Chapter 6 HYDRAULIC SYSTEM

(Completely Revised)

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LIST OF ILLUSTRATIONS

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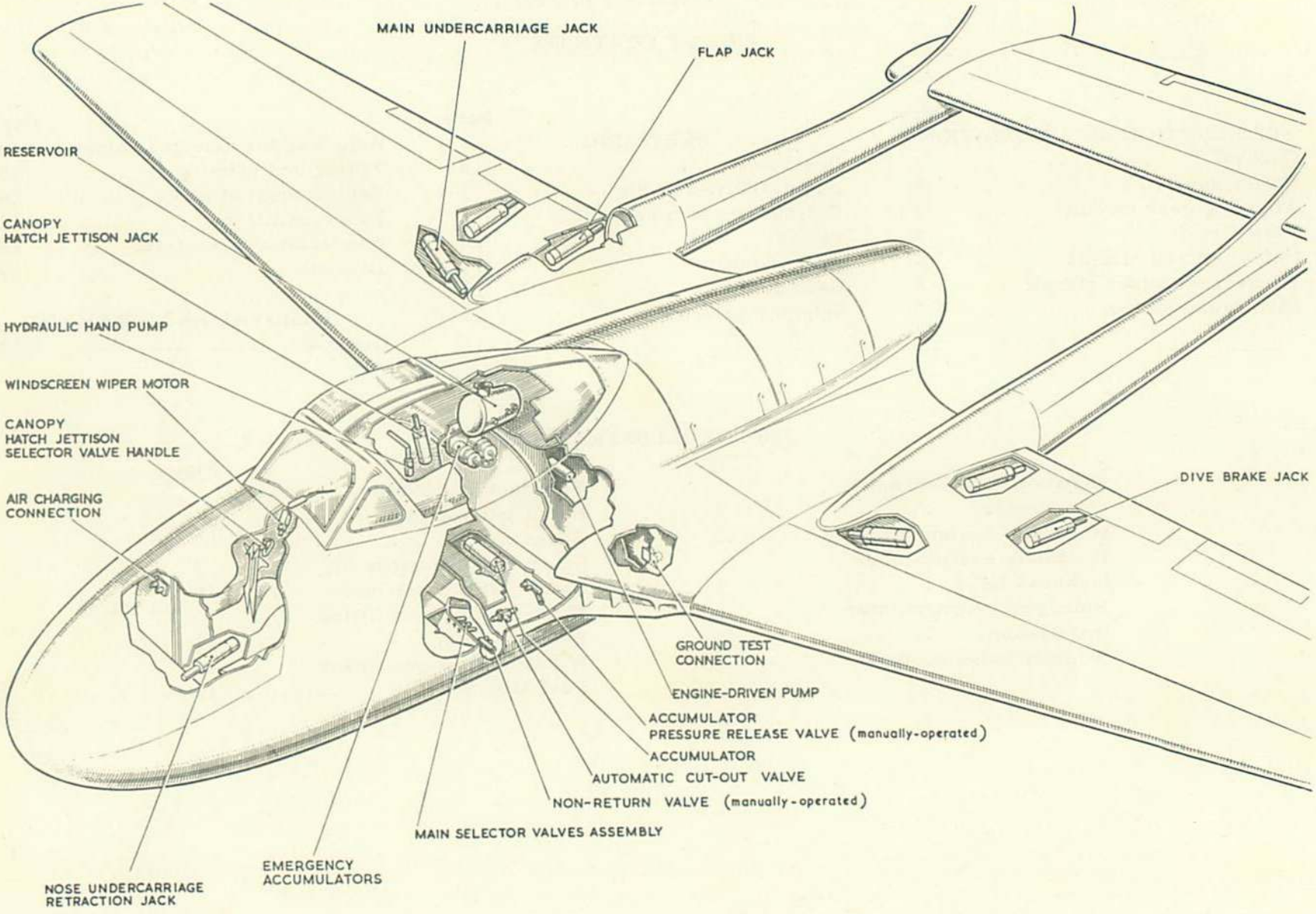

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Fig.1 Disposition of hydraulic components

DESCRIPTION AND OPERATION

General

1. The Lockheed high-pressure hydraulic system is designed to operate the alighting gear, flaps, dive brakes and windscreen wiper, and to release the canopy hatch fasteners in an emergency. The disposition of the various components is shown in fig. 1 and the installation is illustrated diagrammatically in fig. 2. The pressures and fluid specification are tabulated in the Leading Particulars, and a detailed description of the dismantling and servicing of each hydraulic component will be found in A.P.1803 series.

Power supply

2. The power supply is derived from an engine driven pump on the starboard side of the bottom accessory gearbox on the engine. The pump is fed from a reservoir and delivers fluid under pressure through an automatic cut-out valve to charge the main accumulator. The function of the cut-out valve is to control the charging of the main accumulator and to enable the pump to circulate fluid round an idling circuit when the main accumulator is fully charged. A thermal relief valve and a manually operated main accumulator pressure release valve are interposed between the main accumulator and the return junction to the reservoir. The fluid pressure from the main accumulator is applied through non-return valves to the inlet ports of the various selector valves. Two emergency accumulators, fitted in the nose of the aircraft, are provided for the operation of the alighting gear, flaps, canopy fasteners and windscreen wiper; the pressure from these accumulators is fed into the main system by operating a lever situated between the pilots' seats. A hand pump circuit is incorporated in the system but, under flight conditions, this circuit cannot be used to charge the main accumulator or operate the dive brakes.

Alighting gear circuit

3. There are two positions on the selector lever quadrants, UP-DOWN, but to raise or lower the alighting gear, the lever must first be pressed in. When the alighting gear is up, the main undercarriage jacks are extended and the nose undercarriage jack is retracted.

Flap circuit

4. There are three positions on the selector lever quadrants, UP-NEUTRAL-DOWN, but to operate the lever, it must first be pressed in. By returning the lever to NEUTRAL, which creates a hydraulic lock, any desired angle of the flap may be obtained, but for flaps fully up or down, the selector lever should be left at the UP or DOWN position. Fig. 6 shows the method of binding the jack hoses so that they do not chafe against the flap or shroud. The jacks are extended when the flaps are down.

Hatch jettison circuit

5. The canopy hatch, which in normal circumstances is locked and released manually, can be jettisoned in an emergency by using hydraulic power to release the hatch fasteners. From the selector valve, a single pipe is led to a jack which is hydraulically-operated in one direction only when the selector is pulled out; the return stroke is effected by a spring within the jack (fig. 7), when the selector lever is returned to the normal (in) position.

Windscreen wiper circuit

6. A windscreen wiper is provided for the first pilot only; the control knob is situated below the port instrument panel (Sect. 1, Chap. 1) and has three positions, ON-OFF-PARK. A description of the windscreen wiper components will be found in A.P.1803S, Vol. 1.

