back rod and double torque-tubes and an electrical actuator for trimming purposes. Two mass-balance weights are fitted, a non-adjustable weight on an arm projecting into the fin from the rudder nose, and a weight consisting of removable lead discs in the rudder horn balance.

Rudder Pedals.

The foot pedals are pivoted and hinged at either end of a horizontal cross tube and are fitted with alignment linkage giving them parallel motion fore and aft.

The cross tube is linked to an adjusting screw mechanism by which the pedals can be set to suit the Pilot's leg reach. It is attached to a short vertical torque shaft protruding through the Pilot's floor.


AILERON CONTROL ROD
DRIVE TUBE
STOP BUSH
AILERON END RIB
TORQUE ROD
TUBE END
LEVER BRACKET
AILERON INBOARD HINGED BRACKET
TAB OPERATING LEVER
TAB OPERATING ROD
TAB
SPECIAL BOLTS SECURING TUBE END TO TORQUE ROD FLANGE

Consequent upon the movement of the foot pedals the motion of the torque shaft is transmitted to the push-pull control tube through a horizontal lever at the bottom of the torque shaft.

Between the hinged top of the foot pedals and the rudder bar are interposed the foot motors for the toe steering.

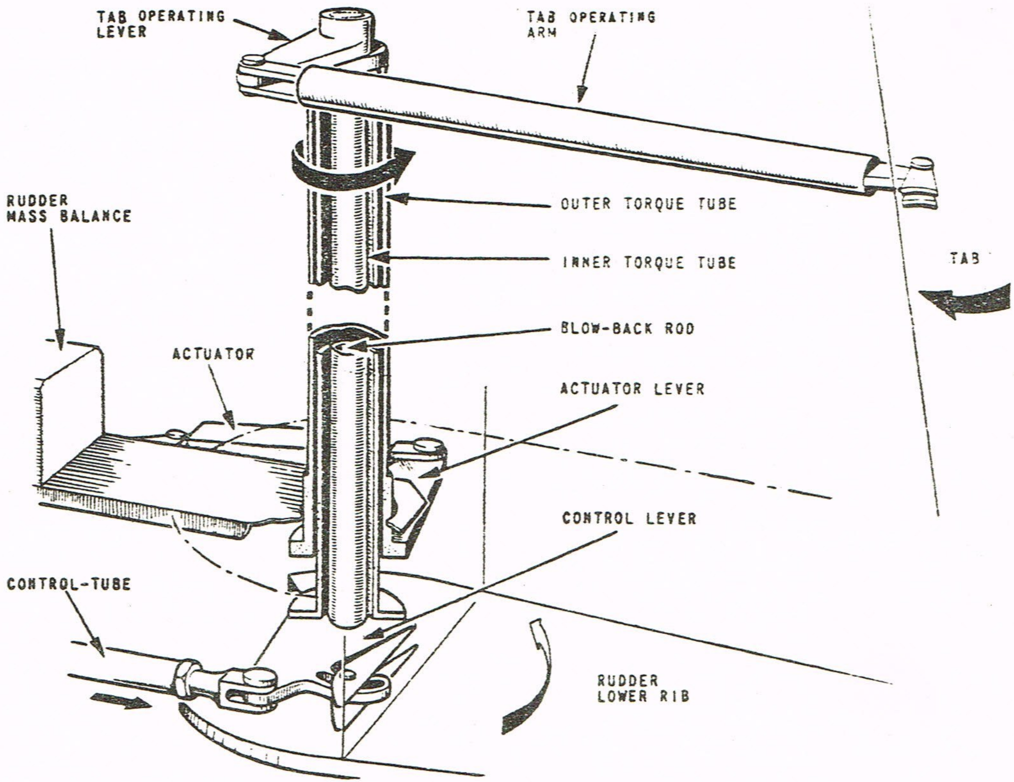
The movement of the rudder bar is restricted by two adjustable stops on the pressure bulkhead, acting on the control-tube lever in the V.H.F. compartment.

Aileron Controls.

The ailerons are controlled by rotation of the Pilot's handwheel which rotates the inner tube of the control column. By means of a lever attached to the bottom of the inner tube the rotary movement is transferred to fore-and-aft movement, and the ailerons are operated by push-pull rods and levers incorporating spring tabs with blow-back rod and torque-tube mechanism. They are supported by pin-and-socket hinges at their inboard and outboard extremities and main centre hinges.

Irving type mass-balance is fitted, the mass-balance weights being heavy alloy blocks rivetted between the aileron beak ribs.

The webb of the mainplane rear wall is curved and the aileron beak is set so closely to the web that the airflow between the upper and



Rudder spring tab mechanism

lower surfaces of the beak is restricted and differential loading thus maintained. Adjustable limit stops are provided at the aileron inboard hinges. The shrouds are hinged and can easily be opened for servicing and adjustment purposes.

Spring Tab Mechanism.

The aileron, port elevator and rudder are fitted with spring tabs complete with blow-back rod and torque-tube mechanism which, in addition to their normal function when operated by the controls in the cabin, have an entirely separate automatic function. The object of this is to relieve the Pilot of heavy physical loads on the controls normally occasioned by major changes of direction at high speed.

With the exception of the rudder gear, which is fitted with two concentric torque tubes, the mechanism differs only in size. The double torque tubes on the rudder mechanism act as one tube but as they appear to make the mechanism slightly more complicated than those fitted to other tabs, the rudder mechanism will be described here fully.

Rudder Spring Tab Mechanism Operation.

Consider a normal turn to starboard. The Pilot pushes on the starboard rudder pedal and the control tube moves forward, rotating the control lever in an anti-clockwise direction.

The torque applied by the control lever is transmitted through the inner and outer torque tubes to the actuator lever which moves the rudder over to starboard by means of the actuator.

Assuming that there is no air load on the rudder and that the rudder hinges are frictionless, the actuator lever and consequently the rudder will rotate through the same angle as the control lever.

During flight, the air load on the rudder resists the rudder rotation, and, since the torque tubes are torsion springs, they twist under the Pilot's efforts. In other words, the control lever moves through a greater angle than the actuator lever and the rudder.

The control lever has now rotated in an anti-clockwise direction relative to the rudder, as has the tab control lever, due to the rotation of the blow-back rod. This rotation of the tab control lever moves the tab to port and the air load on the tab moves the rudder to starboard. In addition to its function as a driven shaft between the control and the tab control levers, the blow-back rod has a safety factor.

