Chapter 6 HYDRAULIC SYSTEM

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION AND OPERATION

Introduction

1. A Lockheed high pressure hydraulic system, whose fluid specification and operating figures are tabulated in the Leading Particulars, actuates the retractable alighting gear, flaps and dive brakes, and also supplie pressure for the power assisted aileron control installation, a detailed description of which will be found in A.P.4602A, Vol. 1. The layout of the entire system is shown diagrammatically in fig. 1 and the location of all the principal components is illustrated in fig. 2. A comprehensive list of component part numbers is included later in this chapter, thus facilitating reference to A.P.s 1803B and 1803P which cover all Lockheed and U.M.C. (Undercarriage Manufacturers Committee) items, except the servodynes. Fig. 4, which illustrates the reservoir, is considered to be self explanatory and no additional description is therefore necessary.

Power circuit (*fig. 1*)

2. Under normal conditions, the pressure supply is derived from an engine-driven pump (*item* 2) situated low down on the port side of the wheel case. In an emergency, the supply is obtained from a hand pump (*item* 9) located on the port side of the pilot's seat. The head of fluid is contained in a reservoir (*item* 1) mounted on the decking in the aft portion of the canopy, immediately behind the pilot's head.

3. The engine-driven pump draws fluid from the reservoir and delivers it at high pressure to the inlet connection of an automatic cut-out valve (*item* 3). From the cut-out valve, the delivery line connects :—

(1) via a manually-operated pressure-release valve (*item* 5), to the return line.

(2) via the two accumulators (*items* 6 *and* 7), to the aileron circuit selector (*item* 26).

(3) via a manually-operated by-pass valve (*item* 11), to the alighting gear and flaps selectors (*items* 16 *and* 19).

(4) direct to the dive brakes selector (*item* 22).

◀A flow warning indicator causes an audio warning note to sound in the pilot's earphones in the event of failure of the hydraulic pump, and a pressure switch energises a warning lamp if the aileron circuit should fail or the selector valve be set to MANUAL (*in*).▶

Component location and function

4. The automatic cut-out valve and the two accumulators are secured to the bottom of the gun bay decking ; the manually-operated release valve is attached to the underside of the cabin rear floor ; the alighting gear, flaps and dive brakes selector valves are bolted together as one unit and mounted outboard of the by-pass valve (*item* 11) on the port lower rear face of bulkhead No. 2. Access to all these components is obtainable by removal of the gun bay doors. The selector for the power assisted aileron circuit is located in the cabin on the port main instrument panel.

5. The cut-out valve restricts the system operating pressure to a pre-determined maximum, by-passing excess fluid via an idling circuit back to the reservoir. The two accumulators, which are charged with compressed air via their individual charging points on the starboard lower rear face of bulkhead No. 2, store fluid at system operating pressure to ensure rapid function of the services when selected and also act as system shock absorbers. Each accumulator ▶◀ comprises a cylinder containing a floating piston which separates the air on its one side from the hydraulic fluid on the other. Operation of the release valve (*item* 5) enables hydraulic pressure to be exhausted simultaneously from ◀the main▶ accumulator and from all circuits except that for the ailerons. The hydraulic pressure in the aileron circuit together with ◀the aileron▶ accumulator pressure may only be released by moving the control column handle from side to side with the selector in the power ON position, i.e., *out*. Manipulation of the by-pass valve lever permits the ground testing of all services using the hydraulic hand pump as described later. In addition to the foregoing, two non-adjustable thermal relief valves, each set to relieve at 3,000 lb., per sq. in. are incorporated in the system, one (*item* 4) being connected between the delivery outlet and the return or idling outlet of the cut-out valve, and the other (*item* 27) in the aileron circuit between the selector and servodyne supply and return lines. The thermal relief valve (*item* 4) can also act as a safety valve in the event of cut-out failure.

6. Non-return valves are interposed in the delivery line between the cut-out and each selector ; items 8, 12 and 20 are fitted in the lines to the ailerons, dive brakes and flaps selectors respectively, whilst a by-pass valve (*item* 11) performs this function in the relevant section of the alighting gear circuit. A further non-return valve (*item* 10) is situated in the delivery line from the hand pump (*item* 9), which also communicates with the engine pump delivery to the alighting gear and flaps, on the outlet side of the by-pass valve.

7. Referring to fig. 1, it will be seen that the location of the non-return valve (*item* 8), allows pressure from both accumulators to be applied to the aileron circuit, whilst permitting that from ◀the main▶ accumulator *only* to energise the remaining hydraulic services. Consequently, when the release valve (*item* 5) is opened by hand, only the hydraulic pressure in that portion of the system served by ◀the main▶ accumulator is exhausted. In addition, from fig. 1 it will be seen that, under normal flight conditions, the manually operated by-pass valve performs the same function as a normal non-return valve, as previously stated (*para.* 6), all circuits being operated by the engine-driven pump. In the event of failure of this source of hydraulic power in flight, the spring loading will return the by-pass valve on to its seating where it will remain, should the hand pump be operated, due to the reversed direction of fluid pressure. In this manner, the hand pump supply is restricted to the alighting gear and flaps circuits only, the ailerons under these circumstances being mechanically operated direct from the control column handle as described later, the dive brakes being completely inoperative. The capacity of ◀the main▶ accumulator is sufficient to lower the undercarriage and flaps *once* only.