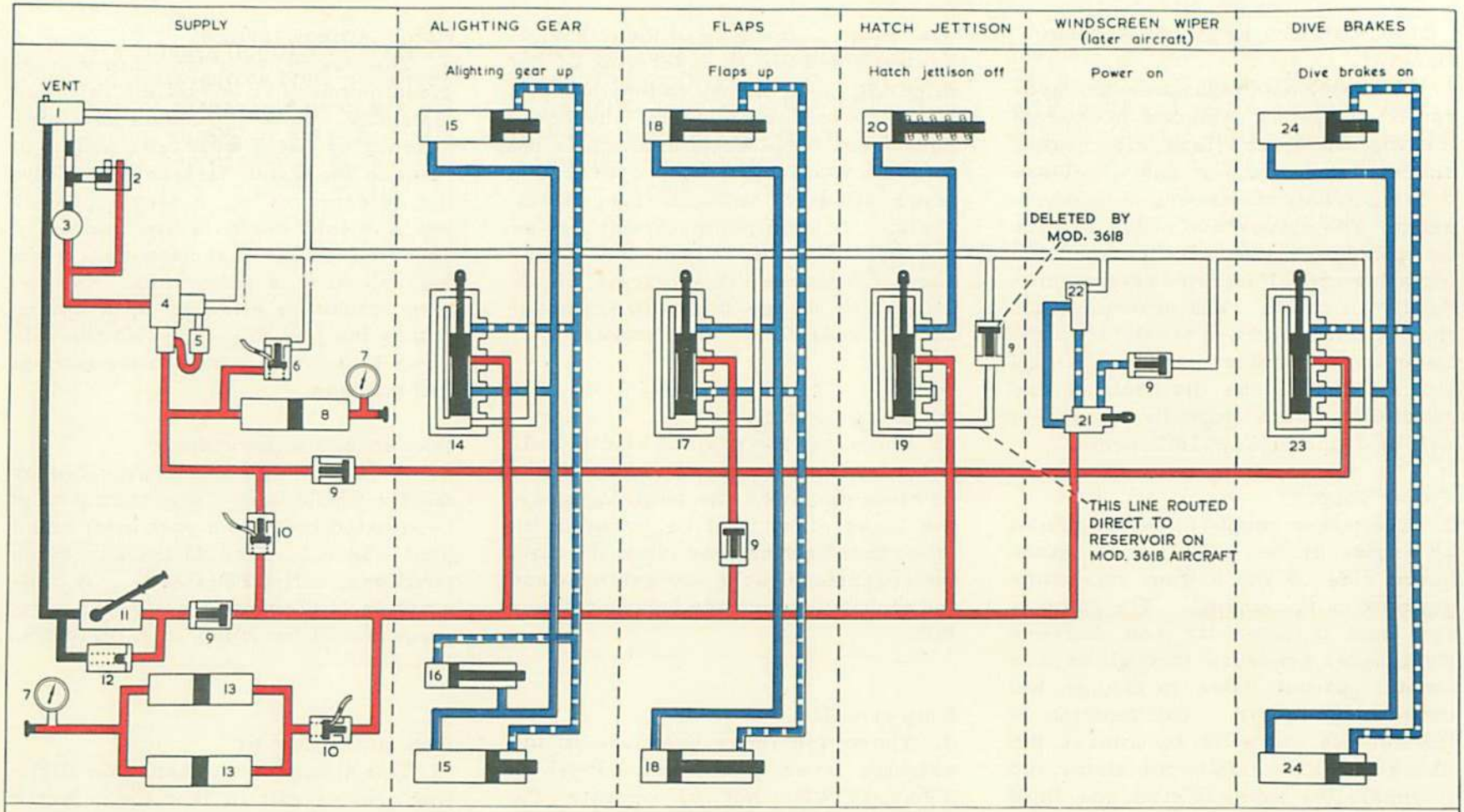
Dive brake circuit

7. This circuit is similar to the alighting gear circuit in that the selector lever quadrants have only the two positions, ON-OFF. The jacks are extended for dive brakes on. Larger diameter pipes are used on this circuit in order to obtain the maximum speed of operation of the brake surfaces.

SERVICING

Reservoir

8. The reservoir has a capacity of



1 RESERVOIR
2 GROUND TEST CONNECTIONS
3 ENGINE-DRIVEN PUMP
4 CUT-OUT VALVE
5 THERMAL RELIEF VALVE
6 MANUALLY-OPERATED MAIN ACCUMULATOR PRESSURE RELEASE VALVE
7 PRESSURE GAUGE (Ground charging) (2)
8 MAIN ACCUMULATOR
9 NON-RETURN VALVES (5) (4, POST 3618)
10 MANUALLY-OPERATED NON-RETURN VALVES (2)
11 HAND PUMP
12 PRESSURE RELIEF VALVE
13 EMERGENCY ACCUMULATORS (2)
14 ALIGHTING GEAR SELECTOR
15 MAIN UNDERCARRIAGE JACKS (2)
16 NOSE UNDERCARRIAGE JACK
17 FLAPS SELECTOR
18 FLAP JACKS (2)
19 HATCH JETTISON SELECTOR
20 HATCH JETTISON JACK
21 WINDSCREEN WIPER SELECTOR
22 WINDSCREEN WIPER MOTOR
23 DIVE BRAKE SELECTOR
24 DIVE BRAKE JACKS (2)

HAND PUMP SUCTION
ENGINE PUMP SUCTION
PRESSURE LINE
RETURN LINE

UNDERCARRIAGE	DOWN
FLAPS	UP
WINDSCREEN WIPER	PARKED
DIVE BRAKES	OFF

UNDERCARRIAGE	UP
FLAPS	DOWN
HATCH	JETTISON
WINDSCREEN WIPER	ON
DIVE BRAKES	ON

Fig. 2 Hydraulic system diagram

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just over 1 gallon, and is situated immediately beneath the rear of the canopy with the filler cap flush with the top surface of the canopy. Fig.8 shows the construction and the positions of the various pipe connections. Fluid returning from the system enters the smaller compartment of the reservoir and then overflows into the larger; in this way a reserve of fluid is always available for the operation of the hand pump.

Engine-driven pump

9. The Lockheed Mk.7 engine-driven pump is of the seven cylinder, radial, fixed delivery, plunger type, and has a maximum fluid output of 720 cu.in. per min. at 3200 r.p.m. and absorbs 7 h.p. approx. under this condition. The inlet and outlet ports of the pump are connected to the suction and pressure lines of the system by Avery self-sealing couplings, the larger coupling being in the suction line. The pump is self-priming by virtue of its position relative to the reservoir, but on no account must the pump be run unless both couplings are connected, as a very high pressure will be generated within the pump and failure will inevitably result. The method of dismantling the pump and details of any servicing which is permitted will be found in A.P.1803B, Vol.1.

Cut-out and thermal relief valves

10. The cut-out valve regulates the operating pressure of the system and it is set to cut-out, i.e. return the pump delivery back to the reservoir, when the accumulators are fully charged. The valve may be adjusted in position on the aircraft provided that a pressure gauge is fitted to the main accumulator; as the valve is sensitive, reference should be made to the pressure gauge after each half turn of the adjuster bolt. The bolt should be screwed in to increase the pressure and must be locked securely after adjustment. In addition to the cut-out valve, a thermal relief valve is positioned between the main accumulator and the return junction of the cut-out valve; the purpose of this valve is to relieve any excess pressure which may build up in the main accumulator as a result of an increase in temperature, and to act as a safeguard in the event of failure of the cut-out valve. The thermal relief valve is set at 3000 p.s.i. and it is not adjustable.