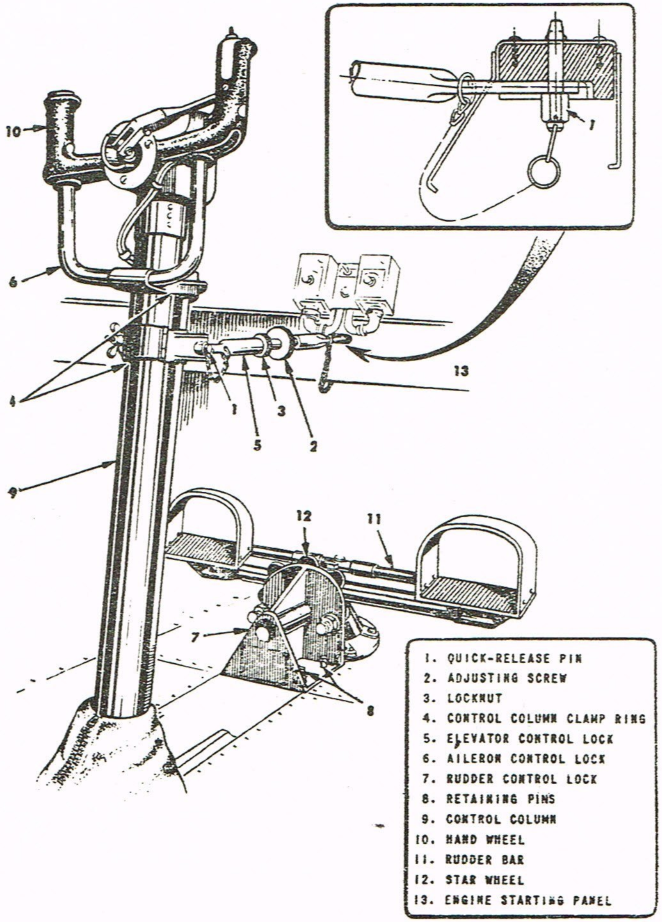
The maximum movements of the rudder and the tab as fixed by their stops are required for control at slow speeds. If it were possible for the Pilot to move the rudder through these maximum angles at high speeds, prohibitive loads would be imposed on the aircraft structure.

In flight the angle of the rudder is determined by the angle of the tab, so that by restricting the tab movement during high speeds, excessive loads on the structure are avoided.

This restriction of the tab movement is imposed by the blow-back rod which acts as a torsion spring. Under the influence of the high air load imposed by the application of large tab angles at high speeds, the blow-back rod twists in the direction opposite to that applied by the Pilot to the control lever, with consequent reduction of the tab and rudder angles.

A stop-bolt attached to the rudder spar operates in the slot in the control lever in order to prevent the Pilot applying excessive twist to the torque tubes.

In flight, when the control lever is moved relative to the rudder and so rotates the tab, one end of the slot will momentarily approach the stop-bolt, but the applied tab will cause the rudder to turn in the same direction as the control lever and the bolt will move away from the end of the slot.



Control neutral rigging locks

FLYING CONTROLS NEUTRAL SETTING.

Level the aircraft longtitudinal and lateral, using the three sets of levelling points, i.e. one in the cabin, one aft of the centre fuselage, and one in the rear fuselage.

Obtain a mean average from these three points, and commence to set your controls, using the incidence gauge to the inboard incidence point on top of the tailplane.

Set the tailplane to $3^{\circ}\ 14' \pm 2'$ and adjust all neutrals and travels to this setting.

Rig the aircraft longitudinal and lateral, using the levelling points in the rear of the centre fuselage at frames 39 and 31.

With the incidence gauge mounted on the inboard gauge position on the top of the tailplane, adjust the upper tappet to give an inclinometer reading of:

$$2^{\circ}\ 12' \pm {}^{14'}_{12'}$$

and the two bottom tappets to give an inclinometer reading of

$$3^{\circ}\ 59' \pm {}^{12'}_{14'}$$

Set the tailplane to $3^{\circ}\ 15' \pm 2'$ (flying neutral) and check that the electrical indicator in the cabin registers zero.

SETTING OF TAIL PLANE WITH
2-SPEED ACTUATOR. (COARSE OR FINE).

Assembly and Adjustment of Micro-Switches.

Switches must be assemblied initially with eccentric bolts in such a position that the switches are at their minimum distance from the tail plane tappet. Thus any adjustment will move them away from the tappet which will be accompanied by the adjustment of the tappet itself.

The micro-switches are capable of being adjusted in the vertical and horizontal (fore-and-aft) plane to ensure correct contact with the tail plane tappets. To adjust the angle of the tail plane maintaining the correct angle of the switches:

(1) Remove locking plate.
(2) Slacken off the nuts.
(3) Rotate eccentric bolts in the required direction simultaneously.

To adjust the angle of the switch:

(1) Remove locking plate.
(2) Slacken off the nuts.
(3) Remove one bolt.
(4) Adjust the remaining bolt and switch to the required angle.
(5) Insert second bolt.

Tail Plane Movement Adjustment.

Before starting adjustment ensure that the tappets are screwed fully home and the upper and lower micro-switches are set in accordance with the instructions as laid down in the previous page. The current to be used whilst adjusting must be no more than just sufficient to drive the actuator (in order to avoid damaging the motors when the mechanical stops take effect).

(1) With the actuator on slow speed gearing, extend the actuator and using the incidence gauge, set the upper micro-switches to give an angle of:

$$2^\circ\ 12' \pm {}^{14'}_{12'}$$

adjusting the upper tappet (and, if necessary the micro-switches) to suit.

Ensure that the actuator has a minimum over-ride of $8' \pm 1'$ after the operation of the micro-switches.

Similarly, with the actuator closed and using the gauge as before, set the lower micro-switches to give an angle of

$$3^\circ\ 59' \pm {}^{12'}_{14'}.$$

Ensure that the actuator has a minimum over-ride of $8' \pm 1'$ after adjusting the lower tappet, as previously stated.

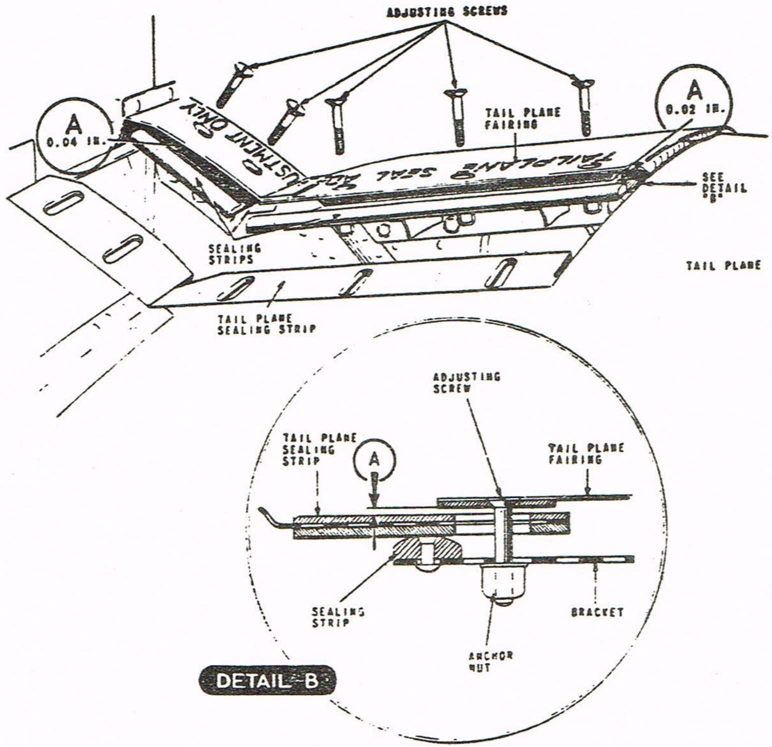
(2) With the actuator on high speed gearing, repeat the checks where necessary.