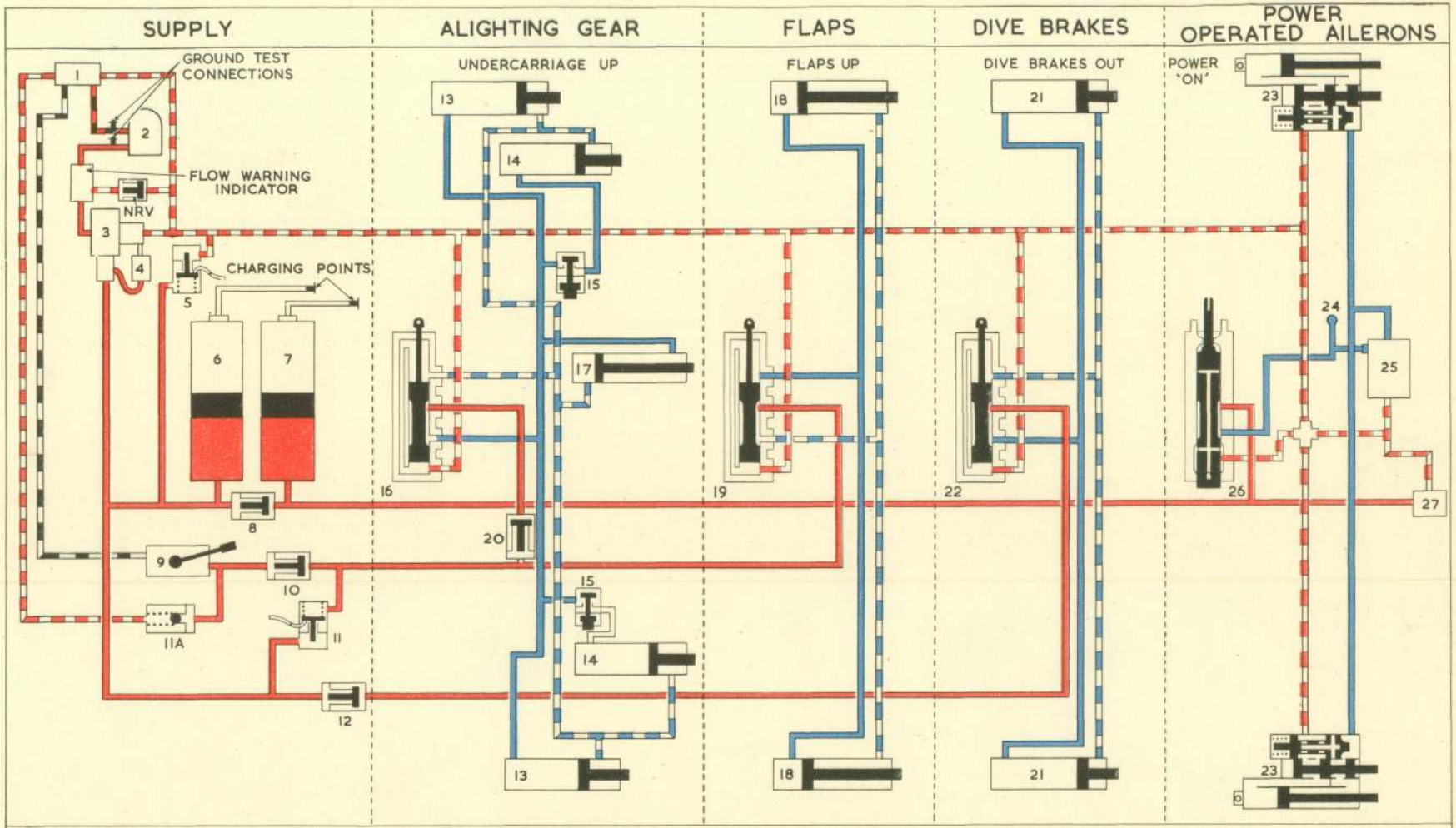
8. The hydraulic hand pump can be used for ground testing any of the services however, *provided that the manually-operated by-pass valve situated on the port rear face of bulkhead No. 2 is held open.* Failure to comply with this instruction on aircraft *not* embodying Venom Mod. 553 will result in serious damage and failure of one or more hydraulic components or attached mechanisms, due to the excessive pressures obtainable without difficulty by this pump. Where this modification has been embodied, however, a pressure relief valve (*item* 11*a*) has been introduced into an additional line, connecting the hand pump delivery to the reservoir, to restrict the fluid supply to a safe working figure ; therefore, it will be unnecessary to hold the manually-operated by-pass valve open, except for the operation of the dive brakes or ailerons, from which circuits the hand pump is normally isolated. Movement of the services selected may not be immediate when this pump is used, due to some of the fluid supply being absorbed by the accumulators.

Alighting gear circuit (*fig. 1*)

9. The alighting gear circuit is controlled by a two-position lever, which protrudes through the aft face of the pilot's engine control box on the port side of the cabin. The *up* line from the selector valve passes directly to the anchored end of each main undercarriage jack (*item* 13), to the piston-rod end of the nose undercarriage jack (*item* 17), and, via a sequence valve (*item* 15), to the anchored end of each main undercarriage door jack (*item* 14), the *down* line being connected to the opposite ends of all these jacks. Thus, when the alighting gear is *up*, the jack for each main undercarriage and its respective door is extended and that for the nose undercarriage is retracted. Fluid is unable to enter and extend the door jacks when the *up* selection is made, however, until their relevant sequence valves are mechanically operated by a striker fitted on their respective radius rod mechanisms, i.e., after the *down* locks are broken and each undercarriage has started to retract.

Flaps circuit (*fig. 1*)

10. The selector lever for the flaps circuit is mounted adjacent to the alighting gear lever on the pilot's engine control box, and has three positions, UP-NEUTRAL-DOWN. The *down* line in this circuit connects directly from the selector to the anchored end of each



1. RESERVOIR
2. ENGINE-DRIVEN PUMP
3. CUT-OUT VALVE
4. THERMAL RELIEF VALVE
5. PRESSURE RELEASE VALVE
6. MAIN ACCUMULATOR
7. AILERON ACCUMULATOR
8. NON-RETURN VALVE
9. HAND PUMP
10. NON-RETURN VALVE
11. BY-PASS VALVE
11A. PRESSURE RELIEF VALVE
12. NON-RETURN VALVE
13. MAIN U/C JACK
14. U/C DOOR JACK
15. SEQUENCE VALVE
16. ALIGHTING GEAR SELECTOR
17. NOSE U/C JACK
18. FLAP JACK
19. FLAP SELECTOR
20. NON-RETURN VALVE
21. DIVE BRAKE JACK
22. DIVE BRAKE SELECTOR
23. SERVODYNE
24. PRESSURE SWITCH
25. FLOW SURGE RESTRICTOR
26. AILERON SELECTOR
27. THERMAL RELIEF VALVE

CAUTION. The pressure release valve operates only on the main accumulator. Pressure in the aileron accumulator is released by operating the control column with the aileron selector 'ON'

HAND PUMP SUCTION LINE
ENGINE PUMP SUCTION LINE
PRESSURE LINE
RETURN LINE
ALIGHTING GEAR ... DOWN
FLAPS ... UP
DIVE BRAKES ... IN
ALIGHTING GEAR ... UP
FLAPS ... DOWN
DIVE BRAKES ... OUT
AILERONS POWER ... ON

