PART 2

CHAPTER 18 — UNDERCARRIAGE SYSTEMS AND BRAKES

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PART 2

CHAPTER 18—UNDERCARRIAGE SYSTEMS AND BRAKES

DESCRIPTION

General

1. The aircraft has a tricycle undercarriage, which consists of a steerable twin-wheel nose undercarriage unit housed in an unpressurised compartment in the fuselage nose and two four-wheeled bogie units, one on each side, housed partly in the wing and partly in an unpressurised compartment in the fuselage. The main wheel bogies are angled with the front wheels down prior to retraction and the rear wheels down after lowering.

2. All units are operated by hydraulic jacks, the nosewheel unit retracting forward into the nosewheel bay and the main undercarriage units retracting inwards into the main wheel bays. All units, when retracted, are totally enclosed. Mechanical locks retain all three undercarriage units in the retracted or lowered positions.

3. The UP/DOWN selector is the normal control for raising and lowering the undercarriage. A STANDBY RAISE switch is provided. Three levers, one for each undercarriage, permit the undercarriage to be lowered, in an emergency, by free falling. If the main undercarriage downlocks should fail to engage when lowering in an emergency, the levers may be used to winch each main undercarriage to the locked position.

4. Hydraulic power is normally used to 'break' the undercarriage uplocks and downlocks. In the event of hydraulic power failure, the uplocks can be 'broken' by use of the levers in para. 3 above, the undercarriage units falling under their own weight to the extended and locked position. The mechanical geometric locks are re-engaged by spring pressure.

5. Electrical systems are provided to indicate the position of the undercarriage units and undercarriage doors, in relation to their locks. In addition, mechanically-operated visual indicators are provided, so that the undercarriage units can be checked for correct locking down if the electrical indication fails.

6 Power steering of the nosewheels up to 70° either side of centre is effected by the steering handles on the flight deck operating a hydraulic control valve which directs pressure to steering jacks. The jacks impart a turning movement to the nosewheels via the shock-absorber strut. When towing, or steering by differential braking on the main wheels, the nosewheels are permitted to castor freely, within a range of 120 degrees on each side of the aircraft centre line. Nosewheel shimmy is checked by a damping device fitted to the shock-absorber strut.

7. Hydraulic brakes are fitted to each main wheel and are controlled by foot-operated master cylinders on the rudder pedals or by the hand brakes, one of which also serves as a parking brake. Foot-operation permits differential pressures for individual undercarriage braking and hand-operation provides equal pressure for simultaneous braking on all eight wheels. The 1st pilot's handbrake handle can be locked in the 'brakes on' position for parking purposes. An anti-skid device is incorporated in the normal hydraulic system to the brakes but is isolated if the standby brake hydraulic system is selected. The main wheel brakes are automatically applied prior to retraction, after selection, and released after the undercarriage is locked up. Nosewheel spin brakes arrest wheelspin when the nose undercarriage is retracted. Each wheel contains three fusible plugs, which release air from the tyre in the event of excessive wheel heat.

8. *Location of Undercarriage Controls and Indicators.* (See **Table 1**)

Undercarriage Position Indicator and Warnings

9. *Indicators.* Indicators showing the position of the undercarriage and their hydraulically-operated doors in respect of their locks are provided as follows:

a. An electrical position indicator on the centre instrument panel A, above the undercarriage selector control; it indicates the position of each undercarriage unit separately. Indication is by three green and three red windows, behind each of which are two bulbs. Failure of a bulb causes the associated window to appear slightly less bright than the remainder. A DAY/NIGHT dimmer control is provided. Indications are:

Green light ...	Unit locked down
Red light	Unit between locks
Green and red lights	Unit selected but not unlocked
No light	Unit locked up.

Table 1. Location of Undercarriage Controls and Indicators

Item	*Location*	*Marking/Indication*
Undercarriage selector	Pilots' centre panel	UP/DOWN
Undercarriage position indicator lights	Pilots' centre panel	LANDING GEAR—UNLOCKED/LOCKED DOWN
Undercarriage door warning lights	Pilots' centre panel	LANDING GEAR DOORS—NOSE/LEFT/RIGHT
Warning horn	Panel A	—
Warning horn test switch	Rear roof panel	U/C HORN—TEST/NORMAL

b. Three red LANDING GEAR DOORS—NOSE/LEFT/RIGHT warning lights, one for each undercarriage unit, adjacent to the undercarriage position indicator. A light is on when the associated door is unlocked; a light is out when the associated door is locked.

c. A mechanical indicator for each main undercarriage unit above the hat rack on each side of the cabin at the undercarriage positions. An indicator shows green (SAFE) when the unit is locked down and red when the unit is unlocked. It should be noted that the whole of the word SAFE should be visible on the green portion when the unit is locked down. The mechanical indicator for the nose undercarriage unit is incorporated in the downlock switch-box operating mechanism and is visible, through a periscope in the right-hand nose tunnel. The indicator shows green for nose undercarriage locked down; when the nose undercarriage is unlocked the green indicator is obscured.

10. *Warning Horn Circuit*

a. A warning horn, on panel A, operates when any undercarriage unit is not locked down and if a pair of throttles (one left and one right) are pulled back at speeds below 147 $^{+3}_{-1}$ knots. Micro-switches controlling the warning horn circuit are operated by the down-lock for each undercarriage unit and by the throttle control linkage at the flight engineer's station.

b. A U/C HORN—TEST/NORMAL switch, on panel EA in the roof of the flight deck, permits the warning horn circuit to be tested.

c. A warning horn in the nosewheel bay operates on the ground, during towing, if the nosewheels are turned through an angle in excess of 55° either side of centre.

d. Power supplies for the electrical circuits are drawn from the 28-volt DC essential bus-bars

Ground Locks

11. *Main Undercarriage.* On each main undercarriage, a toggle lever which extends above the attachment point for the downlock jack has a GROUND LOCK hole which aligns with holes in the cover, the bearing plate and base plate (4 holes in line) when the downlock is engaged. To lock the undercarriage down the ground lock is passed through the four holes.

12. *Nose Undercarriage.* A steel sleeve is slipped over the down lock jack sliding portion and held in position by two lock pins, thus preventing the jack from being compressed.

MAIN UNDERCARRIAGE AND DOORS

Shock Absorber Struts

13. Each main undercarriage consists primarily of a shock-absorber strut attached to a hinged tube supported by the main structure, and braced by a fore-stay and an upper and lower side-stay.

14. Each strut is of the oleo-pneumatic type with two-stage nitrogen compression, the nitrogen and fluid (DTD.585) being separated by two floating separators. It is designed to absorb and dissipate all landing loads, and those taxying loads not absorbed by the hop damper, and to damp out the tendency to rebound.

15. A four-wheeled bogie, containing a hop damper, is pivoted to the front of the strut ram; the wheels are fitted with hydraulically-operated disc brakes. A hydraulic retraction jack is attached to the hinged tube. A mechanical downlock is on the front face of the undercarriage beam and is operated by spring-loading and hydraulic pressure.

Main Undercarriage Doors

16. Two doors are fitted to each main undercarriage. The inboard door is hydraulically-operated and closed when the undercarriage uplock or downlock is engaged. The outboard door is operated by the undercarriage to which it is attached and is closed when the undercarriage is retracted. The hydraulically-operated portion is normally sequenced to close and lock after the undercarriage is locked up or down, and to unlock and open before the downlock or uplock is 'broken'. When the emergency lowering system is used, the doors are unlocked and opened and remain open after the undercarriage is locked down.

Hop Damper

17. *General*

a. The purpose of the hop damper is to absorb part of the initial landing impact and to damp out the 'hopping' or 'pattering' of the bogie during aircraft movement on the ground. The hop damper also positions the bogie at a declined angle before retraction and at an inclined angle after the undercarriage has been lowered. This is accomplished in conjunction with the bogie beam lock mechanism.

b. The hop damper, which is housed in the forward portion of the bogie beam, comprises a cylinder with a ram sliding inside it, a separator tube fitting concentrically around the ram, and a separator sliding in the annulus formed between the separator tube and the cylinder. The hop damper cylinder is pivoted to the bogie beam and the ram end is attached to the lower torsion link. The fluid chambers in the hop damper are filled with DTD.585 hydraulic fluid. Fluid and nitrogen charging valves and a fluid bleed screw are mounted on a charging point bracket which is fitted below the cylinder and accessible from the forward end of the bogie beam. A piston assembly is fitted into the end of the cylinder opposite to the ram end fitting. Skydrol 500B hydraulic fluid is fed to a connection on the piston assembly. A hop damper valve is assembled to each side of the hop damper cylinder.

c. A cover is fitted over the forward end of the bogie beam and must be removed for jacking and access to the hop damper. A pointer is fitted to the left-hand side of the lower torsion link, and moves over a scale plate attached to the upper surface of the bogie beam left-hand axle lug. Nitrogen pressure, required in the hop damper for ram extension, is indicated by the pointer on the scale.

18. *Bogie Angling*

a. When the undercarriage is selected UP, hydraulic pressure is fed into the piston assembly. This causes the piston to extend from the piston housing. The piston contacts the shoulder in the bore of the ram and pushes the ram outward. Fluid is displaced from chamber A into chambers B and C and the separator is forced rearward, positioning the bogie nose-down for retraction.

b. After subsequent lowering, when the undercarriage is locked DOWN a non-return valve in the bogie lock mechanism is opened and a hydraulic lock in the piston assembly is released. The compressed nitrogen in the nitrogen chamber drives the separator forward, displacing the fluid from chamber C into chamber A and driving the ram inwards. The ram pulls on the lower torsion link and positions the bogie to an inclined angle for landing. The piston is driven into the piston housing by the ram..

19. *Landing.* The initial landing impact is taken by the rear wheels and transmitted immediately via the torsion links to the hop damper, pulling the ram forward very sharply. The holes in the land between chambers A and B cannot transfer fluid rapidly enough and a proportion of the fluid is transferred via the hop damper valves. The flutter plate in each valve closes so that the only passage for the fluid is via the restricting hole in the valve head. Pressure rises until the spring-loaded valve head leaves its seat. Thereafter an unrestricted flow takes place. During this time, the relief valve head in the left-hand valve assembly is on its seat but the flutter plate is open and unrestricted flow past the relief valve head ensues.

20. *Rebound.* After the initial landing impact, should the aircraft 'bounce' and the hop damper rebound, the flow of fluid is reversed by the compressed nitrogen behind the separator. The valve heads in both valves immediately re-seat and the flutter plates open, providing unrestricted flow into chamber A. If the rate of travel of the ram is too fast, the holes in the land constitute a restriction and fluid flows from chamber B to chamber A through the left-hand valve assembly. The flutter plate for the relief valve head closes and the fluid pressure builds up until the ball valve in the relief valve head opens to allow flow through the restricting hole in the relief valve head. If the pressure rises even further, the relief valve head is forced off its seat and permits unrestricted flow of fluid.

21. *Hop Damper Operation.* When the aircraft is travelling over uneven ground, slight pattering of the bogie causes small movements of the hop damper ram in the cylinder. The holes across the land permit

fluid transfer between chambers A and B under these conditions and provide slight damping action. Larger movement of the ram is damped by the action of the valve assemblies; rebounds are controlled by the ball valve in the relief valve head.

Weight Switch Services

22. A number of aircraft services are controlled, on landing and take-off, by the operation of relays connected through micro-switches which are operated by the compression and extension of the main undercarriage shock-absorber struts.

23. A switchbox is on the rear face of each main undercarriage shock-absorber strut cylinder at the lower end. Each switchbox houses four micro-switches. A pivot block is attached to the upper face of the walking joint drive bracket. An adjustable switch-operating rod connects the pivot block to the operating lever clamped to the switchbox spindle.

24. Compression of the shock-absorber strut, on landing, pivots the walking joint drive bracket upward. The switch-operating rod and operating lever rotate the switchbox spindle to depress the micro-switches and connect the 28-volt DC essential supplies from the respective bus-bars to various relay coils. The relays are energised and change-over to affect the following circuits:

Undercarriage control
Pre-stall warning system
Flight controls warning system
CSD and generator ground cooling
Flight deck refrigeration system
Cabin refrigeration system
Flight deck air flow control
Cabin air flow control
Water system drains de-icing
Radio rack cooling valve
Hydraulic brake pressure application
APU control and protection
Periscopic viewer — VC10 Mod/077/STC.

NOSE UNDERCARRIAGE AND DOORS

General

25. When retracted, the nose undercarriage unit is housed in an unpressurised compartment in the fuselage. The nose undercarriage unit is operated by hydraulic jacks and, when retracted, is totally enclosed by doors.

26. The nose undercarriage consists of a shock-absorber strut which is braced in the locked down condition by a fore-stay and down-lock assembly and fitted with a pair of wheels.

27. A retraction jack is fitted between extensions of the upper ends of the fore-stay and the strut housing.

28. A down-lock switchbox and mechanical indicator assembly is fitted to, and operated by, a down-lock jack.

29. A pair of spin brakes and an up-lock assembly is in the roof of the nose undercarriage bay. The spin brakes are spring-loaded and stop the wheels rotating when the undercarriage is retracted.

