PART 2

CHAPTER 11 — HYDRAULIC SYSTEMS

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Contents

Illustrations

General

1. There are two separate hydraulic Systems, System A and System B, operated from hydraulic pumps, one on each engine. The services operated by the hydraulic systems are:

Service	*System*	*System*
Left main undercarriage	A	—
Right main undercarriage	—	B
Nose undercarriage	A	—
Flaps	A and B together	
Slats	A and B together	
Spoiler/speedbrakes	A and B together	
Tailplane incidence	A or B	
Nosewheel steering	A or B	
Wheelbrakes	A or B	
Windscreen wiper parking	A	—
No 1 Autopilot auto-trim control arming pressure switch	—	B
No 2 Autopilot auto-trim control arming pressure switch	A	—

System A and System B components are in the rear compartment behind the left-hand and right-hand toilets, respectively.

2. Systems A and B are normally independent but can be interconnected by a flexible pipe ('Commoning hose') and a ferry link valve. The interconnection is normally made prior to a three-engined ferry flight, to ensure complete retraction of the undercarriage should a second engine/pump failure result in the loss of one hydraulic system. In these circumstances, when the undercarriage has been retracted, the ferry link valve must be closed to preserve the separation of the two systems.

3. Provision is made for off-loading individual pumps in each system during cruising flight, when demand on the hydraulic systems is low.

4. An electrically-operated shut-off cock in the fluid supply line to each engine-driven hydraulic pump permits a pump to be isolated should the need arise.

5. A pressure-maintaining valve (2000 PSI) in each system ensures that the pressure to the spoiler/speed-brakes, wheelbrakes and tailplane incidence systems is maintained at 2000 PSI, irrespective of other system demands. The pressure-maintaining valve in System A also ensure maintenance of pressure to the nose undercarriage, nosewheel steering and windscreen wiper parking.

6. A DC-operated auxiliary hydraulic pump is provided to permit recharging of the brake accumulator in the normal brake system (System B).

7. An AC-operated auxiliary hydraulic pump (operative from an external power supply) is provided to permit functioning of either Systems A or B, by selection, during ground testing or pre-flight checks.

8. The HYDRAULICS panel at the engineer's station has a line diagram of the hydraulic system, to indicate diagrammatically the layout of the system. Magnetic indicators are provided to show continuity of flow.

9. An independent hydraulic system is provided for the operation of the cabin freight door.

MAIN AND AUXILIARY SYSTEMS

10. to 12. *Controls and Indicators — Hydraulic Systems.* (See **Table 1.**)

Main Systems

13. *General.* Four engine-driven hydraulic pumps, one on each engine, are arranged so that the pumps on No 1 and No 2 engines supply one hydraulic system (System A) and the pumps on No 3 and No 4 engines supply a second hydraulic system (System B). Each pair of pumps is supplied with fluid from its associated reservoir by means of two hydraulically-operated booster-pumps, and maintains a working pressure of 3000 ± 150 PSI. A relief valve in each system operates at 3800 PSI.

14. *Accumulators.* A hydraulic accumulator in each system is charged initially with nitrogen to a pressure of 1500 PSI and during normal operation is maintained at the system pressure of 3000 PSI.

15. *Reservoirs.*

a. The reservoirs can be filled, via System B return line filters, from an external charging connection on the rear servicing panel or topped up

Table 1 — Controls and Indicators — Hydraulic Systems

The following controls are on the HYDRAULICS panel at the engineer's station:

Item	*Marking/Description*
Fluid contents gauges (two)	LOW/FLIGHT RANGE/ACC RANGE/TANK FULL ACC EMPTY
Fluid temperature gauges (two)	°C (0 to 120) 0° to 75°C — black sector 75°C to 90°C — yellow sector 90°C to 120°C — red sector
Inlet pressure LP warning lights (four)	INLET PRESS LP1 and LP2 (amber) } Light on at INLET PRESS LP3 and LP4 (amber) } 30 PSI
Shut-off cock switches (four) and indicators (four)	SHUT-OFF COCKS-OPEN/SHUT 1, 2, 3 and 4. In-line: Cross-line
Delivery pressure LP warning lights (four) ...	DEL PRESS 1 and 2, 3 and 4 (amber) Light out at 1700 PSI rising; on at 1200 PSI falling
Pump switches (four)	PUMPS-ON/OFF
Pressure gauges (two)	PSI × 1000 (0 to 4)
Ferry link switch	FERRY LINK — NORMAL/LINK
Ferry link indicator	FERRY LINK. In-line: cross-line
The following control is on the forward roof panel:	
Hydraulic system changeover switch and AC auxiliary pump control	HYD SYSTEM C/O—SYSTEM A/OFF/SYSTEM B
The following are behind the centre toilet bulkhead:	
Electrically/Manually-operated ferry link valve.	
Commoning hose, used to common both systems.	

(during flight only), at a filler cap on each reservoir. Sight glasses on the reservoirs permit the fluid levels to be checked. The contents can also be checked by two FLUID LEVEL gauges, one for each reservoir, on the engineer's HYDRAULICS panel, or by a single CONTENTS gauge on the rear servicing panel; this latter gauge, which operates from a float in the reservoir for System A, indicates when the GROUND/FLIGHT switch is at GROUND. The gauges are marked LOW (red sector) FLIGHT RANGE/ACC RANGE/ TANK FULL ACC EMPTY.

SYSTEM 22·5 G.

b. Fluid capacity of each reservoir is as follows:

With system depressurised ...	6·3 gallons
With system pressurised, undercarriage down	4·9 gallons
In flight, undercarriage up ...	3·9 gallons

c. The reservoirs are interconnected by a balance pipe positioned to ensure that:

(1) When one reservoir is filled, the other is filled at the same time.

(2) If a leak develops in one system, sufficient fluid is retained in the other system for satisfactory operation.