Accumulators

11. The main accumulator (fig.3) mounted beneath the decking of the gun bay, maintains a store of hydraulic fluid at the operating pressure and so ensures the rapid operation of the services. The unit consists of a floating piston within a cylinder which is sealed at both ends. The piston separates the hydraulic fluid on the one side from the air on the other, so that the air is progressively compressed until the operating pressure of the system is reached. Two emergency accumulators, fitted in the nose compartment (fig.4) provide a store of hydraulic fluid at operating pressure for use in an emergency to lower the alighting gear and flaps and operate the canopy fasteners and windscreen wiper; the pressure from these accumulators is fed into the main system by operating a lever in the cockpit. The lever, situated between the seats, actuates, via a Bowden cable, a control valve fitted to the starboard aft face of bulkhead No.2.

Hand pump

12. In the event of the main accumulator becoming exhausted, the hand pump will operate any of the hydraulic services satisfactorily on the ground, provided that there is adequate fluid in the reservoir; a manually-operated non-return valve (fig.3) on the aft face of bulkhead No.2, must be held open if it is necessary to operate the dive brakes on the ground by the hand pump. The suction line to the hand pump is fed from the smaller compartment of the reservoir and the pressure is directed through non-return valves to the selector valves of the various services.

Selector valves

13. The selector valves (fig.9) for the alighting gear, flaps and dive brakes are bolted together and connected side by side on No.2 bulkhead; the fork ends of the plungers project forward through a sealing bracket into the cabin. The selector valve for the canopy hatch jettison is similar, ex-