30. Steering and centralising are achieved by hydraulically-operated jacks turning the shock-absorber strut in the housing.

Shock Absorber Strut

31. The purpose of the strut is to absorb and dissipate landing and taxying loads, and to damp out rebound.

32. The strut is of the fluid/nitrogen type, with single-stage nitrogen compression and a floating separator to isolate the nitrogen from the fluid. The strut consists of a cylinder assembly with a sustaining ram assembly sliding in the cylinder.

Doors and Operating Mechanism

33. A forward pair of doors and a rear folding door enclose the nose undercarriage bay when the undercarriage is retracted. The forward pair also close after the undercarriage is locked down. The two forward doors are operated by a hydraulic jack and are secured in the closed position by a door up-lock. The rear folding door is actuated by a lever mechanism connected to the shock-absorber strut housing.

UNDERCARRIAGE RAISING AND LOWERING

General

34. The normal retraction and extension of the undercarriage is by means of the hydraulic system, with electrical control of the three undercarriage selector valves from one selector switch on the flight deck.

35. An alternative electrical circuit, as an emergency raise facility only, is provided to operate the three selector valves should failure of the normal electrical circuit occur. Both circuits operate from a 28-volt DC supply.

36. Each undercarriage unit is provided with a mechanical system to permit lowering in emergency, should the hydraulic system fail.

Undercarriage Selector

37. The undercarriage UP/DOWN selector switch on the pilots' centre panel has a built-in solenoid-operated lock, which can be overridden by twisting

the selector 45° clockwise and selecting UP. The selector switch solenoid lock is controlled by the shock-absorber strut-operated micro-switches via two relays connected in series. The undercarriage control relay controls the supplies to the three undercarriage selector actuators which are in their respective wheel bays.

38. Each of the three selector valves controls the raising and lowering of an associated undercarriage, and has two actuators connected to it. One, the selector actuator, operates the selector valve under normal conditions, and the other, the standby raise actuator, controls the standby raise operation. Both actuators operate the same pilot valve of the selector. The standby provision caters for an electrical failure. A lever, marked '2' and pivoted to the selector mounting plate, is attached to the selector actuator and contacts a shoulder on the selector control valve. A second lever, marked '1' and also pivoted to the selector mounting plate, is attached to the emergency raise actuator and contacts the end of the selector control valve.

39. A pair of link plates, between which the emergency raise lever '1' operates, connects the outer end of the selector control valve to a pointer which is pivoted to a bracket, marked PILOT VALVE INDICATOR, affixed to the mounting plate. The tip of the pointer is coloured red and is visible through a window in the bracket which has the words DOWN and UP marked alongside. A cover is fitted over each undercarriage selector valve with a window through which the red knob at the outer end of the main plunger can be seen. The words DOWN and UP are marked alongside the window. A warning notice on the cover, reads:

WARNING: THIS SELECTOR IS HYDRAULICALLY OPERATED. TO CHECK CORRECT SETTING AFTER INSTALLATION OR EMERGENCY OPERATION, FIT L/G GROUND LOCKS AND/OR SELECT EM. LOWER. SELECT L/G DOWN ON FLIGHT DECK. BEFORE APPLYING PRESSURE CHECK PILOT VALVE POINTER IS AT 'DOWN'. RED KNOB SHOULD INDICATE 'DOWN' WHEN PRESSURISED.

40. The STANDBY RAISE—UP/NORMAL control switch on the pilots' centre panel, adjacent to the selector switch, controls the supply to the standby raise selector. The standby raise control relay controls the supplies to the three standby raise actuators.

Main Undercarriage Retraction

41. When the undercarriage is selected UP, the following sequence of operations takes place for each main undercarriage:

a. The inboard door unlocks and opens, the bogie angles to the retracting position and the wheel brakes are applied.

b. The down-lock disengages, the undercarriage retracts and the up-lock is engaged.

c. The inboard door closes and locks, and the wheel brakes are released.

42. During operation 41a, fluid flows from the main pressure supply line through the main undercarriage selector valve into the 'raise' line and to:

a. The door-operated servo valve via the shuttle valve.

b. The auto-brake system.

c. The hop damper servo valve.

d. The raise line control valve.

e. The main up-lock-operated servo valve.

f. The door control valve.

43. The door control valve responds to pressure from the 'raise' line and diverts fluid to:

a. The auto-brake system.

b. The door up-lock jack and

c. The pressure reducing valve.

44. The inboard door tends to be pulled open under normal loads in flight and therefore requires a very much reduced pressure for operation. The purpose of the pressure reducing valve is to reduce the system pressure for door operation.

45. Fluid flows from the pressure reducing valve to the door jack via the door lock valve; return fluid from the jack flows to system return via the door control valve and the main undercarriage selector valve.

46. The lock valve locks the door jack hydraulically to prevent air loads from closing the inboard door.

47. Pressure fluid from the 'raise' line is directed by the hop damper servo valve to the piston assembly of the hop damper. The relay valve and the down-lock jack are connected with the return line via the hop damper servo valve until the bogie is angled

48. During operation 41b, when the bogie is angled, the hop damper servo valve is mechanically-operated to direct pressure fluid to:

a. Operate the down-lock jack.

NOTE: During the retraction cycle, raise line hydraulic pressure operates the down-lock and cocks it into a geometrically locked open position ensuring that the down-lock remains in the open

position. When the undercarriage is selected down, the down-lock remains geometrically locked open until the side stay engages the spigot, breaking the geometric lock thus allowing the down-lock jack to extend under spring pressure and lock the down-lock. Should the pressure in the down-lock jack be insufficient to move the down-lock into the geometrically locked open position on retraction, pressure from the opposite main undercarriage down-lock line (provided its own door is fully open) will be felt on the secondary piston to move the jack and cock the down-lock into the unlocked position. Due to the differential area of the secondary piston this crossover action can only occur when there is lack of pressure in the appropriate undercarriage system (i.e. hydraulic failure or failure of the actuator to select up).

b. Hold open the relay valve hydraulically.

c. The lock jack relay valve to operate the opposite down-lock as mentioned in para. 48a NOTE.

49. When the door is fully open the door-operated servo valve is mechanically-operated. The return line connection on the valve is closed and the servo pressure fluid is directed to:

a. The up-lock relay valve.

b. The raise line control valve via the relay valve.

50. The up-lock relay valve is held open hydraulically to ensure that fluid can flow from the up-lock jack into the return line.

51. The 'raise' line control valve is held open hydraulically. Pressure fluid from the main 'raise' line is directed to the retraction jack and the side-stay jack via a restrictor valve in the inlet to each jack. The valves restrict fluid flow out of the jacks only. Damper assemblies, integral with the retraction jack, control the final rate of travel of the jack to avoid excessive loads on the locks during engagement.

52. Fluid from the retraction jack flows to return via the two-way flow control valve, the lower line control valve and the main undercarriage selector valve.

53. The two-way flow control valve limits the flow from the retraction jack during negative 'g' conditions, so preventing excessive shock to the system when normal conditions are restored.

54. When the main undercarriage moves away from the fully down position, the hop damper servo valve is spring-operated to trap fluid in the piston assembly, holding the bogie in the angled position.

55. *Paragraph deleted.*

56. During operation 41c, when the up-lock is engaged, the main up-lock servo valve is mechanically-operated. The return connection is closed and servo pressure fluid is directed to the door control valve.

57. The door control valve responds to the hydraulic servo pressure signal and diverts pressure fluid from the main 'raise' line to the pressure-reducing valve, the door lock valve and the door jack. The pressure fluid holds open the pressure-reducing valve and the door-lock valve.

58. Return fluid from the door jack passes through the hydraulically-opened door lock valve, a restrictor valve and the hydraulically-opened pressure-reducing valve to join return fluid from the door up-lock jack and the auto-brake system. The return fluid then passes through the door control valve and the main undercarriage selector valve to the main return line.

59. As the door commences to close, the door-operated servo valve is released; the pressure connection is closed and the return line is connected with the 'raise' line control valve, the relay valve and the up-lock valve. The 'raise' line control valve closes and traps fluid in the side-stay and retraction jack, so that pressure fluctuations in the 'raise' line are not transmitted to the side-stay jack and retraction jack.

Main Undercarriage Lowering

60. When the undercarriage is selected DOWN, the following sequence of operations takes place for each main undercarriage:

a. The inboard door unlocks and opens.

b. The up-lock disengages, the undercarriage extends and the down-lock engages.

c. The bogie angles to the landing position, and the inboard door closes and locks.

61. During operation 60a, fluid flows from the main pressure supply line through the main undercarriage selector valve into the 'lower' line and to:

a. The door-operated servo valve via the shuttle valve.

b. The up-lock relay valve.

c. The lower line control valve.

d. The main down-lock-operated servo valve.

e. The door control valve.

62. The door opens in the same manner as described under 'Main undercarriage retraction'.

63. Fluid is allowed to drain from the downlock jack and relay valve into the return line via the hop damper servo valve.

64. During operation 60b, when the door is fully open, the door-operated servo valve is mechanically-operated. The return line connection on the valve is closed and the servo pressure fluid is directed to:

a. The relay valve.

b. The uplock relay valve.

65. The uplock relay valve is held open hydraulically to allow pressure fluid from the 'lower' line to flow to the uplock jack and to the lower line control valve. The uplock relay valve incorporates a restrictor which permits a gradual pressure build-up downstream of the relay valve to enable the uplock jack to operate before the lower line control valve.

66. When the lower line control valve is operated, fluid is directed to the retraction jack via the two-way flow control valve which controls the flow of fluid into the retraction jack during extension.

67. A damper assembly, integral with the retraction jack, retards the final travel of the jack during undercarriage extension to control the rate at which the sidestay engages with the undercarriage beam spigot.

68. Return fluid from the retraction jack and the sidestay jack passes through the associated restrictor valves to the 'raise' line via the raise line control valve and into the main return line via the main undercarriage selector valve. The restrictor valves control the rate at which the retraction jack and sidestay jack operate. As the bogie angles to the landing position, the hop damper servo valve is operated further to connect the line from the relay valve and the downlock jack to the main return line. Fluid trapped in the servo section of the raise line control valve can drain into the main return line via the two non-return valves and the hop damper servo valve when the bogie angles.

69. When the undercarriage reaches the 'down' position, the hop damper servo valve is mechanically-operated and releases the fluid trapped in the bogie jack.

70. When the undercarriage reaches the 'down' position the downlock engages.

71. When the downlock engages, the downlock-operated servo valve is mechanically-operated. The door closes as described under 'Main undercarriage retraction'.

72. As the door commences to close, the door-operated servo valve is released; the pressure connection is closed and the main return line is connected with the uplock relay valve. The uplock operated relay valve closes so that pressure fluctuations in the lower lines are not transmitted to the uplock jack and retraction jack control valve.

Nose Undercarriage Retraction

73. When the undercarriage is selected UP, the following sequence of operations takes place for the nose undercarriage:

a. The forward doors unlock and open, the nosewheels and steering mechanism are centralised and the fluid pressure available for steering is cancelled.

b. The downlock disengages, the undercarriage retracts and the uplock is engaged.

c. The forward doors close and lock.

74. During operation 73a, fluid flows from the main pressure supply line through the nose undercarriage selector valve, into the 'raise' line to:

a. The steering system to centralise the steering jacks.

b. The uplock-operated servo valve.

c. The door-operated servo valve via the shuttle valve.

d. The raise line control valve.

e. The downlock relay valve.

f. The door control valve.

75. The door control valve responds to pressure from the 'raise' line and diverts fluid to the door lock jack. When the door lock jack operates, the return connection is closed and pressure fluid is directed to the door jack via the door lock valve. The lock valve locks the door jack hydraulically to prevent air loads closing the main door.

76. Return fluid from the door jack is directed to system return via the door control valve and the nose undercarriage selector valve.

77. During operation 73b, when the main doors are fully open, the door-operated servo valve is mechanically operated. The return line connection on the valve is closed and servo pressure fluid is directed to:

a. The uplock relay valve.

b. The downlock relay valve, via the steering servo valve and

c. The raise line control valve.

78. The steering jacks must be centralised to permit the steering servo valve to direct servo pressure fluid to the downlock relay valve and raise line control valve to hold them open hydraulically. Pressure fluid then passes from the main 'raise' line to the downlock jack and to the retraction jack via the flow control valve, damper valve and choke valve. The

flow control valve controls the rate of retraction of the nose undercarriage. The retraction jack will not move until the downlock is disengaged. The damper valve and an internal damper in the retraction jack control the final rate of travel of the jack ram in either direction to avoid excessive loads on the locks during engagement.

79. The choke valve does not restrict the fluid entering the retraction jack. Fluid from the return side of the jack passes to return via the lower line control valve and the nose undercarriage selector valve. The uplock relay valve is held open hydraulically to ensure that fluid can flow from the uplock jack cylinder to return when the uplock is engaged.

80. During operation 73c, when the uplock is engaged, the uplock operated servo valve is mechanically operated. The return connection is closed and servo pressure fluid is directed to the door control valve.

81. The door control valve responds to the hydraulic servo pressure signal and diverts pressure fluid from the main 'raise' line to the door lock valve and the door jack.

