Chapter 6

HYDRAULIC SYSTEM

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DESCRIPTION

Introduction

1. A high-pressure hydraulic system is installed to operate the following:-

(1) Alighting gear and associated doors.

(2) Bomb doors.

(3) Nose wheel steering.

(4) Wheel brakes.

2. The various hydraulic circuits are separately controlled by electrically-operated selector valves with the exception of the nose-wheel centring jack, which is connected directly into the main supply line. A separate hydraulic circuit for ground and emergency operation of the bomb doors is provided.

3. The emergency air supplies are coupled to the alighting gear and associated door circuits for lowering them in the event of hydraulic failure.

4. Subsequent paragraphs describe the system and give details of servicing operations, but reference must be made to the A.P.1803 series for detailed information on the various hydraulic components and to A.P.2337 for the wheel brakes. A list of the main components comprising the system, together with their A.P. references and their location in the aircraft is given in Table 1.

COCKPIT CONTROLS AND INDICATORS

5. These are all located at the pilots' station and, with the exception of the brakes and the emergency air control, are electrical in operation. Fig.1 illustrates the controls and indicates their position while the key to fig.1 gives a brief description of them. Reference must be made to Vol.1, Book 2, Sect.5, Chap.1 of this publication for details of the electrical function of the controls.

TABLE 1

System Components

Component	Part No.	No. off	A.P.Ref.	Location
Reservoir	A.6785Y	1	1803D	Bomb bay
Filter	C.5655Y	3	1803D	Port wheel bay (for No.1 pump). Port side bomb bay (for No.2 pump). Starboard side bomb bay (for No.3 pump)
Engine-driven pump (Vardel) Ref.No.37J/8002	-	3	1803D	Engine bays (1, 2 and 3 engines)
Main-wheel retraction jack (port)	1.01295.001	1	1803D	Wheel bay - port
Main-wheel retraction jack (starboard)	1.01295.002	1	1803D	Wheel bay - starboard
Main-wheel door jack (port forward)	1.01297.001	1	1803D	Wheel-bay - port
Main-wheel door jack (port rear)	1.01298.001	1	1803D	Wheel bay - port
Main-wheel door jack (starboard forward)	1.01297.002	1	1803D	Wheel bay - starboard
Main-wheel door jack (starboard rear)	1.01298.002	1	1803D	Wheel bay - starboard
Nose-wheel retraction jack	1.01299.013	1	1803D	Nose-wheel bay
Nose-wheel door jack	1.01300.001	1	1803D	Nose-wheel bay

TABLE 1 - *continued*

Components	Part No.	No. off	A.P. Ref.	Location
Bomb door jack (right hand)	A7897Y Mk.A	2	1803D	Bomb bay - forward port, rear starboard
Bomb door jack (left hand)	A7897Y Mk.B	2	1803D	Bomb bay - forward starboard, rear port
Main wheel down-lock jack	C903Y	2	1803D	Wheel bays - P and S
Bogie trimming jack	C8207Y	2	1803D	Wheel bays - P and S
Nose-wheel centring jack	11976Y A01	1	1803D	Nose-wheel bay
Selector valve (main wheel jack and doors, and nose-wheel doors)	1.00112.005	5	1803D	Each main-wheel bay - 2 Nose-wheel bay - 1
Brakes control valves	AC.14512	1	1803S	Nose-wheel bay
Accumulator, brakes	AC.14048	2	1803S	Nose-wheel bay
Pressure gauge, brakes accumulator Ref. No. 6A/2693		2		Nose-wheel bay
Dual pressure gauge	AHO.29130	2		Nose-wheel bay
Pressure relay valve	ACM.18798	7	1803S	Nose-wheel bay - 6, Bomb bay - 1
Emergency power pack	A6787Y	1	1803D	Bomb bay starboard side
Jettison valve - main alighting gear	C6770Y Mk.A	2	1803D	Main-wheel bays port and starboard
Jettison valve - nose-wheel unit	C6770Y Mk.B	1	1803D	Nose-wheel bay
Snubber valve	C6771Y Mk.A	2	1803D	Main-wheel bays port and starboard
Emergency air cylinder Ref. No. 6D/9429887		2		Nose-wheel bay
Selector valve, bomb door	1.00125.002	1	1803D	Bomb bay
Selector valve, bomb door, with T.R.V.	1.00112.004	1	1803D	Bomb bay
◀ Selector valve, emergency power pack	0.7489.Y.803	1	1803D	Bomb bay ▶
Selector valve, nose-wheel jack	1.00112.006	1	1803D	Nose-wheel bay
Pressure switch	C1829Y Mk.B	1	1803D	Bomb bay
Pressure transmitters	S122 Form 4	3	-	Bomb bay - 1, Nose-wheel bay - 2
Brakes master cylinders	AC13812	4	1803S	Rudder pedals
Reservoir charging valve	C7335Y	1	1803D	No.3 engine bay
Triple pressure gauge	S214.1.11	1	-	Cockpit, centre instrument panel
Release valves manually operated	D4930	2	1803D	Nose-wheel bay
Air release valve	C7037Y	2	1803D	Nose-wheel bay
Steering control valve	1.00112.007	1	1803D	Nose-wheel bay
Steering stop valve	1.00137.002	1	1803D	Nose-wheel bay
Brake pressure reducing valve	AC12220	1	1803D	Nose-wheel bay
Shut-off valve accumulator charging	1.00148.002	1	1803D	Nose-wheel bay
Filter, reservoir charge	D7515Y	1	1803D	No.3 engine bay
◀ Pressure relief valve	ACM.23256	2	4303B	Nose-wheel bay ▶

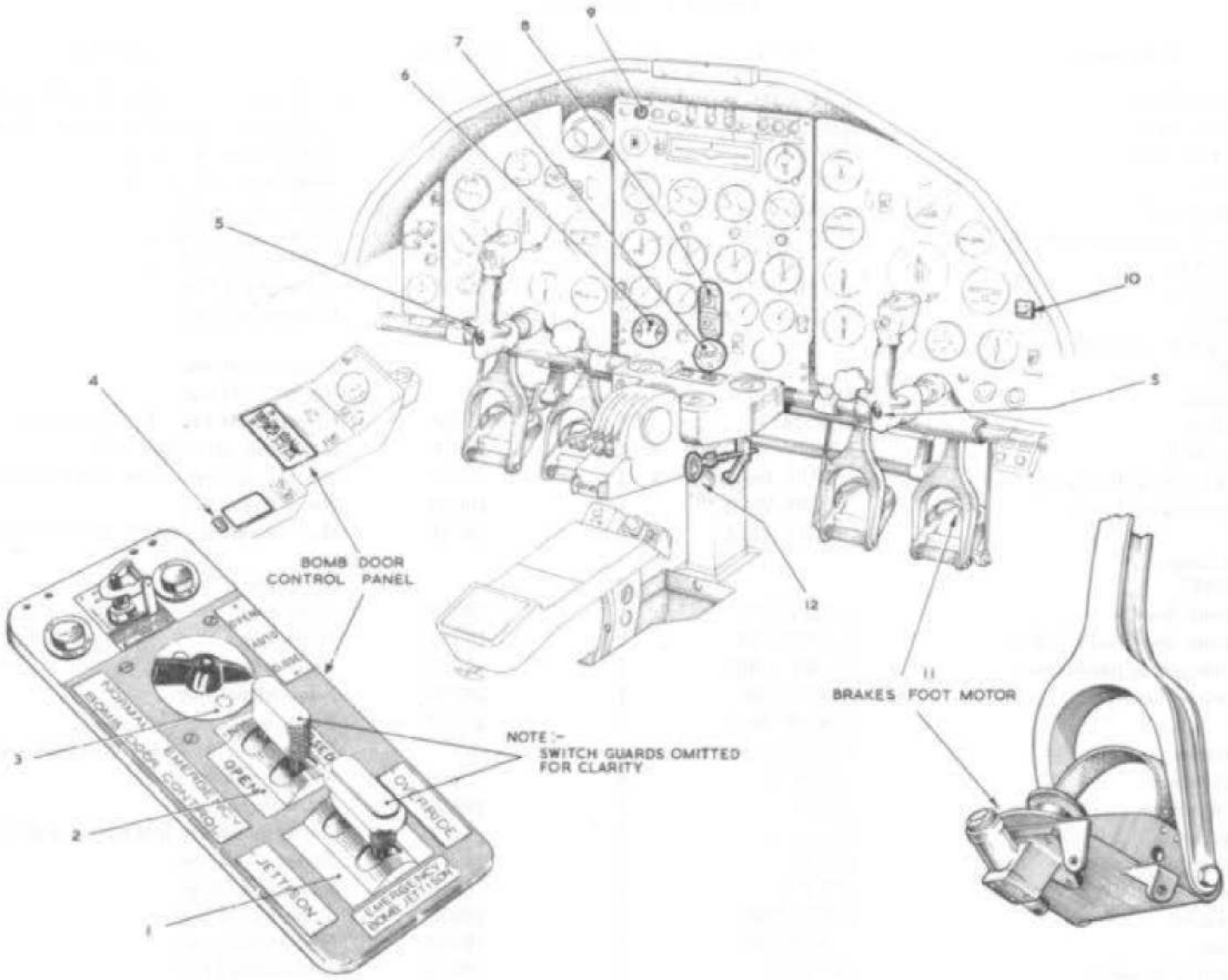

Fig. 1. Cockpit controls and indicators

KEY TO FIG.1

Cockpit controls and indicators

1. EMERGENCY BOMB JETTISON AND JETTISON OVERRIDE SWITCH
   Outer positions - JETTISON - OVERRIDE
   Spring loaded to central OFF position
   Guarded switch
2. BOMB DOOR EMERGENCY SWITCH
   OPEN - NORMAL - CLOSED
   Guarded switch
3. BOMB DOOR SELECTOR SWITCH (NORMAL)
   OPEN - AUTO - CLOSED
4. HYDRAULIC POWER PACK MOTOR SWITCH
   Outer positions - START - STOP
   Spring loaded to central OFF position
5. NOSE-WHEEL STEERING ENGAGE SWITCH
   Guarded push switch
6. HYDRAULIC TRIPLE PRESSURE GAUGE
7. ALIGHTING GEAR POSITION INDICATOR
   UNLOCKED - LOCKED DOWN
8. ALIGHTING GEAR SELECTOR SWITCH
   Two buttons - U/C UP - U/C DOWN
9. BOMB DOOR INDICATOR
   Magnetic indicator
   Energised when bomb doors are closed
10. WINDSCREEN WIPER CONTROL SWITCH
    FAST - OFF - SLOW
11. BRAKE FOOT MOTORS
    For full descriptive use refer to A.P.1803S, Vol.1
12. EMERGENCY AIR CONTROL HANDLE
    Pull to operate
    After being used can only be reset when aircraft is on the ground.