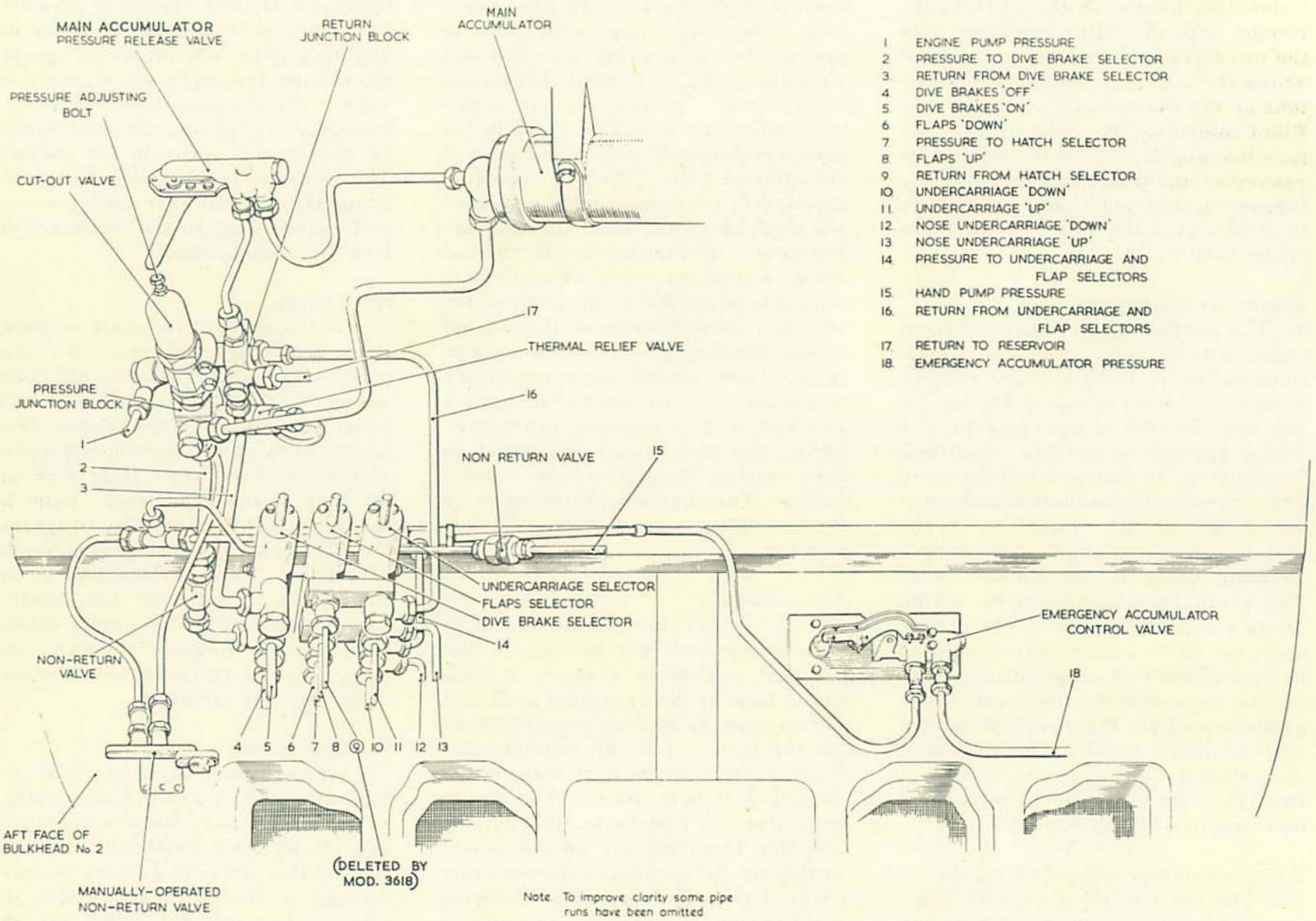

Fig. 3 Hydraulic equipment on bulkhead No. 2

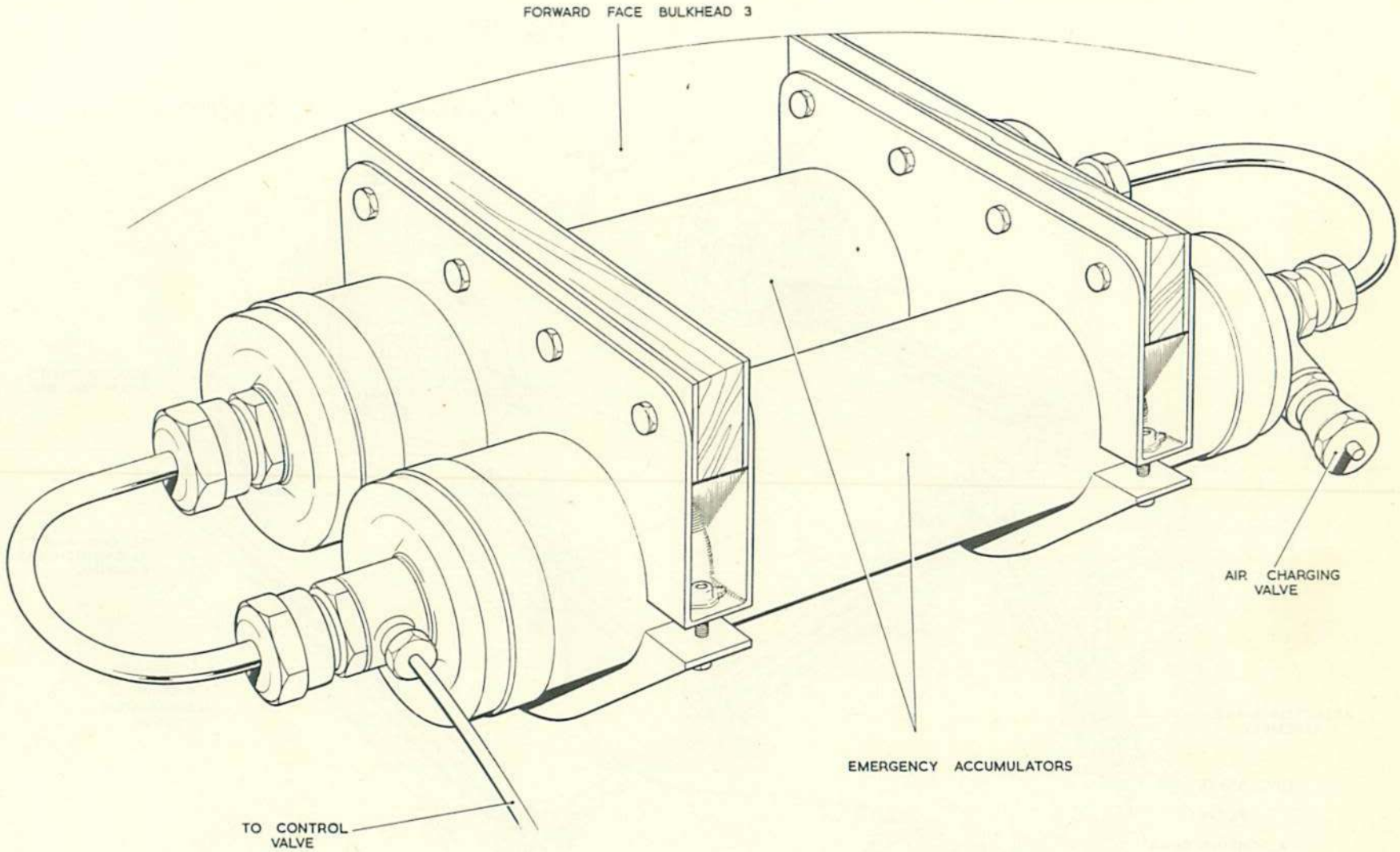

Fig. 4. Emergency accumulator installation

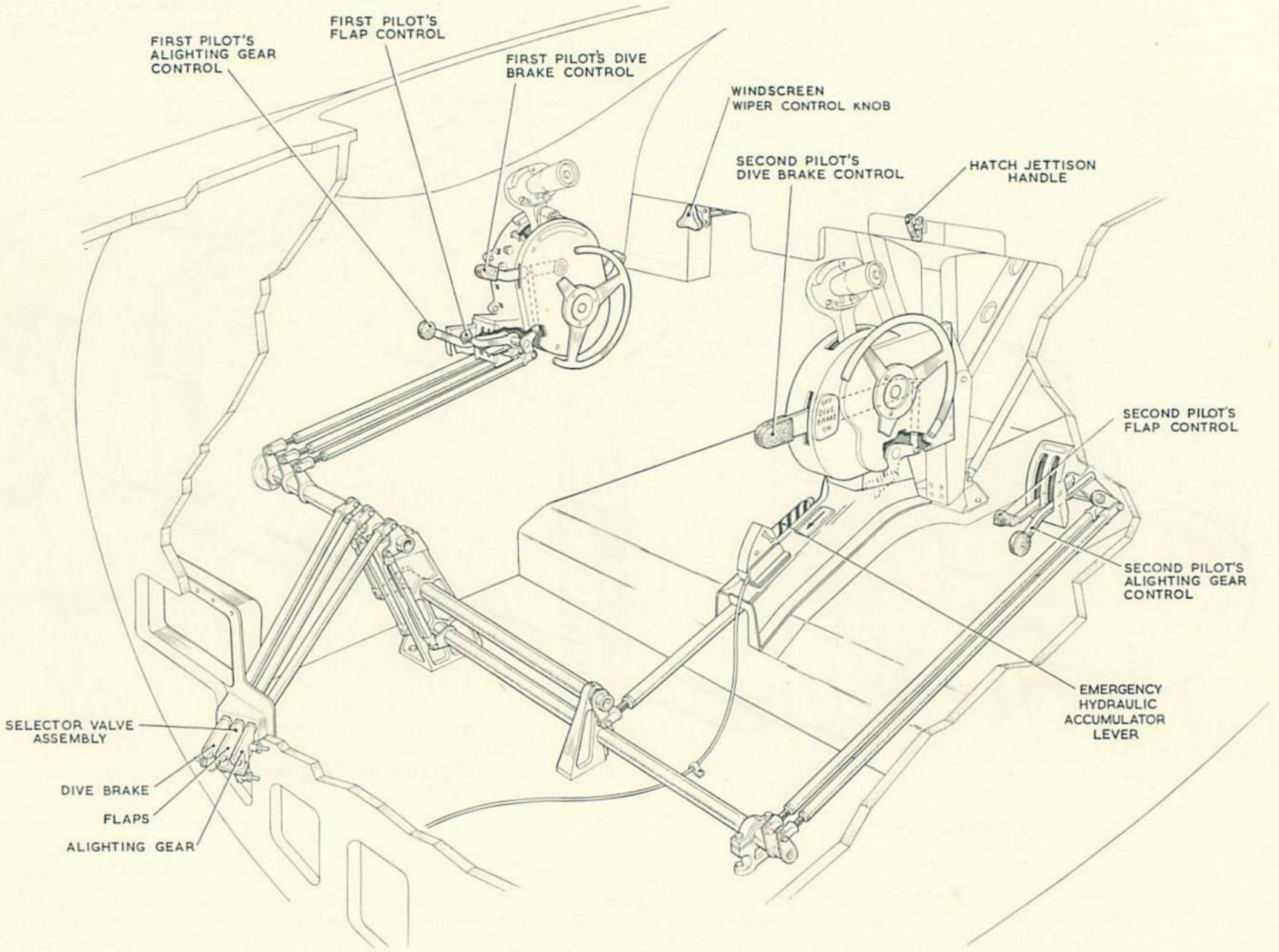

Fig.5 Selector valve controls

cept that one port is blanked off; this valve is mounted on a horizontal member directly behind the instrument panel and linked to the jettison handle by a short connecting-rod (fig. 10).

Adjusting the selector valves

14. The procedure for adjusting the various selector valves (fig. 5) is as follows :-

(1) Alighting gear: Depress the valve plunger of the outboard of the three selector valves so that the fork end is bearing against the gasket nut. Adjust the eye end of the connecting-rod so that the alighting gear selector lever is almost against the upper end of the quadrant slot. Move the selector lever fully down and check that a travel of approximately 1 in. is obtained on the valve plunger; this may be measured with a depth gauge applied at the rear end of the selector valve ensuring that the measurement includes the amount by which the plunger recedes into the selector body.

(2) Flaps: As the flaps have a neutral setting, the valve plunger should be extended $\frac{1}{2}$ in. and the connecting-rod adjusted to the valve plunger when the selector lever is in the NEUTRAL position. Check that the overall movement of the valve is 1 in.

(3) Hatch jettison: Adjust the selector valve in position before it is bolted finally to the bracket so that, with the piston retracted solidly in the off position, there is a minimum gap of 0.03 in. between the housing bush and the connecting-rod flange. Lock the handle in the off position with 26 S.W.G. locking wire, passed round the handle to the housing attachment bolt.

(4) Dive brakes: The procedure for the dive brakes is similar to that described in sub-para. (1), except that the length of the connecting-rod is adjusted so that the selector valve is almost against the lower end of the quadrant slot.