82. The door lock valve is held open hydraulically and the door lock jack extends under spring pressure to uncover the return connection into the main return line; fluid expelled from the lock jack by the extension of the piston passes to return via the door control valve and the nose undercarriage selector valve. Fluid from the door jack flows into the main return line via the door lock valve and the door lock jack.

83. As the forward door commences to close, the door-operated servo valve is released; the pressure connection is closed and the return line is connected to the uplock relay valve and, via the steering servo valve, to the raise line control valve and the downlock relay valve. The raise line control valve and the downlock relay valve close and trap fluid in the retraction jack and the downlock jack so that pressure fluctuations in the 'raise' line are not transmitted to the retraction jack and the downlock jack.

Nose Undercarriage Lowering

84. When the undercarriage is selected DOWN, the following sequence of operations takes place for the nose undercarriage:

a. The main doors unlock and open; fluid pressure is made available to the steering system.

b. The uplock disengages, the undercarriage extends and the down-lock engages.

c. The main doors close and lock.

85. During operation 84(a), fluid flows from the main pressure supply line through the nose undercarriage selector valve, into the 'lower' line and to:

a. The downlock servo valve (via the shuttle valve).

b. The uplock relay valve.

c. The door-operated servo valve, via the shuttle valve.

d. The lower line control valve.

e. The door control valve.

86. The main doors open in the same manner as described in paras. 73 to 76 above, 'Nose undercarriage retraction'.

87. During operation 84(b), when the forward doors are fully open, the door-operated servo valve is mechanically operated. The return line connection on the valve is closed and servo pressure fluid is directed to:

a. The uplock relay valve.

b. The downlock relay valve, via the steering servo valve.

c. The raise line control valve.

88. The downlock relay valve and the raise line control valve are held open hydraulically to allow fluid to escape freely from the downlock jack and through a choke, from the retraction jack into the 'raise' line and, via the nose undercarriage selector valve, to the return line. The choke valve in the retraction jack controls the rate of undercarriage extension. The non-return valve connected in parallel with the flow control valve permits fluid to escape from the retraction jack in the event of a malfunctioning flow control valve.

89. The uplock relay valve is held open hydraulically to allow pressure fluid from the 'lower' line to flow to the uplock jack and to the lower line control valve. The uplock relay valve incorporates a restrictor which permits a gradual pressure build-up, downstream of the relay valve to enable the uplock jack to operate before the lower line control valve.

90. When the lower line control valve is operated, fluid is directed to the retraction jack via the damper valve. During undercarriage extension under hydraulic power the damper valve controls the power input to the retraction jack and, therefore, the rate at which the nose undercarriage extends.

91. During operation 84(c), when the downlock engages, the downlock servo valve is mechanically operated. The return connection of the valve is closed and servo pressure fluid is directed to:

a. The door control valve.

b. The steering system.

92. The main doors close as described in paras. 80 to 83 above 'Nose undercarriage retraction'.

93. As the door commences to close, the door servo valve is released; the pressure connection is closed and the return line is connected to the uplock relay valve and, via the steering servo valve, the raise line control valve and the downlock relay valve. The uplock relay valve closes and traps fluid in the uplock jack.

UNDERCARRIAGE EMERGENCY LOWERING AND RAISING SYSTEM

General

94. If the undercarriage fails to lower after a DOWN selection, due either to failure of the electrical or hydraulic control systems, each undercarriage unit can be unlocked and lowered mechanically by disengaging the doorlock and undercarriage uplock and allowing the undercarriage to lower and lock down under its own weight (free fall system).

95. The air loads on the nose undercarriage strut assist in engaging the nose undercarriage downlock. If the main undercarriage downlocks do not engage, a hand winding mechanism (operated by the same handles which are used to release the main undercarriage door and uplocks in para. 94 above can be used to lock the main wheels down.

96. A standby raise facility is provided.

97. *Controls and Indicators—Undercarriage Emergency System.* (See Table 2)

Nose Undercarriage — Free Fall

98. The operating handle for the nose undercarriage emergency lowering system is on the aft face of the nose undercarriage bay rear bulkhead, near the left side, and contains a spring-loaded latch and knob.

99. To operate the nose undercarriage free fall system, the pip-pin attached to the warning disc on the handle must first be withdrawn and the warning disc removed. The knob protruding from the handle must then be pulled to disengage the latch before the operating handle can be pulled down. When the handle is pulled down the door lock mechanism and the nose undercarriage uplock are released, in sequence. At the same time the emergency down plunger in the undercarriage selector valve is operated to a position so that the pressure supply line is closed and the retraction jack service lines are connected to each other and to the main return line.

100. When the nosewheel starts to lower under its own weight, the tyres contact the doors and push them open. Air loads on the strut assist to lock the unit fully down. The doors remain open after the nosewheel unit has locked down.

NOTE: After operation, the emergency lowering control must not be returned to the normal condition until ground locks have been fitted to the undercarriage units and the fault has been investigated.

101. On a hinged cover over the selector valve is a warning notice which reads:

WARNING: THIS SELECTOR IS HYDRAULICALLY-OPERATED. TO CHECK CORRECT SETTING AFTER INSTALLATION OR EMERGENCY OPERATION, FIT LANDING GEAR GROUND LOCKS AND/OR SELECT EMERGENCY LOWER AND LANDING GEAR DOWN ON FLIGHT DECK BEFORE APPLYING PRESSURE, CHECK PILOT VALVE POINTER IS AT 'DOWN'. RED KNOB SHOULD INDICATE 'DOWN' WHEN PRESSURISED.

102. When the handle is returned to the stowed position, it may be necessary to pull the knob protruding from the handle in order to permit the handle latch to be re-engaged with the catch plate. The warning disc must be replaced so that the stop lies beneath the handle and the pip-pin is inserted through the warning disc and mounting tube. Whilst the handle is being returned, the nose undercarriage uplock, the door uplock, and the selector valve emergency down plunger will revert to their normal condition.

Main Undercarriage — Free Fall

103. The operating handle for each main undercarriage emergency lowering and winching mechanism is located on each side of the centre gangway at the rear of the electrics bay.

104. To operate the emergency lowering mechanism, a disc pin must first be withdrawn from the mounting structure. The spigot protruding from the operating handle must then be pulled, to disengage the latch, before the handle can be pulled downward. The red coloured latch handle projects below the side plate when fully down.

105. When the main undercarriage commences to lower under its own weight, the aft tyres contact a ramp on the inboard door and push the door open

Table 2. Controls and Indicators — Undercarriage Emergency System

Item	*Location*	*Marking/Indication*
Main U/C down mechanical position indicator	Cabin roof above hat rack at U/C positions	Green SAFE indication—locked down Red indication—not locked
Nose U/C down mechanical position indicator	On nose U/C downlock. Visible through tube in right wall of nosewheel bay	Green indication visible—locked down Not visible—not locked
Instruction label for visual downlock check ([redacted])	Above viewing tube	FOR LOCKED DOWN CONDITION GREEN FLAG MUST BE IN POSITION SHOWN (see diagram on label)
Free fall levers (3)	Equipment bay	NOSE, LEFT, RIGHT. Left and right levers also used to winch main undercarriage into downlock if green lights not showing
Undercarriage standby raise switch	Pilots' centre panel	STANDBY-RAISE/NORMAL

to clear the wheels as they emerge from the undercarriage bay. The door remains open after the undercarriage has locked down.

NOTE: After operating the emergency lowering control, sufficient time (30 secs.) must be allowed to permit the undercarriage to lock down. If it locks down of its own accord, the winching operation (see paras. 106-108 below) is not necessary.

Main Undercarriage — Winching

106. If the main undercarriage does not lock down of its own accord within 30 seconds when the free fall system is operated, it is possible to apply a load to assist the sidestay jack to engage the lower sidestay with the downlock.

107. When the latch handle is pulled down to its full extent to initiate the 'free fall' technique, a spring-loaded plunger assembly in the handle engages with a recess in the disc attached to the lever shaft. This connects the handle to the winching mechanism.

NOTE: It is important to ensure that the spring-loaded plunger is correctly engaged before commencing the winching operation.

108. Operating the handle (4 inch stroke) causes the lower sidestay, via a ratchet/pawl and cable arrangement, to engage with its downlock. Only a few movements of the handle are necessary to engage the lower sidestay with its downlock.

109. Instructions for resetting the winching and emergency lowering controls are on a label affixed to the door at the aft end of the equipment bay. (See para. 111 below.)

NOTE: After operation, the emergency lowering control must not be returned to the normal condition until ground locks have been fitted to the undercarriage units and the fault has been investigated.

110. On a hinged cover over each selector valve is a warning notice which reads:

WARNING: THIS SELECTOR IS HYDRAULICALLY-OPERATED. TO CHECK CORRECT SETTING AFTER INSTALLATION OR EMERGENCY OPERATION, FIT LANDING GEAR GROUND LOCKS AND/OR SELECT EMERGENCY LOWER AND LANDING GEAR DOWN ON FLIGHT DECK BEFORE APPLYING PRESSURE, CHECK PILOT VALVE POINTER IS AT 'DOWN'. RED KNOB SHOULD INDICATE 'DOWN' WHEN PRESSURISED.

Resetting the Undercarriage in Flight after Use of Free Fall System. (Training Purposes)

111. The undercarriage free-fall re-setting notes are given on an instruction panel at the aft end of the equipment bay, and are as follows:

LANDING GEAR FREE-FALL RE-SETTING NOTES

(1) *After Use of Free-fall in Emergency*
Free-fall levers *must not* be returned to normal position until ground locks are fitted and fault investigated.

(2) *After Use of Free-fall for In-flight Test or Training*
Ensure pilots' landing gear control is selected DOWN.

Return free-fall levers to normal position as instructions below.

Raise landing gear by normal retraction drill.

(3) *If Landing Gear is not Raised in Flight after Use of Free-fall*

The free-fall levers must be left in the down position until ground locks are fitted and all selector valves and pilots' landing gear control have been checked for correct down position.

WARNING: Do not allow personnel to stand near open landing gear doors when levers are repositioned and pressure is introduced to the system.

MAIN LANDING GEAR FREE-FALL AND WINCHING RE-SETTING INSTRUCTIONS

(1) Pull down yellow catch on free-fall lever to release winching control.

(2) Push up red catch at forward end of unit.

(3) Reset control handle to normal position.

(4) Check that hand grip catch has reset.

(5) Replace disc pin.

NOSE LANDING GEAR RE-SETTING

(1) Re-set control handle to normal position.

(2) Check that the hand grip catch has re-set.

(3) Replace disc pin.

Standby Raise Facility

112. A standby raise facility is provided, operated by the STANDBY RAISE — UP/NORMAL switch. (See para. 40.)

NOSEWHEEL STEERING

General

113. Interconnected steering handles at each pilot's station operate a steering control valve which directs hydraulic pressure to and from steering packs to turn the nose shock-absorber strut.

114. Powered steering is limited to 70° on each side of centre. Free castoring is possible through 120° on either side of centre. Audible warning is given by the sounding of a horn in the nosewheel bay when a steering angle of 55° is attained. The nosewheels are automatically centred before retraction.

115. The steering system is normally operated by System A; if, for any reason, System A pressure should fail, an alternative supply from System B (right main undercarriage 'down' line) is made available via the emergency steering selector. With normal system (System A) selected, the pressure supply is taken from the nose undercarriage 'down' line. With emergency steering (System B) selected, the pressure supply is taken direct from the right main undercarriage 'down' line. In either case, return fluid from the nosewheel steering system is directed to System A reservoir.

116. A servo-operated shut-off valve ensures that the steering system can be operated only when the nose undercarriage is extended.

117. *Controls and Indicators — Nosewheel Steering.* (See Table 3)

Nosewheel Steering Installation

118. The purpose of each of the components in the steering hydraulic system is as follows:

a. The steering shut-off valve, when operated by servo pressure, allows pressure fluid to the steering control valve. It also allows pressure fluid to flow to the centring release valve.

b. The steering control valve permits steering to be selected and maintained and also permits free castoring of the nosewheels when it is in a neutral condition.

c. The steering servo valve consists of two separate valves within one body. One of the valves allows servo pressure to pass to the steering shut-off valve only when the nosewheels are within the powered steering range. The other valve is operated when the nosewheels are centred during the retraction cycle.

d. The emergency steering selector valve is electrically actuated and permits emergency steering to be selected.

e. A two-way relief valve protects the nose undercarriage steering mechanism from the excessive torque loads which could be caused by the nosewheels striking an obstruction and being violently displaced, so building up excessive pressure.

f. The steering pressure switch energises an electrical circuit to provide flight deck indication when hydraulic pressure is available for the steering system.

g. The centring steering jacks perform two functions. They steer the nose shock-absorber strut via the steering head and, when the nose undercarriage is selected UP, centralises the strut.

h. The shuttle valve responds to hydraulic fluid pressure from either hydraulic system and allows pressure to flow to the steering shut-off valve.

i. The centring release valve allows fluid from

Table 3. Controls and Indicators — Nosewheel Steering

Item	*Location*	*Marking / Indication*
Emergency steering switch	Hydraulic panel	NORMAL/EMERG
Emergency steering hydraulic supply indicator	Hydraulic panel	EMERG. STEERG. INDICATOR. In-line; cross-line
Steering hydraulic supply	Hydraulic panel	STEERG. Cross-hatch; in-line; cross-line.
Steering handles (2)	(1) Left console	70°-0-70°
Steering warning horn	(1) Right console Nose U/C bay	

the centralising steering jacks to by-pass the steering control valve into a return line during the centralising cycle. It blanks of the return line during normal steering operation.

j. The non-return valves, in the lines between the steering control valve and the centralising steering jacks, prevent hydraulic fluid flowing from a higher pressure steering line to a lower pressure steering line during normal steering.

k. The choke between the nose undercarriage retraction circuit and the pressure reducing valve restricts the flow to the centralising fluid jacks during undercarriage extension.