(3) Inter-system transfer exists when both systems are interconnected by the 'commoning hose'.

d. Both reservoirs can be drained from the servicing panel; a drain cock is provided on each reservoir. (Access to drain cocks is via doors in the rear wall of left and right toilets.)

e. Two hydraulically-operated booster-pumps, located in the base of each reservoir, supply fluid at low pressure to its associated engine-driven pump.

Engine-Driven Pumps and Booster-Pumps

16. *Engine-Driven Pumps.* The engine-driven pumps are of the variable displacement fully automatic type; they maintain pressure in the system at 3000 PSI and deliver fluid on demand. A pump delivers full capacity up to 2850 ± 50 PSI reducing to zero at 3000 PSI.

17. *Booster-Pumps*

a. The booster-pumps are of the positive displacement type and are driven by hydraulic motors supplied by the high pressure delivery from the associated system. When the system pressure is 3000 PSI and the system demand is zero, the booster-pumps stall and cease to rotate when the engine-driven pump inlet oil pressure reaches 100 PSI. If this pressure falls, the booster-pumps rotate to supply fluid and maintain the engine-driven pump-inlet pressure. In practice, due to system leakage, the booster-pumps never completely stop, but rotate slowly when the system demand is zero.

b. Thus, with the engines running and the accumulators fully charged, the system pressure drives the booster-pumps to supply the engine-driven pumps and maintain pressure in the reservoir-to-engine-driven pump lines. Either booster-pump in a reservoir will serve both engine-driven pumps but, in these circumstances the INLET PRESS warning lights may be on, depending upon demand. Flow control valves prevent booster-pumps overspeeding if a drive shaft is broken.

18. *Operation of the System*

a. When a service is selected, the accumulator in the associated system initiates operation of the service. The engine-driven pump pressure control system, sensing the drop in pressure, increases the stroke of the pump. As pump delivery commences, the reduced pressure on the inlet side of the pump results in the booster-pump increasing speed to satisfy the engine-driven pump demand. When the service operation is completed and the associated system accumulator is charged, the engine-driven pump assumes the 'no-stroke' condition.

b. During operation of a service, inlet and delivery pressures at the engine-driven pumps fall but rise to the correct value when the operation is completed.

c. Switching off a pump (ie off-loading the pump) has the effect of altering the datum setting of the pump to control delivery pressure at 300 PSI instead of 3000 PSI.

19. *Case Drains.* During normal operation, a natural internal leak occurs from the engine-driven pump case and drains to the reservoir via filters, non-return valves and cooler unit.

20. *Cooler Unit.* The cooler unit is a heat exchanger positioned in the engine stubs. It is used to cool hydraulic fluid from the engine-driven pump case drains as the fluid returns to the reservoir. Ram air flowing over the matrix is the coolant. A relief valve positioned across the cooler unit prevents excessive pressure building up in the drain line.

Reservoir Fluid Temperature Gauges

21. Two fluid temperature gauges, one for each system, are provided to indicate fluid temperature at the reservoirs. They should normally indicate in the black sector (0° to 75°C). If a system gauge indicates

in the amber sector (75° to 90°C), each pump in that system should be off-loaded, in turn, to determine which is causing the overheating. The pump that is causing the overheating should then be switched OFF. If a gauge indicates in the red sector (90°C plus), both pumps in that system should be off-loaded. When the fluid temperature has returned to the amber sector, each pump should be switched on, in turn, to determine which is causing the overheating. The pump that is causing the overheating should then be switched off.

Inlet and Delivery LP Warnings and System Pressure Gauges

22. Four INLET PRESS LP amber warning lights, one for each pump, are provided. A light comes on when the associated booster-pump pressure falls below 30 PSI.

23. Four DEL PRESS LP warning amber lights, one for each pump, are also provided. A light goes out at 1700 PSI when pressure is rising and comes on at 1200 PSI when pressure is falling.

24. Two 0 to 4000 PSI pressure gauges are provided, one for each system.

Hydraulic Shut-Off Cocks

25. Four guarded SHUT-OFF COCKS — OPEN/SHUT control switches, one for each engine, are provided. Use of a switch enables the fluid supply to the engine-driven pump to be cut-off in the case of engine fire, fluid loss, pump break-up, or inability to depressurise a pump under fluid overheat conditions. An associated magnetic indicator for each shut-off cock is adjacent to each switch.

26. Normally the switches are OPEN and the magnetic indicators show in-line. If a switch is set to SHUT, or if a fire control handle is pulled, the associated cock is closed and the magnetic indicator shows cross-line.

Note: Resetting a fire control handle, after use, opens the hydraulic shut-off cock, provided that its control switch is at OPEN, but does not open the high pressure anti-icing stop valves which must be reset manually.

Pump Switches

27. Four PUMPS — ON/OFF switches, one for each engine-driven pump, are provided. They control a solenoid-operated valve on their associated pumps, to permit a pump to be off-loaded when demand is low, to conserve pump life, or in case of pump failure.

Interconnection of Hydraulic Systems

28. Systems A and B can be interconnected by a flexible hose ('commoning hose'), which has one end permanently connected to System B (via a ferry link valve) and the other end, which has self-sealing quick-release coupling, normally connected to a STOWAGE POSITION dummy connection. The commoning hose pipe and the ferry link valve are adjacent to each other in the rear fuselage on the front face of the front engine bearer, accessible via a panel at the back of the centre toilet.

28A. To interconnect Systems A and B, both Systems must be depressurised and the commoning hose disconnected from the STOWAGE POSITION dummy coupling and connected to the FERRY FLIGHT coupling above it. Opening the ferry link valve then interconnects both systems. The ferry link valve is electrically-operated with a manual override facility.

28B. The 'commoning hose' is normally connected to the STOWAGE POSITION connection, since the ferry link valve has a small leak rate when closed. This ensures complete separation of the two hydraulic Systems.

28C. The Systems are normally interconnected prior to a three-engine take-off to ensure complete retraction of the undercarriage should a further engine/hydraulic pump failure occur.