Fig.1 Hydraulic system diagram

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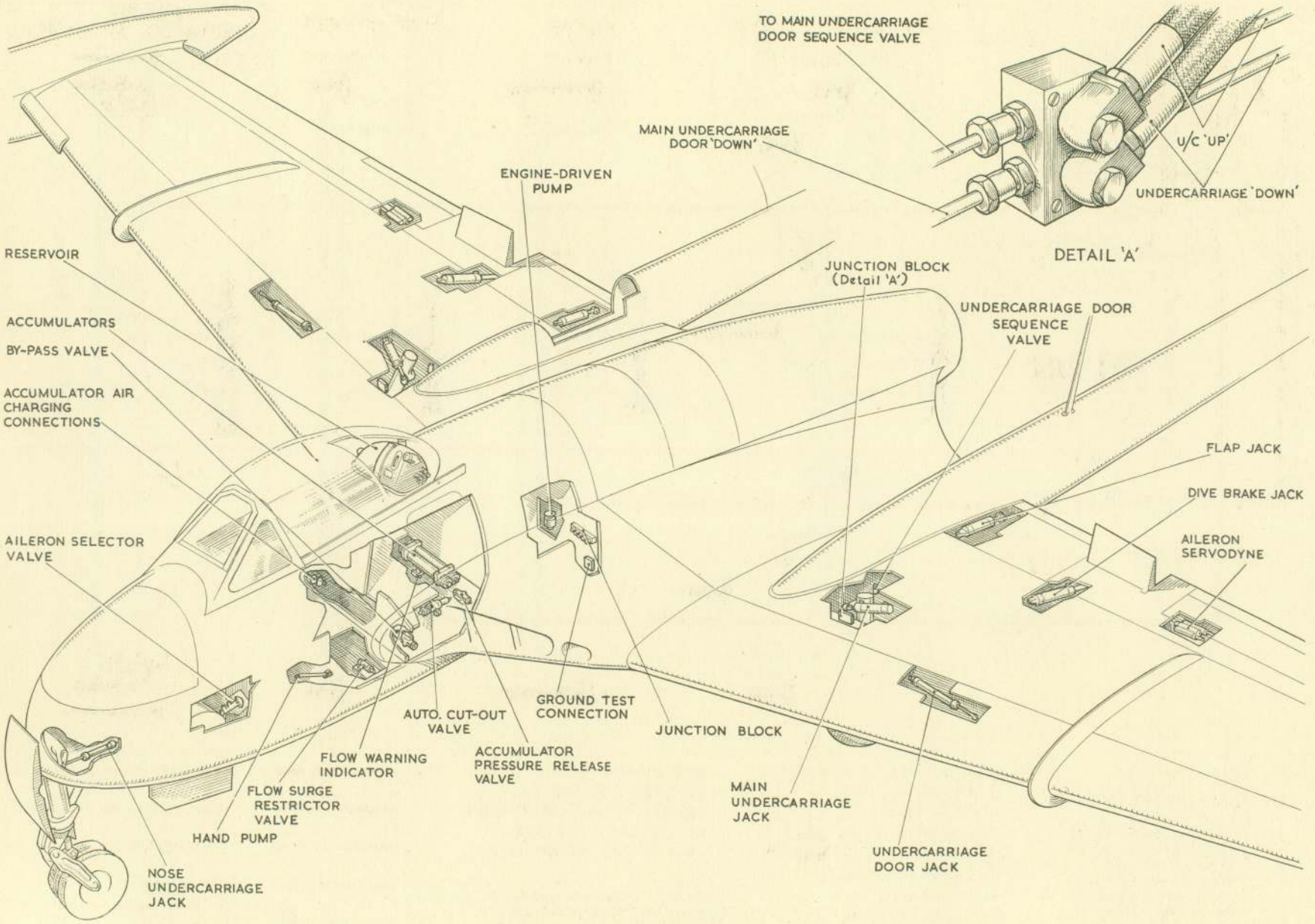

Fig.2 Disposition of hydraulic components

jack (*item* 18), thus extending the jack when the flaps are lowered. The arrangement of the selector mechanism is such, that any angle within the flap range can be selected and maintained by returning the lever to NEUTRAL immediately the required degree of flap movement has been obtained. Under these circumstances, an effective hydraulic lock is created in the relevant section of the circuit connecting the selector valve with the flap jacks. The cabin lever should also be returned to NEUTRAL after a full DOWN selection has been made. If the flaps are to be kept closed in flight however, it is essential to leave the selector lever in the UP position, to prevent them drooping under the influence of aerodynamic loads.

Dive brakes circuit (*fig.* 1)

11. The two-position, IN-OUT, dive brakes selector lever is on the aft face of the engine control box and is mounted adjacent to the flap lever. The *out* line is coupled directly between the selector valve and the anchored end of each dive brake jack (*item* 21) to extend the jack when OUT is selected. To ensure maximum speed of dive brake operation, large-bore pipe is used throughout the dive brake circuit.

Power operated ailerons circuit (*fig.* 1)

12. The hydraulic installation for the operation of the ailerons under high Mach number conditions, is controlled from a two position, MANUAL (*in*) POWER ON (*out*) selector valve (*item* 26) mounted low down on the port main instrument panel. The pilot is able to operate the ailerons, with or without the assistance of power from the hydraulic system, by pulling the selector *out* for POWER ON or pushing it *in* for POWER OFF or MANUAL, then rotating the handle ◄ anti-clockwise to lock the valve for POWER ON and clockwise for MANUAL (*fig.* 6). ►

13. From the selector valve, the pressure supply and return lines connect to two servodyne units (*item* 23) located one on each main plane rear spar adjacent to the inboard aileron hinge. The supply line incorporates a pressure switch (*item* 24) and a flow surge restrictor valve (*item* 25), which is also connected to the return line. Each servodyne unit comprises three major components:— (1) a spring-loaded *on-off* valve, (2) a selector plunger and (3) a servo piston, all of which are housed in separate ported cylinders within the common unit body. Fluid entering the unit passes to each of these components in the order listed.

14. The mounting of both servodynes and the arrangement of their respective control runs and aileron operating mechanisms is identical (*fig.* 3). The operating mechanisms are attached to an eye end formed on the unit body, whilst the exposed end of each servo piston ram is pivot-mounted on the rear spar. The ram of the selector plunger, which protrudes adjacent and parallel to that of the servo piston on the outboard side of each unit, is linked by a connecting-rod to a sprocket and lever assembly (*Sect.* 3, *Chap.*4). Movement of the control column handle is transmitted to both the latter assemblies through a chain and cable run (*Sect.* 3, *Chap.* 4), which is basically similar to the conventional flying control system, and from these, via the attached connecting-rods, to the servodyne selector plungers.

15. *POWER ON.* The cabin selector valve (*fig.* 6) is pulled *out* and locked at POWER ON, the flow restrictor valve preventing control column 'snatch' if the selection is made in flight. The fluid pressure applied at the selector plungers overcomes the spring loading of the servodyne *on-off* valves forcing them on to their seatings. Operation of the control column handle causes the plungers to open ports communicating with the servo-piston chambers, directing hydraulic pressure to the appropriate sides of the pistons and connecting their opposite sides to the return lines. The pressure differential so formed in the servo chambers causes the servodynes to move bodily over their stationary pistons and selector plungers in the same direction as that in which the plungers were initially moved by the control column. Movement continues until the plunger supply and return ports are closed and the pressures on each side of the servo-pistons are balanced, i.e., when the degree of aileron movement which would normally have been applied by an unassisted control column movement has been reached. In this manner, the ailerons are hydraulically-locked in their new positions until the column handle is again operated. It will be appreciated that the above operations occur simultaneously and the movement of the control column handle and the ailerons under powered conditions is completely synchronised.

16. *POWER OFF.* If the manual selector valve is pushed *in* and locked at POWER OFF or MANUAL, or if the fluid pressure falls below 1,400 lb. per sq. in. the automatic *on-off* valve in each servodyne will be held by its spring in the open position, allowing an unrestricted fluid flow from one side of its servo piston to the other. The unit body and its attached aileron is thus permitted to be moved mechanically by the direct pressure of the selector plunger against the relevant end of its servodyne chamber. The small amount of 'dead travel' of the plunger, as it moves from one end of the chamber to the other, results in a certain amount of backlash in the control. Under POWER OFF conditions, the pressure switch located adjacent to the manual selector valve operates a warning lamp (*Sect.* 1, *Chap.* 3) and at the same time completes an electrical circuit between a three way control switch on the engine control box and an electrical actuator in the port wing trailing edge. This actuator is connected to the aileron balance tab and provides an alternative means of aileron control under high aerodynamic loadings.