Tail Plane Movement Adjustment. (cont.)

Re-check the angle of the incidence at the maximum and minimum incidence positions and check that, when a reading of $3^\circ\ 15' \pm 2'$ is obtained on the inclinometer, the tail plane indicator on the Pilot's instrument panel registers zero.

WARNING:

BEFORE ATTEMPTING TO REMOVE THE TAIL PLANE, THE FIVE UPPER SEALING STRIP ADJUSTING SCREWS EACH SIDE MUST BE REMOVED.



Tail plane seals

TAIL PLANE UPPER SEALING STRIP CLEARANCE.

This clearance is adjusted by five countersunk headed setscrews each side on top of the tailplane stub immediately above the hinge point.

3 Setscrew adjustment position. 0.020"

2 Setscrew adjustment position. 0.040"

This measurement must be constant over the full movement of the tailplane, i.e.

$$2^\circ\,12' \pm {}^{14'}_{12'} \quad - \quad 3^\circ\,59' \pm {}^{12'}_{14'}$$

IMPORTANT: THESE ADJUSTMENT SCREWS MUST BE REMOVED BEFORE ANY ATTEMPT IS MADE FOR THE TAILPLANE REMOVAL.

Supplement to Canberra Mk. 8.
Airframe Lecture Notes.

FLIGHT TRIM CHECKS.

This supplement details the flight trim checks, and subsequent trimmimg of the elevator trailing edge strips necessary whenever a tail plane, or component affecting the longitudinal trim of the aircraft has been removed, replaced or adjusted.

During flight tests two crew members only (pilot & navigator) are to be carried, and the aircraft re-fuelled as follows:-

1. Wing tip tanks to be removed, and integral wing tanks drained for all flight tests.

2. With gun pack and flare doors fitted:- No's 1 & 2 tanks full.
   No. 3. tank to contain 440 gals. Avtur 3520 lbs.
   Avtag 3432 lbs.

3. With bomb doors fitted:- full fuselage fuel load.

Take-off should be normal on all three tanks, but the actual trim checks should be carried out on No. 2. tank only, with No' 1 & 3 tanks switched 'OFF'.

Preparation for Flight Testing.

Whenever an aircraft component which affects longitudinal trim is removed, replaced or adjusted, the flight trim checks must be repeated. Should the aircraft trim be outside the limits specified, a new trailing edge strip should be fitted, and the flight trim checks and subsequent trailing edge strip adjustments carried out. Components likely to affect longitudinal trimming are main plane (s), rear fuselage, tail plane, tail plane actuator, elevators, ailerons, and aileron and elevator tabs.

NOTE.

1. All speeds quoted are I.A.S.

2. Before the first flight test the elevator trailing edge trimming strips (Part No. EA1.31.677) should be examined and, if they are bent, kinked, or damaged, should be removed and new ones fitted.

Bowing where the strip follows the line of the elevator trailing edge is acceptable.

3. If too much metal is removed by filing, the aircraft trim will be over-adjusted and a new trailing edge strip will have to be fitted, and the tests re-commenced.

Operation.

NOTE. Tests are to carried out in calm air and good visibility.

Operate the fuel system as previously instructed, and climb to 5,000 ft increasing speed slowly until:-

Case. 1.

a/ The aircraft can be trimmed 'hands off' in level flight with the speed steady using full aircraft NOSE-DOWN trim.

Record the speed. Increase the speed slowly beyond this point to ensure that a push force develops on the control column.

Case. 2.

b/ If 450 knots is reached before the condition described in Case. 1. trim the aircraft 'hands off' at 450 knots and, without further adjustment of the tail plane trimmer, reduce speed slowly using elevator and throttle, and land the aircraft.

NOTE.

Care should be exercised when reducing speed, since an aircraft NOSE-DOWN change of trim will generally occur as speed is reduced. The stick force to hold this change of trim may increase initially as speed is reduced, but will diminish below about 350 knots. Lower the under-carriage at 190 knots and flaps at 160 knots. The pull force on the control column should be greatly reduced, and may become a small push force when the flaps are lowered

Correction. Case. 1.

For an aircraft in Case. 1. category, refer to Figure 1. of the graph and proceed as follows:-

1/ Read off the amount of metal to be removed from the elevator strip according to the speed reached, and remove this amount from the depth of the lower strips on both elevators, along the whole length of the strips.

2/ Refuel the aircraft and repeat the flight check, noting the new steady trim speed with full aircraft NOSE-DOWN trim. Record this speed. Again increase speed beyond this point to check if the aircraft still requires a push force on the control column at, or approaching 450 knots.

3/ Repeat the procedure carried out in No.1. on the previous page.

4/ Refuel the aircraft and carry out further flight checks as necessary until the aircraft, using full aircraft NOSE-DOWN trim, is trimmed 'hands off' between 425 and 450 knots.

5/ Should this check indicate that the strips have been over-adjusted resulting in a slight pull force on the control column at 450 knots, renew the trailing edge strips and carry out the procedure as detailed on page 3. Case.1. (a).

NOTE.

1/ If the tail plane angle required to trim at 450 knots is not more than 3 mins from the electrical stops, then the trailing edge strip adjustment is satisfactory; if more than 3 mins. renew the strip and re-commence the tests.

2/ There is no restriction on the amount of lower strip which may be removed, the whole of the strip may be removed if found necessary.

Aircraft Fitted with Gun Pack.

Example.

Consider an aircraft which on its first check flight can be trimmed 'hands off' at 300 knots with full aircraft NOSE-DOWN trim:-

From Figure.1. it will be found that 0.25" is to be removed from the depths of the strips. After the second flight (assuming that the aircraft is now in trim at 390 knots) a further 0.10" should be removed from the strips. This procedure should be repeated until the aircraft satisfies the trim rewuirements as laid down on page 5, No.4.

Correction. Case. 2.

For an aircraft in Case. 2. category (page 3. b/) refer to Fig. 2. and proceed as follows:-

a/ Place the aircraft in the rigging position without disturbing the tail trimmer setting, and measure the tail plane incidence. (This was the angle found necessary to trim 'hands off' at 450 knots).

b/ Without re-moving the inclinometer, run the actuator on to its 'UP' electrical stop. Record the difference in angle between the 'hands off' 450 knots trim position, and the electrical stops.

c/ Refer to Fig, 2. and read off the amount of metal to be removed from the upper strips corresponding to the difference in anglb found in (b). Remove the required amount of metal from both elevator strips along the whole length of the strips.

d/ Repeat the flight trim checks (page 3. b/.) and return to base without adjusting the tail plane setting.