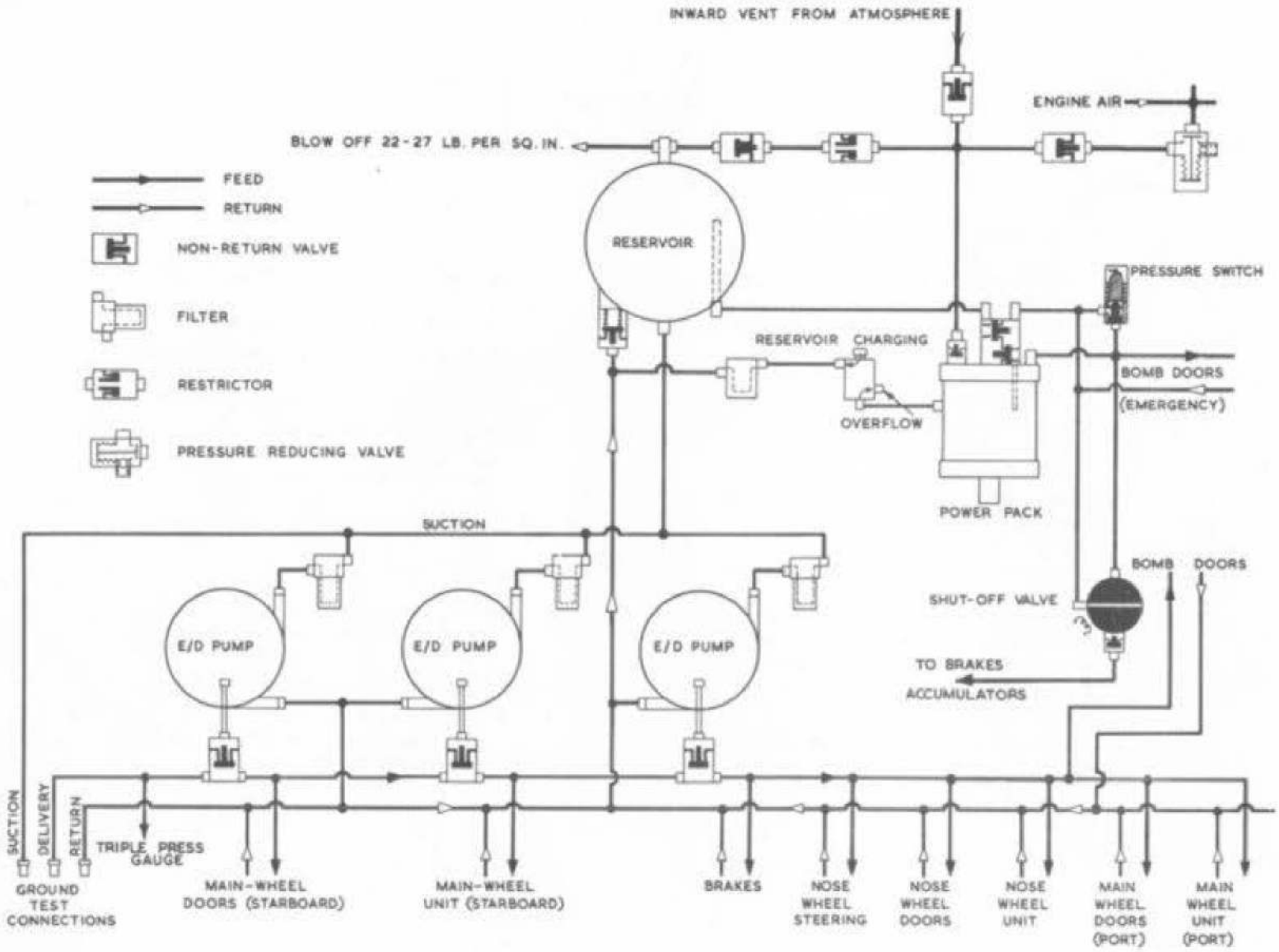

Fig. 2. Main feed and return diagram

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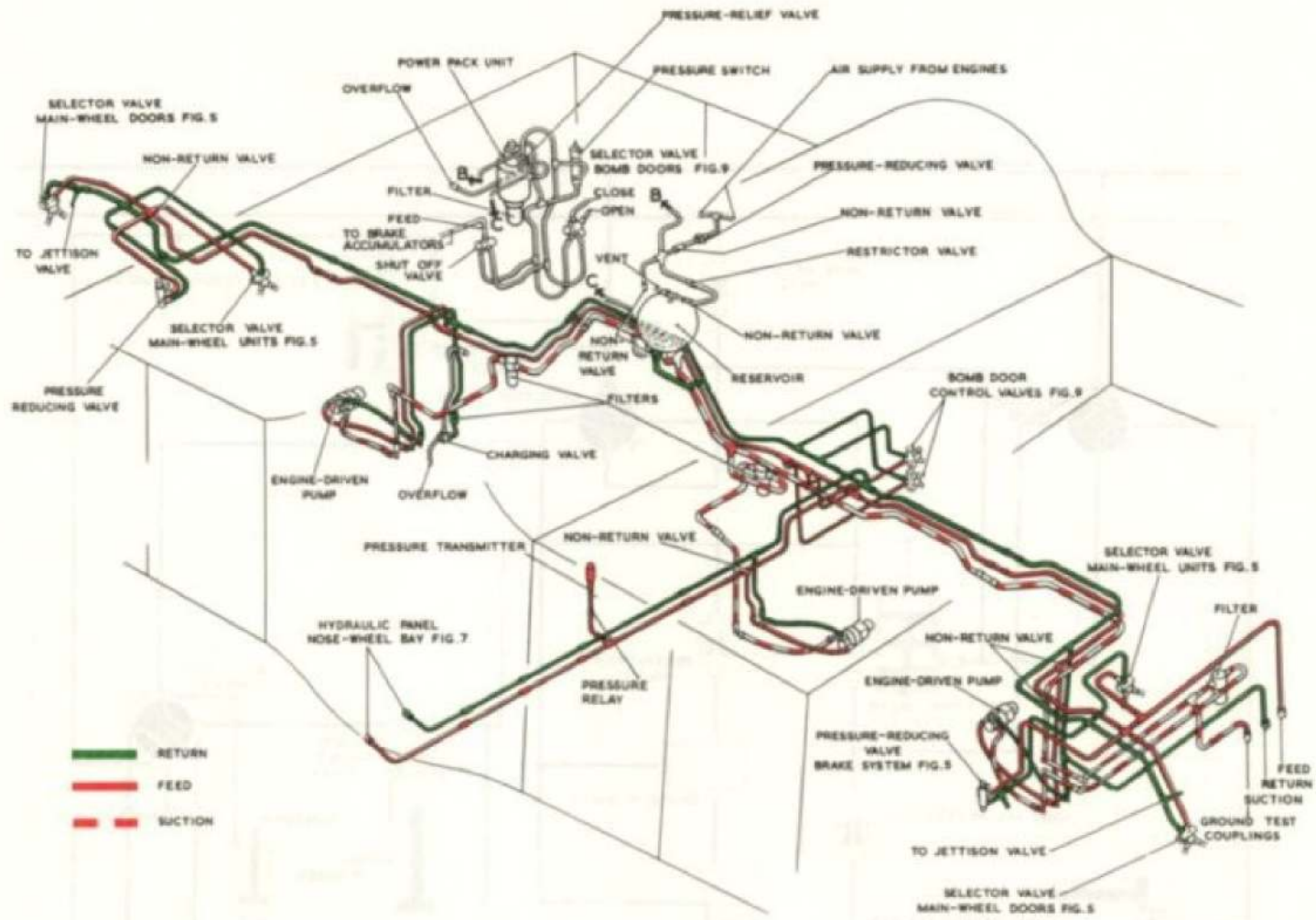

Fig. 3. Hydraulic system – main feed and return.

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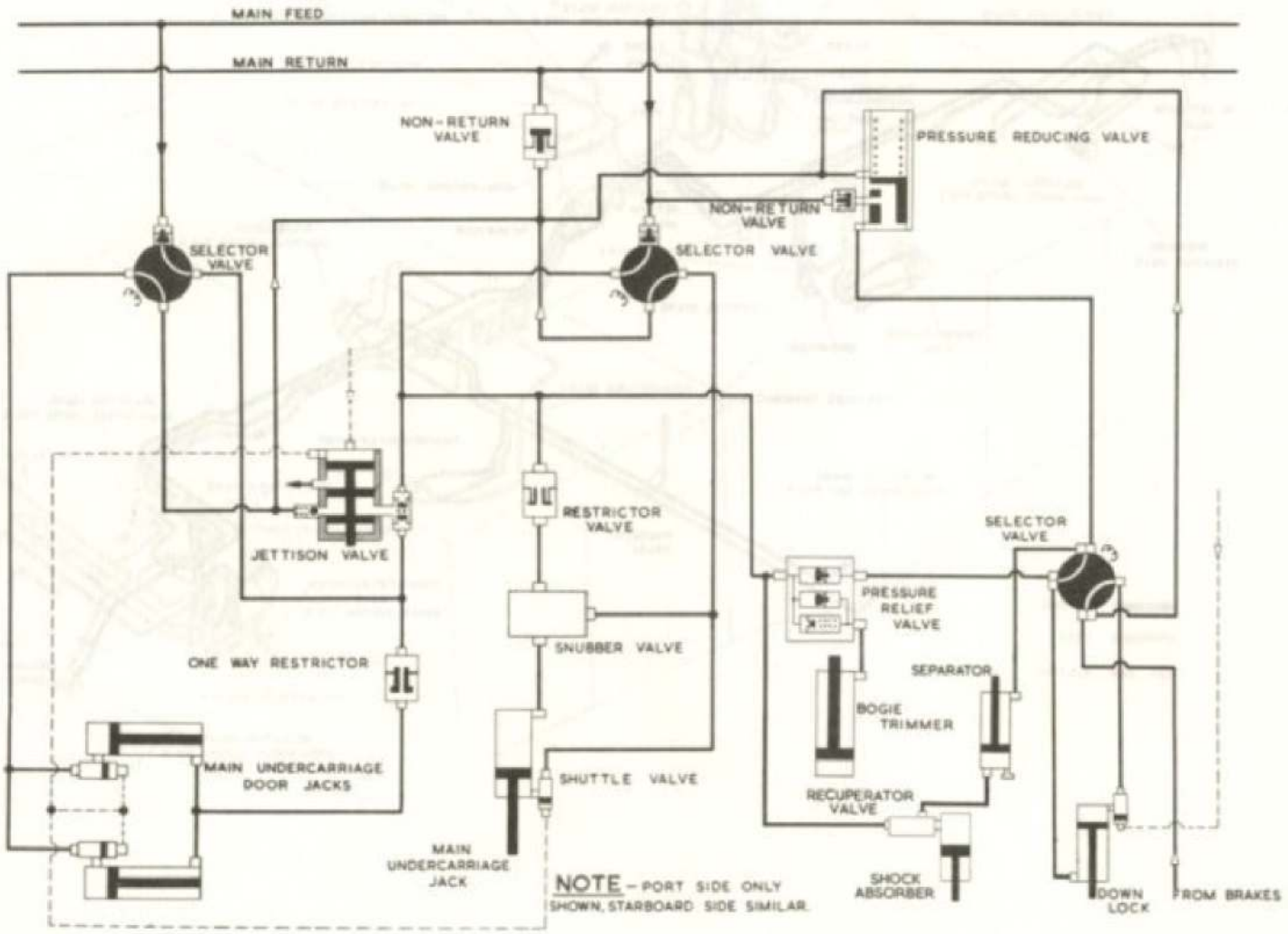

Fig.4. Main wheel circuit diagram.
(Mod. No. 1971)

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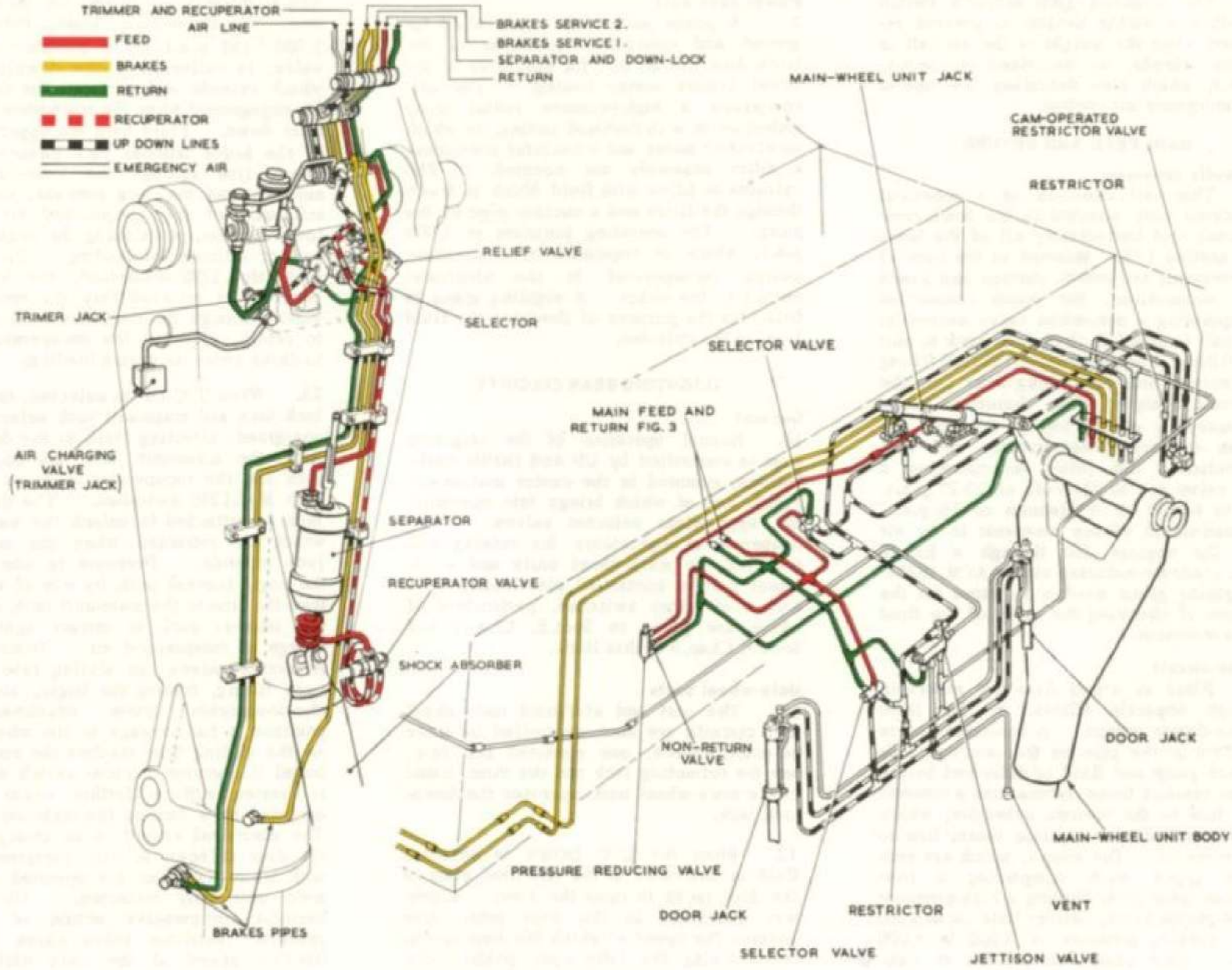