29. The electrically/manually-operated ferry link valve is electrically controlled by the FERRY LINK — NORMAL/LINK switch, which should normally be set to NORMAL. A magnetic indicator adjacent shows cross-line when the switch is at NORMAL (or when the valve has been opened manually, see para 31 below) and in line when the switch is set to LINK.

30. When the facility is used, the ferry link valve should be closed immediately after take-off by setting the FERRY LINK switch to NORMAL. The commoning hose pipe should be left in the FERRY FLIGHT position but Systems A and B reservoir levels should be monitored for fluid transfer. If the level in System A reservoir falls to the LOW sector, System A must be depressurised and the commoning hose pipe disconnected from the FERRY FLIGHT coupling and connected to the STOWAGE POSITION coupling. System A should then be re-pressurised.

31. To open the ferry link valve manually, remove the pip pin in the lever at the top of the valve and then pull down the manual lever at the bottom of the valve and lock it in the selected position by inserting the pip pin through the lever into the holes in the end plate. The ferry link magnetic indicator will still show cross-line.

Auxiliary Systems

32. *AC-Operated Auxiliary System.* An AC-operated hydraulic-pump, fed from the 200-volt ground

power busbar is provided, to permit ground functioning of the hydraulic systems when the engines are not running or a test rig is not available. It is not necessary to close the ground power breaker switch to use this facility. The pump, which cannot be operated in flight, is controlled from a HYD AUX PUMP-SYSTEM A/OFF/SYSTEM B switch on the forward roof-panel on the flight deck. The pump derives its supply from the return line of System B and has an off-loading valve to control delivery pressure: fluid from its idling circuit is directed to the System B return line.

33. *DC-Operated Auxiliary System.* A DC-operated hydraulic pump fed from the aircraft 28-volt DC supply is provided to permit topping up of the Normal brake system (System B) accumulator when no other source of hydraulic power is available. The pump is controlled from a BRAKES HYD PUMP-OFF/ON switch, which is spring-loaded to OFF, between the applied brake pressure gauges on the left inner sill panel on the flight deck. The pump also derives its supply from the return line of System B; it has a 5 minute rating at full load and an interval of 5 minutes must elapse between each period of operation.

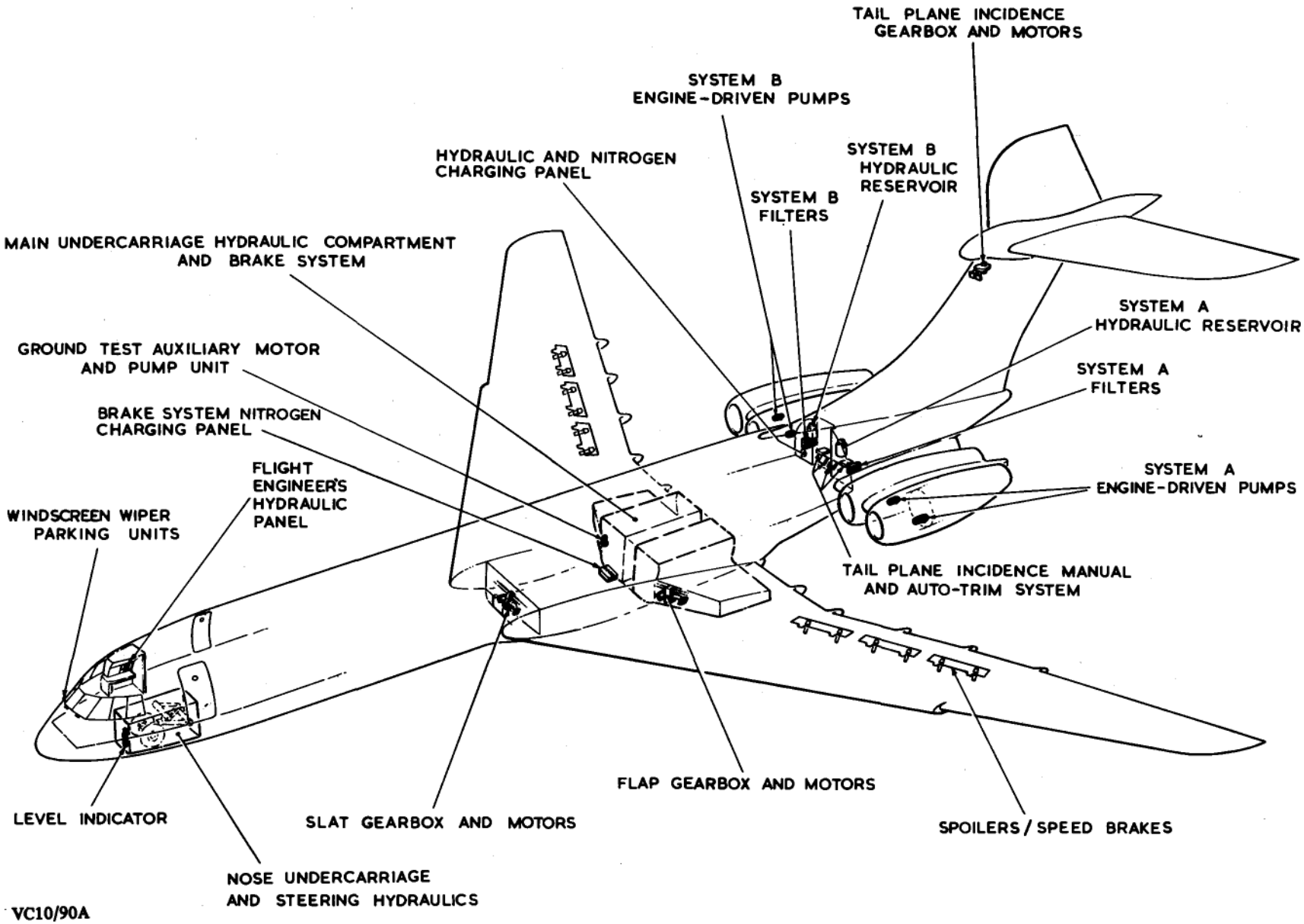
34. Both AC and DC-operated auxiliary pumps are in the right main undercarriage bay, wing stations O (leg recess). The AC pump selector is at the forward end of the bay (bogie recess).