Should this on subsequent checks indicate that the strips have been over-adjusted, resulting in a push force on the control column at 450 knots, renew the trailing edge strips and carry out the procedure as indicated in (c).

NOTE. If the aircraft can still be flown 'hands off' using full aircraft NOSE-DOWN trim between 425 and 450 knots, the trailing edge strip adjustment is satisfactory, if not, renew the strips and re-commence the tests.

e/ The aircraft trim may be considered satisfactory if the tail plane setting required to fly 'hands off' at 450 knots is no more than 3 mins from the 'UP' electrical stop.

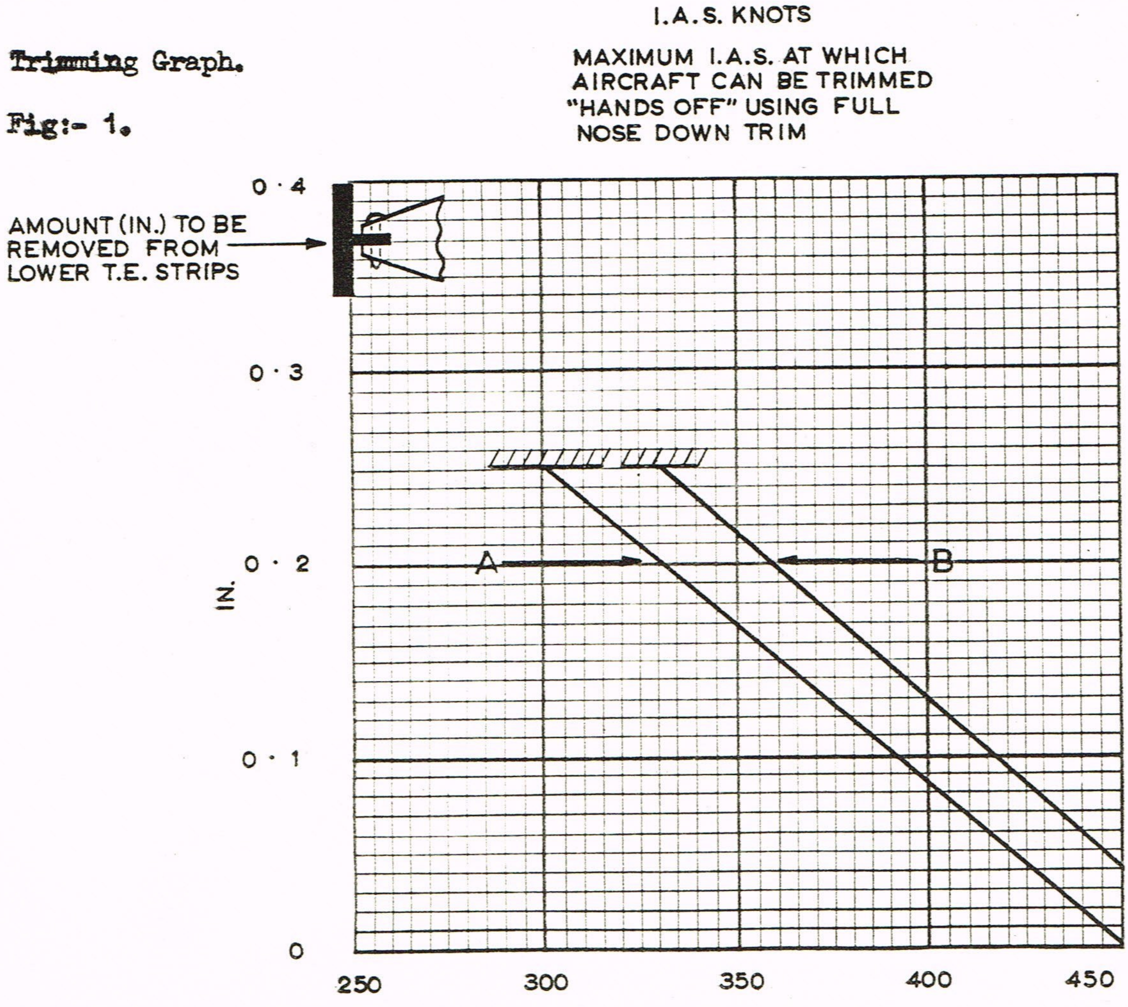
NOTE. The amount of metal that can be removed from the upper strips is restricted to half the depth of the strips.

Example:- (Aircraft fitted with gun pack)

Consider an aircraft on which the tail plane angle required to fly 'hands off' at 450 knots was 3^{o} 50', and the electrical stops are found to be set at 4^{o} 00', giving a difference of 0^{o} 10'. From Fig. 2. it will be found that 0.1" of the upper strip has to be removed.

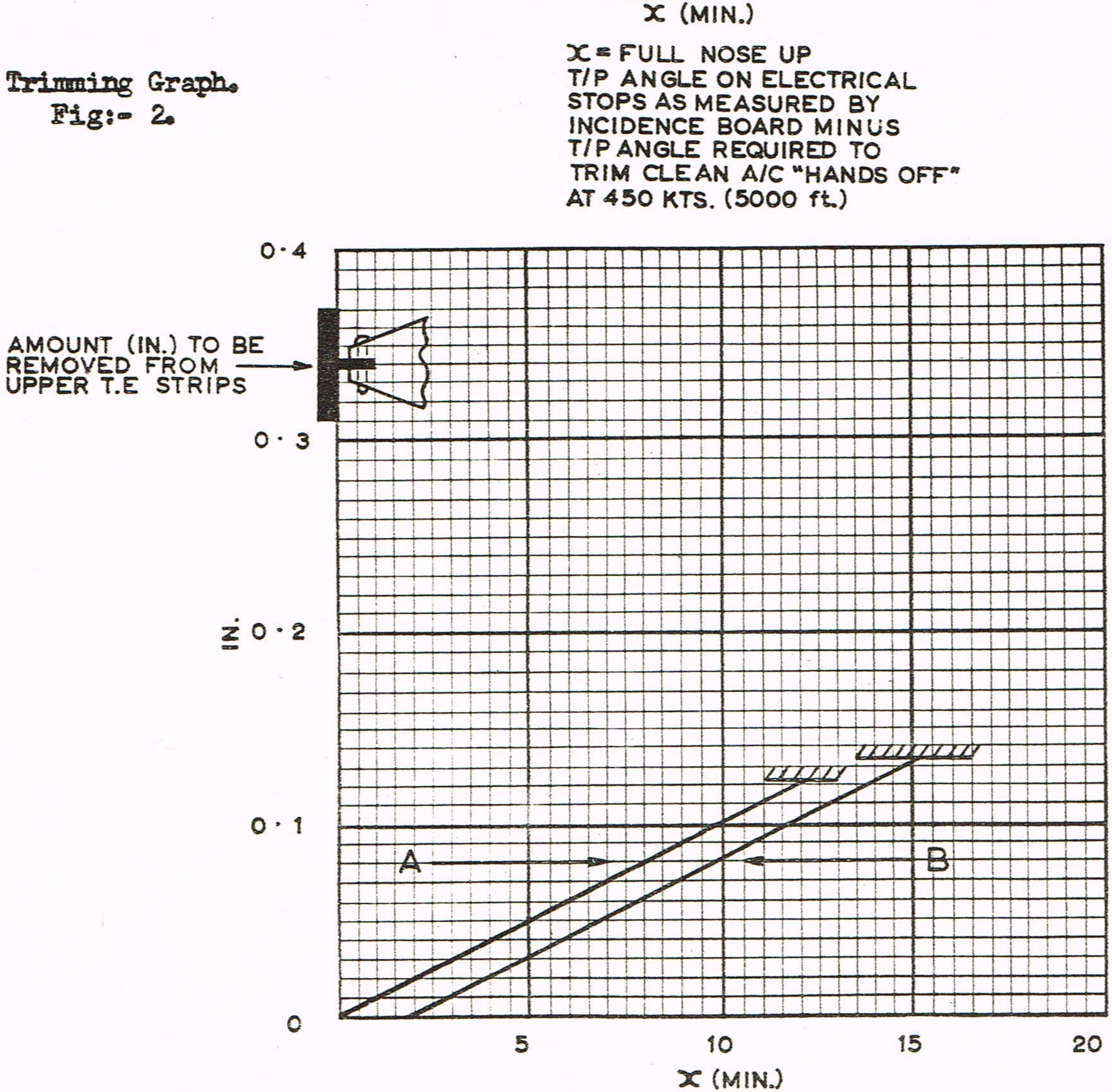
Trimming Graph.