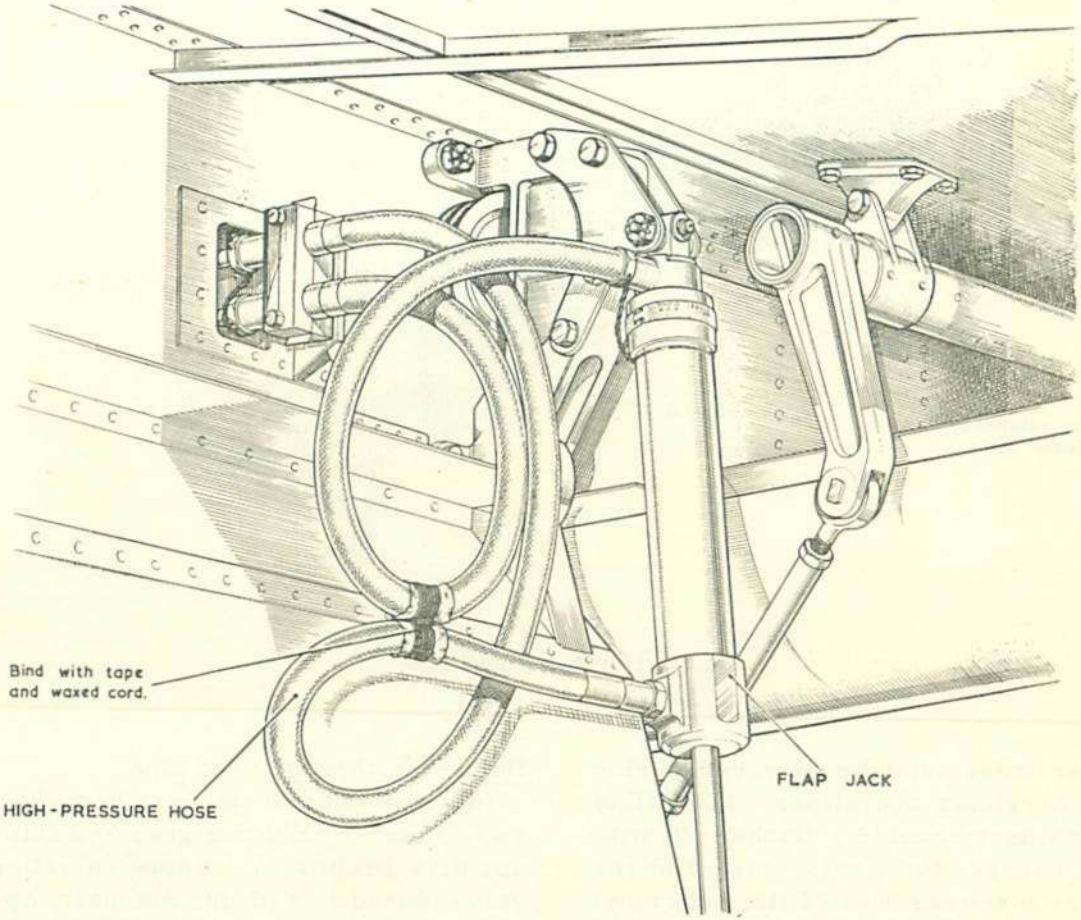

Fig. 6 Flap jack installation

Filling and priming

15. The following servicing instructions cover the system as a whole. If, for example, a single jack has been serviced or replaced, it will be necessary only to carry out the instructions in so far as they affect that particular unit or circuit. Scrupulous

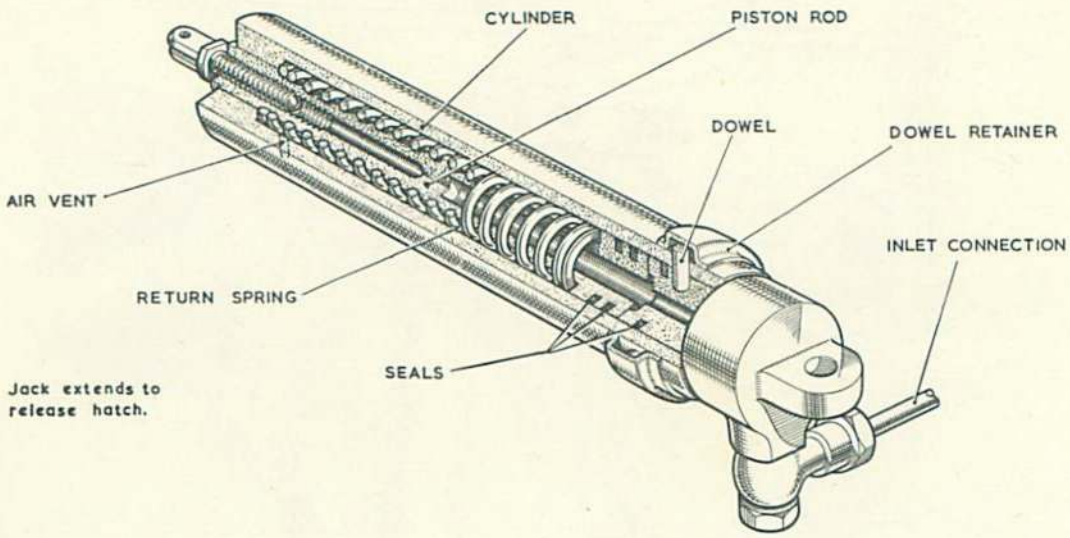

Fig. 7 Hatch jettison jack

cleanliness must be observed during all servicing operations. The fluid containers should be flushed out with the correct fluid before use and the filter in the reservoir filler neck must always be in place. Care should be taken to avoid spilling the fluid as it has an injurious effect upon most aircraft finish. The procedure for filling and priming the system is as follows:-

(1) With the aircraft on jacks, remove the canopy and select alighting gear and flaps down, dive brakes out, and canopy selection valve open.

(2) Inflate main and emergency hydraulic accumulators to 1250 p.s.i. air pressure and inspect for leaks.

(3) Fill hydraulic reservoir until fluid runs through vent pipe.

(4) Set control levers in cockpit as follows:- Alighting gear and flaps up, dive brakes in, canopy selection valve closed. With the manually operated non-return valve in the hand pump pressure line held open, work the hand pump until all jacks are fully operated.

(5) Set control levers in the cockpit as follows:- alighting gear and flaps down, dive brakes out, canopy selection valve open. With the manually operated non-return valve in the hand pump pressure line held open, pump on the hand pump until all jacks are fully operated.

(6) Top up hydraulic reservoir to the FULL mark indicated on the window.

WARNING

This FULL mark indicates the quantity of fluid required in the system when the main accumulator oil pressure is released. It is therefore important to release this pressure through the main accumulator pressure release valve (fig. 3) before filling or topping-up the reservoir.

Replacement of jacks

16. When a replacement jack has been installed it should be operated fully by the hand pump. The stroke of each jack should be within the limits below:-

Main undercarriage	5.25 in. ±0.015 in.
Nose wheel	4.8 in. ±0.02 in.
Dive brakes	5.25 in. ±0.015 in.
Flaps	7.0 in. ±0.015 in.
Canopy fastener	2.0 in. ±0.015 in.

If satisfactory, release the main accumulator pressure and replenish the reservoir. The fork end of the piston rod may now be connected and final adjustments made prior to the functional tests.