WARNING

Personnel must take special care to keep their hands clear of the ailerons when they are being 'power' operated.

Flow warning indicator

17. The flow indicator is mounted on the main hydraulic accumulator (*fig.* 2) in the cannon bay and indicates pump failure by an audio warning note in the pilot's ear-phones. A control switch, on junction box No. 1, allows the warning note to be cut off.

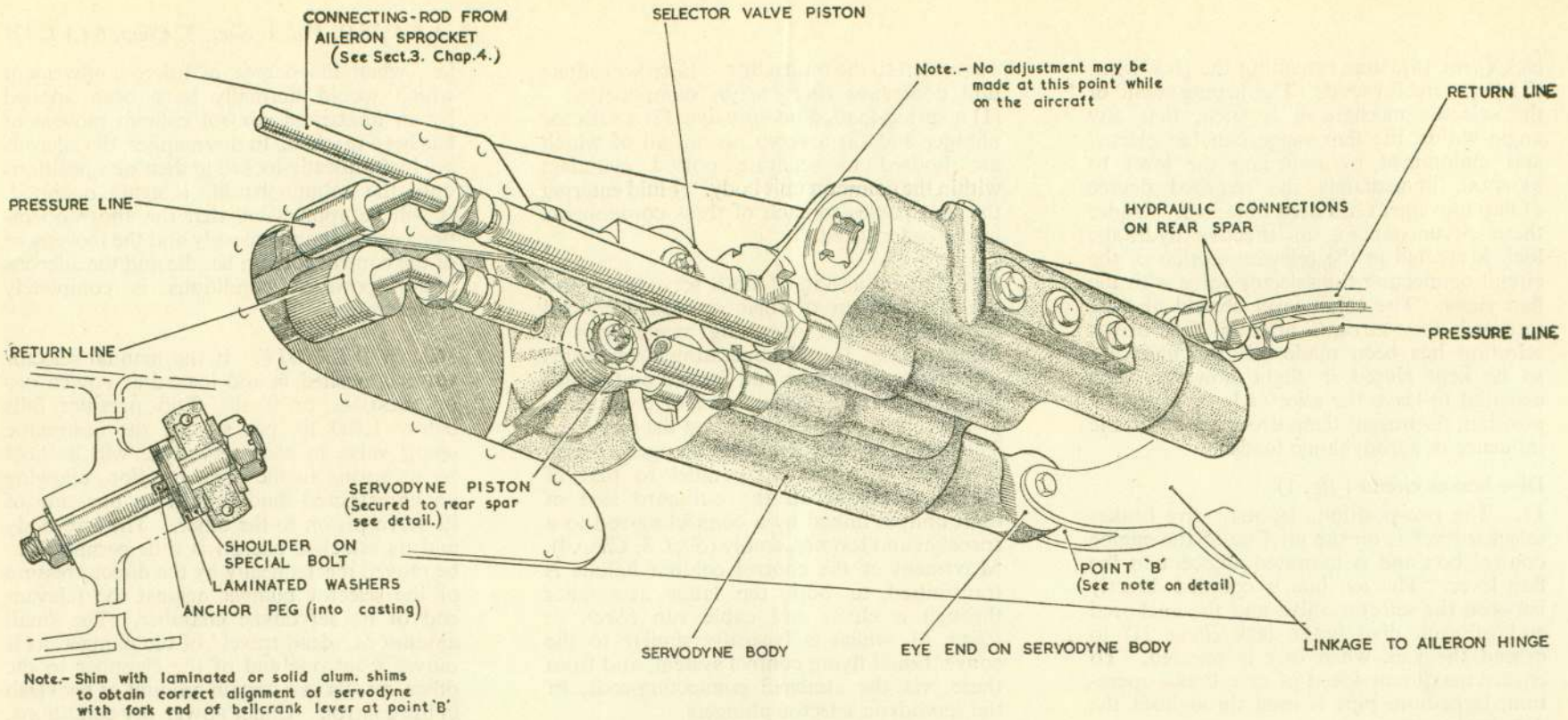

Fig. 3. Aileron servodyne

SERVICING

General

18. Instructions for dismantling and servicing all Lockheed (AIR) and UMC components listed in the following paragraph will be found in A.P. 1803B and 1803P respectively, whilst those for the servodynes will be found in A.P.4602A, Vol. I. The servodynes are correctly set and wire-locked in the course of manufacture and no subsequent adjustment is permissible. Servicing of the reservoir, which is of de Havilland manufacture, is confined to the thorough flushing of all sediment from the interior of the unit and its filter. For this purpose, the reservoir must be removed from the aircraft and only fluid of the same specification as that normally used in the aircraft hydraulic system must be employed as a flushing medium.

List of components

19. Reference should be made to fig. 1 whenever it is desired to identify the part number of any one of the following components:—

Key No.	*Component*	*Part No.*
1	Reservoir	12.S.1243A (D.H.)
2	Engine driven pump	AIR.4100
3	Automatic cut-out valve	AIR.42268
4	Thermal relief valve	UMC.632
5	Pressure release valve	AIR40018
6	Main accumulator	AIR.40016
7	Aileron accumulator	AIR.40016
8	Non-return valve	UMC.706
9	Hand pump	UMC.501
10	Non-return valve	UMC.703
11	By-pass valve	AIR.40504
11a	Pressure release valve	AIR.42704
12	Non-return valve	UMC.706
13	Main undercarriage jacks (2 off)	AIR.41684
14	Main undercarriage door jacks (2 off)	AIR.41472
15	Main undercarriage door sequence valves (2 off)	AIR.40068
16	Alighting gear selector valve	AIR.40758

375/6 Wt. No. 15628 D. No. 6714 500 12/8/58 C.S. Co.

17	Nose undercarriage jack	AIR.41932
18	Flap jacks (2 off)	AIR.42208
19	Flaps selector valve	AIR.40272
20	Non-return valve	AIR.34126
21	Dive brake jacks (2 off)	AIR.41474
22	Dive brakes selector valve	AIR.40272
23	Servodynes (2 off)	AIR.42515 (port) and AIR.42414 (stbd.)
24	Pressure switch	TP.5216 (Thermal Controls Ltd.)
25	Flow surge restrictor valve	AIR.42500
26	Ailerons selector valve	AIR.42164
27	Thermal relief valve	UMC.632

Servicing precautions

20. *The following precautions must be strictly observed before and throughout all servicing operations, in order to eliminate the extreme consequences which will otherwise result :—*

(1) Before any connection is broken down, all hydraulic pressure must be exhausted from the system by holding the manually-operated release valve open for a short period, and by moving the control column handle full travel from side to side at least six times, with the aileron selector in the *out* (power ON) position. Failure to release the pressure in the above manner, may result in serious personal injury being inflicted.

(2) All pipe ends and unit ports exposed by disconnection must be immediately sealed off by the fitting of approved A.G.S. blanking plugs to prevent the ingress of foreign matter. On no account must rag, masking tape or similar material be used for this purpose.