Fig:- 1.



USE GRAPH 'B' FOR AIRCRAFT WITH STANDARD BOMB DOORS
USE GRAPH 'A' FOR AIRCRAFT WITH GUN PACK FITTED

Trimming Graph.
Fig:- 2.



USE GRAPH 'B' FOR AIRCRAFT WITH STANDARD BOMB DOORS
USE GRAPH 'A' FOR AIRCRAFT WITH GUN PACK FITTED

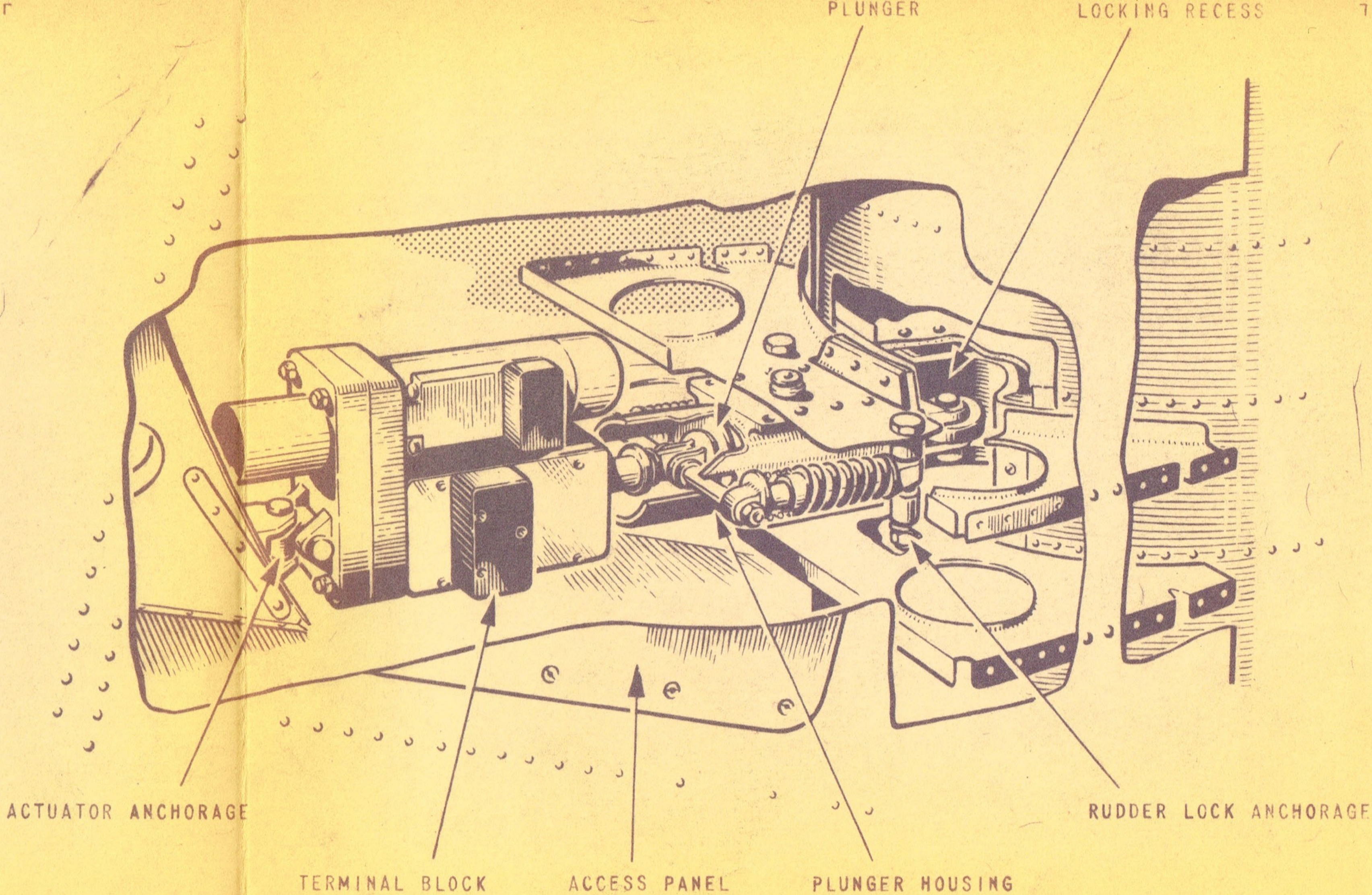
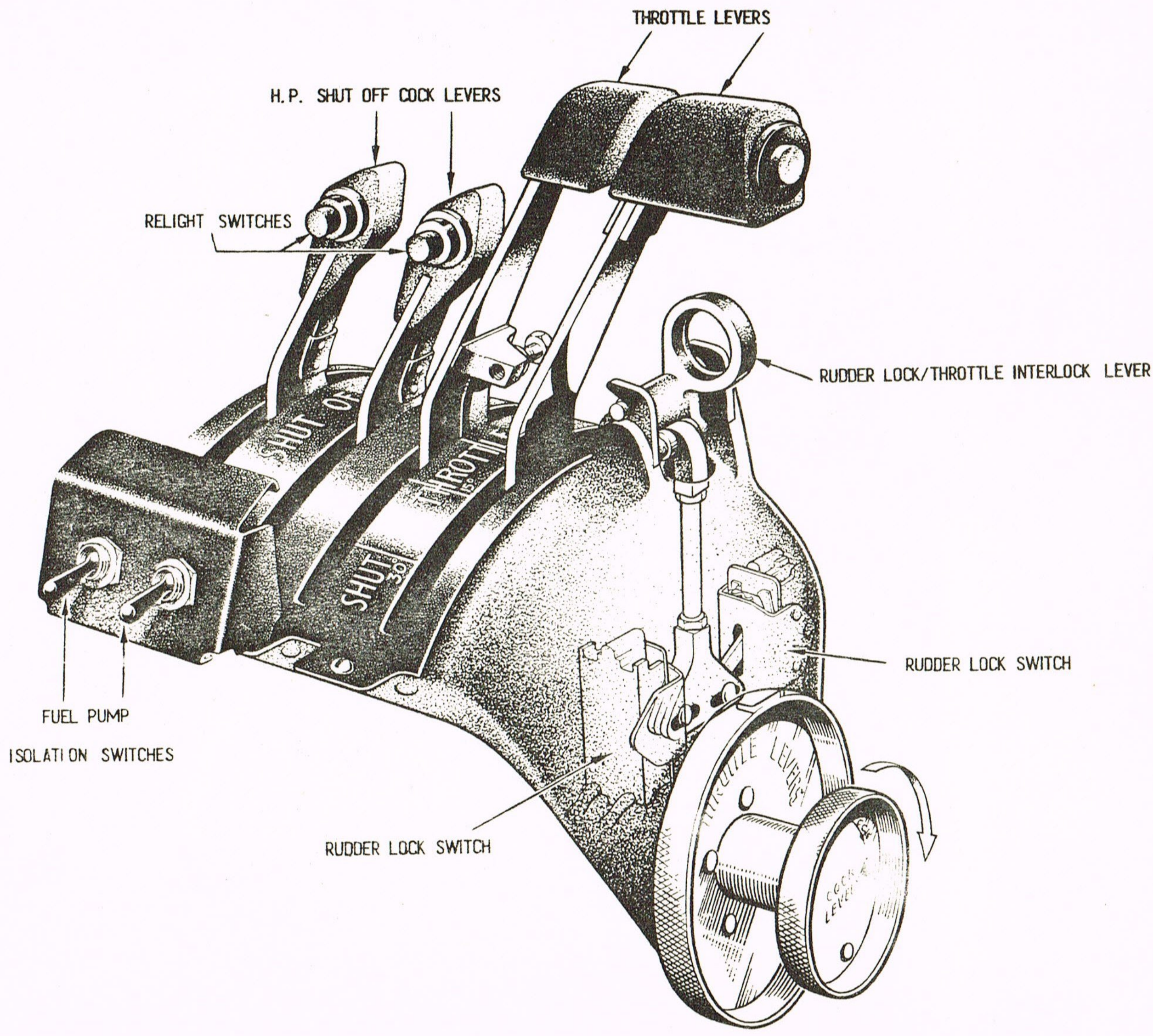