Functional tests

17. Functional tests should be made as follows:-

(1) With the manually operated non return valve in the hand pump pressure line held open, using the hand pump,

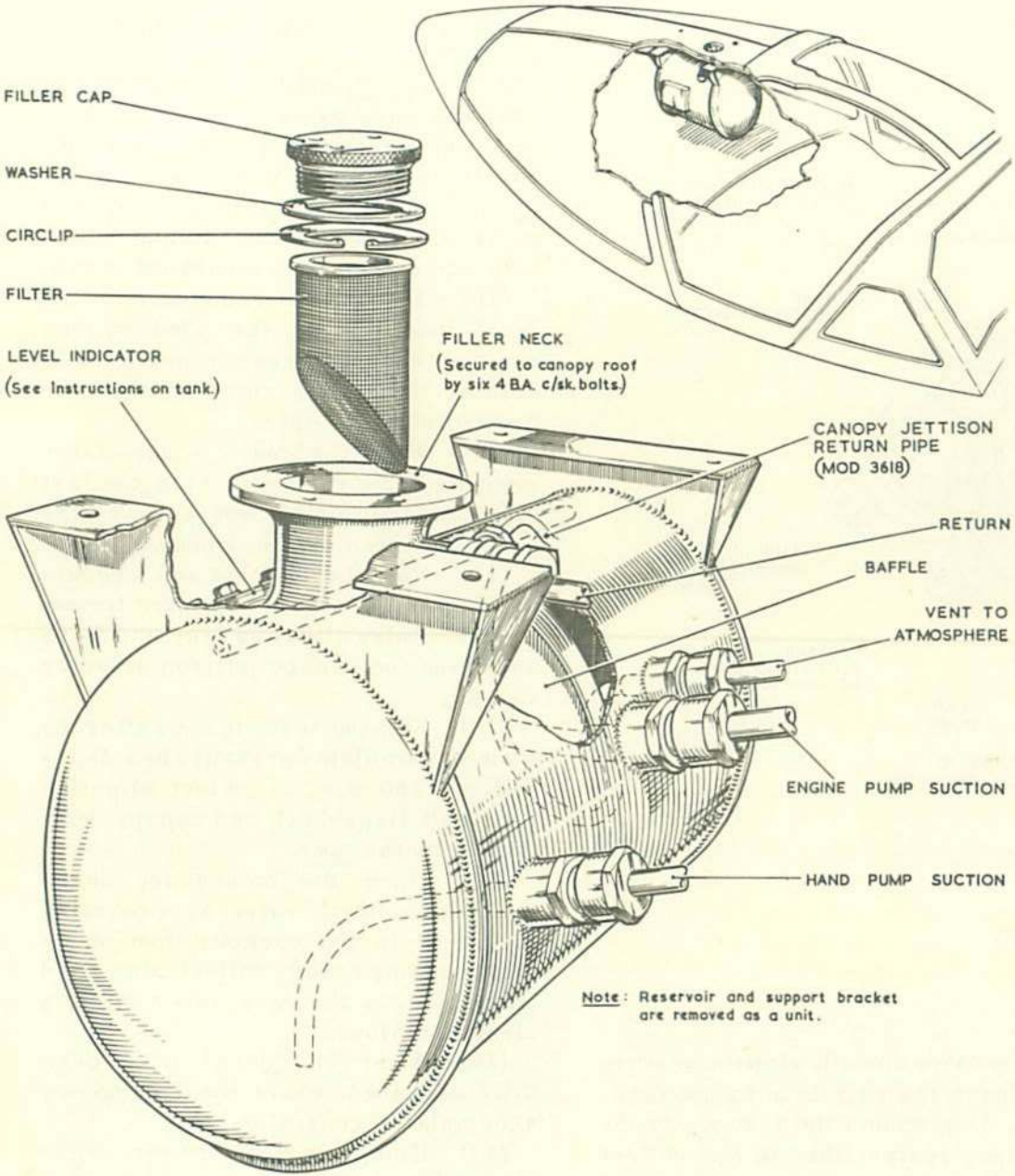

Fig. 8 Reservoir

pressurise the emergency hydraulic accumulators to 2500 p.s.i. ± 150 p.s.i.

(2) Top up the hydraulic reservoir to the "FULL" mark indicated on the window.

(3) Remove the blanking caps and couple up the test rig hoses to the test connections (fig. 1) on the lower port side of the firewall. Run the test rig for two minutes holding the main accumulator pressure release valve open.

(4) With the pressure gauge attached to the Turner charging adapter on the main accumulator, adjust the cut-out valve (para. 10) to cut out within the pressure limits given in the Leading Particulars. Wire lock the adjuster bolt if this has to be reset. With the test rig pump running at 1400-1500 r.p.m. and all services static, the valve should not cut in for at least one minute after cutting out.

(5) Raise and lower the alighting gear five times and check the position indicator lights. The operational times for up or down are between two and five seconds.

(6) Operate the flaps three times checking the position indicator in the cabin and the operational times:- down, nine to fourteen seconds; up, eleven to sixteen seconds. Select flaps DOWN and, when the cabin indicator records 30 deg., move the selector lever to NEUTRAL. Leave the pump running for three minutes during which time the flaps should not move.

(7) Operate the dive brakes three

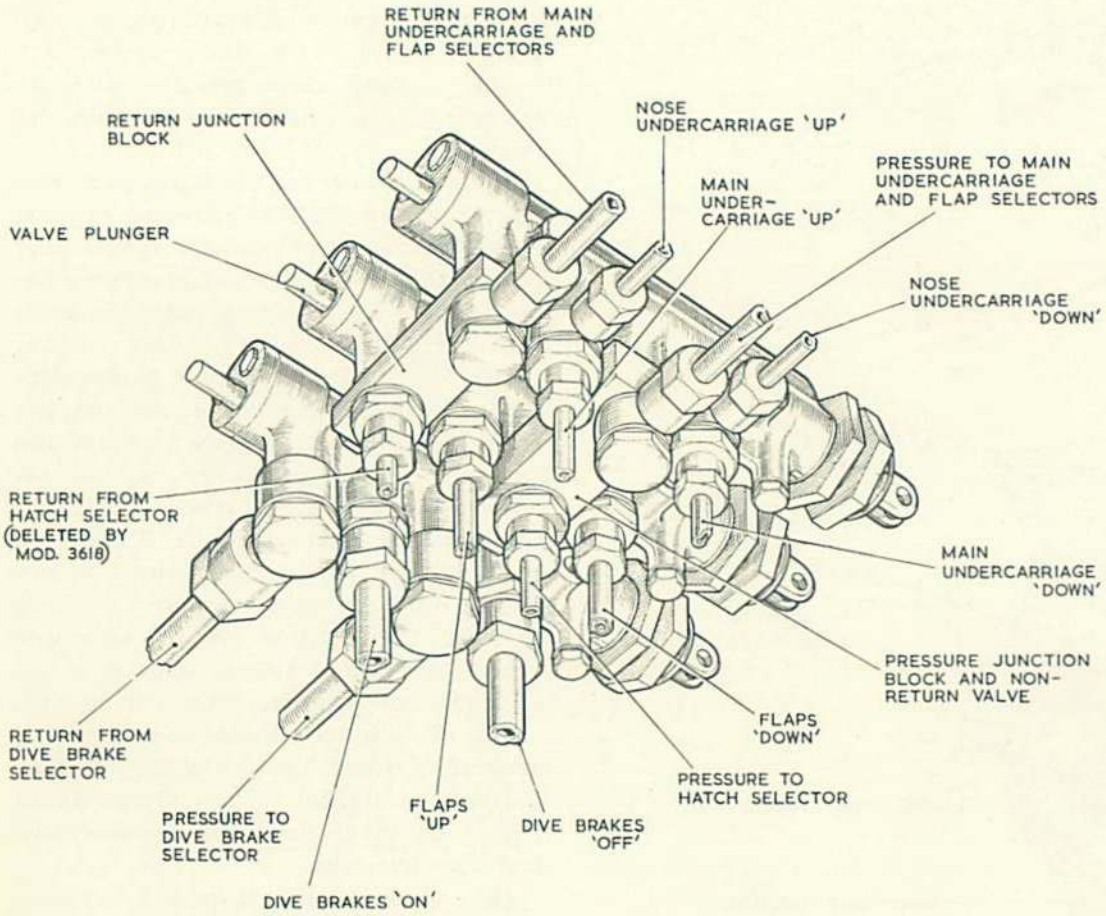

Fig. 9 Selector valve assembly

times and check that they move on or off in about one second.