Servicing and Test Points

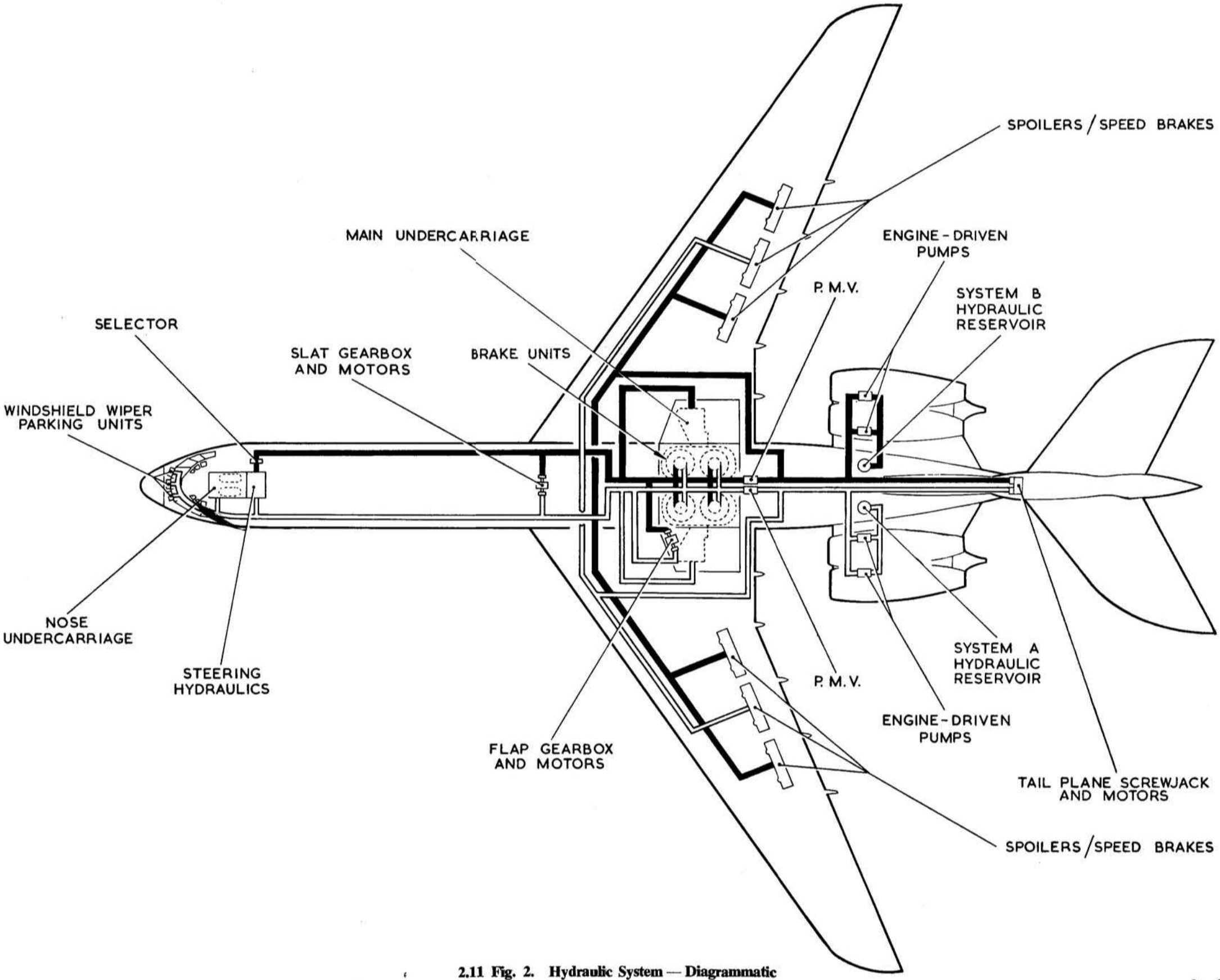
35. Ground test connections are provided at points between each pair of engines.

36. A hydraulic/nitrogen charging panel, just forward of the right main undercarriage bay, contains for each system, a hydraulic pressure release lever, a nitrogen pressure gauge and a nitrogen charging valve.