FIG. 5A RUDDER LOCK AND ACTUATOR


THROTTLE LEVERS
H.P. SHUT OFF COCK LEVERS
RELIGHT SWITCHES
RUDDER LOCK/THROTTLE INTERLOCK LEVER
RUDDER LOCK SWITCH
FUEL PUMP
ISOLATION SWITCHES
RUDDER LOCK SWITCH
SHUT OFF
THROTTLE
SHUT
THROTTLE LEVERS
COCK LEVERS

RUDDER LOCK.

The rudder lock is made up of a spring assembly and a plunger carrying a roller in the forked end, controlled by a linear actuator; these are mounted inside the fin, whilst the lock plate forms part of the rudder leading edge.

Function.

No. A.E. 4009 Actuator is a series wound, non-reversing motor with a magnetic clutch, gear train and a linear ram.

The rudder lock switch is mounted on the throttle box, whilst the electrical indicator (lamp) is mounted on the console aft of the throttle box base. The plunger and roller are in the rudder lock "OUT" position due to the action of the compression springs.

Immediately the switch is moved to the rudder lock "IN" position, the magnetic clutch solenoid is energised, engaging the gear train and ram to the motor armature. Current flow to the field coil and the armature rotates, extending the ram and plunger, allowing the roller to enter the lock plate.

Whilst this is taking place, the springs are now in a full state of compression.

When the lock is fully engaged the internal actuator limit switch breaks the current to the field coils, leaving the clutch solenoid energised.

When the rudder lock switch is moved to the "OUT" position, the clutch solenoid is de-energised, freeing the gear train from the armature, allowing the fully compressed springs to withdraw the lock moving the plunger and ram, rotating the gear train into the unlocked position.

NOTES.

FIRE EXTINGUISHER SYSTEM.