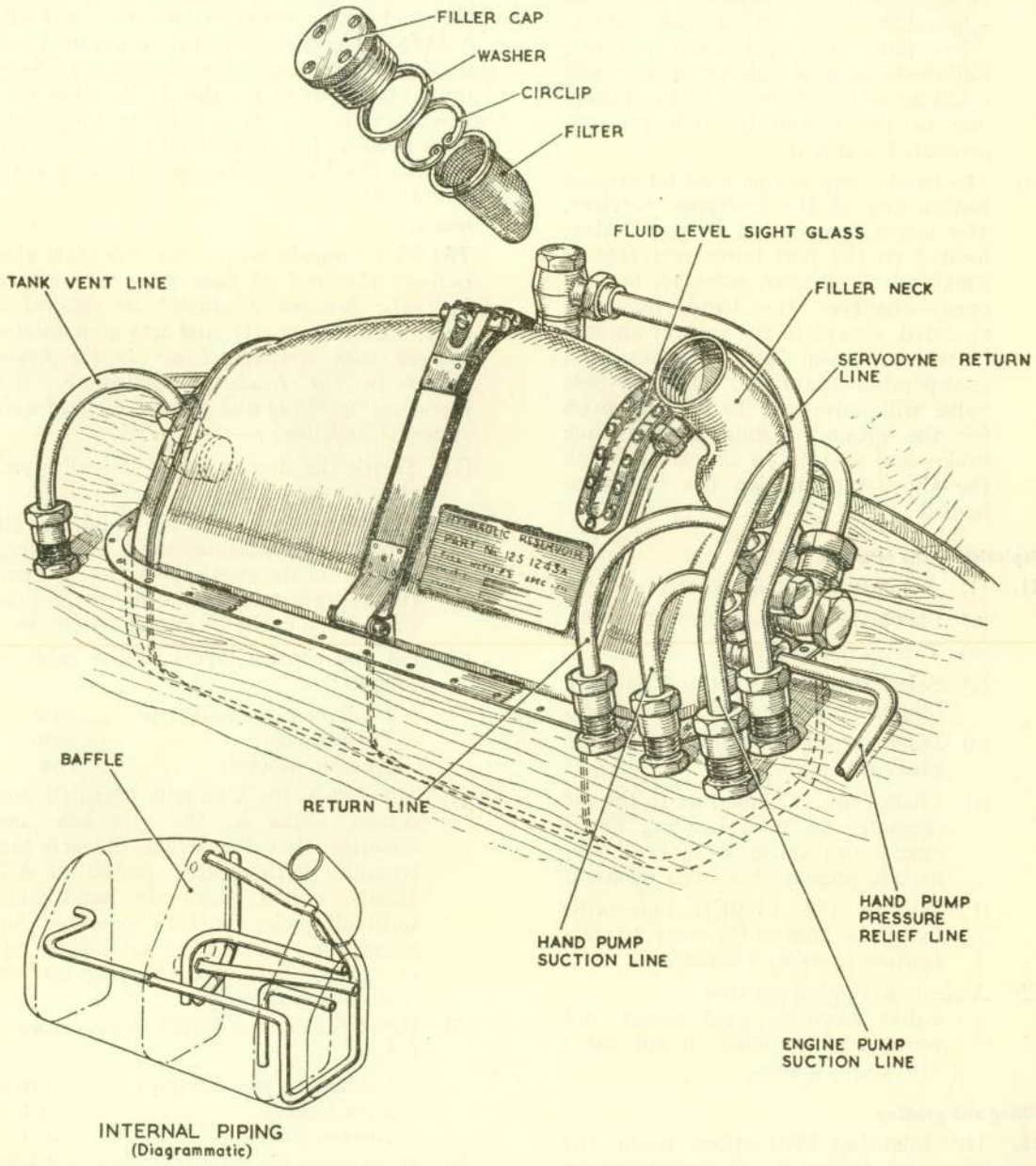

Fig. 4. Hydraulic reservoir

(3) Under no circumstances must the engine be turned with either the inlet or outlet self-sealing couplings at the engine-driven pump slackened or disconnected. Failure to observe this precaution will result in serious damage to the pump, due to the extremely high pressure generated within it.

(4) The hand pump can be used for ground testing any of the hydraulic services. The manually-operated by-pass valve, located on the port lower rear face of bulkhead No. 2 *must*, however, be held open whenever the hand pump is operated, except in the case of aircraft in which Venom Mod. 553 has been incorporated (*para.* 8). The by-pass valve will only need to be held open for the ground testing of the dive brakes and ailerons on aircraft in which the above modification has been embodied.

Replenishing the reservoir

21. (1) Aircraft parked on wheels :—

(a) Check the tyre and oleo pressures.

(b) Top-up the reservoir.

(c) Select dive brakes IN and flaps UP (alighting gear DOWN, if trestled).

(d) Discharge all accumulator hydraulic pressures (*para.* 20).

(e) Charge the accumulators to the air pressures given in Leading Particulars and re-check that all hydraulic pressure has been released.

(f) Fill to the LEVEL line with hydraulic fluid of the correct specification (*Leading Particulars*).

(2) Aircraft in rigging position :—
Select alighting gear DOWN and proceed as outlined in sub-paras 1(b) to (f) above.

Filling and priming

22. The following instructions cover the system as a whole, but if a single component has been removed and refitted or replaced by a new component, it will only be necessary to carry out these instructions in so far as they affect that particular unit and its circuit. Scrupulous cleanliness must be observed throughout all servicing operations, the fluid containers must be flushed out with fluid to the specification laid down in the Leading Particulars and the reservoir filter (*fig.* 4) must always be in position in the filler neck whenever the system is filled or topped-up. Care should also be taken to avoid spilling fluid, as this has a deleterious effect upon the aircraft finish.

Note . . .

The FULL marks on the reservoir sight glass indicate the level of fluid required with all hydraulic pressure exhausted, as detailed in para. 20, *sub-para.* (1), *and both accumulators charged with compressed air to the figures quoted in the Leading Particulars. The procedure for filling and priming the hydraulic system is as follows :—*

(1) Trestle the aircraft safely with all wheels clear of the ground.

(2) Fill the reservoir with fluid to the correct specification until the excess flows from the vent pipe outlet. Inflate the hydraulic accumulators to the pressures given in the Leading Particulars.

(3) Set the control levers in the cabin as follows :—

Undercarriage and flaps . .	UP
Dive brakes	IN
Aileron selector	IN

(4) Hold open the manually-operated non-return valve in the gun bay and, ensuring that the stroke of each jack complies with figures quoted in A.P. 1803B, Vol. 1, work the hand pump until all jacks are fully operated and maximum resistance to pumping is felt, at the same time topping-up the reservoir as necessary.

(5) Reset the control levers in the cabin as follows :—

Undercarriage and flaps . .	DOWN
Dive brakes	OUT
Aileron selector	OUT

(6) Hold open the manually-operated non-return valve in the gun bay and work the hand pump until all jacks are fully operated and maximum resistance to pumping is felt, then once more top-up the reservoir, this time to the level mark on the sight glass and with all hydraulic pressure released.

Note . . .

The position of the engine-driven pump in relation to the reservoir renders the pump self-priming, but the vent plug must be removed and a check made to ensure that fluid is reaching the pump.