(8) Operate the canopy jettison jack three times.

(9) With the alighting gear and flaps up, the dive brakes off and the canopy selector valve closed, stop the test rig and release the main accumulator pressure. Disconnect the test rig pressure line, restart the rig and collect the oil flowing from the test rig pump in a clean container. When the flow ceases, stop the rig and reconnect the pressure line. Select alighting gear and flaps down and lower the alighting gear and flaps by using the hand pump and continue pumping until maximum resistance is felt. Select dive brakes on and maintain pressure on the hand pump for two minutes, during which time the dive brakes should not move.

(10) Top-up the reservoir to the level indicated on the window, and run the test rig for two minutes while holding the main accumulator pressure relief valve open.

(11) With the main accumulator pressure now released, stop the test rig and top-up the reservoir to the level indicated on the window.

(12) Run the test rig and operate the alighting gear and flaps five times.

(13) Raise alighting gear and flaps and close the canopy jettison selector valve.

(14) Stop the test rig and, after the main accumulator pressure has dropped to 1250 p.s.i., select alighting gear and flaps down and canopy jettison selector open.

(15) Open the emergency accumulator control valve by operating the lever in the cockpit, then operate the flaps and collect the fluid flowing from the reservoir vent in a clean container.

(16) After the jacks have been fully operated, close the emergency accumulator control valve.

(17) Using the hand pump, pressurise the emergency accumulators to 2500 p.s.i.

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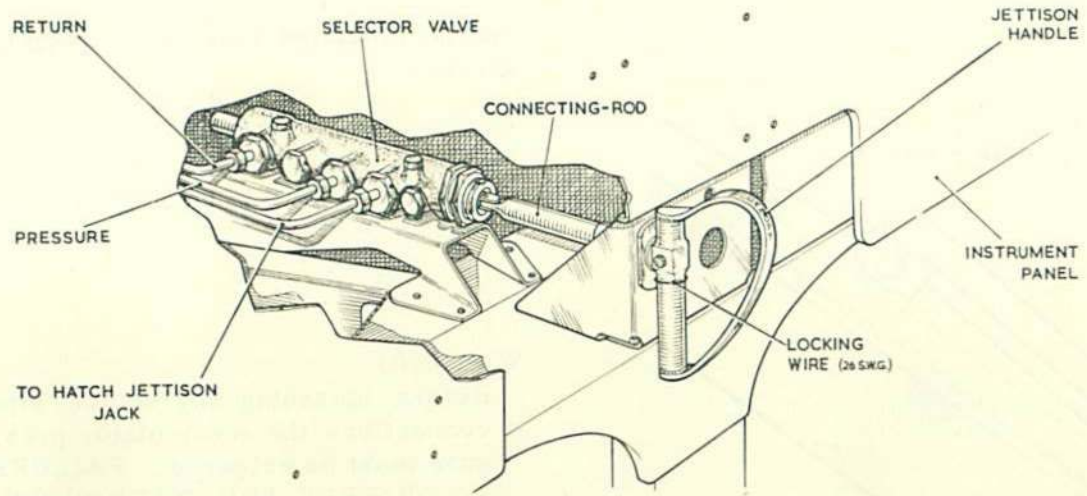

Fig. 10 Hatch jettison selector

(18) Top-up the reservoir to the level indicated on the window.

(19) Refit the canopy and reconnect the canopy jettison jack.

Windscreen wiper tests

18. With hydraulic supply available at operating pressure, select PARK and check that the blade parks firmly at the edge of the windscreen, then proceed as follows:-

(1) Lubricate the screen with clean water, select wiper ON and slowly increase speed: care must be taken when increasing speed that the screen is covered with water all the time.

Note...

Under no circumstances must the wiper be operated on a dry windscreen for even one sweep; minute score damage weakens toughened glass. Dust or dirt on the windscreen must be washed off with clean water before the wiper is operated.

(2) Operate the complete sequence, i.e., PARK-OFF-ON, five times, taking care to change slowly from PARK to ON, and check that the wiper operates smoothly and correctly according to selection.

(3) Check that the word PARK on the knob is at the top and the arrow vertical when the control valve is set to the PARK position.

(4) Ensure that the cavities in the seal are kept adequately packed with anti-freeze grease to prevent loss of cabin pressure, and that the clearance on the wiper arm shown on fig. 11 is maintained.

Leakage

19. Leakage in the system, which may be either internal or external, will cause erratic functioning of the cut-out valve and the services. Firstly, all pipe connections which are known to have been recently dismantled, also the jack piston rods and selector valve plungers should be examined for external leaks, then if no sign of external leakage is visible, the various items of equipment should be checked for internal leaks in the following order:-

(1) Main accumulator pressure release valve: Depress the valve manually several times to clear a possible foreign body from the valve seat. If ineffective, dismantle the valve in accordance with A.P.1803B.

(2) Thermal relief valve: Refer to A.P.1803P for the remedy.

(3) Cut-out valve: Refer to A.P. 1803B for the remedy.

(4) Jacks: Place all selector valves in the mid-position to isolate the pipe lines to the jacks. If the pressure now remains constant, the leakage must be either in one of these pipe lines or in one of the jacks. Check each circuit in turn to locate the fault. If the jack is suspected, dismantle it in accordance with A.P. 1803B.

REMOVAL AND ASSEMBLY

General

20. The sequence of operations for the removal of any of the hydraulic components will be clearly apparent when the items are viewed on the aircraft