Fig.5. Hydraulic system main wheel unit and doors.
(◂ Mod. No. 1971 ▸)

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6. The alighting gear selector switch embodies a safety device to prevent retraction when the weight of the aircraft is on the wheels, as described in Sect.1, Chap.3, which also describes the use of the emergency air control.

MAIN FEED AND RETURN

Hydraulic resersoir

7. This unit consists of a spherical fabricated body mounted in the bomb compartment roof immediately aft of the bomb arch station 123. Mounted in the base of the reservoir are return, suction and power pack connections, the return connection incorporating a non-return valve assembly. The unit is piped to the power pack to suit the filling arrangements, combined filling of reservoir and pack being done from the reservoir charging valve through a filter. An assembly at the top of the unit embodies separate pressurisation and vent connections, the latter incorporating a vent valve set to blow-off at 22-27 p.s.i. and to reseat at a minimum of 16 p.s.i. Pressurisation of the reservoir is by air from the engines fed through a 105-18 p.s.i. pressure-reducing valve, ACM.16354. A sighting glass window is fitted for the purpose of checking the level of the fluid in the reservoir.

Power circuit

8. Fluid is drawn from the reservoir, through separate filters, by the three engine-driven pumps. A non-return valve is fitted in the pipe on the pressure side of each pump and fluid is delivered by the pumps through these valves into a common feed line to the various selectors, which are connected to a common return line to the reservoir. The pumps, which are two-stage types each comprising a low-pressure gear pump feeding a high-pressure radial-piston pump, deliver fluid on demand at a working pressure of 3,600 to 4,000 p.s.i. Each pump incorporates an automatic cut-out device, and when idling between operational demands, circulates fluid to the reservoir through the main return line.

Power pack unit

9. A power pack unit is installed for ground and emergency operation of the bomb door circuit and for operation of the wheel brakes during towing. The unit comprises a high-pressure radial pump embodied in a cylindrical casing, to which an electric motor and a canister containing a filter assembly are mounted. The cylinder is filled with fluid which is drawn through the filter and a suction pipe by the pump. The operating pressure is 4,000 p.s.i. which is regulated by a pressure switch incorporated in the electrical circuit to the motor. A sighting glass is fitted for the purpose of checking the fluid level in the cylinder.

ALIGHTING GEAR CIRCUITS

General

10. Normal operation of the alighting gear is controlled by UP and DOWN push-buttons, mounted in the centre instrument panel, use of which brings into operation the appropriate selector valves. The sequence of operations for raising and lowering the main-wheel units and nose-wheel unit is controlled electrically by a series of micro switches, particulars of which are given in Sect.5, Chap.1 and Sect.3, Chap.5 of this Book.

Main-wheel units

11. The port and starboard main-wheel unit circuits are each controlled by three selector valves, one operates the door, one the retracting jack and the third, fitted to the main-wheel unit, operates the downlock jack.

12. When the U/C DOWN is selected fluid is delivered to the anchored ends of the door jacks to open the door. A one-way restrictor in the door return line governs the speed at which the door opens. On reaching the fully open position the door trips a micro switch which energises the selectors serving the main-unit jack and the downlock jack. High-pressure fluid is delivered to the main-unit jack which retracts to lower the main-wheel unit, simultaneously, fluid, reduced to 1,500 ±150 p.s.i. by a pressure-reducing valve, is delivered to the downlock jack which extends and prepares the downlock for engagement when the main-wheel unit is fully down. Fluid from the upper portion of the bogie trimmer jack passes to the return line through the main-unit jack selector and the jack extends, under the influence of the compressed air in the lower portion, positioning the bogie in the correct attitude for landing. On aircraft with Mod.1280 embodied, the hydraulic pressure is relieved from the recuperator valve, through the main-unit jack selector to return, allowing the recuperator valve to close under its spring loading.

13. When U/C UP is selected, the downlock jack and main-unit jack selectors are energised, directing fluid to the downlock jack, the main-unit jack, the bogie trim jack and the recuperator valve on aircraft with Mod.1280 embodied. The downlock jack is retracted to unlock the main unit, which is retracted when the main-unit jack extends. Pressure is admitted to the bogie trimmer jack, by way of a branch from the line to the main-unit jack, causing the trimmer jack to retract against its charge of compressed air. Trimmer jack retraction raises the sliding tube in the main fitting, turning the bogie, about the shock-absorber lower attachment, to position it for stowage in the wheel bay. As the sliding tube reaches the end of its travel it operates a micro switch which is in series with a further micro switch operated by a cam on the main-unit pivot. The electrical circuit is so arranged that the door selector is only energised when both micro switches are operated and the main unit fully retracted. During retraction, progressive action of a cam operated restrictor valve slows the retraction speed of the main unit as it enters the wheel bay. On aircraft with Mod.1280 embodied, a branch line, taken from the supply line to the bogie trimmer jack, supplies pressure to hold the re-

cuperator valve open against its spring loading. The open recuperator valve ensures that over recuperation of the shock-absorber is prevented when the shock-absorber is subjected to extreme cold at high altitude.

Nose-wheel unit

14. A circuit similar to that for the main-wheel units, controlled by two selectors, is installed for the nose-wheel unit and doors. When U/C DOWN is selected, the doors selector is energised concurrently with those for the main wheels, and fluid is directed to the DOWN ends of the door jacks. When the doors are open, a micro switch energises the nose-wheel selector valve to direct fluid to the DOWN end of the nose-wheel jack. The unit is then lowered and the retraction strut straightened and locked automatically.

15. When U/C UP is selected, fluid is directed by the nose-wheel selector valve to the 'up' end of the nose-wheel jack to effect retraction. As retraction is completed, a micro switch is operated to energise the doors selector valve and fluid is directed to the 'up' ends of the door jacks to close them.

Nose-wheel steering

16. The operation of this circuit is governed by a selector and a control valve. The selector, which is supplied from the main feed line through a pressure reducing valve, functions as a stop valve and directs or isolates the pressure line to the steering circuit. Units in the steering circuit are, a two-way relief valve, a by-pass valve and a steering motor which are mounted on the nose-wheel unit leg, together with a centring jack. The centring jack is fed directly from the main supply line through a pressure-regulating valve which maintains an essential minimum pressure to the jack should the supply to the steering jack fail. When the steering switch, on the pilot's control handle is engaged, the stop valve is opened and fluid fed through the control valve to that end of the steering jack selected by the pilot's control. When the nose wheel has reached the turning angle selected by the rudder pedals, further movement is prevented by electrical means, described in Book 2, Section 5, Chapter 1, until a further signal is received from the pilot's controls. When the stop valve is open, the by-pass valve is closed and any overload imposed while taxying is relieved by the two-way relief valve. When the wheels leave the ground, the stop valve is closed and the by-pass valve opened, permitting flow from one side of the steering motor to the other. The centring jack is then the only unit exerting force on the wheels unit, which is therefore automatically centred.

BOMB DOORS

17. This circuit is supplied through three selectors for the operation of the bomb door jacks. For normal operation two selectors are used which are fed from the engine-driven pumps. For ground use and for emergency operation in flight, the third selector, which is fed from the power pack, is used. The pilot's controls for this circuit are located on the port console (fig.1).

18. When normal control is used, fluid is directed from the main supply to the jacks through the selector valves on the port side of the bomb bay. When emergency control is used, fluid is supplied from the electro-hydraulic power pack through its associated selector valve on the starboard side of the bay. Shuttle valves attached to the rod ends of the jacks move according to the source of supply selected, closing the feed and return lines of the supply not being used. Prior to the embodiment of Mod. 1236, the door locking struts are unlocked hydraulically but are mechanically extended and closed to the locked position by the operation of the doors. Post Mod.1236 the hydraulic unlocking of the struts is deleted, the struts take tension loads only when the bomb doors are open.

WHEEL BRAKES

19. There are two feed lines to the brake control valve, each passing through a non-return valve and a pressure-reducing valve which reduces the operating pressure for the brakes to 2,500 p.s.i. Between the non-return valve and the pressure-reducing valve the lines are branched to accumulators, which meet the immediate requirements of the system and provide an emergency fluid supply. To facilitate depressurising the accumulators, the feed lines to them are branched to manually-operated release valves. Two dual pressure gauges which record the brake line pressure, are mounted on the panel in the nose-wheel bay, together with two accumulator air pressure gauges and two air charging points. Interposed in each line to the dual pressure gauges is a pressure relay valve which prevents loss of fluid from the main system should a failure occur between the valve and the gauge. Connected to T-pieces in the pipes from the accumulators to the manually operated pressure-release valves are pipes leading to a triple pressure gauge mounted on the pilot's centre instrument panel.