Operational testing

◀ **Note . . .**

Where operating times of a service in excess of requirement are encountered, the Issue No. of the cut-out valve AIR.42268 should be checked, and if found to be Issue 4 *should be replaced by an Issue* 5, *or* 3, *valve.*▶

23. (1) Remove the blanking caps from the ground test connections on the firewall, couple up the power operated test rig supply and return lines, and run the pump for two minutes holding the lever of the pressure release valve under the cabin rear floor in the *open* position.

(2) With a suitable pressure gauge fitted to the charging point of the main accumulator and both accumulators charged to the correct figure, run the test rig, check that the cut-out valve relieves at the pressure quoted in the Leading Particulars. If the cut-out pressure is not correct, refer to para. 25. With all services static and the rig pump running, the valve should not cut in for at least one minute after cutting out. If this condition is not satisfied, refer to para. 25.

(3) Using the test rig, operate the flaps three times, checking the relative position of the cabin indicator and the operational times :—

DOWN	6 to 13 seconds
UP	8 to 15 seconds

With the flaps *up*, select DOWN, returning the lever to NEUTRAL when the indicator registers 30 deg. and leave the test rig running. A maximum flap creep of $\frac{1}{8}$ in. is permissible within a period of three minutes under these conditions.

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(4) Using the test rig pump again, operate the dive brakes three times, checking the operation times.

IN or OUT . . . . 0·5 to 2 seconds

(5) Once again using the test rig, operate the alighting gear five times, checking the correct functioning of the indicator lights and the operational times to be :—

UP or DOWN . . 2 to 4 seconds

At the same time, check for the satisfactory opening and closing of all undercarriage wheel doors.

(6) Transfer the pressure gauge from the charging point of ◀the main▶ accumulator to that for ◀the aileron▶ accumulator and, by first operating the release valve or any one service, once again check that the cut-out figure agrees with that quoted in the Leading Particulars.

(7)◀(a) Set the test rig to run at 2,800 to 2,900 r.p.m.

(b) Check that the aileron accumulator air pressure agrees with that given in the Leading Particulars (unless this has already been carried out under sub-para. (2) above). Check the general operation of the servodyne installation, and ensure that all backlash has been eliminated, that all cables have been correctly tensioned and that all joints have been greased (*Sect.* 3, *Chap.* 4 *and Sect.* 2, *Chap.* 4).

(c) If necessary, top-up the reservoir.

(d) Check the controls for judder. Slight aileron tremble during operation is permissible providing that it can be damped out with one hand holding the trailing edge, but the complete installation should operate smoothly. If necessary, check the servodyne units for smoothness by disconnecting the controls at each unit and then operating by hand.

(e) Check that the stick " break-out " forces conform to the figures given in Sect. 3, Chap. 4.

(f) Check the operation of the aileron selector valve, in particular that there is no appreciable snatch in the control column when selecting to power ON.

(g) Reduce the test rig speed to between 1,300 and 1,400 r.p.m.

(h) Operate the ailerons continuously by moving the control column handgrip from *centre* to *port*, *port* over to *starboard* and finally return to *centre*, ensuring in each case that full travel is engaged and that each complete cycle takes approximately 4 seconds. Select alighting gear UP and DOWN twice, dive brakes IN and OUT six times and flaps UP and DOWN twice. Individual selection, without overlapping any other, should be made at intervals of not less than 5 to 8 seconds. At no time should the aileron control tighten up (i.e., revert to MANUAL) through lack of pressure. Repeat the cycle of operations 40 times, unless a new servodyne has been fitted, when 100 reversals must be made.

Note . . .

No adjustments to the servodynes may be carried out on the aircraft.

(i) If necessary, replenish the reservoir. ▶

(8) Ensure that in the event of complete loss of all fluid available to the engine-driven pump through leakage under flight conditions, sufficient fluid still remains in the reservoir for the operation of the essential services by the hand pump, also that the by-pass valve positively restricts the hand pump supply to these services by isolating the dive brake and aileron circuits. The procedure is as follows :—

(a) With the alighting gear and flaps *up*, the dive brakes *in* and the aileron selector OUT, release all hydraulic pressure from the system. Then disconnect the rig pump pressure line from the firewall connection, and restart the rig to drain the reservoir as far as possible without allowing the pump to run dry. Collect the fluid so discharged in a clean container.

(b) Reconnect the rig pressure line and, by the hand pump (*para.* 19, *sub-para.* (4)), lower the alighting gear and flaps completely ensuring that the former is securely locked *down*. On aircraft in which Venom Mod. 553 has been embodied. operate the hand pump until maximum resistance to pumping is felt (this pressure is governed by the setting of the relief valve (*item* 11*a*)) and select dive brakes OUT. Maintain this pressure for two minutes and check that during this period, the dive brakes do not move. On aircraft pre. Venom Mod. 553, it will first be necessary to disconnect the hand pump delivery branch line at the by-pass valve and to connect a suitable pressure gauge between the valve and the detached pipe connection. The hand pump should then be operated until this gauge registers 2,500 lb. per sq. in., and this pressure maintained for two minutes during which period the dive brakes should not move.

WARNING

Under no circumstances must this pressure be exceeded.

Remove the slave gauge, where fitted for this test, and reconnect and re-lock the pipe connection to the by-pass valve.

(9) Finally, release all hydraulic pressure, refill the reservoir and start the test rig, allowing it to run for two minutes with

the release valve held open. Then stop the rig, release all hydraulic pressure again, top-up the reservoir to the level mark on the sight glass, and, by means of the rig pump, operate the alighting gear, flaps and dive brakes five times.

(10) Re-check the fluid level, disconnect the rig from the firewall connections and refit and re-lock the blanking caps securely.

Leakage

24. Internal or external leakage of the hydraulic fluid will cause erratic functioning (hammering) of the cut-out and sluggish operation of the services. If no sign of external leakage is visible, the various components must be checked for internal leakage in the following manner :—

(1) By operating the levers of the release valve and by-pass valve several times with pressure being applied from the engine pump, or from a power-operated test rig, ensure that any foreign matter is flushed from the valve seatings.

(2) With cut-out pressure applied and all services in one of their 'extreme' positions, return the selector levers to their mid-travel positions. If a gauge fitted to No. 1 accumulator charging point records no drop in pressure, apply fluid at the cut-out pressure with the selector levers in their other extreme selection position and again return the levers to the mid-travel position. If again no drop in pressure is recorded, the leakage must be in one or more of the jacks. Check each circuit in turn in the above manner until the faulty component is located, and rectify in accordance with the relevant Air Publication.

Adjustment of the automatic cut-out valve

25. The cut-out pressure of the valve must be tested on the aircraft with a pressure gauge on the main accumulator, and both accumulators charged to the correct air pressure (*Leading Particulars*). It is not satisfactory to check the *cut-in* pressure while the valve is on the aircraft ; this must be done periodically by removing the valve and testing on a suitable flow test rig. If the *cut-out* pressure does not conform to that given in the Leading Particulars, the valve must be removed and adjusted on a test rig in the manner given in A.P.1803B, Vol. 1, Sect. 10 ; *no adjustment may be made on the aircraft.*

Adjustment of the selector valves (*fig. 5 and 6*)

Note . . .