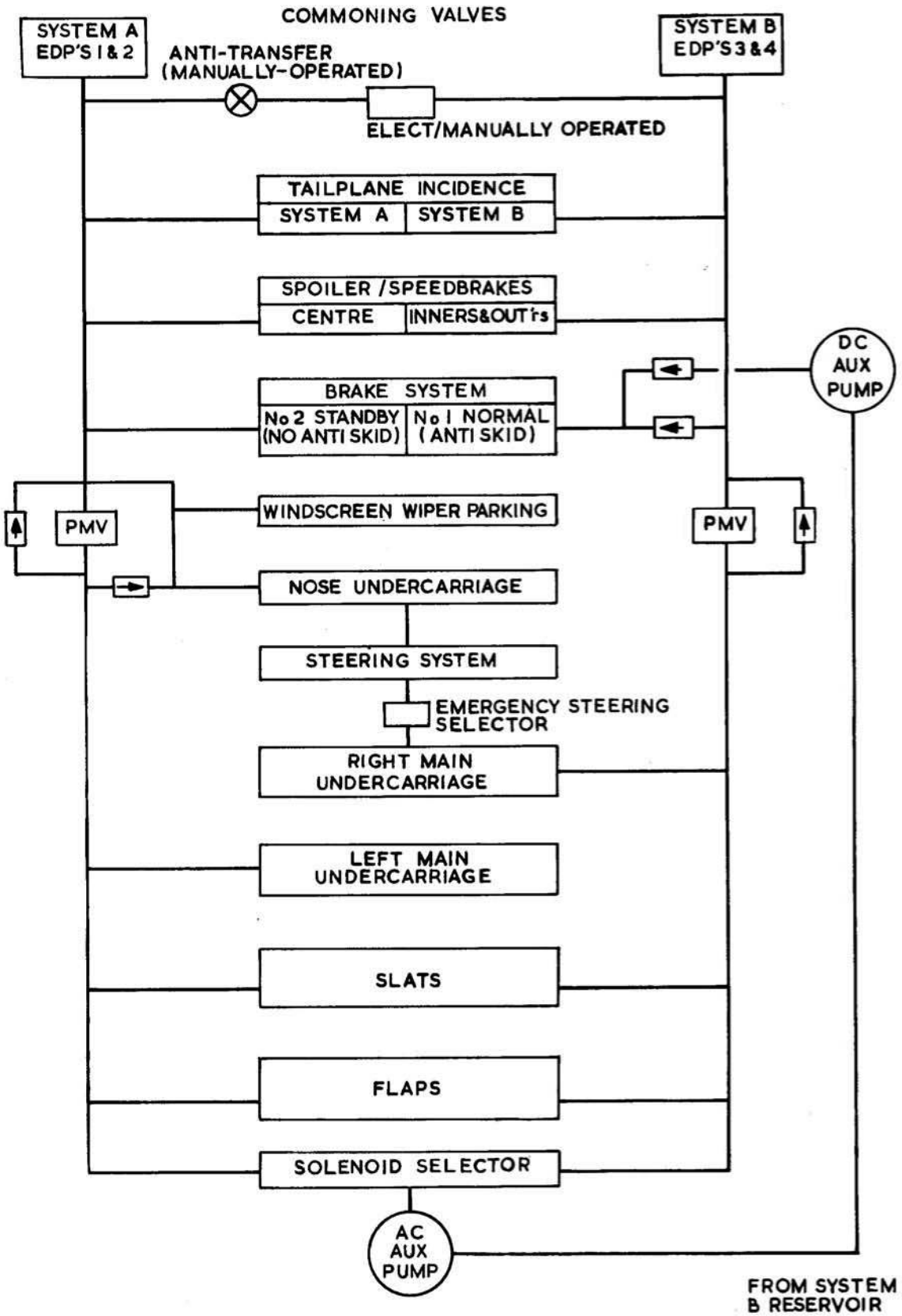
37. A rear service panel, behind a panel on the right side of the rear fuselage contains a system contents gauge, nitrogen charging connections and their associated gauges for Systems A and B, a tank drain and a fluid charging valve. The system contents gauge is energised from a float in System A reservoir when the GROUND/FLIGHT switch is at GROUND.