20. Operation of the brake foot motors, which are mounted one on each rudder pedal, provides the pressure necessary to operate the brake control valve to allow pressure fluid from the hydraulic system to pass to the brake units. Pressure delivered to the brakes is proportional to the pressure applied to the master cylinders. Fluid to the brakes from the control valve passes through shuttle valves which ensure that fluid is taken only from the accumulator with the greater

reserve of pressure. When pressure on a master cylinder is released, the relay unit in the control valve closes and the pressure fluid from the brake unit is returned to the reservoir. The Maxaret units, fitted to the main wheels, permit maximum braking effort to be applied without fear of locking the wheels. Should a wheel tend to lock, the associ-

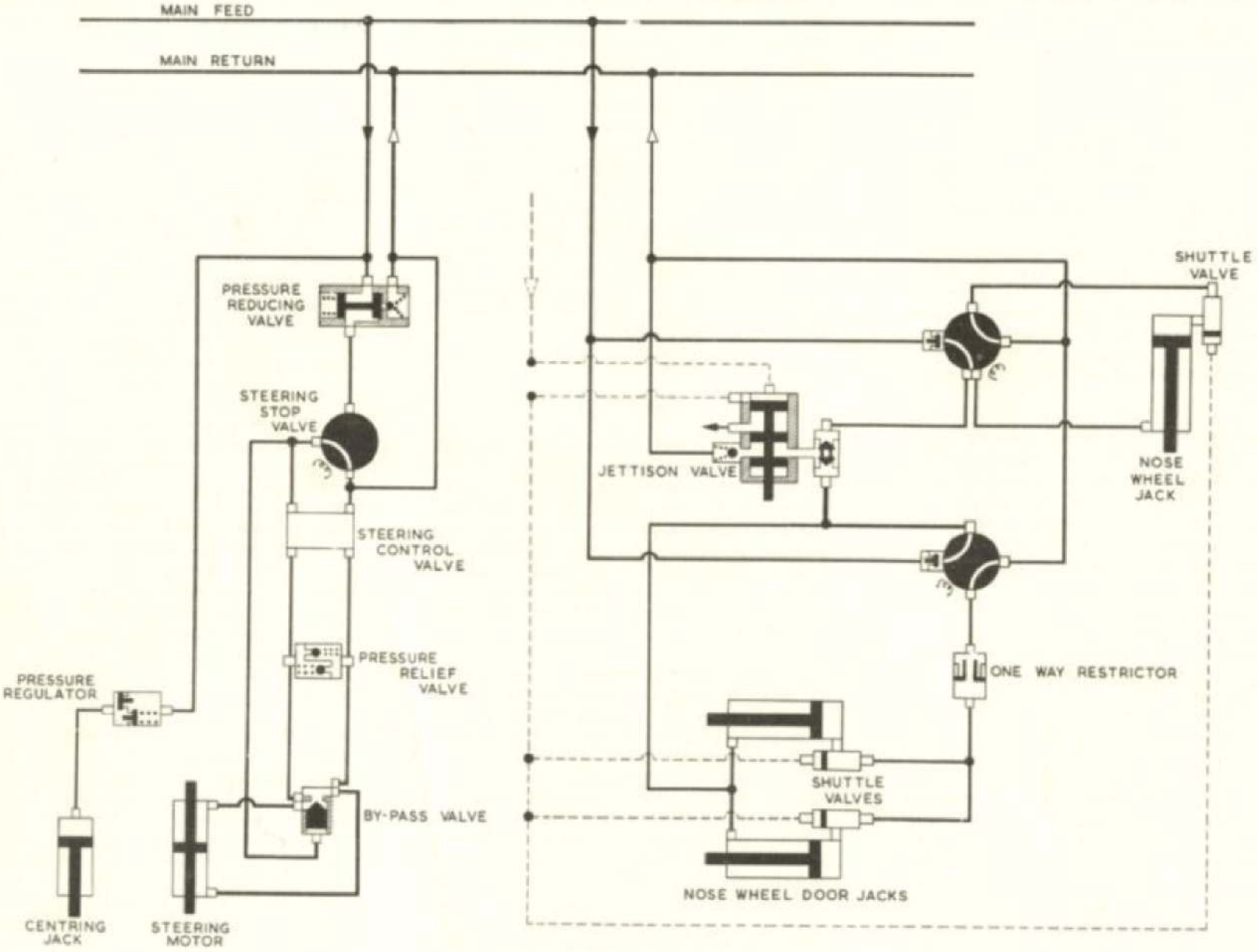

Fig.6. Nose-wheel circuit diagram

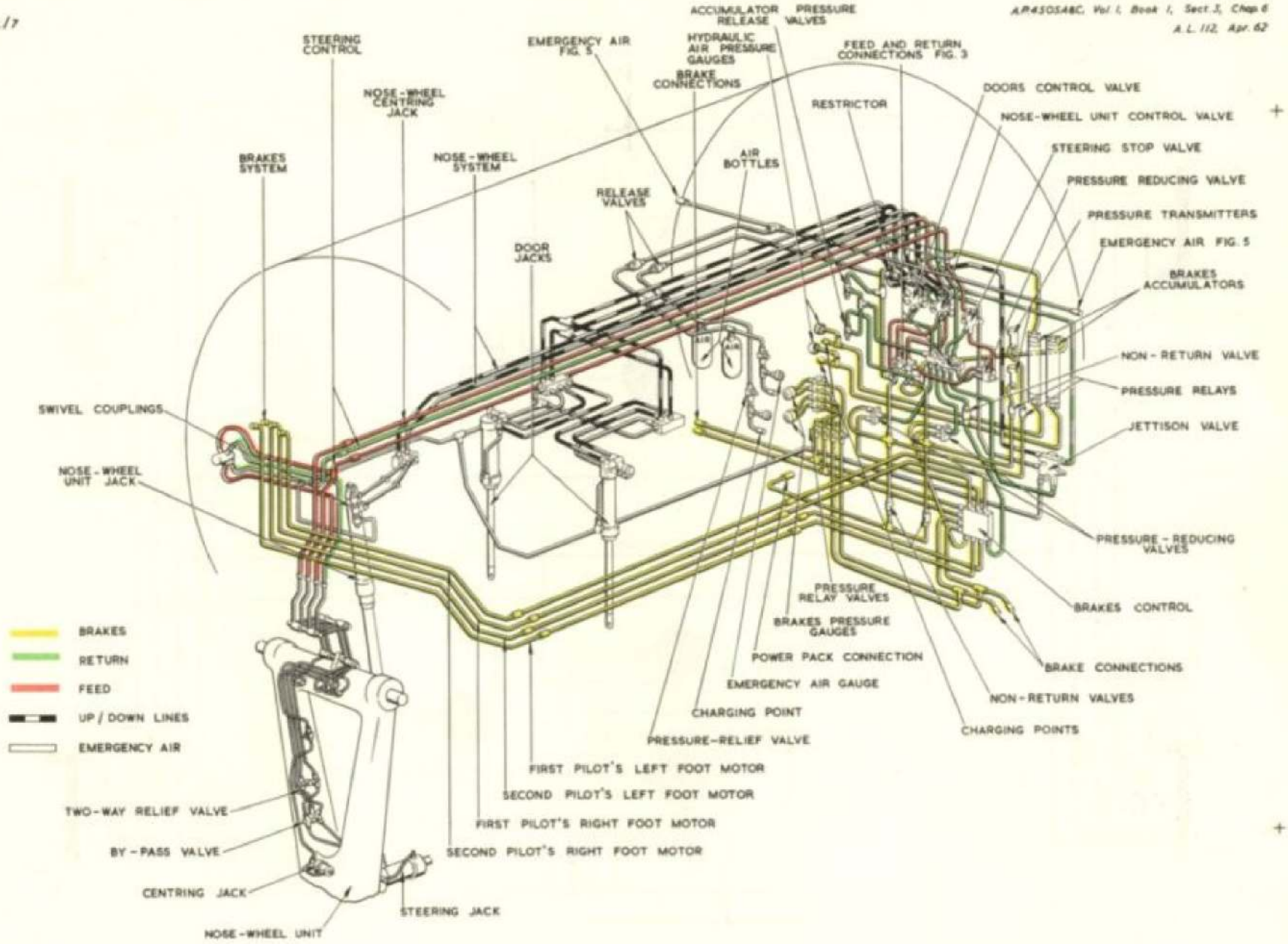

Fig. 7. Hydraulic system in nose wheel bay

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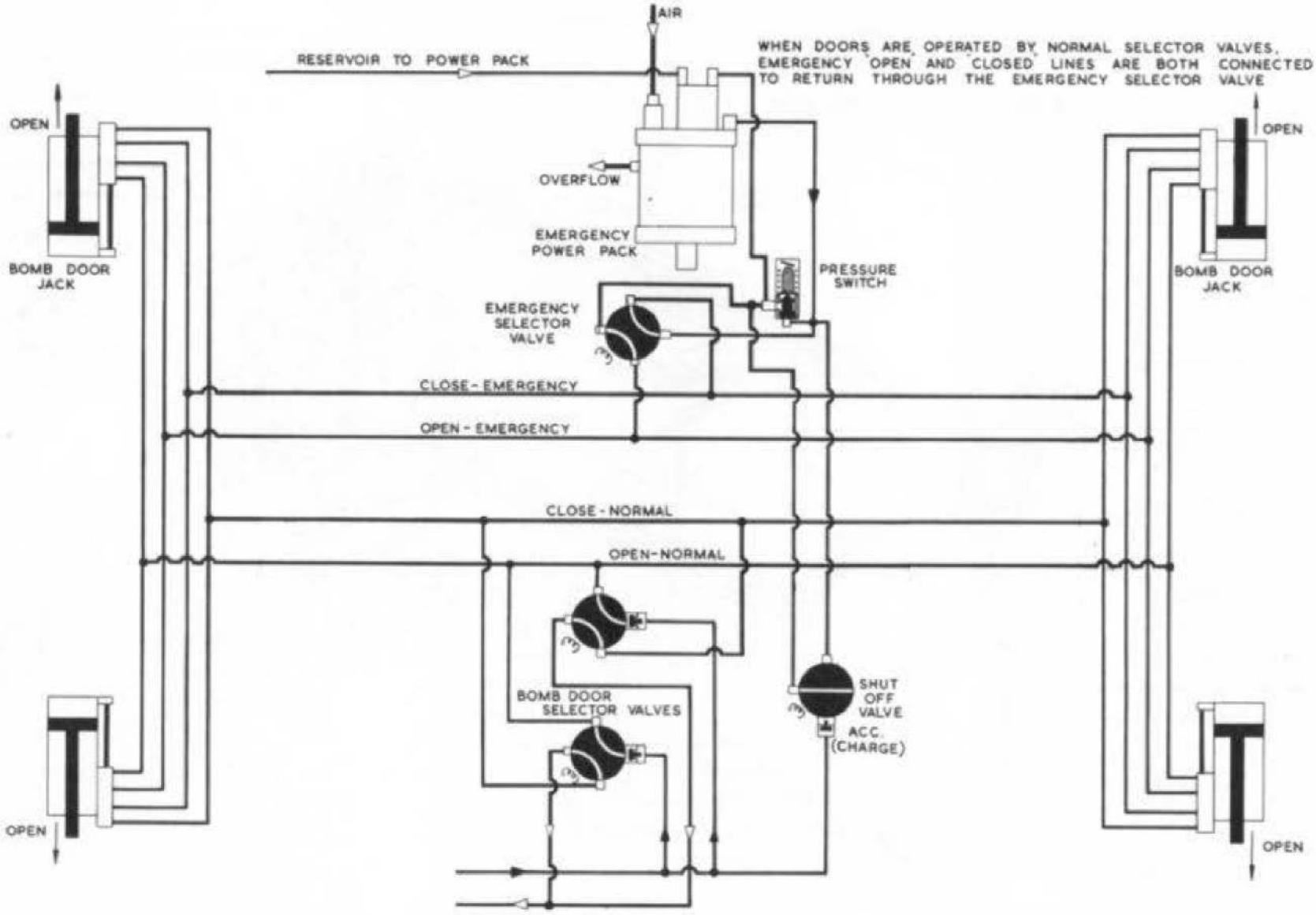

Fig. 8. Bomb door circuit diagram

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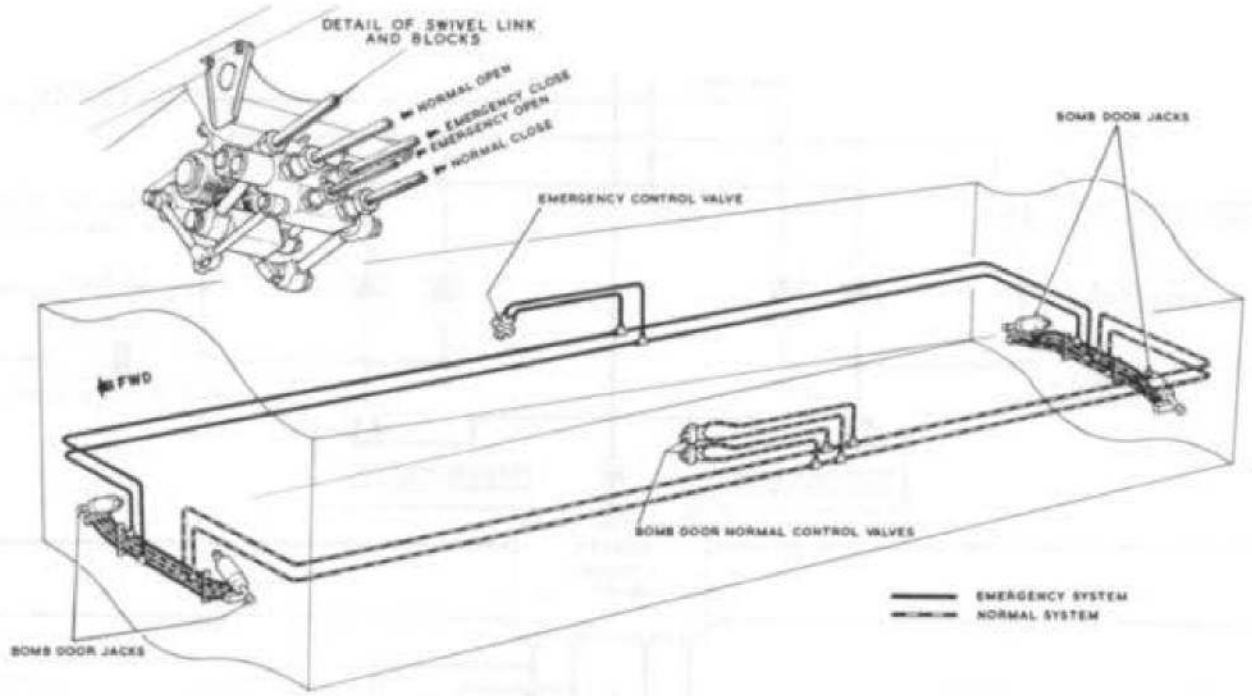

Fig.9 Hydraulic system - bomb doors

ated Maxaret unit momentarily reduces the hydraulic pressure at the brake unit and applies it when the tendency to lock ceases.