Subsequent to the adjustment of any selector valve control rods, the adjustable ends of the rods connecting the selector to its operating handle or lever must be securely locked and their clevis and split pins correctly fitted.

26. (1) *Alighting gear.* Disconnect the control rod from the selector valve and manually press the forked end of the valve into the selector as far as possible. With the selector lever almost against the *upper* end of its slot, adjust the control rods as necessary to allow them to be re-connected between the valve and the lever without altering the setting of these components. Move the selector lever fully DOWN, checking that the total travel of the valve plunger which protrudes through the aft face of the selector is 1 in.

(2) *Flaps.* As this valve has a *neutral* setting, the plunger should be moved to the mid-travel position, i.e. $\frac{1}{2}$ in. from either full travel position, after disconnection of the control rod from the valve forked end. The control rods should then be adjusted with the selector lever in the NEUTRAL position, so that they may be reconnected to the valve and lever without altering the setting of these components. The plunger should then be checked for a full travel of 1 in.

(3) *Dive brakes.* The procedure for adjusting this selector valve is similar to that for the alighting gear unit, except that with the control rods disconnected, adjustment should be made with the dive brakes control lever almost against the *lower* end of its quadrant slot. The total plunger travel will again be 1 in.

(4) *Aileron selector valve.* The length of stroke, measured at the bottom of this valve, is 0·60 in., and this travel must be obtained with the pin on the handle engaging correctly in the sleeve slots at both the *in* and *out* positions. The lock-nut at the base of the slotted sleeve must be tightened and wire-locked after adjustment.

REMOVAL AND ASSEMBLY

General

27. The sequence of operations for the removal and assembly of most of the hydraulic components will be obvious when the items are viewed on the aircraft, and detailed instructions are not given. The procedure for the removal and assembly of the main and nose undercarriage jacks and the main undercarriage door jacks, which is not readily apparent, is given in para. 30 to 32 inclusive.

Note . . .

All precautions listed under para. 20 *must be strictly observed whenever components are dismantled or assembled to the aircraft.*

28. Whenever a pipe line is connected, care must be taken to avoid damaging the flared end by overtightening the union nut. The latter should first be screwed on to the adapter by hand as far as possible (after the flare, the collar and the adapter have been cleaned), then a further $\frac{1}{16}$ of a turn beyond this point made with the correct spanner should then be sufficient to render the connection oil-tight under system pressure. If this is not effective, the joint should be disconnected and the flare, collar and adapter examined for cracks.

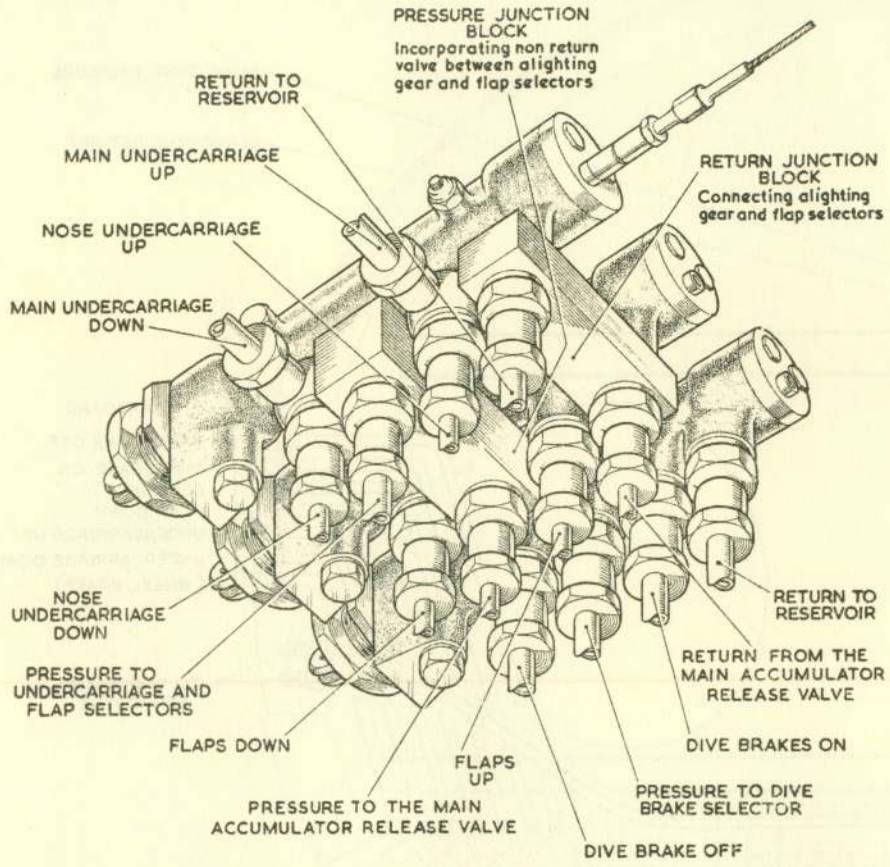

Fig. 5. Selector valve assembly

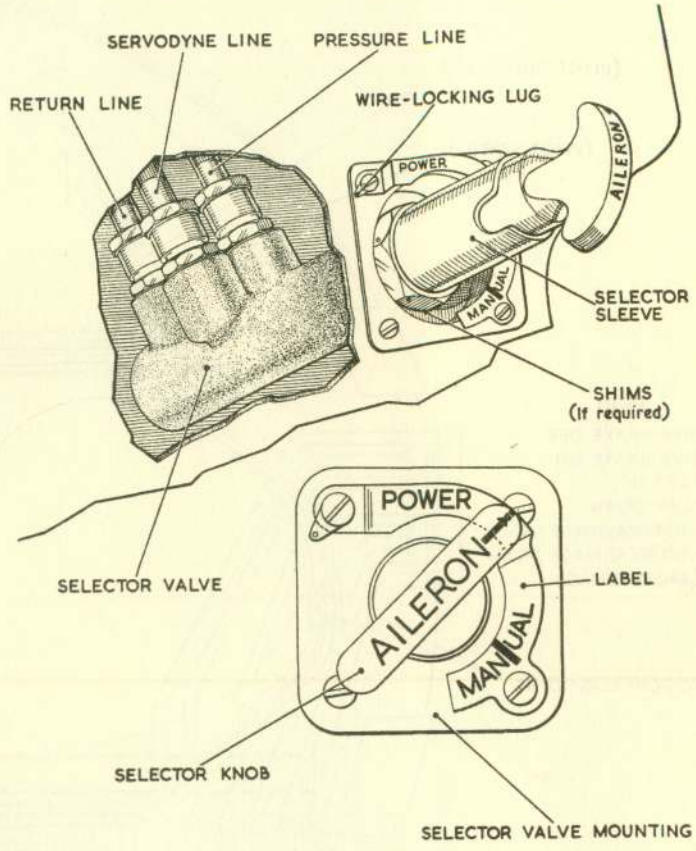

Fig. 6. Aileron selector valve

Alighting gear jacks

29. Before attempting to remove any of these components, the aircraft should be safely trestled in such a manner, that if a main undercarriage jack is to be removed, the respective leg can be swung inboard after it has been suitably disconnected. All wheels must be clear of the ground. In addition, all hydraulic pressure must be released from the system as detailed in para. 20, sub-para. (1) and, unless the system has been drained, the circuit must be isolated by moving the selector valve to the mid-travel position, where it should be allowed to remain until the hydraulic system is once more complete. Assembly in each case is the reverse of the removal procedure. The installation of the various jacks will be found illustrated in Sect. 3, Chap. 5.