Nosewheel Steering Hydraulic Pressure Indicator

119. The nosewheel steering hydraulic pressure indicator circuit consists of a pressure switch in the nosewheel bay and a STEERG. magnetic indicator on the hydraulic panel, which shows in-line when pressure is 700 to 800 PSI, and cross-line before the pressure has fallen to 450 PSI.

120. The indicator circuit operates from the 28-volt DC No. 2 essential bus-bar via a 3 amp. fuse, there being no switch to control it.

Emergency Steering Electrical Circuit

121. The emergency steering electrical circuit consists of a NORMAL/EMERG. selector switch and a three-position EMERG. / cross-hatch / STEERG. magnetic indicator on the hydraulics panel, together with an emergency steering selector actuator in the nosewheel bay. The actuator incorporates a magnetic brake.

122. The circuit operates from the 28-volt DC No.1 essential bus-bar via a 5 amp. fuse.

Nosewheel Steering

123. Hydraulic pressure to operate the steering systems becomes available when the steering shut-off valve is opened by servo pressure. Servo pressure is available when the downlock-operated servo valve is operated by the nose undercarriage reaching the extended position and the steering servo valve is open.

124. The steering servo valve is normally held closed by hydraulic pressure but is opened mechanically when the nosewheels are within the powered steering rang.

125. When the emergency steering selector switch is set to NORMAL, hydraulic pressure for operating the nosewheel steering is supplied from System A. The System B pressure is blanked off by the selector which, at the same time, connects the lines from the steering pressure change-over shuttle valve, and the steering sequence shuttle valve into the system return line. System A fluid is fed through the steering pressure change-over shuttle valve to the steering shut-off valve, the pressure switch and the steering control valve. The pressure switch completes the electrical circuit to the indicator on the hydraulics panel which shows in-line when pressure is available.

126. Drain lines from the pressure switch, steering servo valve, and the steering shut-off valve take care of internal leakages within the valves. Return fluid from the steering system is routed into the System A via the return line distributor.

Free Castoring

127. While the steering handles on the flight deck are left free to turn, a centring spring holds the steering control valve in the neutral position. The steering jack lines remain open to each other and to the pressure supply line; but the return line is blanked off. Castoring action displaces fluid between opposite ends of the jacks and the movement is transmitted mechanically via a follow-up mechanism and the steering boxes to the steering handles on the flight deck.

Nosewheel Steering — Normal Operation

128. Manual movement of the steering handles is transmitted mechanically via gearing in the left-hand steering box to an operating arm. Movement of this operating arm overrides the steering control valve centring spring and moves the valve from its neutral position, connecting one side of the steering jacks with the pressure supply and the other side to return. The subsequent powered movement of the nosewheels provides a restoring motion of the valve spindle via the follow-up mechanism.

129. To continue steering, the displacement of the steering control valve from its neutral position must be maintained. To hold the nosewheels in the steering position a steering handle must be held stationary, the feed-back from the follow-up mechanism being allowed to bring the valve back to a fluid 'locked' position. When a steering handle is released, the valve is returned to neutral under the influence of its centring spring, leaving the nosewheels free to castor.

Nosewheel Steering — Emergency Operation

130. When the NORMAL/EMERG steering switch is set to EMERG, the actuator moves the emergency steering selector, and fluid from hydraulic System B (right main undercarriage 'down' line) is directed to the steering shut-off valve via the steering pressure changeover shuttle valve. Simultaneously, System B fluid is directed to the servo side of the steering shut-off valve via the steering sequence shuttle valve, the undercarriage 'down' servo valve and the steering servo valve. With the shut-off valve opened by servo pressure, System B fluid flows via the pressure switch to the steering control valve to operate the steering system.

131. At the same time the magnetic indicator is de-energised and shows cross-hatched, the actuator is run to the 'in' position and, on reaching maximum travel, the limit switch operates to stop the actuator, simultaneously changing over the supply to the indicator which shows in-line.

132. When the switch is set to NORMAL, the indicator is de-energised and shows cross-hatched; the actuator runs to the 'out' position and on reaching maximum travel, the limit switch operates to stop the actuator, simultaneously changing over the supply to the indicator, which then shows cross-line.

Power Centring

133. When undercarriage 'up' is selected, a tapping from the 'raise' line is fed into the steering jacks and automatically centres the nosewheels prior to retraction. Fluid expelled from the jacks during centring is forced into the return line via non-return valves and a centring release, by-passing the steering control valve. When undercarriage 'down' is selected the fluid used for centring is displaced from between the main and secondary pistons of the steering jacks into the 'raise' line.

WHEELS AND BRAKES

General

134. Twin wheels are fitted to each nose undercarriage unit and each main undercarriage unit is fitted with a four-wheel bogie. Each wheel comprises a two-piece hub with a fusible plug in the well and is fitted with a tubeless tyre.

135. Hydraulically-operated brakes are fitted to the main wheels only. Two independent brake systems are provided. The Normal System (System B) incorporates an anti-skid device; the Standby System (System A) is provided in case the Normal System fails. Both systems have separate accumulators which store pressure for brake application in the event of there not being a continuous supply from the Main systems.

136. A DC-operated auxiliary pump supplies pressure to the Normal System for braking during ground handling.

137. Anti-skid units are provided to permit maximum braking effort to be applied under all conditions without fear of wheel skidding. They function only when the Normal braking system is in use and are sensitive to angular deceleration consistent with an approaching skid of the wheel. When this condition occurs, they release the pressure existing in the associated brake unit. Subsequent acceleration of the wheel re-admits pressure to the brake.

Wheelbrakes

138. Hydraulically-operated disc brakes which operate at 1900 PSI are fitted to the main wheels; there are two independent braking systems provided. The Normal System (System B) incorporates an anti-skid device; the Standby System (System A) is provided in case the Normal System fails. Both Systems have separate accumulators which store pressure for brake application should there not be a continuous supply from the Main systems. Normal and Standby systems are selected by a BRAKE CHANGEOVER—NORMAL/STANDBY lever at

the front of the centre console, left side. When selected, a stop holds the lever in the STANDBY position.

139. The brakes can be applied by handbrake levers, one on each side of the centre console, or by toe pedals, which operate master cylinders on the rudder pedals. Use of the handbrake levers permits equal pressure to be applied to each wheelbrake. Use of the toe pedals permits differential braking which is proportionate to the amount of pedal depression. The 1st pilot's handbrake lever only can be locked in the 'brakes applied' condition for parking.

140. Two wheelbrake accumulators in each system have associated nitrogen pressure gauges marked SYSTEM B BRAKE ACCUMULATORS and SYSTEM A BRAKE ACCUMULATORS and charging points on the hydraulic nitrogen charging panel under the centre section. Each gauge indicates the nitrogen inflation pressure (1700 PSI at ISA) when its system is depressurised and the system pressure when the system is pressurised.

141. Pressure release valves are also provided on the nitrogen charging panel to depressurise the accumulators for servicing purposes. A choke valve in the return line from each pressure release valve prevents surging of fluid in the return line when the valve is operated.

142. When the undercarriage is selected UP an automatic braking system, operating from the Standby System, applies the brakes before retraction commences and releases them when the undercarriage is locked up. Application of brakes when the undercarriage is retracted will be ineffective.

143. A servo-reservoir located at the nose servicing bay, ensures that the foot-operated master cylinders are charged with fluid. A level indicator provides a means of filling the reservoir and of checking the fluid level. The servo-reservoir also serves the windscreen wiper hydraulic system.

144. Two electrically-operated brake pressure applied gauges, one for the Normal System and one for the Standby System, are provided on the 1st pilot's inner sill panel. A pair of lights, marked L and R, beneath each gauge are on as long as there is pressure in the respective system. The Standby System lights come on briefly on undercarriage retraction or extension.

145. A DC-operated pump, controlled from a switch between the brake pressure applied gauges, is provided to supply pressure in System B during ground handling.

146. The NORM BRAKES and STANDBY BRAKES Main pressure available gauges are on the hydraulics panel at the engineer's station.

147. *Controls and Indicators — Wheelbrakes.* (See **Table 4**).

Braking Systems

148. Non-return valves in hydraulic Systems A and B isolate each brake system as a safeguard against failure of a system. The brake accumulators store hydraulic pressure energy for brake operation in case of Main system failure. The pressure release valves are fitted to allow the accumulators to be depressurised for servicing purposes.

149. Pressure reducing valves reduce the hydraulic pressure from the accumulators to 1900 PSI maximum before supplying it to the brake emergency selector and the brake control valve.

150. The foot-operated master cylinders on the rudder pedals are used in conjunction with the brake control valve to operate the main wheelbrakes. Shuttle valves in the lines between the left and right master cylinder, on each side, isolate one side from the other during brake operation.

151. A servo reservoir (which also serves the windscreen wiper system) ensures that any loss of fluid sustained during brake operation is immediately replenished. A level indicator, on the forward bulkhead in the nosewheel bay, provides a means of checking the fluid content and charging the servo reservoir.

152. The shuttle valves in the Standby brake lines, downstream of the brake control valve, permit either the auto-brake system or System A to supply the brake units.

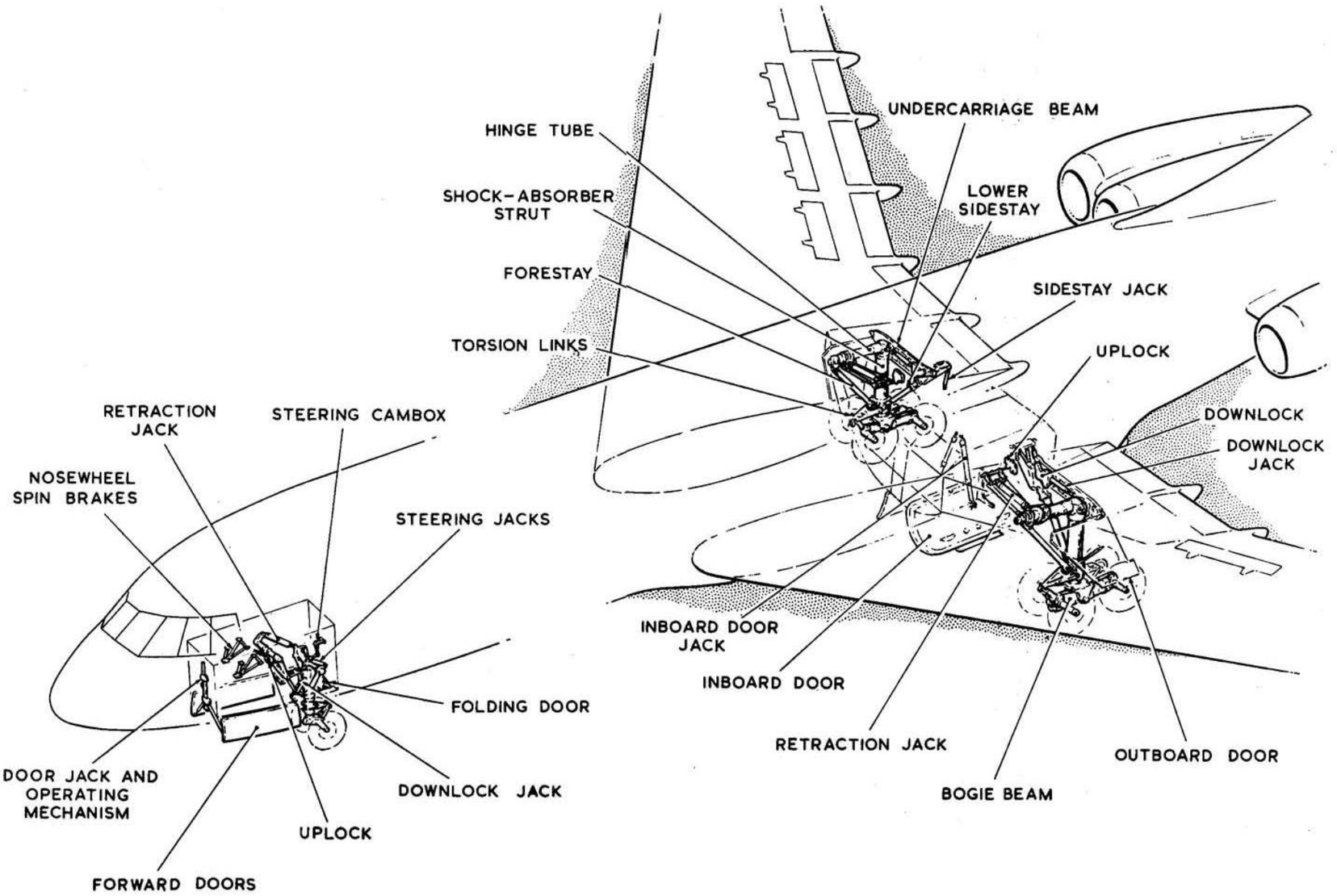
153. A pressure-reducing valve in the auto-brake system reduces the pressure delivered to the auto-brake relay valve to 700 PSI. This valve allows the brakes to be applied automatically to stop wheelspin during the undercarriage retraction cycle.