21. On the ground with engines not running the accumulators can be charged, when necessary, by the electro-hydraulic power pack. This is achieved by operating either one of two switches, one at the rear of the nose-wheel bay on the starboard side and the other on the lower side of the port console in the cockpit. This operation automatically opens the shut-off valve and pressure fluid is admitted to the main delivery line. Provided that no other circuit is selected to operate, the brake system accumulators will be charged. When the power pack outlet pressure reaches 3,900± 20 p.s.i., a pressure switch, in the supply line from the power pack, operates to cut-out the motor and stop the supply to the accumulators. The motor will not start again until a new operation is selected.

NOTE...

When Mod.241 is embodied, the pipe from the shut-off valve to the main delivery line is deleted and a line introduced from the valve direct to the brake accumulators. This ensures that, in the event of a hydraulic failure in the main system, the accumulators can be charged from the power pack.

WARNING...

The motor of the power pack is short-time rated and must not be allowed to run for more than one minute in any period of 20 minutes.

EMERGENCY AIR SYSTEM

22. Two separate air supplies, contained in air cylinders mounted in the nose-wheel bay, are provided for emergency lowering of the alighting gear, one for the main-wheel units and one for the nose-wheel unit. Each cylinder is charged through an A58 Mk.2 (or D.C.22) charging valve, overcharging being prevented by relief valves set to blow off at 3,300 p.s.i. Cylinder pressures are registered on gauges calibrated 0-4,000 p.s.i.

23. Air is released to the circuits by the operation of two air release valves mechanically linked together. Control of these valves is by a single control handle located on the starboard side of the pilot's engine console. When emergency air is used, the supply first passes to the jettison valves, two in the main-wheel

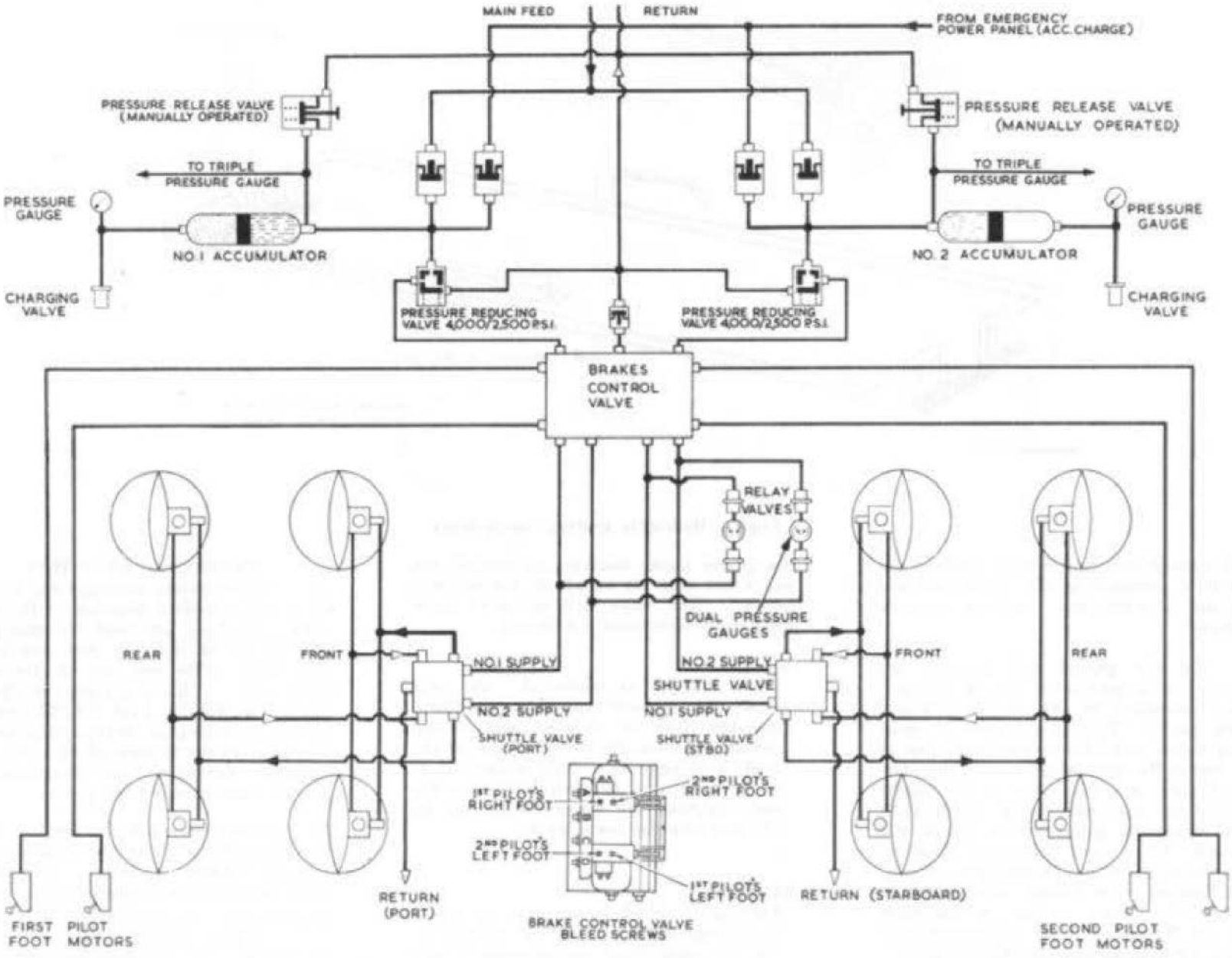

Fig. 10. Wheel brakes circuit diagram
(*Control valve detail added*)

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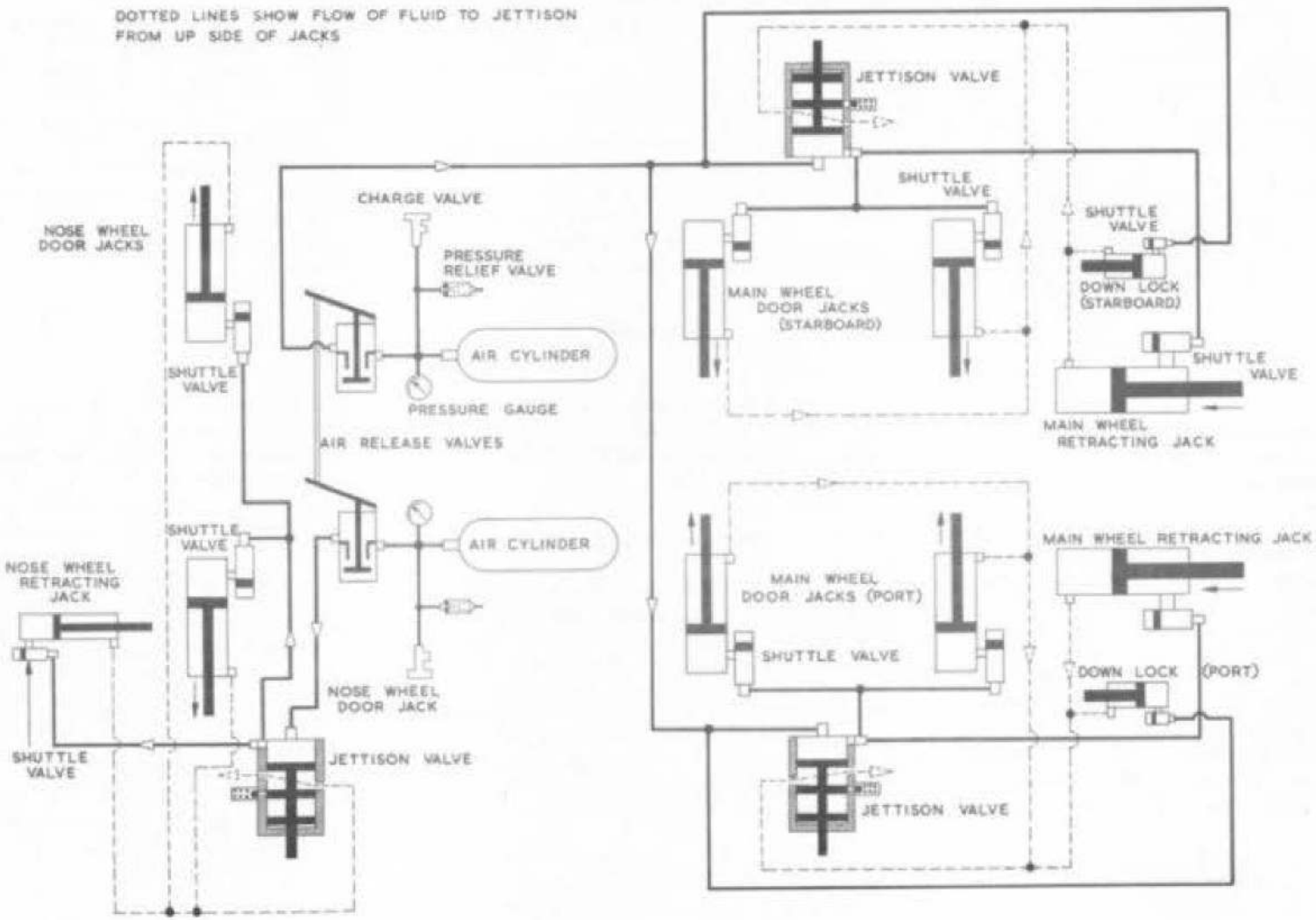

Fig. 11. Emergency air circuit diagram.

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circuit and one in the nose-wheel circuit, and the pressure moves the internal pistons of the valves so that the fluid expelled from the actuating jacks is able to pass to atmosphere. The spigoted end of the valve piston protrudes at one end to provide a means of manually resetting the piston after emergency air operation. From the jettison valves, air then passes to the shuttle valves integral with the main and door jacks of each wheel unit and the main-wheel unit downlock, forcing the shuttles in the valves to move and shut off the fluid supply to the jacks. Air then passes to the downside of the jacks, the pressure being sufficient to ensure that the alighting gear will be fully lowered and locked down. Use of the emergency air control cuts off the electrical supply to all the electro-hydraulic valve solenoids except the nose-wheel steering valve, which can still be operated in the normal manner.

WINDSCREEN WIPERS

24. Three Dunlop hydraulically-operated windscreen wipers are provided, one to each pilot's windscreen and one to the centre windscreen. Operation of the wipers is controlled by a three-position switch located on the second pilot's instrument panel and labelled OFF, FAST, SLOW. No parking control is provided, the wipers being held against their stops by the pressure of the airstream during flight.

25. The wipers are powered by two Dunlop Maxivue pump units (Pt.No.AC. 13444) mounted on the pilots' floor, one below each console. The wipers on the first pilot's and centre windscreens are operated by the port pump unit, and the second pilot's windscreen wiper by the starboard pump. Pressure and return lines connect the pump units to the wiper heads which are secured to the windscreen base.

SERVICING

General

26. Cleanliness is essential in the maintenance of the hydraulic system. All fluid containers, funnels, etc. should be thoroughly cleaned and rinsed with hydraulic fluid before being used. Only clean fluid from sealed containers should be used when filling or topping up. Disconnected pipes must be sealed to prevent the entry of dirt. It should be ensured that all components are clean before installation, and that new pipes and couplings are flushed out with hydraulic fluid before they are fitted. For specifications and reference numbers of fluids used in the system, reference should be made to the Leading Particulars.