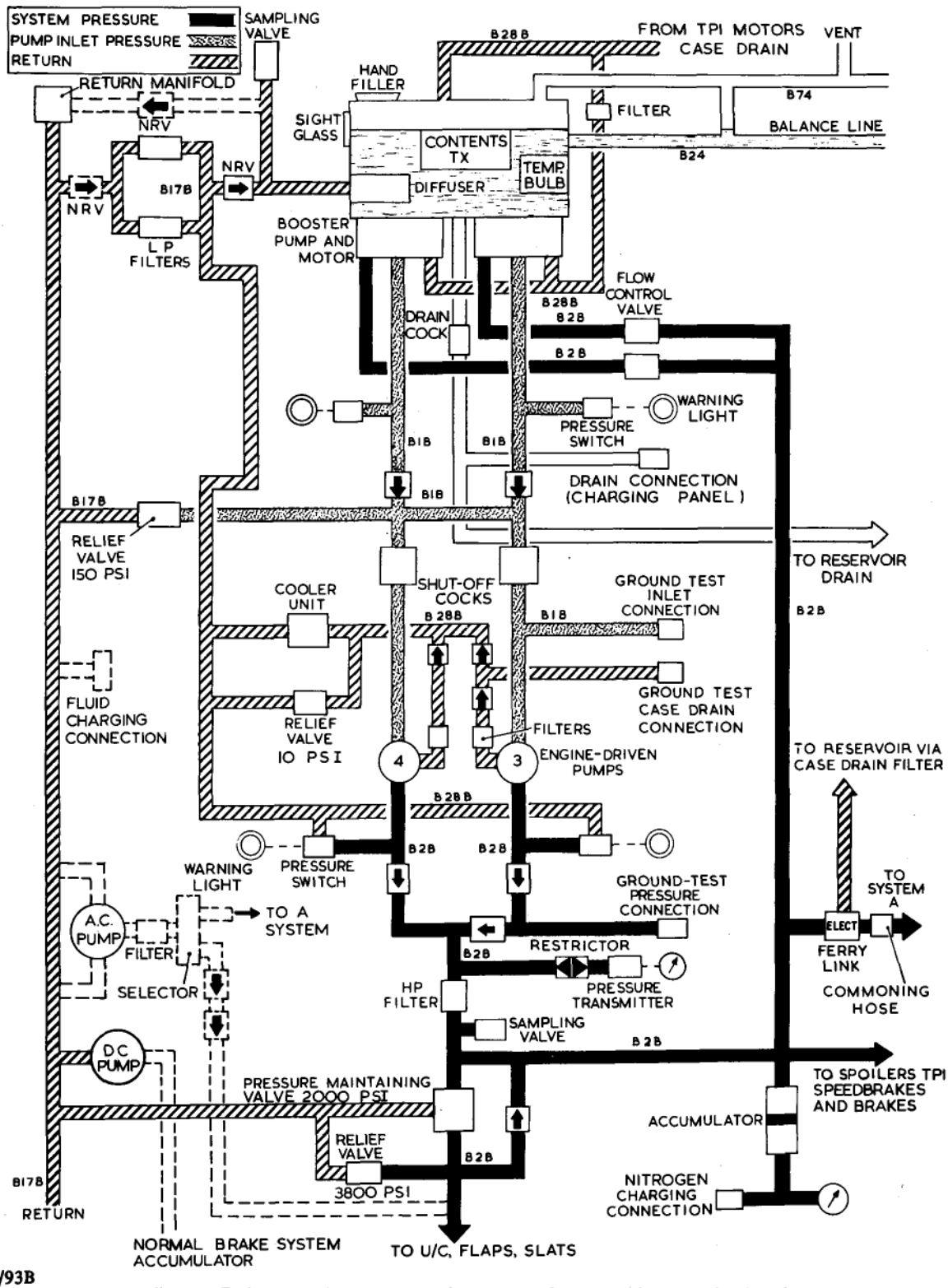
2-11 Fig 1 Hydraulic Installation



2.11 Fig. 2. Hydraulic System — Diagrammatic



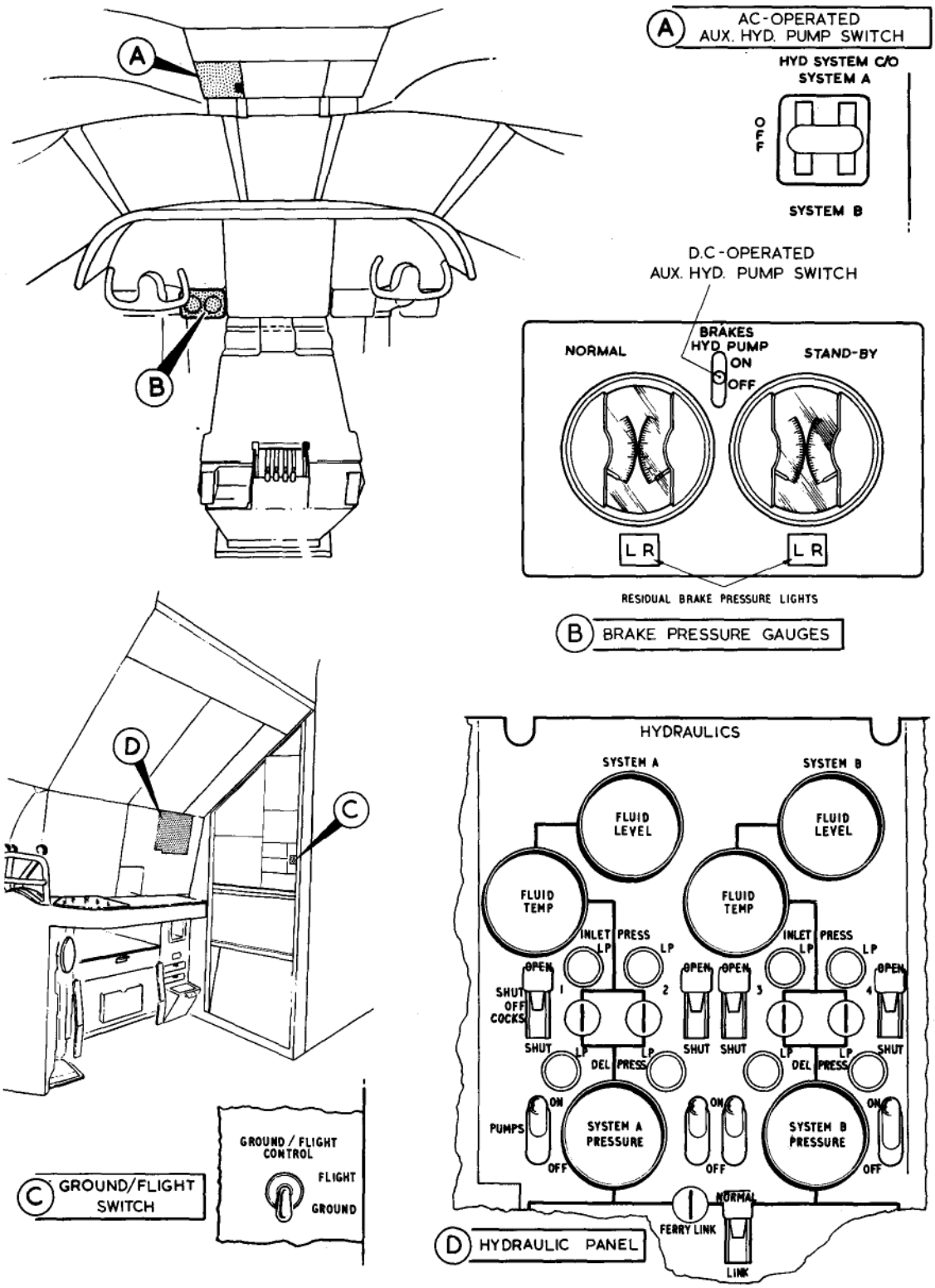
2.11 Fig. 3. Hydraulic System — Block Schematic