154. The Standby System flow to each brake unit is via a fuse unit which is sensitive to pressure and normally divides the flow equally between the two delivery lines. Should a delivery line or system failure occur downstream of the unit, the reduction in pressure causes the unit to seal off that line and supply fluid only to the other delivery line.

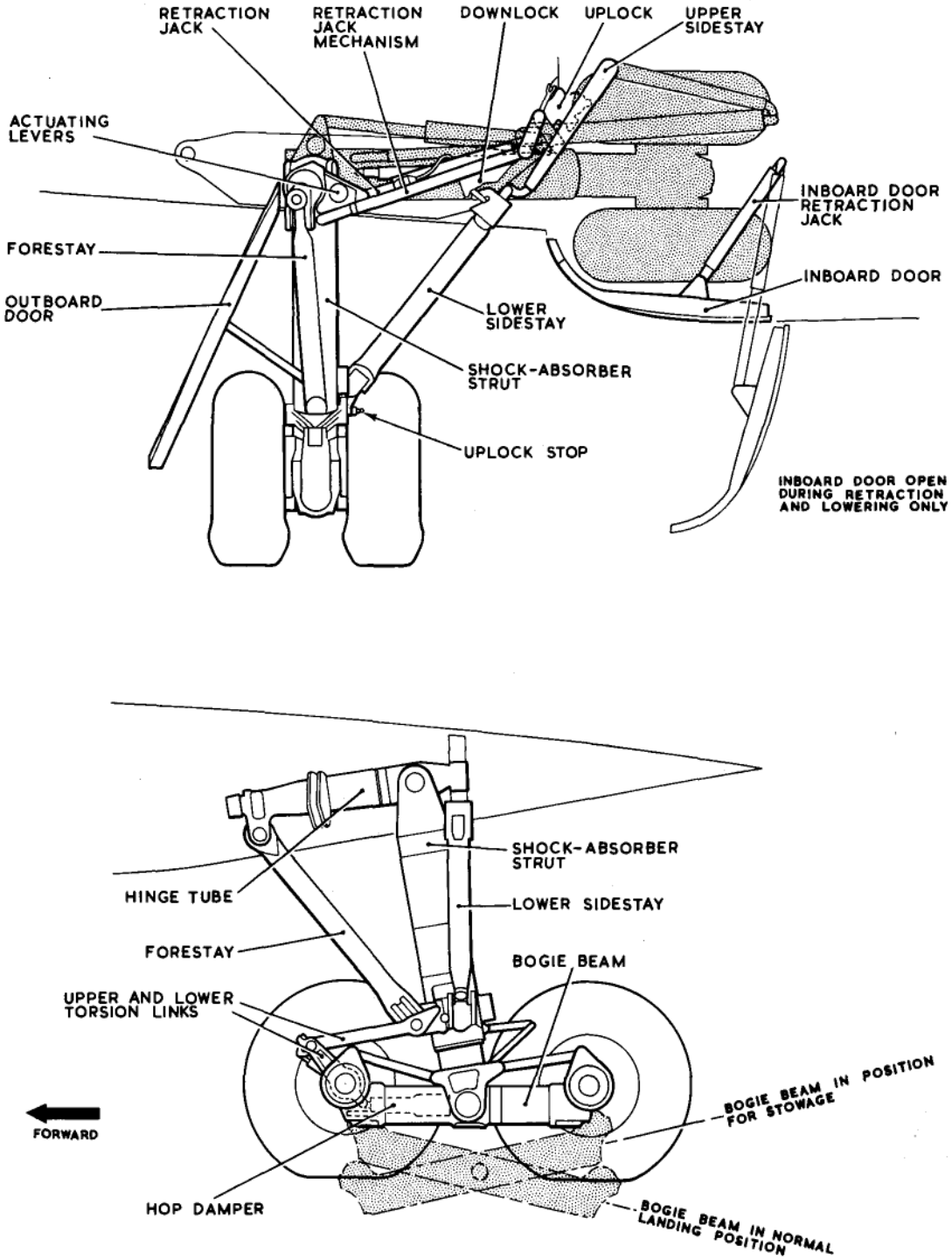
155. A shuttle valve on each brake unit allows either Normal or Standby brake systems to pressurise the brakes.

Table 4. Controls and Indicators — Wheel Brakes

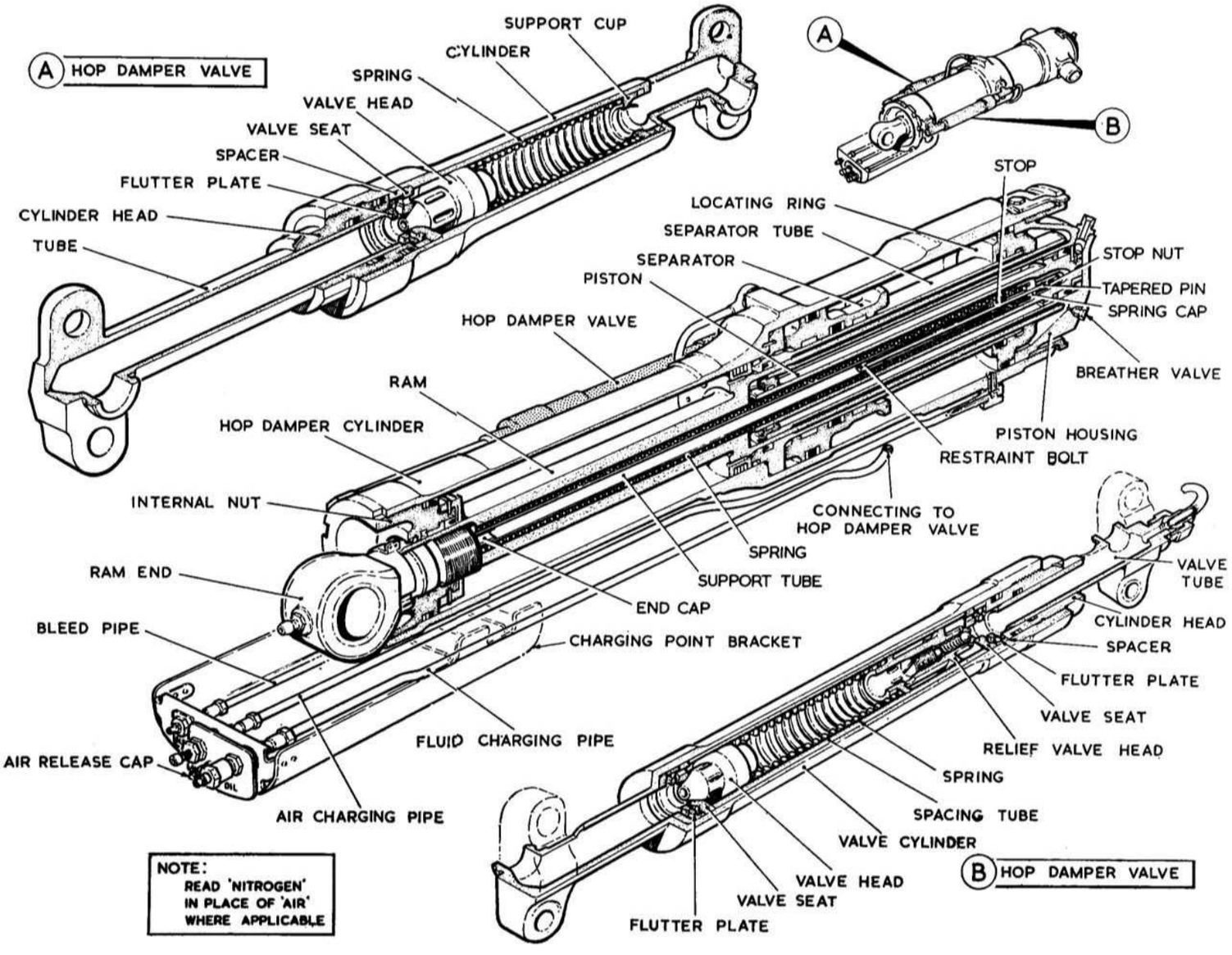
Item	*Location*	*Marking/Description*
Wheel brakes DC auxiliary supply pump	1st pilot's inner sill panel	BRAKES HYD PUMP—ON/OFF (spring-loaded to OFF)
Brake pressure applied gauges (2)	1st pilot's inner sill panel	NORMAL PSI x 100 STANDBY PSI x 100
Brake pressure available gauges (2)	Engineer's hydraulics panel	NORM BRAKES—PSI x 1,000 STANDBY BRAKES—PSI x 1,000
Brake change-over selector lever	Centre console	BRAKE CHANGEOVER—NORMAL/STANDBY
Hand brake levers (2) (1st pilot's combined with parking brake lever)	Centre console. 1st pilot's, co-pilot's	TURN TO LOCK BRAKES. BRAKES
Residual brake pressure warning lights (4)	1st pilot's inner sill panel	NORMAL L.R. (amber) STANDBY L.R. (amber)
Foot brakes (4)	Rudder pedals	—



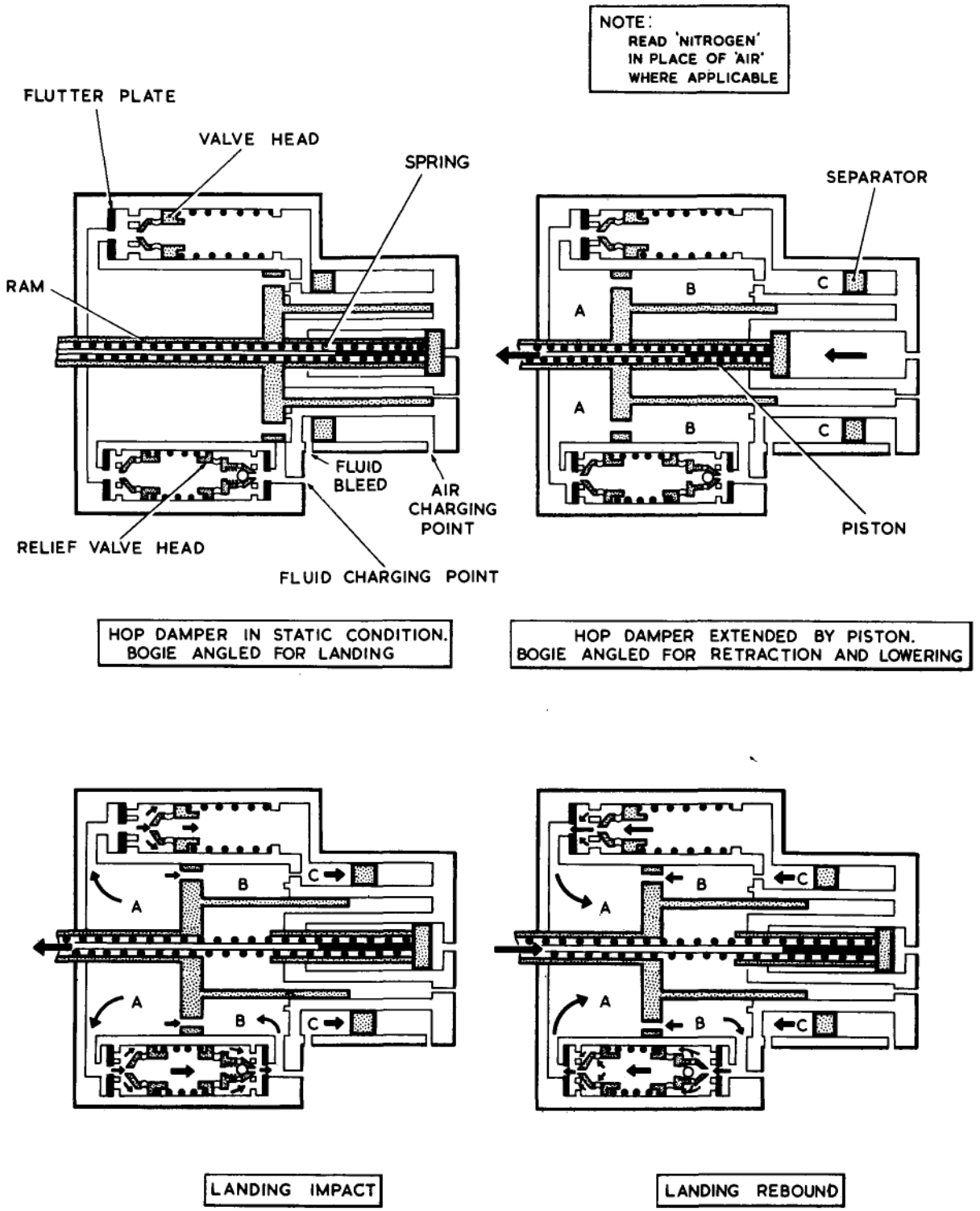
2.18 Fig. 1. Undercarriage — Location of Components