27. In all ground operations involving the functioning of the hydraulic system, it is necessary to use a servicing trolley and a ground electrical supply. Satisfactory operations may be carried out using a hydraulic servicing trolley Mk.2A, 2B or 2C (Ref.Nos. 4F/1796, 4F/2345 or 4F/2375), and the operating times given in para.48 are based on their use. It is emphasised that scrupulous cleanliness of the trolleys is essential at all times, and end caps must be kept on the hoses when these are not in use.

FAULTS IN THE SYSTEM

28. Faulty operation of the system can be caused by hydraulic, electrical or mechanical defects. It is unlikely that a complete stoppage of the system will occur, but should this occur it will be due to failure of the pumps or to serious obstructions between the pumps and the control valves. In all cases of unsatisfactory operation, the fluid contents of the reservoir should be checked.

29. Before dismantling any components for examination, the functioning of the system as a whole should be observed; by adopting this procedure faults can usually be traced and the cause localised. For example, if all services operate sluggishly it suggests that the power circuit is at fault, and if one circuit only fails to function satisfactorily it implies a power leakage in that particular circuit. Tests should be carried out in accordance with the paragraphs dealing with testing, and for instructions on the testing of components, reference should be made to the appropriate A.P.1803 series Vol.1.

30. Table 2 lists some of the common hydraulic faults and their remedies. As the various hydraulic circuits are controlled by electrically-operated selector valves, complete failure of the system, or the failure of any particular circuit, may be the result of a break in the electrical circuit or failure at the source of electrical supply. Reference should be made to Vol.1, Book 2, Sect.5, of this publication for information on electrical operation of the system and rectification of electrical faults.

31. Faulty operations may also be caused by mechanical defects, which may be summarised as follows:-

(1) Side load on jack pistons due to malalignment.

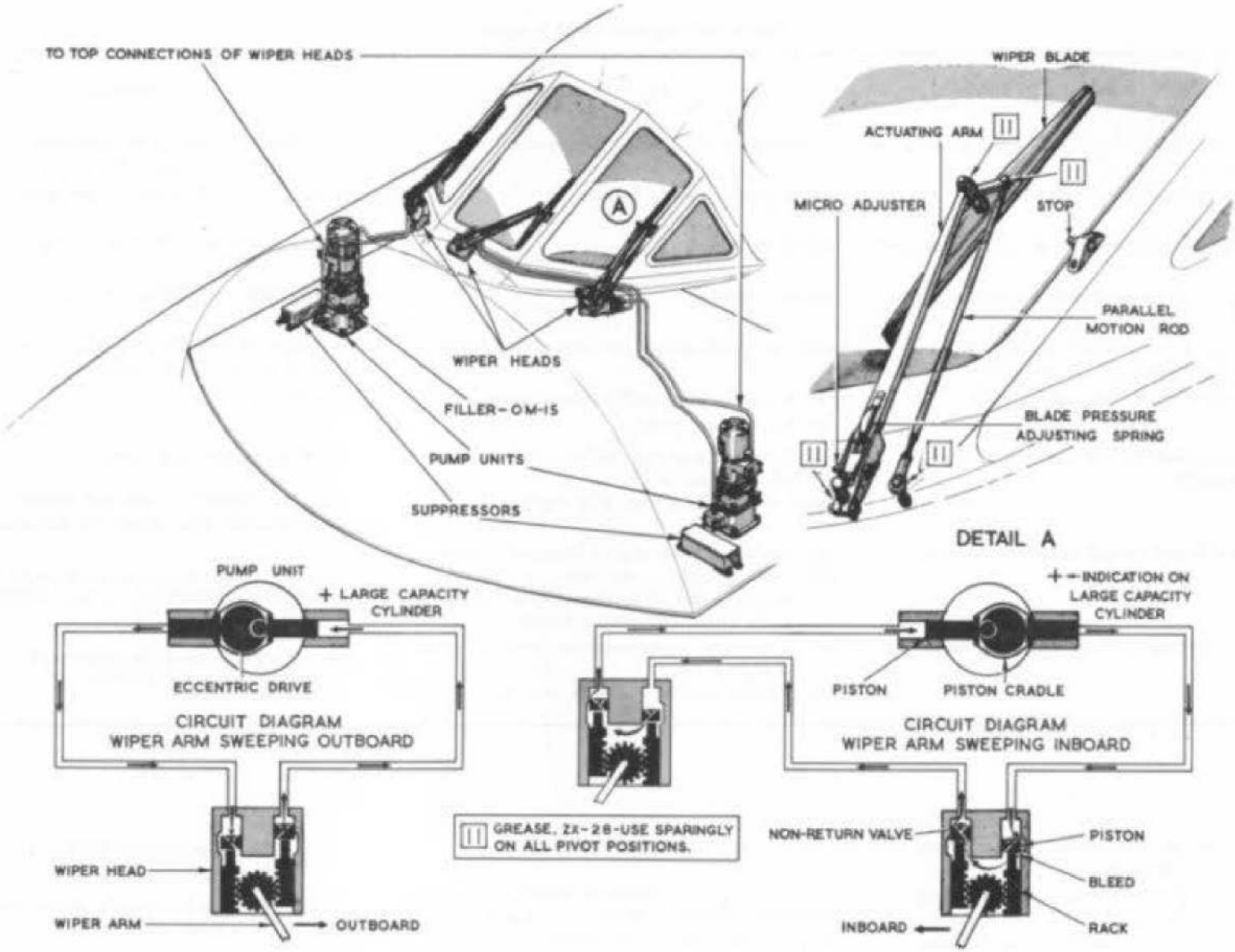

Fig. 12. Windscreen wipers.

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TABLE 2

Fault Finding and Rectification

Fault	Possible cause	Remedy
All services fail to operate when engine-driven pumps are in action	Insufficient or no oil in the system	(a) Refill or top-up the reservoir (b) Check for leaks and rectify
Operation speed below normal for all services.	Engine driven pump failure	Replace defective pump with serviceable one.
Operation speed below normal for a particular service.	Air in system	Prime and bleed affected circuit.
Backlash at the bomb doors or alighting gear doors.	Air in system	Prime and bleed affected circuit.
Doors droop or can be moved slightly by hand when control is in neutral.	Leakage past glands on jack pistons.	Service defective jacks according to instructions in A.P.1803D.
Alighting gear does not retract fully.	(a) Leakage past jack piston glands. (b) Mechanical fault.	As above.
Excessive deflection of main-wheel unit shock-absorber.	(a) Leakage past recuperator valve on shock-absorber.	Change recuperator valve.
	(b) Loss of fluid from shock-absorber.	Top up shock-absorber and separator with fluid mixture after checking for leaks.
Excessive recoil speed of shock-absorber.	(a) Broken piston ring in shock-absorber (b) Leakage past plate valve in shock-absorber due to foreign matter between plate valve and piston flange.	Service affected shock-absorber in accordance with instructions in A.P.1803D.
Sluggish steering or nose wheel shimmy.	(a) Faulty two-way relief valve in steering circuit. (b) Faulty control valve in steering circuit.	Service valve in accordance with instructions in A.P.1803D.

(2) Mechanical interference between moving parts.
(3) Presence of obstruction between moving parts.
(4) Excessive friction due to over-tightening of the gland nuts, etc.
(5) Lack of lubrication at bearings, hinges, etc.

FILLING THE RESERVOIR

32. A sighting glass is provided in the reservoir through which the fluid level may be checked. The reservoir must be filled through the reservoir charging valve under the following conditions:-

(1) Alighting gear DOWN.
(2) Bomb doors OPEN.
(3) Brake controls OFF.
(4) Brake system accumulators CHARGED.

The charging valve is located in the rear of the No.3 engine bay. To replenish the reservoir, remove the blanking cap from the charging inlet, fit the charging line

end fitting and pump in the fluid. An escape of fluid from the valve overflow indicates that the reservoir is full.

NOTE . . .
The fluid overflow should be allowed to cease before the charging line is removed.

Remove the charging line and fit the blanking cap. Finally check the fluid level through the sighting glass in the reservoir.

CHARGING THE BRAKES ACCUMULATORS

33. The accumulators, mounted on the panel in the nose-wheel bay, are charged with both air and hydraulic fluid, the procedure being as follows:-

(1) Discharge all fluid from the accumulators by depressing the push button of the manually-operated release valves on the hydraulic panel in the nose-wheel bay.

(2) Connect an air supply in turn to each of the air charging valves adjacent to the air pressure gauges, and apply air at low pressure to position the accumulator piston, at the far end of its stroke. This position will be indicated by a steady reading on the gauge. The manually-operated release valves should be kept open during this operation.

(3) Continue applying air to charge the accumulator to a pressure of 2,550 p.s.i.

(4) Using a hydraulic servicing trolley (para.27), or the emergency electro-hydraulic power pack (para.21) with an external 112v. supply, charge the accumulators with hydraulic fluid to the main system working pressure of 4,000 p.s.i. The pressure will be registered on the air pressure gauges as entry of fluid into the accumulators moves their pistons to further compress the air.

WARNING . . .
It is important that the accumulators are correctly charged with air before introducing fluid under pressure. Hydraulic fluid at working pressure with no air in the opposite end of the accumulators will cause unbalanced pressure on the piston with possible damage to the sealing rings.

CHARGING THE BOGIE TRIMMERS

34. Each bogie trimmer jack must be charged with air through the inflation valve located on the front face of the main-wheel unit leg assembly outboard of the jury strut lugs.

NOTE . . .
On aircraft without Dowty Mod.AC/3293 embodied, the inflation valve is located at the bottom of the main-wheel strut just above the front axle. When Dowty Mod. AC/3293 is embodied, the valve is located at the upper end of the main body casting adjacent to the jury strut lugs. If the alighting gear is fully extended and off the ground the jacks must be charged in accordance with the instructions in Sect.2, Chap.2. If the charging operation is effected with the aircraft on the ground under load reference must be made to the graph in Sect.2, Chap.2, for the correct pressure.

PUMP FILTERS

35. The filters in the engine-driven pump suction lines must be examined and the element replaced if necessary at the periods stated in the Servicing Schedule. Each filter incorporates a canister which may be removed for the purpose of examining or changing the element, without loss of fluid from the system. The canister must be filled with hydraulic fluid prior to refitting, in order to exclude air from the pipes. Surplus fluid will pass into the system through the valves in the filter head. The reservoir level must be checked after this procedure.

PRIMING AND BLEEDING

36. To prime and bleed the complete system proceed as follows:-

(1) Jack the aircraft clear of the ground (Sect.2, Chap.4).

(2) Inflate the brake accumulator to 2,550 p.s.i. Connect at least one ground rig pump (three will be required later for functional tests) to the ground test couplings in the port main-wheel bay.

(3) Leaving the main-wheel unit operating jacks connected, disconnect all remaining jacks at the rod end attachment points and support these ends so that the jacks can be operated without fouling the adjacent structure. Disconnect the 24v. supply to all control valves.

(4) Connect the ground dispensing trolley to the reservoir charging valve. Pump in hydraulic fluid until fluid emerges from the overflow in the charging valve. Wait until the flow ceases.

(5) Start a power pump running (ground test rig) preferably at low r.p.m. (1,000 r.p.m. or less) and wait for the suction and pressure lines to become primed.