Main undercarriage jacks

30. (1) Remove the circular access panel situated just forward of the wheel well in the undersurface of the wing, and dismantle the *down* lock micro switch complete with bracket from the front diaphragm of the radius rod recess, leaving the leads connected.

(2) Disconnect the radius rod eye-bolt from the pick-up casting on the undercarriage leg.

(3) Remove the forward detachable tail boom fairing from the under-surface of the wing.

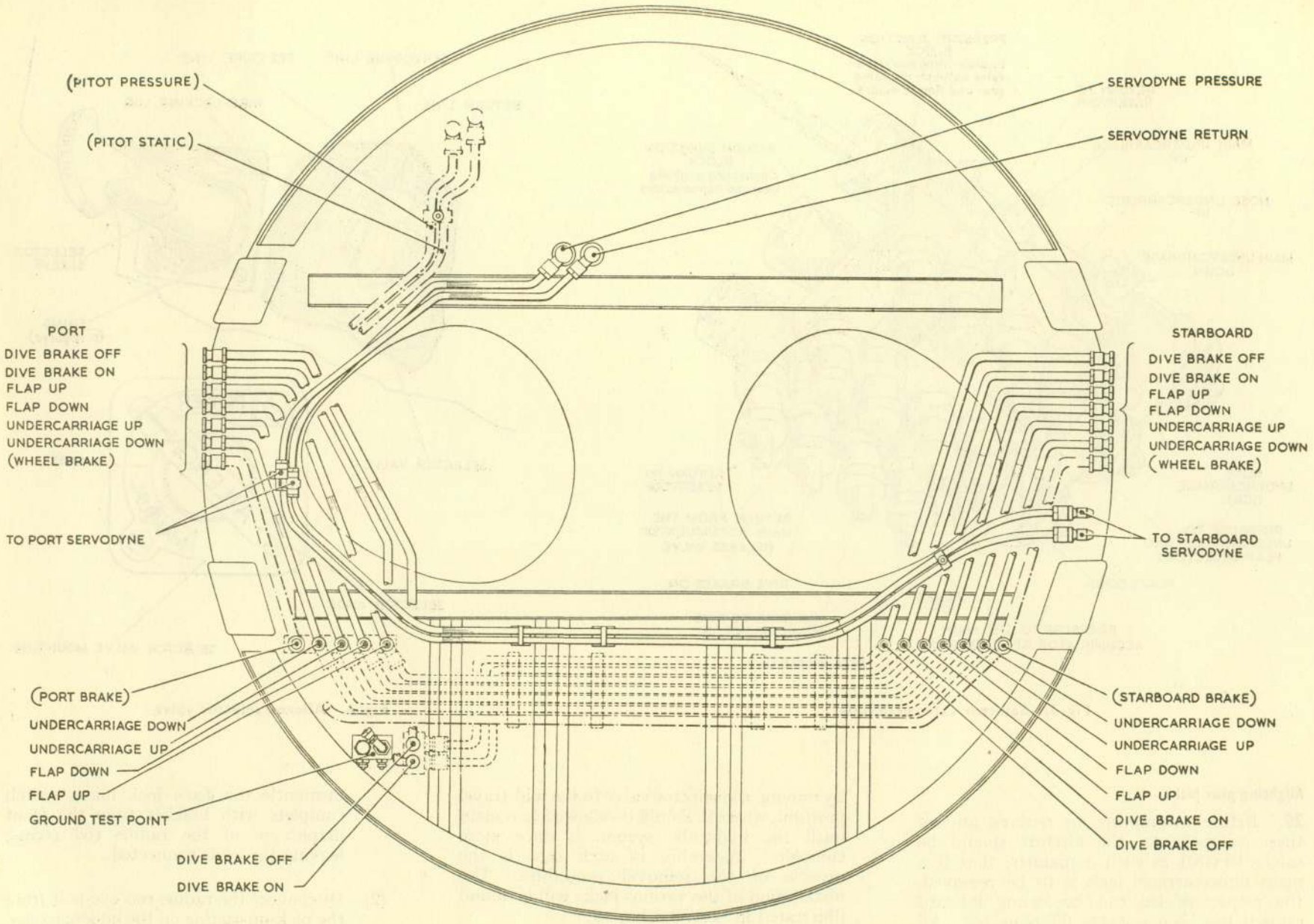

Fig. 7. Hydraulic pipe-lines on aft face of fireproof bulkhead

(4) Unscrew the grease nipple from the head of the special jack cylinder attachment bolt and disconnect the jack cylinder from the radius rod lug.

Note . . .

The radius rod lock plate flange is scalloped to permit the withdrawal of this bolt, which must be fitted with its head aft on re-assembly of the jack.

(5) Disconnect and blank off the hydraulic hose connections and jack adapters.

(6) Swing the undercarriage leg inboard and disconnect the fork-end of the jack ram from the undercarriage lever.

Main undercarriage door jacks

31. (1) Disconnect the door catch operating cable on the forward wall of the wheel well from the door catch lever, and remove the bolts securing the large access panel on which the cable is mounted.

(2) Remove the bolt securing the jack cylinder to the shackle and lower the jack carefully.

Note . . .

It is not normally necessary to disturb the nut which secures the shackle to its mounting bracket on rib No. 3. If the alignment of the jack requires adjusting, however, this nut must be loosened and not re-tightened and re-locked until the jack is correctly aligned.

(3) Disconnect and blank off the hydraulic hose connections and jack adapters.

(4) Remove the small access panel situated immediately below the door operating torque shaft on the forward wall of the wheel well.

(5) Swing the undercarriage door to approximately the half closed position and remove the bolt connecting the jack ram to the operating lever.

Note . . .

On re-assembly, this bolt must be fitted with its head aft.

Nose undercarriage jack

32. (1) Remove the upper and main nose fairings and take out the bolt securing the support link to the lock and radius rod links.

(2) Slacken the hydraulic hose connections on the jack and the nut securing the jack ram attachment bolt to the undercarriage lever.

(3) Swing the undercarriage leg rearwards just sufficiently to bring the jack ram attachment bolt above the level of the decking; then remove the bolt and return the leg to the down position.

(4) Disconnect and blank off the hydraulic hose connections and jack adapters.

(5) Unscrew the grease nipple and its extension from the head of the bolt which attaches the jack cylinder to the radius rod lug, and remove the slotted nut securing the bolt.

Note . . .

On re-assembly, the grease nipple and its extension must be fitted in the same relative position as before.

(6) Swing the radius rod assembly downwards until the jack cylinder attachment bolt can be withdrawn and remove the jack.