VC10/93B

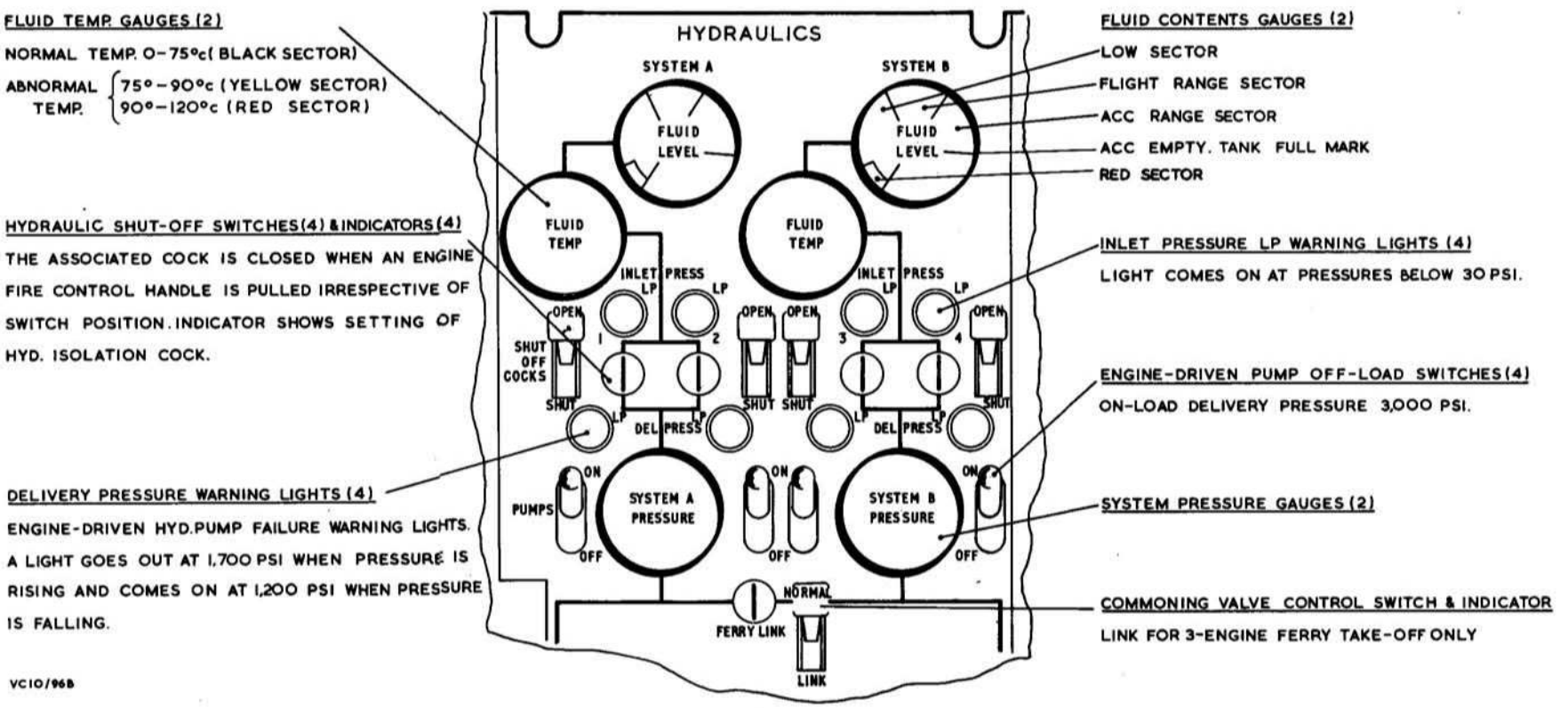
System B shown – System A similar, except for items shown in broken lines

2–11 Fig 4 Hydraulic System – Simplified
◀ Illustration Updated ▶



VC10/94A

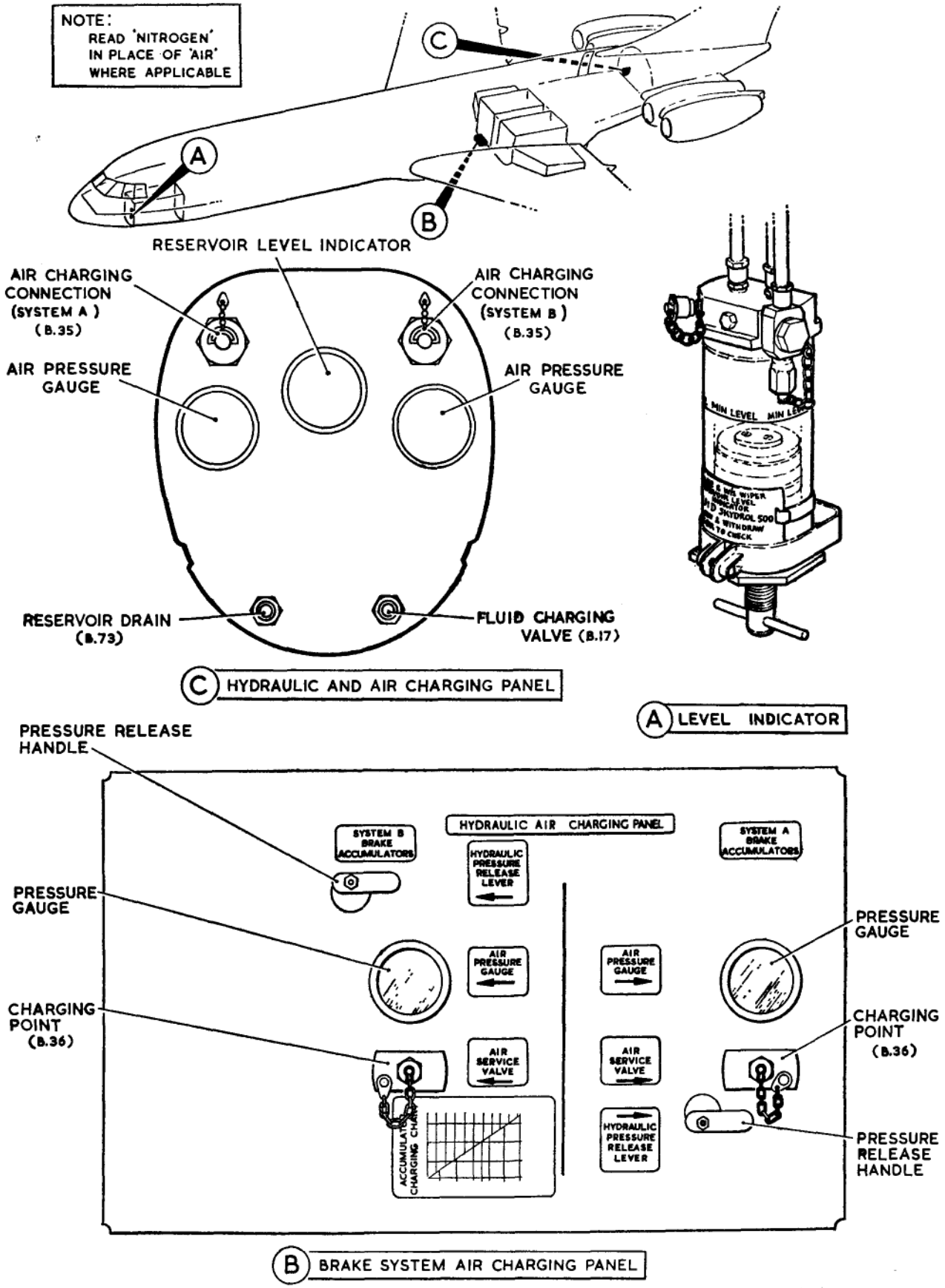
2–11 Fig 5 Hydraulic System – Controls and Indicators