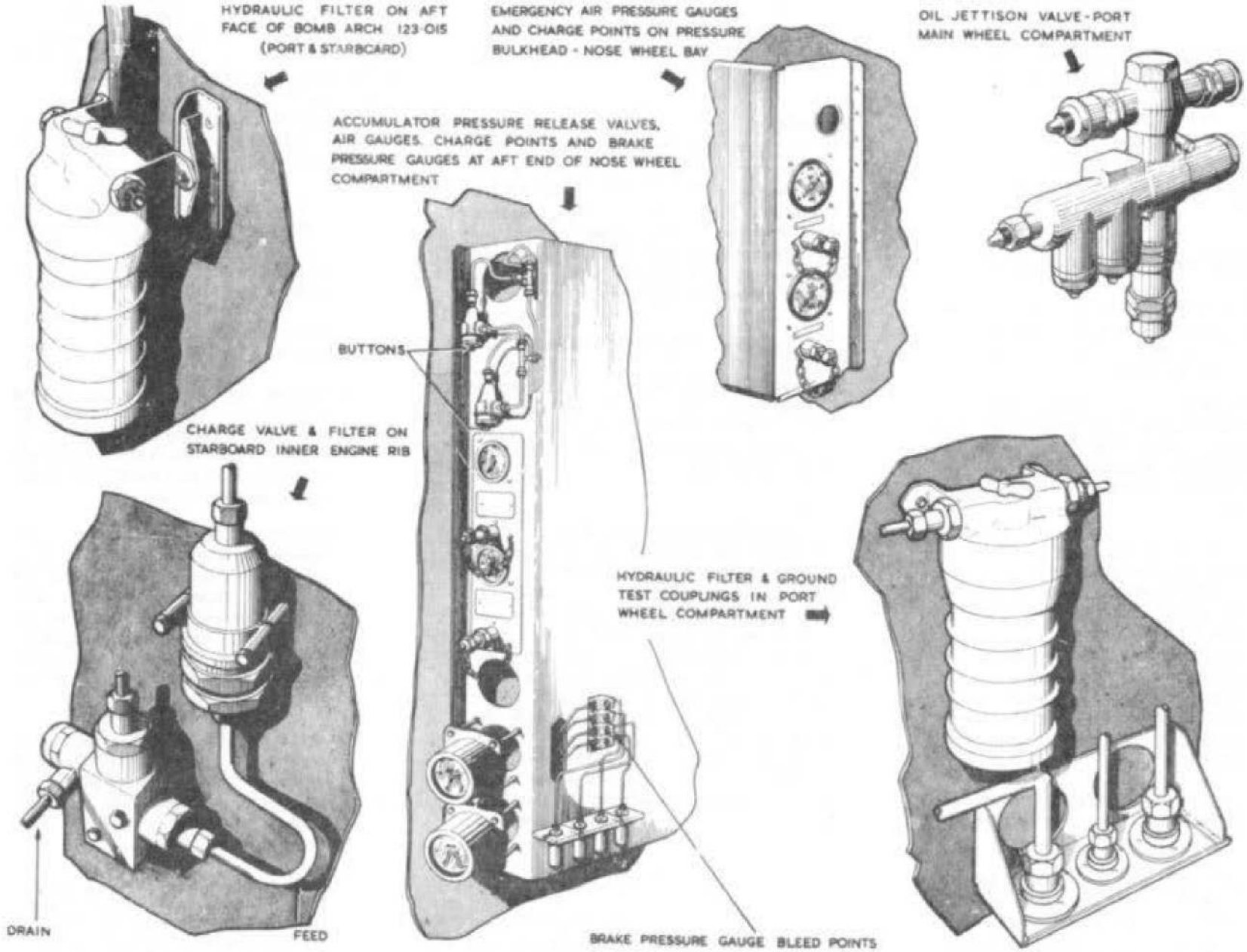

Fig. 13. Hydraulic system-servicing points

(6) With the pump still running, open the bleed screw on the DOWN side of one main-wheel unit jack and depress the manually-operated solenoid on the appropriate selector valve. Bleed until all air is expelled. Close the bleed screw and release the solenoid.

(7) A similar operation should be carried out on the remaining jacks in the nose and main alighting gear circuits. It is not considered necessary to bleed the downlock jacks or the bomb door locking struts. Open the bleeder screw at the banjo fitting on both main alighting gear separators until all air is expelled. Check by reference to the level indicator on the separator that the oil content is correct and top up as necessary.

(8) Before bleeding the UP side of the jacks, stop the power pump and check the reservoir fluid level. If necessary top up and disconnect the ground dispensing trolley. As the bleeding operation continues, a constant check must be kept on the level of the fluid in the reservoir.

(9) The UP side of the jacks are bled in a similar manner by opening the appropriate bleed screw and depressing the corresponding manually-operated solenoid. It must be noted that the operating jacks are connected to the main-wheel units, therefore, the units will retract.

(10) Bleed the bomb door jacks in a similar manner, by opening the bleed screw and depressing the appropriate solenoid. Keep a constant check on the reservoir fluid level and remove the dispensing trolley if the jacks are to be operated.

(11) Connect an electrical supply to the aircraft and bleed the bomb door jacks using the emergency system.

(12) When all air has been expelled from the circuit, connect the jacks to their respective components. Adjust, if necessary, the jack eye-ends to line up with the attachment points on their respective components in accordance with the instructions for each particular service.

(13) In the case of the nose alighting gear, fully pressurise the jack in the DOWN position, and with the unit locked DOWN, adjust the jack eye-end to give 0·050 to 0·060 in. override; this is very important. Lock the jack eye-end and retract the jack sufficiently to insert the attachment pin.

(14) The UP positions of the alighting gear may be adjusted by the gland nut adjustment. The adjustment of these jacks, and the connecting of the door jacks and locking struts should be carried out in conjunction with the instructions given under Servicing in Sect.3, Chap.5 of this book.

(15) When all jacks have been connected and adjusted, the system as a whole is ready for functional testing. Check the setting of the micro switches in the alighting gear circuits in conjunction with the instructions given in Sect.3, Chap.5, of this book, and reconnect the 24v. supply.

Bleeding the brake hydraulic system

37. The brake system may be bled in three stages:-

(1) Master cylinders on the rudder foot pedals to the brake control valve.

(2) Brake control valve to the brake units.

(3) Brake control valve to the dual pressure gauges.

38. To bleed from the master cylinders to the brake control valve, apply the following sequence to each master cylinder in turn:-

(1) Remove the filler cap from the master cylinder and connect the filling device (Ref.No.6C/603) to the cylinder with adapter (Part No. 1Z/9892). A description and the method of operating the filling device may be obtained by reference to A.P.1275T, Sect.7, Chap.4. Before the filling device is connected to the master cylinder, the pipe should be primed with fluid as follows:-

(a) Open the ON/OFF cock on the filling device.

(b) Operate the pump and allow fluid to pass slowly through the ON/OFF cock in the adapter until it is free from air.

(c) Close the ON/OFF cock in the adapter.

(2) Connect a bleed adapter or a piece of rubber tubing to the bleed screw on the brake control valve. Each master cylinder pipe has its own bleed screw on the control valve, their location being shown on fig.10.

(3) Open the ON/OFF cock on the master cylinder adapter, release the bleed screw and pump fluid from the filling device through the section of the system until fluid,

free from air, leaves the bleed screw. The pressure of the fluid as indicated by the gauge on the filling device must not exceed 25 p.s.i. If this pressure is exceeded the seals in the master cylinder may be damaged.

NOTE . . .
In exceptional cases, it may be necessary to bleed through the screw blocks on the rudder pedals first.

(4) When the fluid is free from air, close and wire-lock the bleed screws, close the master cylinder adapter ON/OFF cock, disconnect the filling device from the master cylinder and refit the filler cap.

39. To bleed from the brake control valve to the brake units:-

(1) Ensure that the parking brake is off.

(2) Check that the accumulators are properly charged with oil and air.

(3) Connect a hydraulic servicing trolley to the ground servicing couplings in the port main-wheel bay.

(4) Ensure that the pistons of the pressure relay valves in the lines to the dual pressure gauges are at the bottom of the valve cylinders. To do this release the pipe coupling at the top and bottom of the valve and then blow into the top of the valve. Attach a clamp (Part No.ACO.5928) to each valve body between the two grooves near the bottom of the cylinder. The clamp should be tightened just enough to flex the body slightly and grip the piston, but not enough to cause permanent distortion. Attach warning streamers to the clamps.

(5) Reconnect the pipe couplings to the top and bottom of each relay pressure valve.

(6) Start the hydraulic servicing trolley and build up a low pressure of approximately 200 p.s.i. in the brake system by slowly operating the foot pedals or parking brake. Release the bleed screws on each brake unit in turn and bleed fluid until it is free from air. At this stage it is only necessary to bleed most of the air as this section of the system is finally bled with the accumulators as a source of pressure. When bleeding each brake unit, flick the Maxaret unit two or three times in the direction indicated by the arrow on the unit. If the main wheels have not been removed, the Maxaret tyre should be moistened with a damp rag to allow it to turn on the wheel.

(7) Stop the hydraulic servicing trolley and complete the bleeding of this section of the system with the accumulators as a source of pressure. A low pressure should be maintained in the brake system when bleeding as in item (6).

(8) Close and wire-lock the bleed screws.

40. To bleed from the brake control valve to the dual pressure gauges:-

(1) Leave the clamp in position on the pressure relay valves as detailed in para.39 sub para.(4).

(2) Admit fluid at low pressure to this section of the system by operation of the foot motors or the parking brake.

(3) Bleed fluid from the bleed screws in the bleed block above the pressure relay valves until it is free from air.

(4) Partly release each coupling at the dual pressure gauge in turn and bleed fluid until it is free from air.

(5) Wire-lock the bleed screws.

(6) Remove the clamps and warning streamers from the pressure relay valves.

41. If necessary the lines to the pressure transmitters for the triple pressure gauge may be bled in a manner similar to that outlined in para.40, i.e., by clamping the pressure relay valve, admitting fluid to the system at low pressure and bleeding fluid from the coupling at the transmitter until it is free from air. Note that it will be necessary to discharge the oil and air pressure from the accumulators, before clamping the pistons in the pressure relay valves, and to recharge them before bleeding the transmitter lines.

BLEEDING AFTER EMERGENCY AIR OPERATION

42. After the emergency air circuit has been used, nothing must be touched in connection with the alighting gear circuits until the aircraft has been jacked with the wheels well clear of the ground. The following procedure is then necessary:-

(1) Ensure that the alighting gear normal selection button is DOWN.

(2) Return the alighting gear emergency lowering control to the off position and wirelock using 28 s.w.g. copper wire (Sect.3, Chap.11, fig.5).

(3) Open all the DOWN side bleed screws on the alighting gear and door circuits. The nose centring jack is not in the emergency air circuit and so is not affected.

(4) When all high-pressure air has been expelled, close all bleed screws. Reset the pistons on the three jettison valves, one for each main and nose alighting gear unit. To ensure that the piston has been reset correctly, lightly tap the plunger with a hide-faced hammer.

(5) Connect a hydraulic servicing trolley to the ground test connections and a ground dispensing unit to the reservoir charging valve. Top up the reservoir and start the hydraulic servicing trolley pump.

(6) Bleed the down side of each jack individually, at the same time ensuring that the reservoir level is maintained.

NOTE...
With the 24-volt supply ON to the alighting gear circuit all valves are energised in the DOWN position, so there is no necessity for manual operation of the solenoid button.

(7) It is not considered necessary to bleed the UP sides of the jacks after an emergency air operation, as this would entail disconnecting the 24-volt supply and the jacks from the nose wheel unit and the nose and main-wheel unit doors. It should be sufficient to operate the alighting gear a few times, topping up the reservoir after each operation and not omitting to disconnect the ground trolley after each top-up.

PRESSURE RELAY VALVES

43. Mounted on the hydraulic panel in the lines to the dual pressure gauges are four pressure relay valves with associated bleed points mounted in a bleed block above them. After installing or replacing a valve, or after a pipe or component on the remote side of the valves has been disconnected, the following procedure should be carried out:-

(1) Ensure that the piston of the affected valve is at the bottom of the valve cylinder.

(2) Attach a clamp (Pt.No.ACO.5928) to the valve body between the two grooves near the bottom of the cylinder. The clamp should be tightened just enough to flex the valve body slightly and grip the piston, but not enough to cause permanent distortion. Attach a warning streamer to the clamp.

(3) Open the appropriate bleed point.

(4) Admit fluid at low pressure to the valve, by applying gentle and steady pressure to the associated foot motor, until fluid free from air issues from the bleed point.

(5) While fluid is still escaping, close the bleed point.

(6) Remove the clamp and warning streamer from the valve.

WINDSCREEN WIPER SYSTEM BLEEDING

44. The procedure for priming and bleeding the windscreen wiper system is as follows:-

(1) Remove the wiper blade and operating arm assembly.

(2) Fill the pump unit reservoir with oil OM-15.