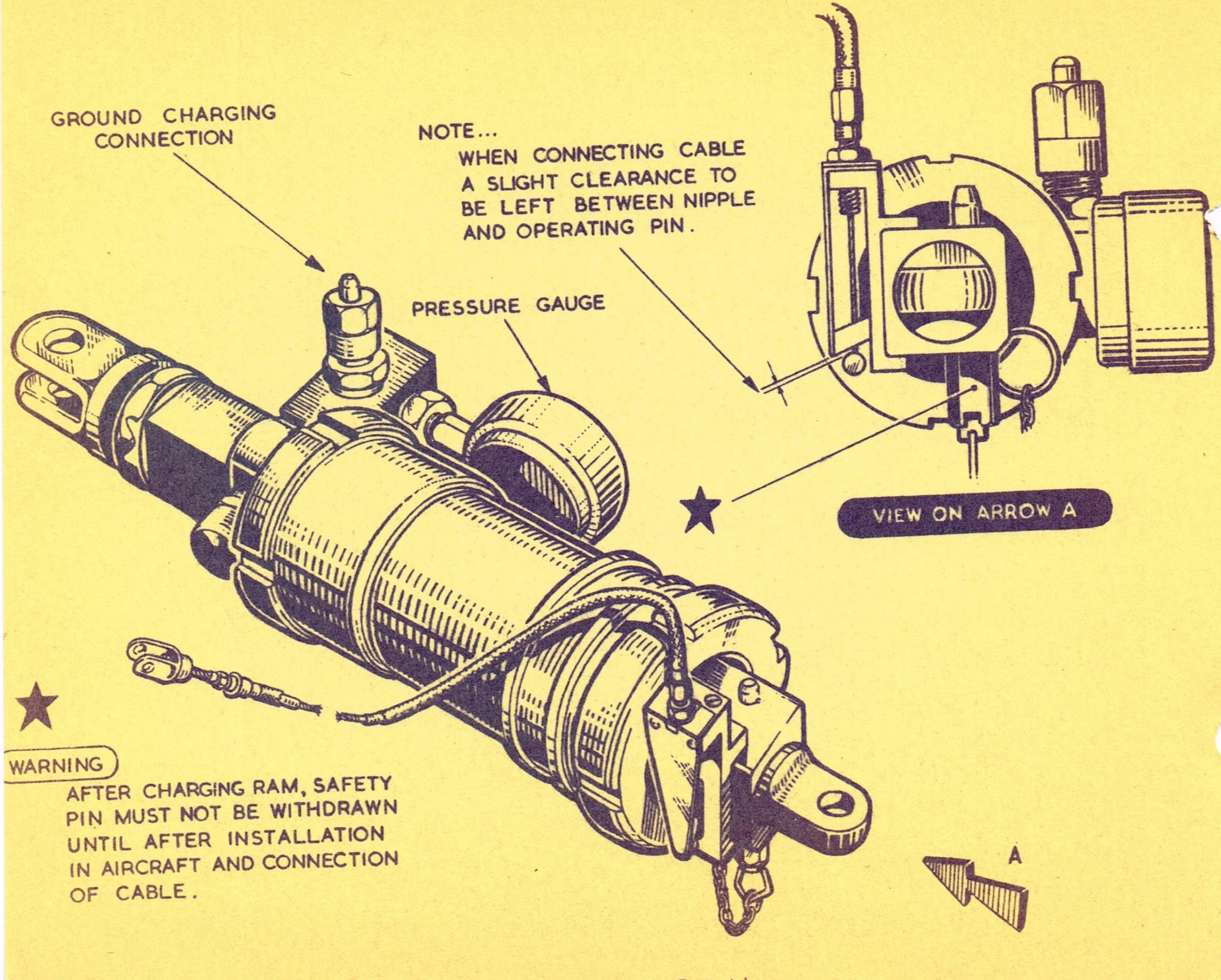
A complete fire extinguisher system incorporating flame detector switches and five fire extinguisher bottles is provided for the protection of the fuel tanks and engines. One Mk.14.A extinguisher bottle fitted with a cartridge operated dual head, and one Mk.12.A extinguisher bottle fitted with a cartridge operated single head are mounted in each wheel well.

A further Mk.12.A extinguisher bottle fitted with a cartridge operated single head is mounted on the rear diaphragm of No. 3 fuel tank adjacent to the fuel float valve inlet.

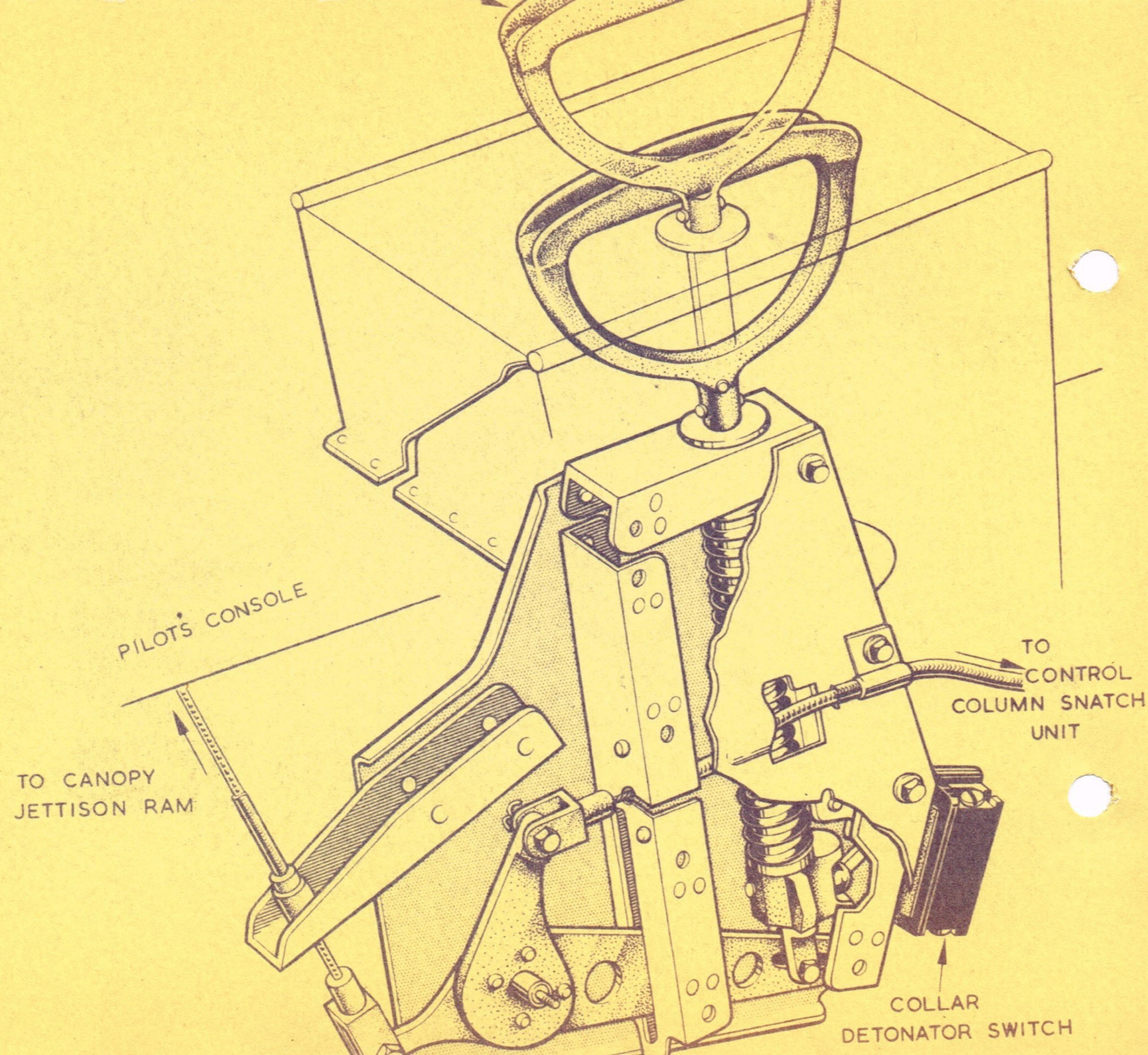
Indication of engine fires is given by warning lamps on the starboard coaming panel. The engine fire warning lamp filaments are incorporated in the operating knobs of their respective switches; pushing the knob in fires its associated extinguisher bottles.