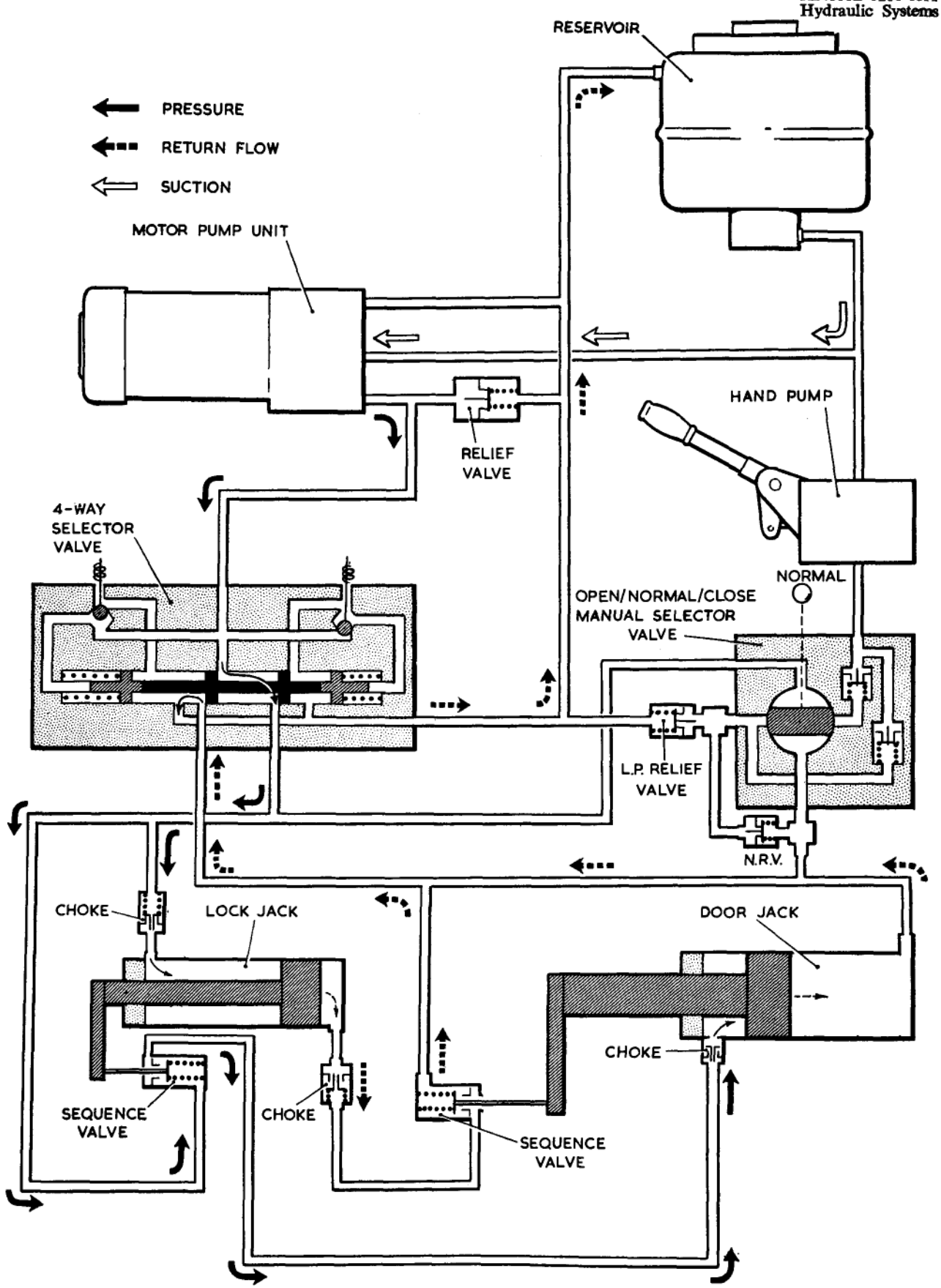
2.11 Fig. 6. Hydraulic Panel

Top: System Controls and Indicators ◀*Fluid Contents Gauge Markings Revised*▶

Bottom: Flight Controls and Indicators ◀*Emerg. steer* M1▶



2.11 Fig. 7. Hydraulic System — Servicing Panels



VC10/98A

2.11 Fig. 8. Cabin Freight Door Hydraulic System

46. Two sequence valves (one in each line to the door lock jack) ensure that the lock jack operates before the door jack when 'door open' is selected, and after the door jack when 'door close' is selected.

Electrical Supplies

47. A 3-phase AC supply from No. 1 generator is fed via a contactor to the motor-driven pump unit. The contactor which is mounted below the cabin floor at station 379, is energised by a 28-volt DC supply from No. 1 essential bus-bar.

48. A push-pull FREIGHT DOOR ARM switch, on panel EA, controls the electrical supplies to the two door operating switches referred to in para. 43 above. These switches, which control, via the solenoid selector, door opening and door closing, also govern the energising coil of the motor-driven pump; the switches are connected in parallel, so that operation of the door is possible from either panel. Pushing the FREIGHT DOOR ARM switch in provides electrical power to the door selector switches and causes an amber light within the switch to come on.

Operation of the Cabin Freight Door System

49. See Chap. 4, paras 2º to 43 of this Part.