(3) Operate the system at slow speed and continue filling the reservoir until the fluid level remains constant at approximately ½ in. below the filler orifice. Continue operation of the system for 5 minutes. If difficulty is experienced in expelling the air from the system, it is permissible to undo the 1/8 in. B.S.P. unions on the wiper head.

(4) When all the air has been expelled tighten the unions, switch off the supply and lock the unions as necessary. Top up the reservoir to the level stated in sub para.(3) and replace the filler cap.

(5) Fit the wiper blade and operating arm assembly in accordance with the instructions given in para.45 of this chapter.

WINDSCREEN WIPER SETTING

45. The procedure for setting the actuating arm and wiper blade on assembly is as follows:-

(1) Turn the serrated drive of the wiper head to the fully parked position.

(2) Fit the wiper operating arm complete with wiper blade to the serrated drive of the wiper head so that the wiper blade is 0·25 in. from and parallel to the windscreen frame. Any fine adjustment that may be required can be made on the micro adjuster.

(3) Adjust as necessary and connect the parallel motion rod to its pivot below the windscreen.

(4) Check the actuating arm for full angular movement of 50 degrees.

(5) Check that the wiper blade pressure is approximately 4 lb. on the windscreen over the full range of movement, this is measured by a spring balance on the blade pivot.

WARNING...
The wiper blades must not be operated on a dry window.

TESTING

General

46. When it is necessary to perform functional tests, the aircraft should be jacked as described in Sect.2, Chap.4 of this book.

Emergency air

47. At the specified periods the emergency air system should be tested, prior to hydraulic operational tests. The procedure is as follows:-

(1) Check that the air cylinders are correctly charged.

(2) Place containers under the mouths of the vent pipes from the jettison valves to receive the fluid expelled from the jacks. The main and nose alighting gear must be hydraulically raised to the up position.

(3) Operate the emergency air control valves by pulling the emergency air control handle on the pilots' throttle pedestal. It is not necessary to operate any of the selector valves.

(4) The alighting gear doors should open and the main and nose alighting gear should move smoothly to the DOWN position. Check that the alighting gear is locked DOWN.

(5) After the emergency air operation, the complete system must be re-primed and bled in accordance with para.42 of this chapter before normal operation tests are performed.

(6) Reset the emergency air control handle the instructions for which are given in Sect.3, Chap.11, para.34 of this book, and re-charge the emergency air cylinders.

Normal functioning testing

48. The procedure for testing the hydraulic system is as follows. A ground electrical supply must be used, and the hydraulic servicing trolley (Ref. No.4F/1796) must be coupled to the ground servicing couplings at the port main-wheel bay.

(1) Jack the aircraft with the wheels clear of the ground. (Sect.2, Chap.4).

(2) Remove the blanking caps from the half-couplings on both the aircraft and servicing trolley flexible hoses and connect the three sets of half-couplings. Incorrect attachment is avoided by the use of different sized couplings, i.e., the suction line is 3/4 in. dia. delivery ½ in. dia. and return 3/8 in. dia.

(3) With the servicing trolley operating retract and lower the alighting gear at least four times, and ensure that:-

(a) The alighting gear retracts and extends correctly.

(b) The locks engage correctly.

(c) The alighting gear doors open and close correctly.

(d) The position indicator functions in agreement with the position of the alighting gear units.

(4) With the servicing trolley operating and using the NORMAL bomb door control switch, operate the bomb doors and check for correct opening and closing. Check that the bomb door warning lamp functions correctly.

The following operating times are given for use when using the Mk.2A single-pump trolley coupled to the aircraft ground test points:-

Alighting gear:-
UP 32 ± 2 sec. DOWN 24 ± 2 sec.

Bomb doors:-
OPEN 14 ± 2 sec. CLOSE 12 ± 2 sec.

Snubber valves setting

49. A snubber valve is situated in the hydraulic lines to each main-wheel unit, its function being to slow down the unit during the final stages of retraction. Each valve is mechanically operated by a striker and cam on its main-wheel unit pivot shaft. On initial installation the valve should be adjusted so that with its plunger depressed to the seating position the gap between the striker adjusting screw and the valve plunger is 0·035 to 0·040 in. with the alighting gear in the down position. The seating position of the valve plunger varies on individual valves, but can be plainly felt as the plunger is depressed. A retraction test should be done to check the correct operation and timing of the snubber valve, and final adjustment made so that the valve causes the main-wheel unit to check visibly when the rear wheel axle is just inside the retraction bay. Due to the very slow movement of the alighting gear

when using the single pump Mk.2A trolley, accurate observation of the 'check point' is difficult, and a more efficient observation can be made by setting each main-wheel unit independently; this can be done by disconnecting the electrical leads to those selector valves not to be operated, a final retraction of the whole alighting gear being done to ensure that electrical connections have been correctly remade. After final snubber valve adjustments are complete, the locknuts and adjusting screws must be wire-locked to resist rotation in both directions.

Testing the brake system

50. With the accumulators correctly charged, operate successively each pilot's left and right foot motors, and note the reading shown by the dual pressure gauges on the hydraulic panel in the nose-wheel compartment. The progressive rise in pressure as each motor is depressed should be correspondingly equal for all motors, and the final pressure for each should be 2,500 p.s.i. with the foot pedal motor fully depressed.

Bomb doors emergency operation

51. To check the bomb doors emergency operation, operate the bomb doors using the emergency selector switch on the port console, and check for correct opening and closing. If the electrical supply to the emergency selector valve has failed, the doors may be opened by operating a handle located on the port side of No.3 engine bay, the label for which reads:- PULL TO OPEN BOMB DOORS IF ELECTRICS FAIL. Operation of this handle depresses the appropriate solenoid of the selector valve, causing it to function correctly to open the doors. On completion of this check, the emergency switch must be set to NORMAL.

◀*NOTE . . .*

The bomb door EMERGENCY selector switch must be returned to the centre NORMAL position immediately the selected service is completed, i.e., after automatic shut down of the power pack. If for any reason the EMERGENCY selector switch is left in a selected position for a period in excess of one minute, the switch must first be returned to the centre NORMAL position, an identical selection made and then return the switch to the centre NORMAL position. ▶

REMOVAL AND ASSEMBLY

General

52. No special instructions are considered necessary relative to the methods of removal of components from the system. Extreme care should at all times be exercised in handling, in order to avoid damage to components and pipes and where special tools are called for they must always be used. Used locking wire, tab washers and split pins removed during dismantling must be discarded. In the case of pressurised components, the pressure must be released carefully before removal operations are commenced.

53. Should the brakes accumulators or components connected directly to them require to be removed, before any disconnections are made the fluid should be discharged from the accumulator (para.33), after which the air pressure must be discharged using an inflation adapter (Ref.No.4G/4131) at the appropriate charging valve. Similarly with emergency air cylinders or gauges, before any attempt at removal, the air pressure in the cylinders must be discharged by the inflation adapter.

54. If a power pack is removed and refitted, or renewed, ensure that the gear box is charged with oil OX-23.

WINDSCREEN WIPER HEAD

55. A removal sequence for the centre windscreen wiper head is given, but this may be applied in part, to the port or starboard units as required. The work must be carried out in conjunction with an electrical tradesman as the removal of certain electrical components is involved.

(1) Ensure that all electrical supplies are disconnected.

(2) On the outside of the aircraft, remove the windscreen wiper arm and its associated parallel motion rod, and the two nuts from the bolts which secure the wiper head to the windscreen frame.

(3) Lower the pilots' centre panel (Vol.1, Book 3, Sect.5, Chap.2 of this A.P.).

(4) Remove the small access panel from the front central area of the cockpit coaming.

(5) Disengage all plug connectors from the plug panel and, after removing the four securing bolts and nuts, remove the plug panel.

(6) Remove the locking wire and disconnect the hydraulic pipe unions from the wiper head. Blank off the pipe ends and unit connectors.

NOTE...

Adequate precautions must be taken to ensure that hydraulic fluid does not spill over adjacent components and cables.

(7) Withdraw the unit from the windscreen frame, taking care to retain packing block, seals, etc., on the front face of the unit.

NOTE...
When Mod.1366 is embodied, a Gaco seal is fitted on the shaft and housed in a recess in the packing block, fore and aft of which are fitted two neoprene/cork seals.

When a port or starboard windscreen wiper head is to be removed, the first or second pilots' panel must be lowered and the plug panel need not be disturbed. Precaution, with regard to spillage, must still be exercised and care of seals (Mod.1366) must still be taken.

56. In addition to reversing the procedure given in the preceding paragraph, the following instructions are considered necessary for the installation of a windscreen wiper head.

(1) Ensure that all seals are undamaged and show no sign of deterioration.

(2) Thoroughly clean all pipe ends and unit connectors.

(3) When a new Gaco seal is to be fitted, the special tool (Part No. 1/Z10582) must be used and assembly carried out in the following manner (fig.14 refers):-

(a) Place seal (Part No.28/Q2058) over the shaft and locating bolts to rest against the front face of the wiper head.

(b) Remove the internal spring from the Gaco seal (Part No. M.I.S.O.6) and lightly lubricate the seal with grease XG-315.

(c) Position the seal on the special tool with its open end opposite the open end of the tool.

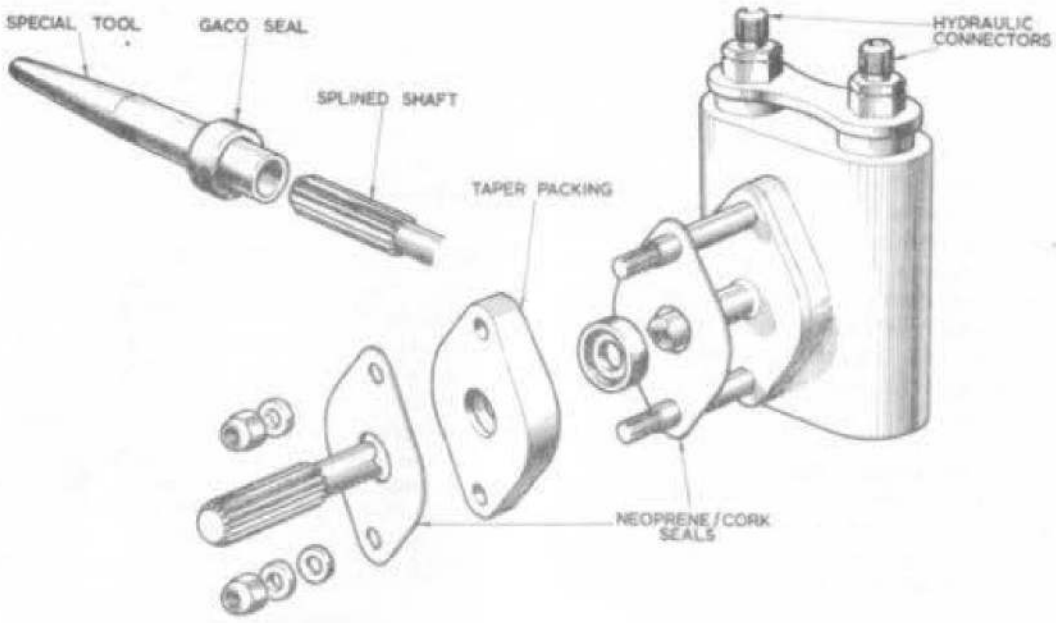

Fig.14 Arrangement of windscreen wiper head seals

(d) Place the tool, complete with seal, over the splined portion of the shaft and slide the seal on to the waisted portion. Remove the tool and slide the seal along the shaft to the face of the neoprene/cork seal (a).

(e) Replace the internal spring on the Gaco seal and pack cavity with grease XG-315.

(f) Assemble the taper packing block (Part No.26/92058) to the wiper head so that the Gaco seal is accommodated in the recess provided.

(g) Place seal (Part No.27/Q2058) over the shaft and locating bolts to rest against the front face of the packing block.

The wiper head is now ready for assembly to the windscreen frame.

(4) When the wiper head is secure to the windscreen frame, reconnect the two hydraulic pipes and prime the system in accordance with the instructions given in para. 44 of this chapter. On completion of this operation the pipe unions must be wire-locked.

(5) Fit wiper arm and associated parallel motion rod. Set and adjust in accordance with information contained in para. 45 of this chapter.