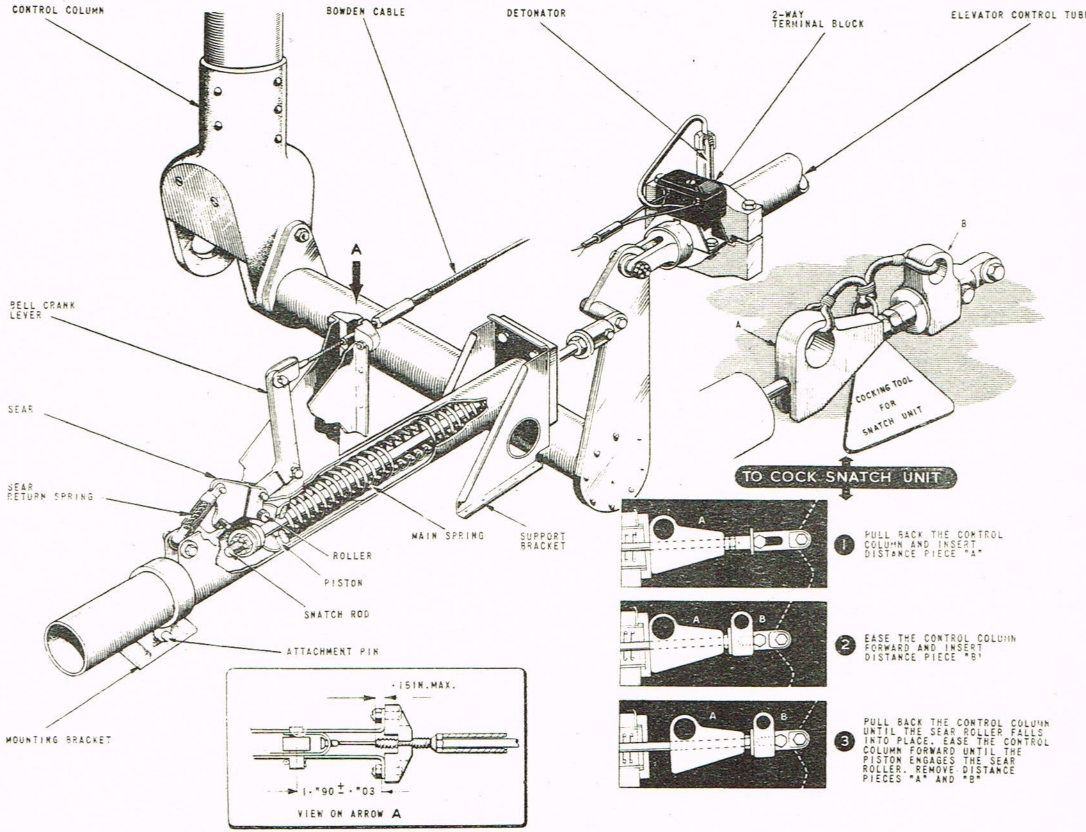
Engine fires are detected by re-setting fire detectors in each engine nacelle, seven in the port and eight in the starboard.

The inertia crash switches, which are wired in series, are mounted one in the Main Electrical compartment, whilst the second one is mounted in the V.H.F. compartment.



CANOPY JETTISON RAM.


PILOTS CONSOLE
TO CANOPY
JETTISON RAM
TO
CONTROL
COLUMN SNATCH
UNIT
COLLAR
DETONATOR SWITCH



CONTROL COLUMN SNATCH UNIT

Lecture 1

FUEL CONTENTS GAUGES.

The fuel contents gauge system is of the Smith-Waymouth design and manufacture, and comprises of three separate tank systems, each one indicating the amount of fuel in each fuel tank.

The three indicators are mounted on the Engine Instrument Panel, and are calibrated in Lbs. of fuel.

In No.1. and No.2 fuel tanks four channel type condenser units are mounted on the tank internal bracing, whilst No. 3 fuel tank, due to its form of bag construction, has four flexible condenser units fitted in pockets cemented to the interior of the fuel tank.

The four condenser units in each tank automatically compensate for the aircraft angle and the surging of fuel, in point of fact, a gain in capacitance by some of the units, resulting from a change of aircraft angle will automatically be compensated by loss of capacitance in others.

Interposed between the tank terminal block and the amplifier is a cable box, containing a small capacity variable condenser, to 'ZERO' the fuel contents gauges when fitting either a new fuel tank, or fuel gauge.

Three thermionic amplifiers are mounted on the starboard side of the bomb-bay above the skirt to amplify the changes of capacitance in the fuel tank units.

Briefly, the amplifiers function in the following manner:-

The oscillator's frequency is determined by a parallel tuned circuit, consisting of inductances and the tank system's capacitance.

This capacitance varies, of course, as the quantity of fuel in the aircraft tank increases or decreases, and therefore the quantity of fuel controls the frequency of the oscillator (25L6).

The discriminator converts a change in the frequency (see diagram) into a change of oscillatory amplitude, while the rectifier in turn detects (rectifies) the discriminator's output.

The resulting direct voltage is applied to the grid of the output valve (25L6) which controls the output current of the circuit, and therefore the indicator's reading. (A milli-ammeter calibrated in lbs)

INSTALLATION OF SMITH-WAYMOUTH CAPACITORS INTO No 3. FUEL TANK.

Difficulty has been experienced in fuel calibration after the installation of No.3. Fuel tank, this in many cases has been due to damaged capacitors, the damage occurring before, during and after installation.

To off-set the many man hours expended on tank removal, a system has now been devised whereby the capacitor units can be fitted with the tank in situ, partially laced.

Installation of Fuel Tank.

Ensure that the tank bay is clean, and there is no possibility of the tank chafing when installing:- before folding the tank make sure that all projections are covered, position the tank in the tank bay, and partially unfold:- lace the first three rows of nylon cords on the starboard side, and repeat on the port side.

NOTE. The first row is laced with double nylon cord.

Fit the first row of metal loops to project through the floor into the bomb-bay, fit spreader plates and split rings. (Hycatrel)

Continue to insert the second and third row which are rubber buttons and lock these with spreader plates and split pins.

Fitting the Capacitor Units.

The electrician must first ensure that the units are serviceable and the negative lead is cleanly soldered to the required tag at the co-axial connector, and the connector leads are attached to the two forward capacitor belts. Part No. TC. 17. Stores Refs. 6A/2804.

The tank must now be folded so that the booster pump apertures are as far forward as possible.

The next stage, the electrician will position himself on the tank floor face upwards, after receiving the starboard capacitor belt, he will insert this through the fuel pump aperture, and by manipulating the tank fabric to locate it in the rubber envelope which is cemented to the side of the tank, finally clipping on the locking button.

Repeat the same process for the port side:- now unfold the tank and place the connector leads in a position suitable for connecting to the rear capacitor belts.

Visually inspect that the capacitor units are correctly fitted.

The electrician will now insert the starboard rear capacitor unit T. 10. Stores Refs. 6A/2805 through the float valve aperture into the rubber envelope, by manipulating the tank fabric, finally clipping on the locking button. Repeat the same operation on the port side.

The electrical connections are now completed and visually checked, finally complete the lacing of the tank, the last row of buttons is laced with a double nylon cord, and the metal loops projecting through the floor are locked with spreader plates and split rings.

NOTE.

Marston tanks (black nylon), the rear capacitor units may be fitted either through the filler neck aperture, or the float valve aperture.

o
oo