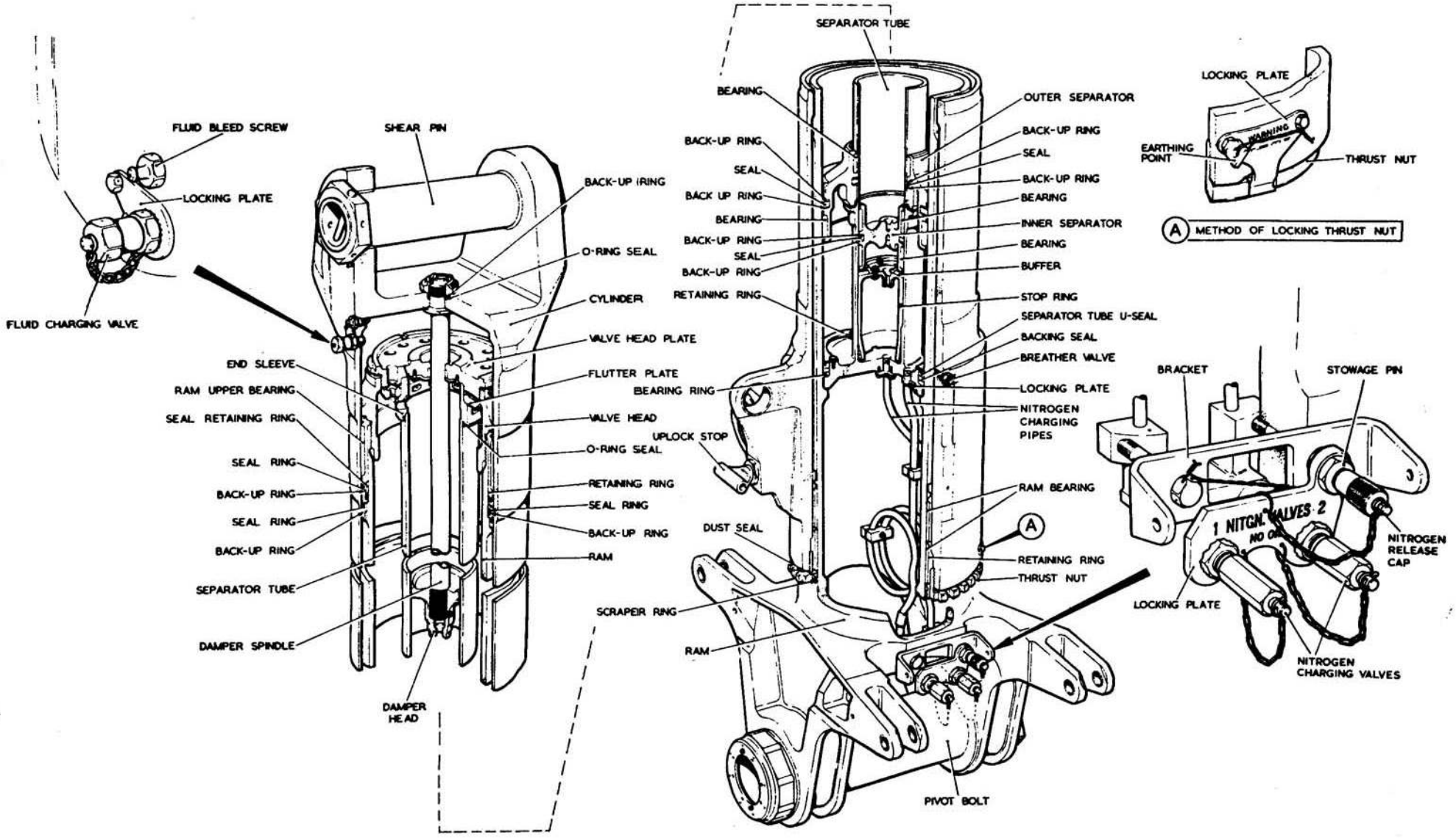
2.18 Fig. 2. Main Undercarriage — Functional Diagram



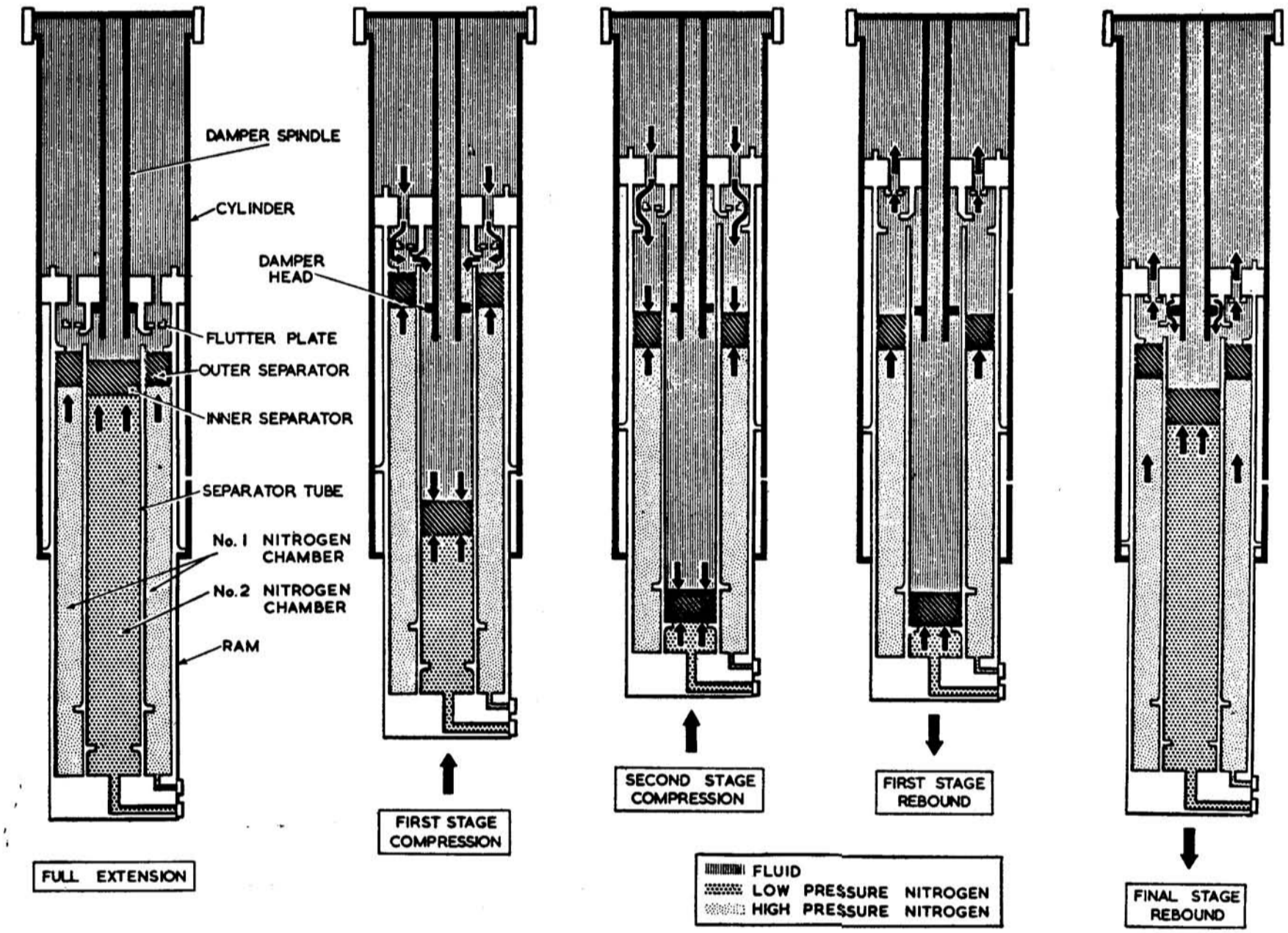
2.18 Fig. 3. Main Undercarriage Hop Damper



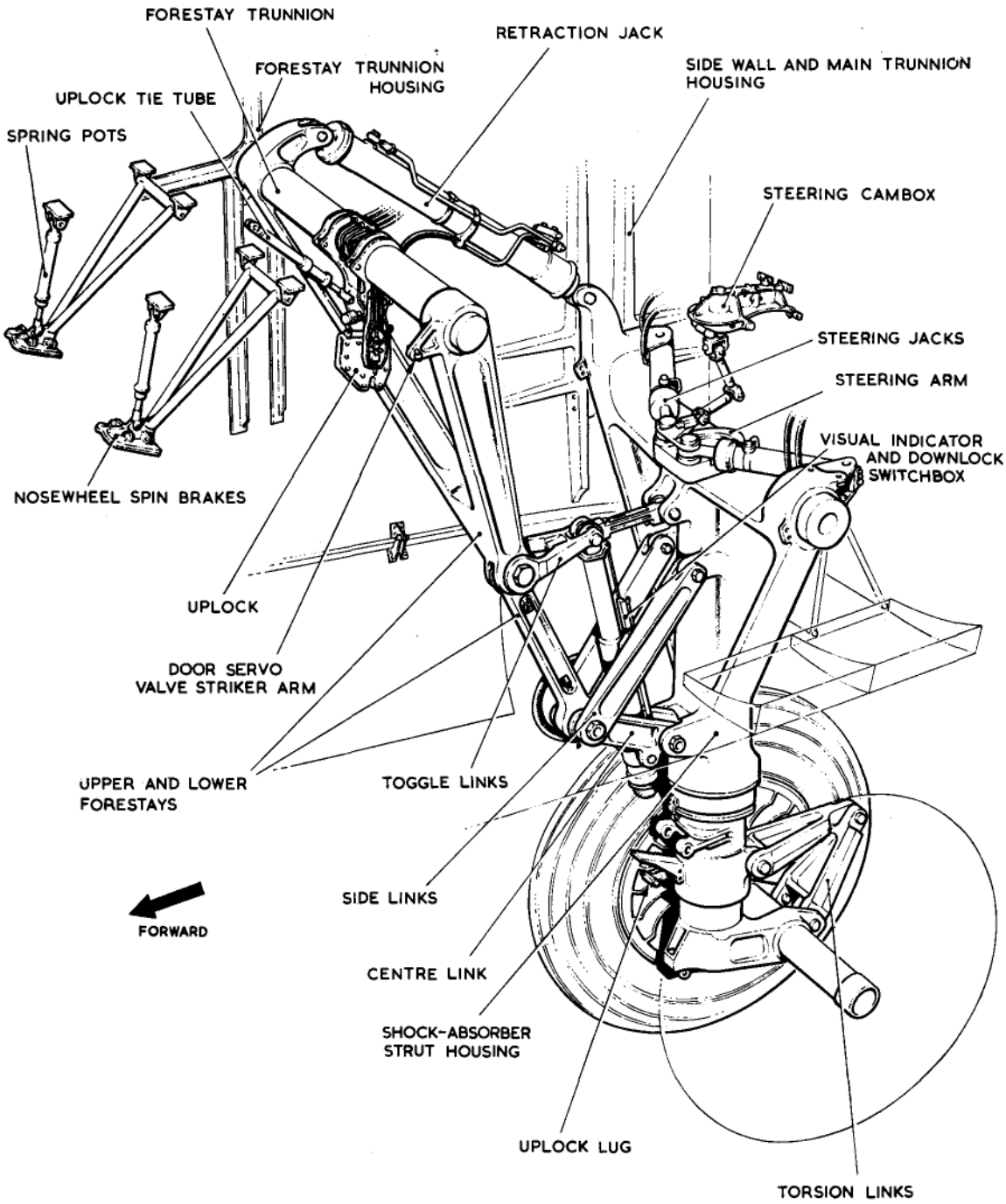
2.18 Fig. 4. Main Undercarriage Hop Damper — Functional Diagram