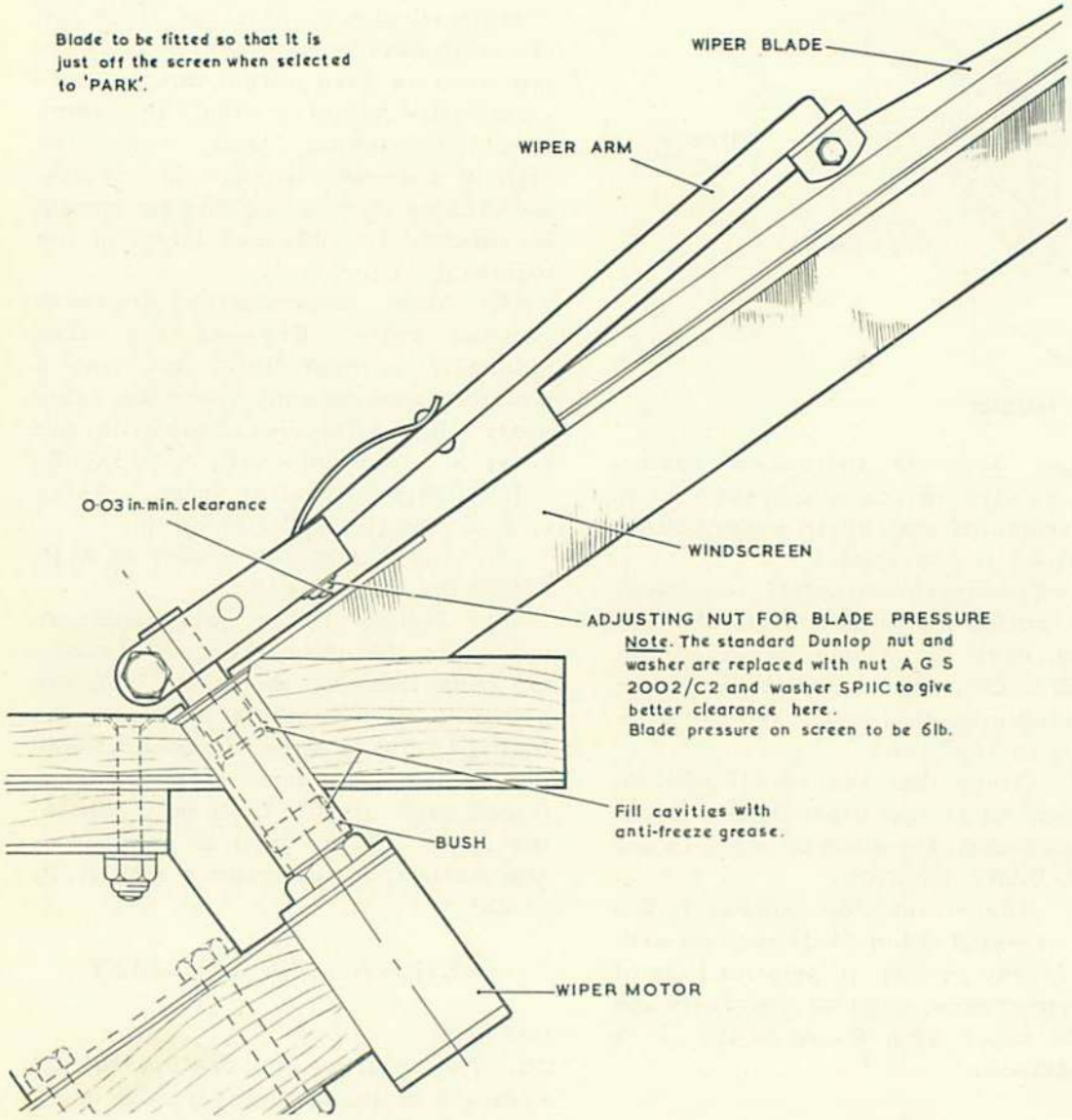

Fig.11 Windscreen wiper fitting, pre mod 3617

and no tabulated instructions will be given.

WARNING

Before loosening any of the pipe connections the accumulator pressure must be released. FAILURE TO OBSERVE THIS INSTRUCTION MAY RESULT IN SERIOUS INJURY.

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21. All disconnected pipe ends and adapters must be sealed with adhesive tape or other protective material to prevent the ingress of foreign matter. When connecting a pipe, care must be taken to avoid damaging the flared joints by overtightening; the union nut should be screwed on to the adapters (after the flare, collar and adapter have been cleaned) until resistance is felt; another 1/16 of a turn should be sufficient to hold the fluid under pressure. If leakage persists, the joint should be disconnected and examined for scoring or cracks, and renewed as necessary.

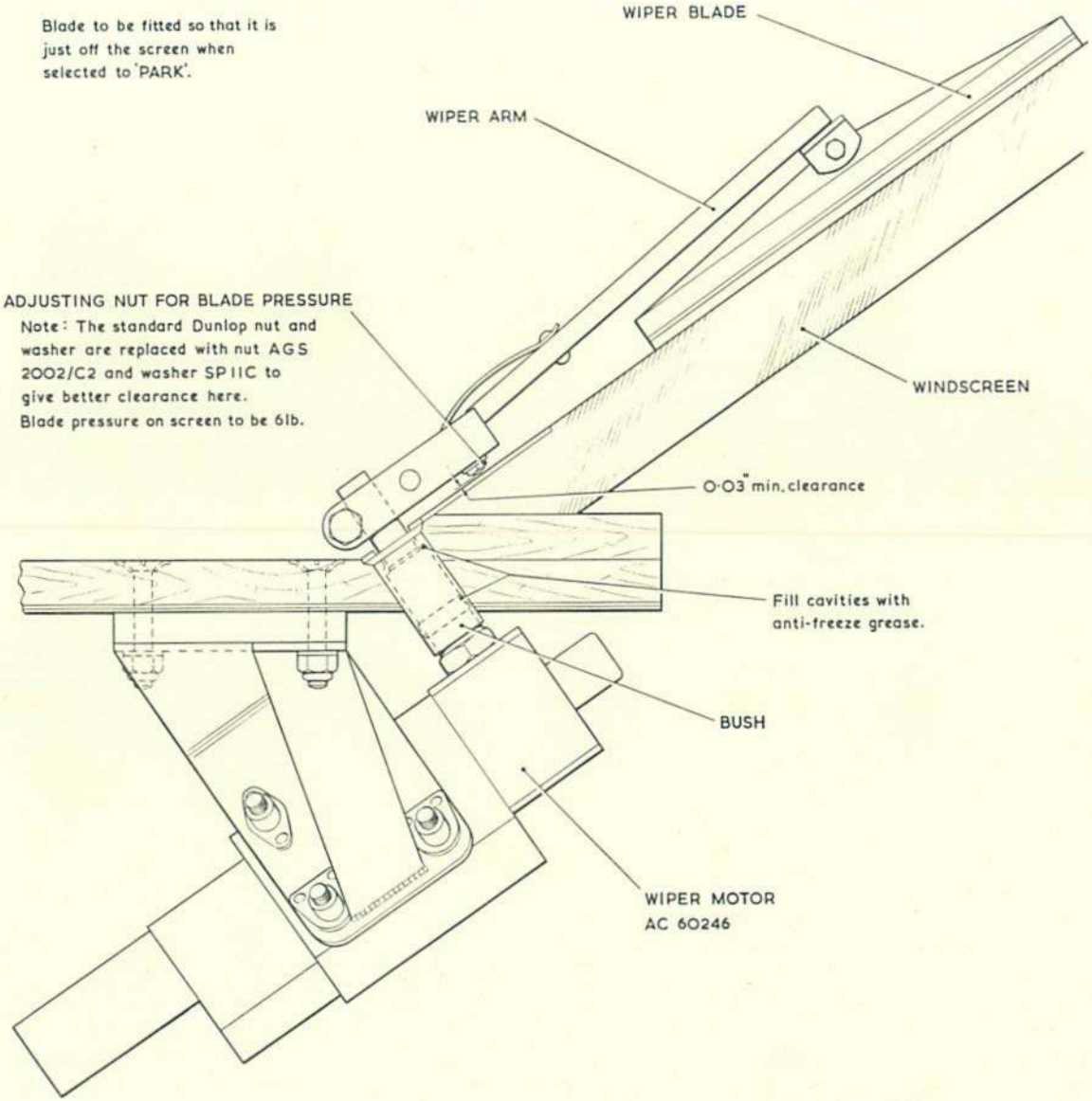

Fig.12 Windscreen wiper fitting, post mod 3617

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