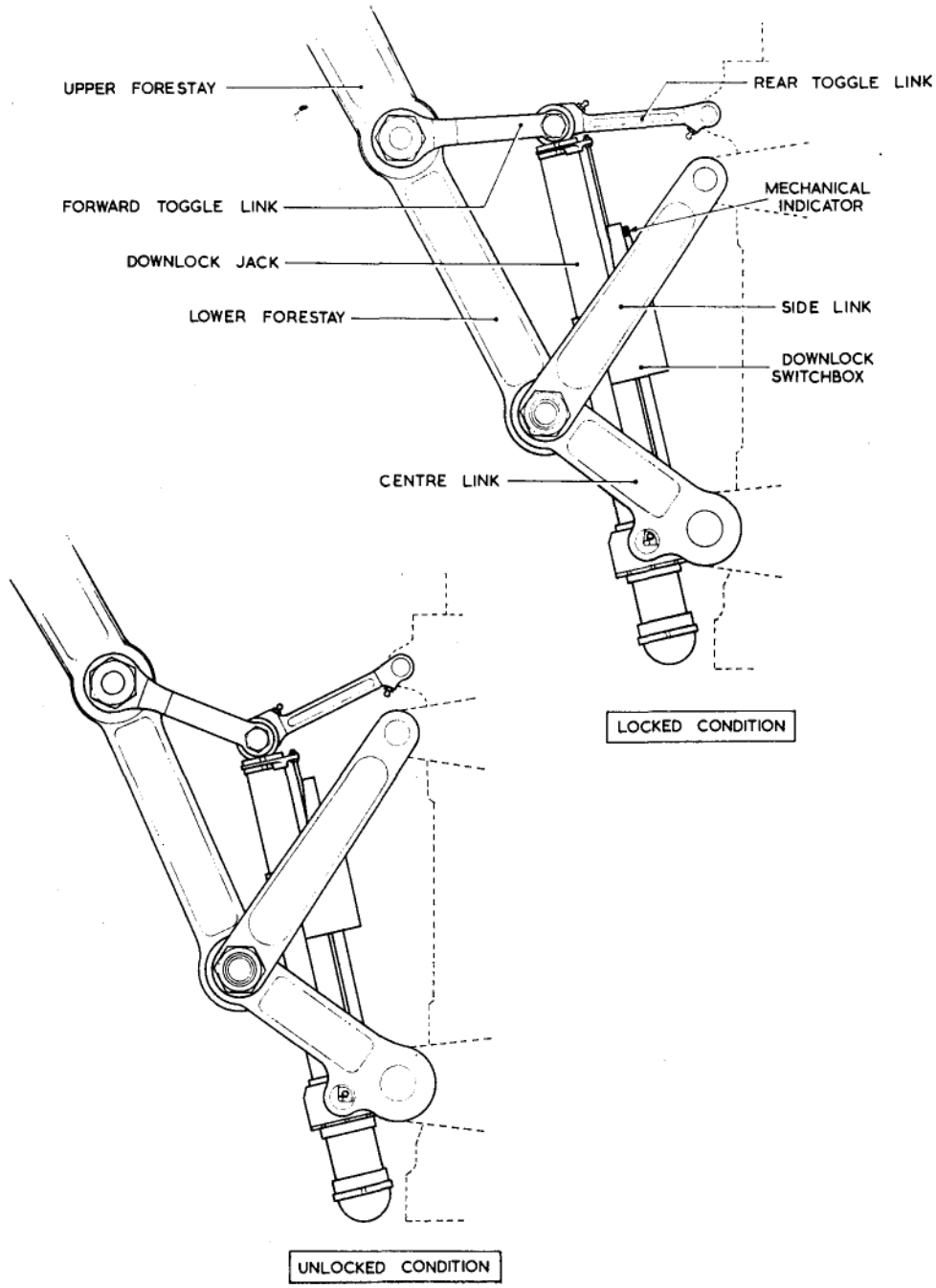
2.18 Fig. 5. Main Undercarriage Shock Absorber Strut



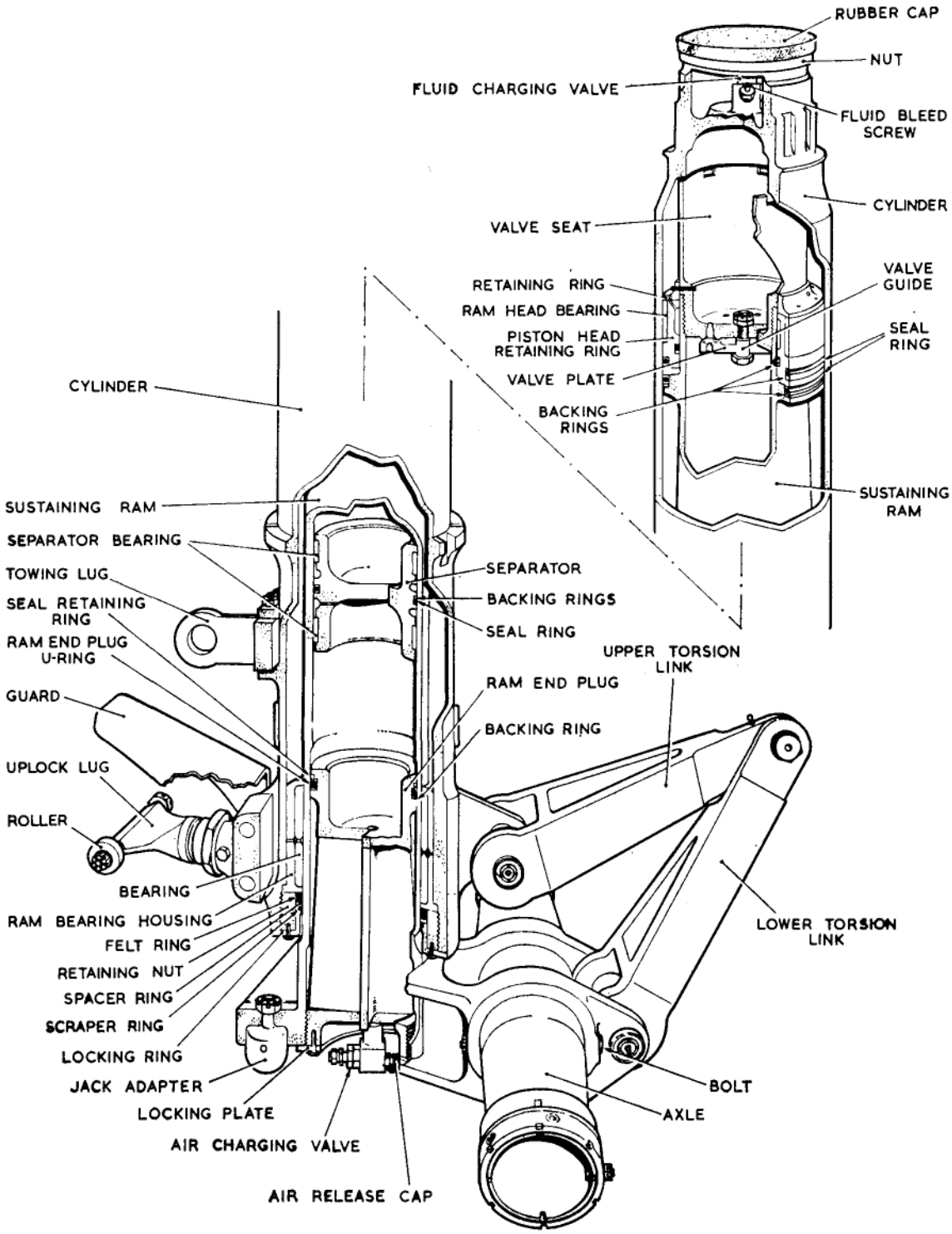
2.18 Fig. 6. Main Undercarriage Shock Absorber Strut — Functional Diagram



2.18 Fig. 7. Nose Undercarriage

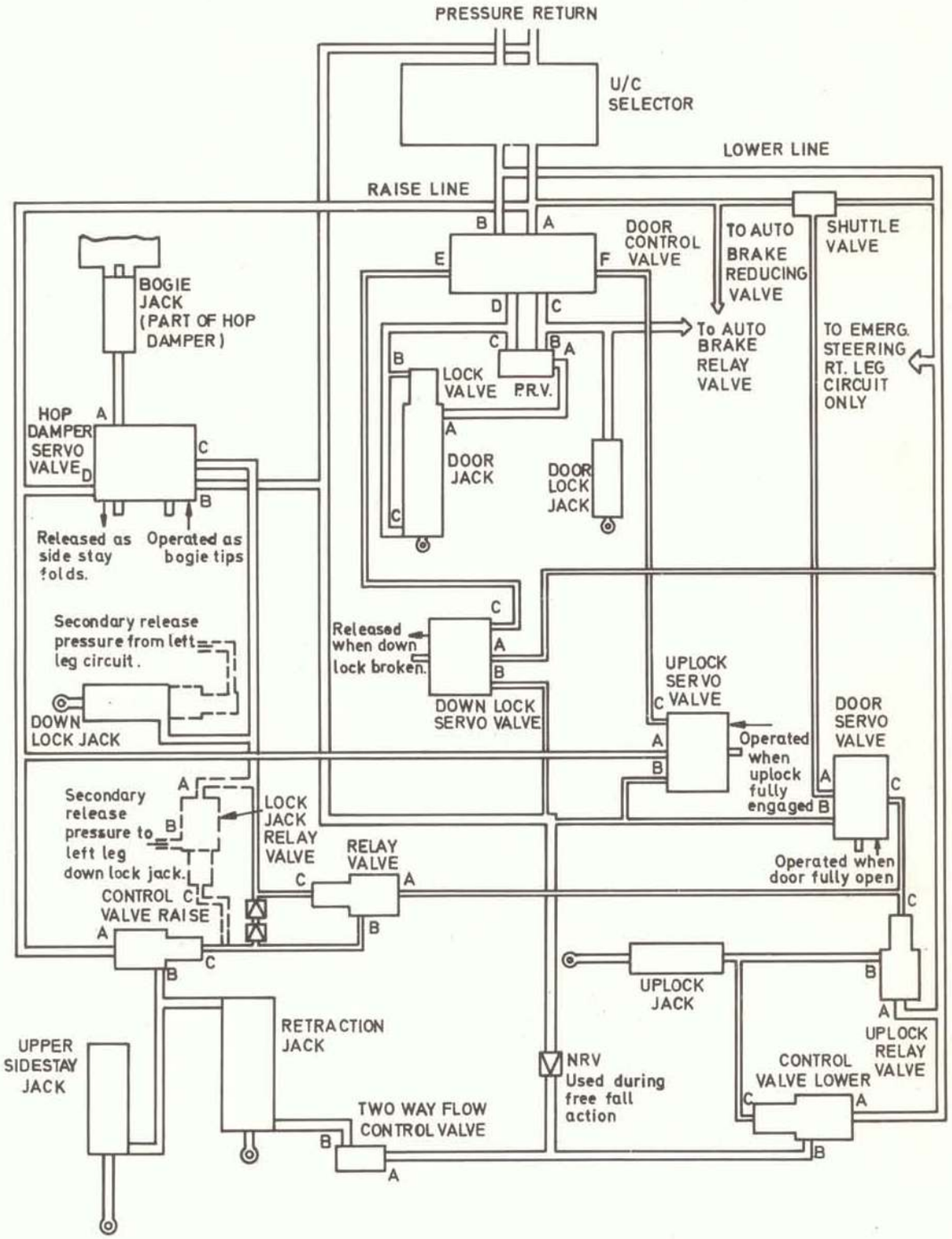


2.18 Fig. 8. Nose Undercarriage — Downlock Mechanism



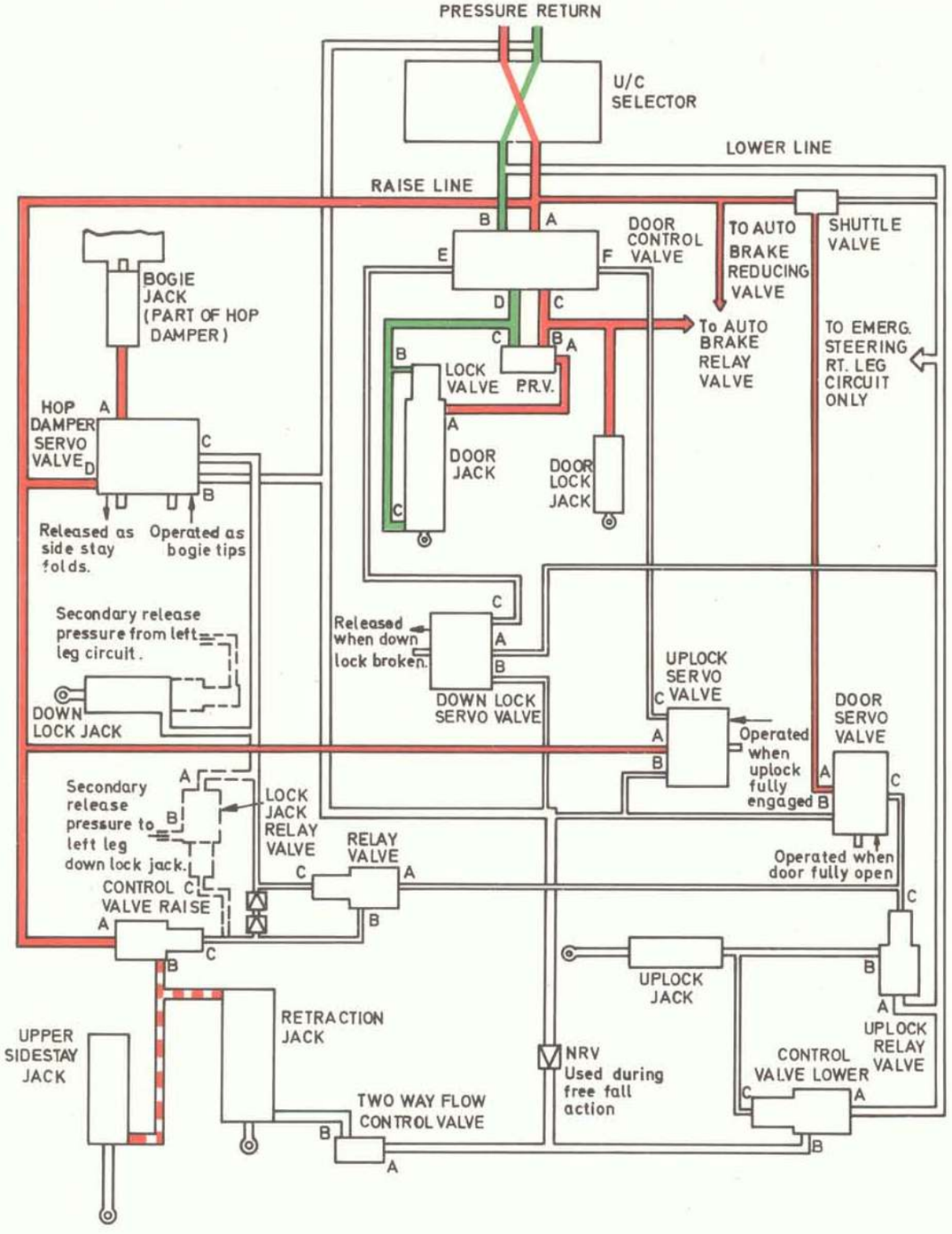
VC10/143A

2.18 Fig. 9. Nose Undercarriage Leg Shock Absorber Strut



VC10/233A

2.18 Fig. 9A. Main Undercarriage System



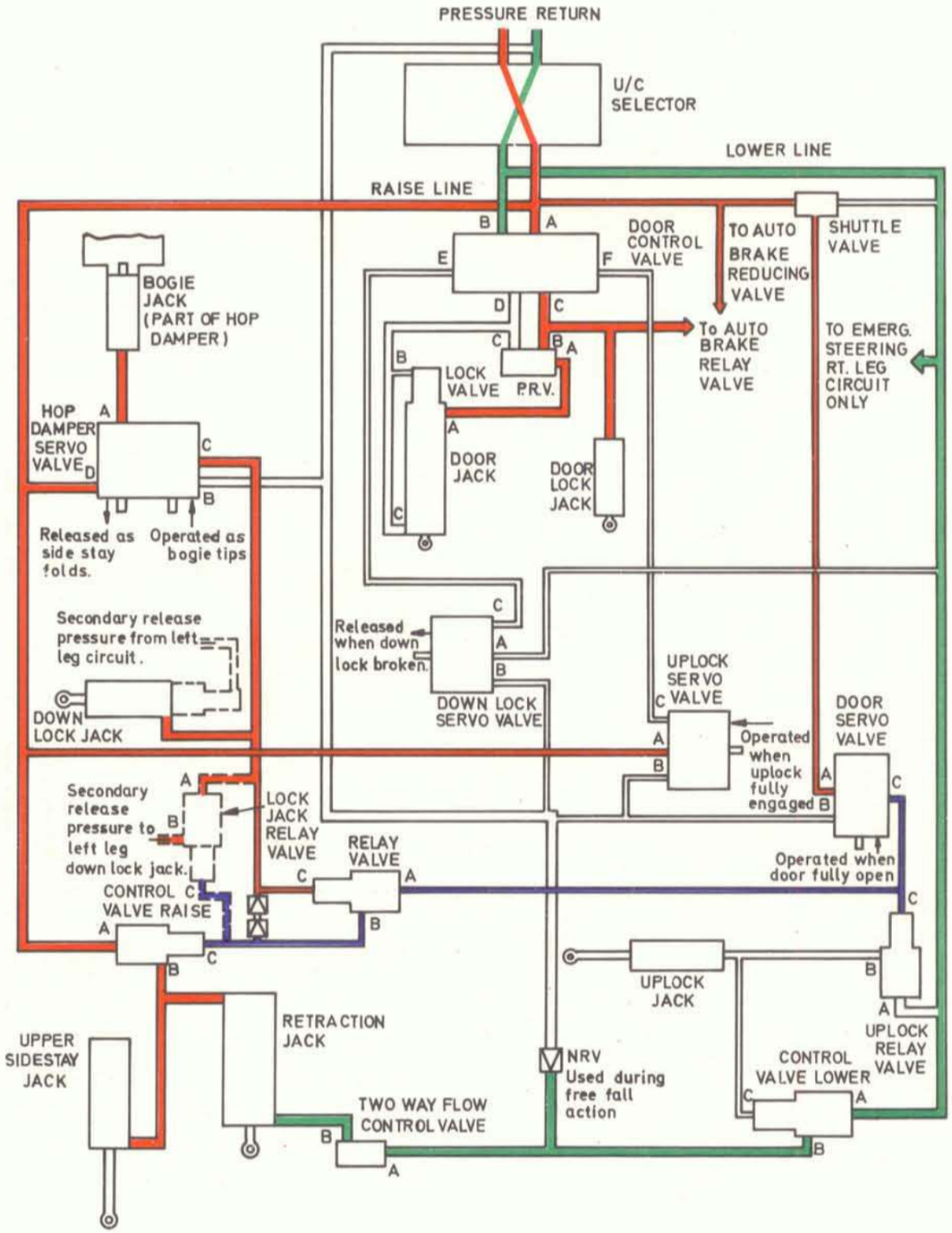
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/144B

2.18 Fig. 10. Main Undercarriage Retraction (1)

◀ *Illustration Up-dated* ▶



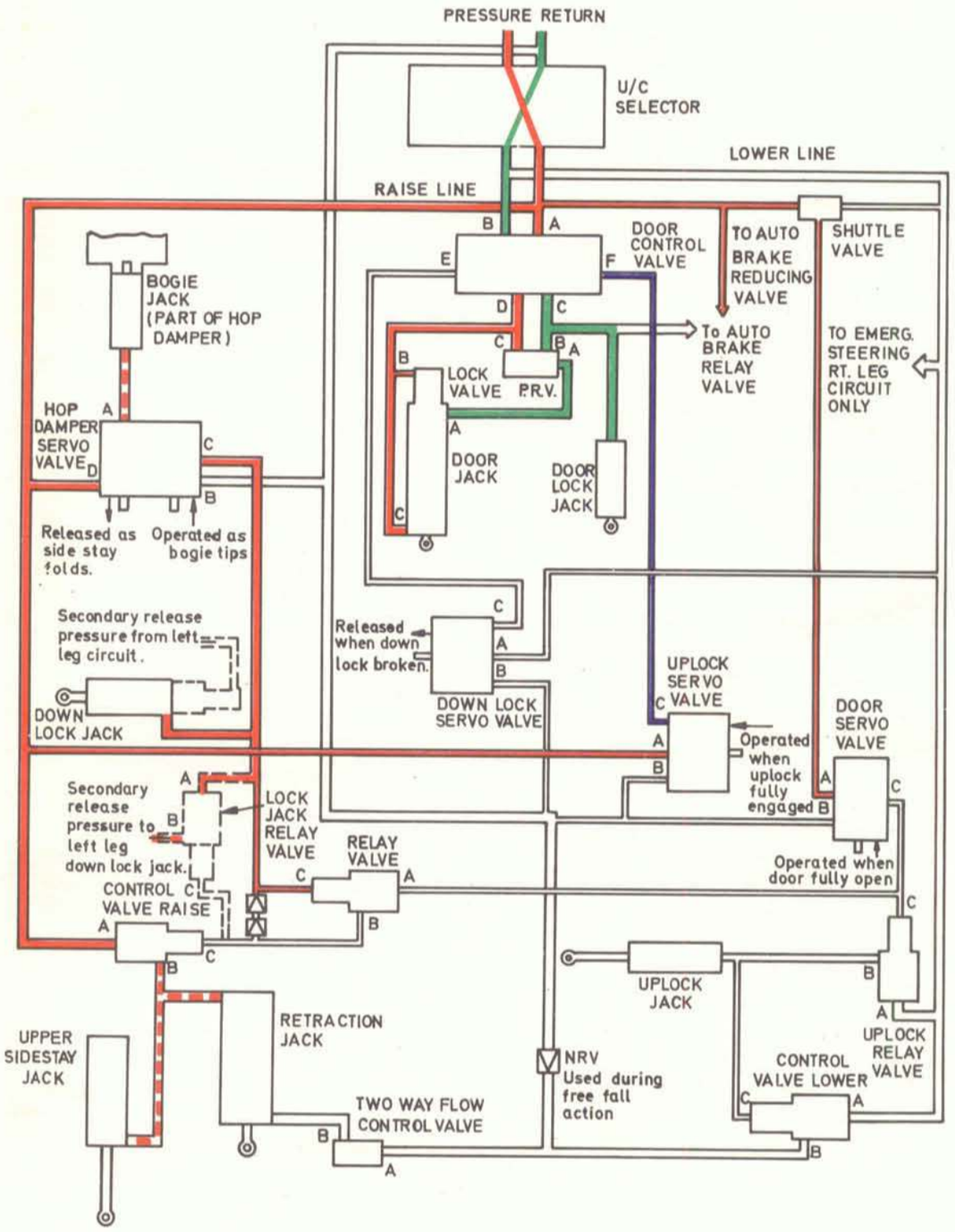
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/145B

2.18 Fig. 11. Main Undercarriage Retraction (2)

◀ *Illustration Up-dated* ▶



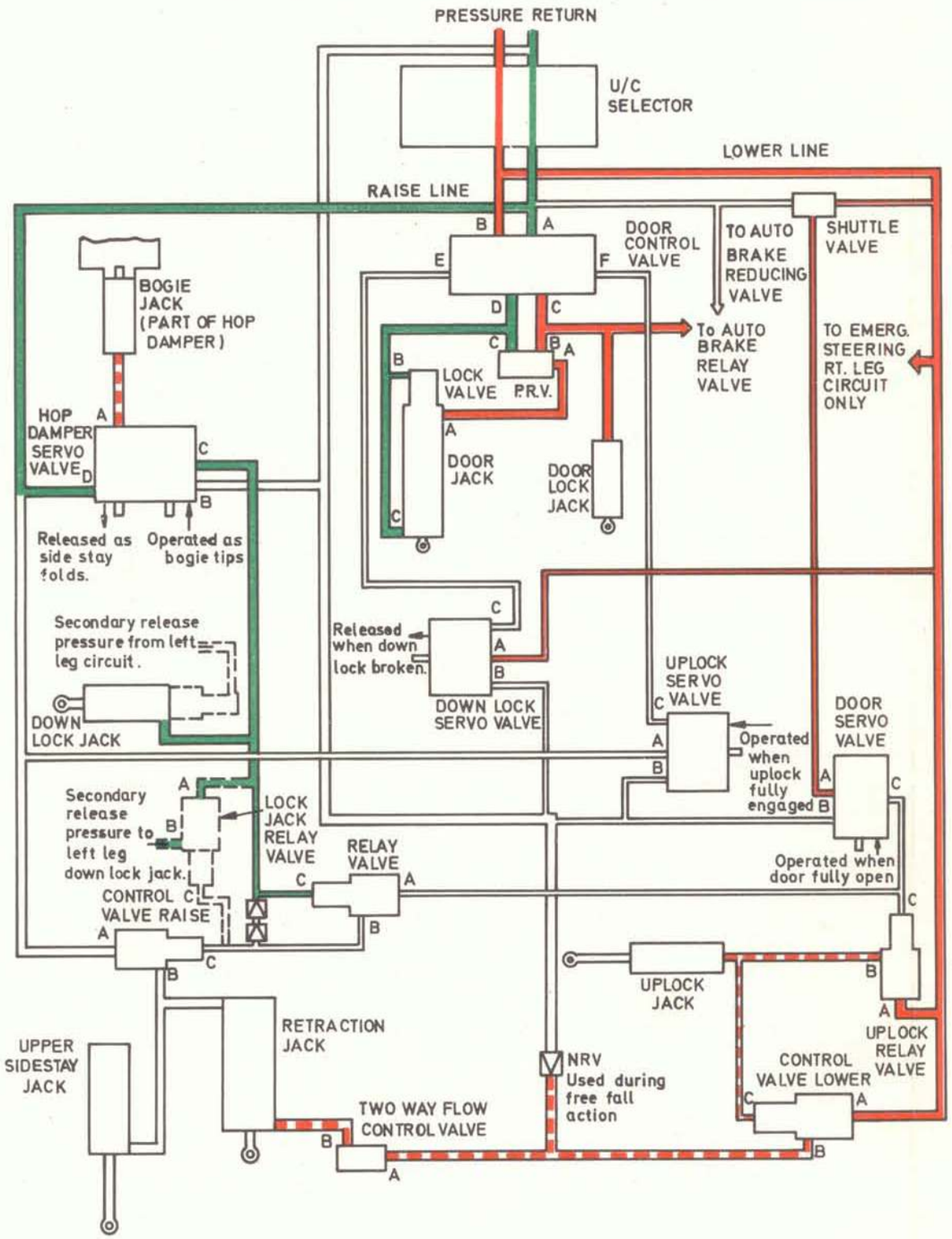
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/146B

2.18 Fig. 12. Main Undercarriage Retraction (3)

◀ *Illustration Up-dated* ▶



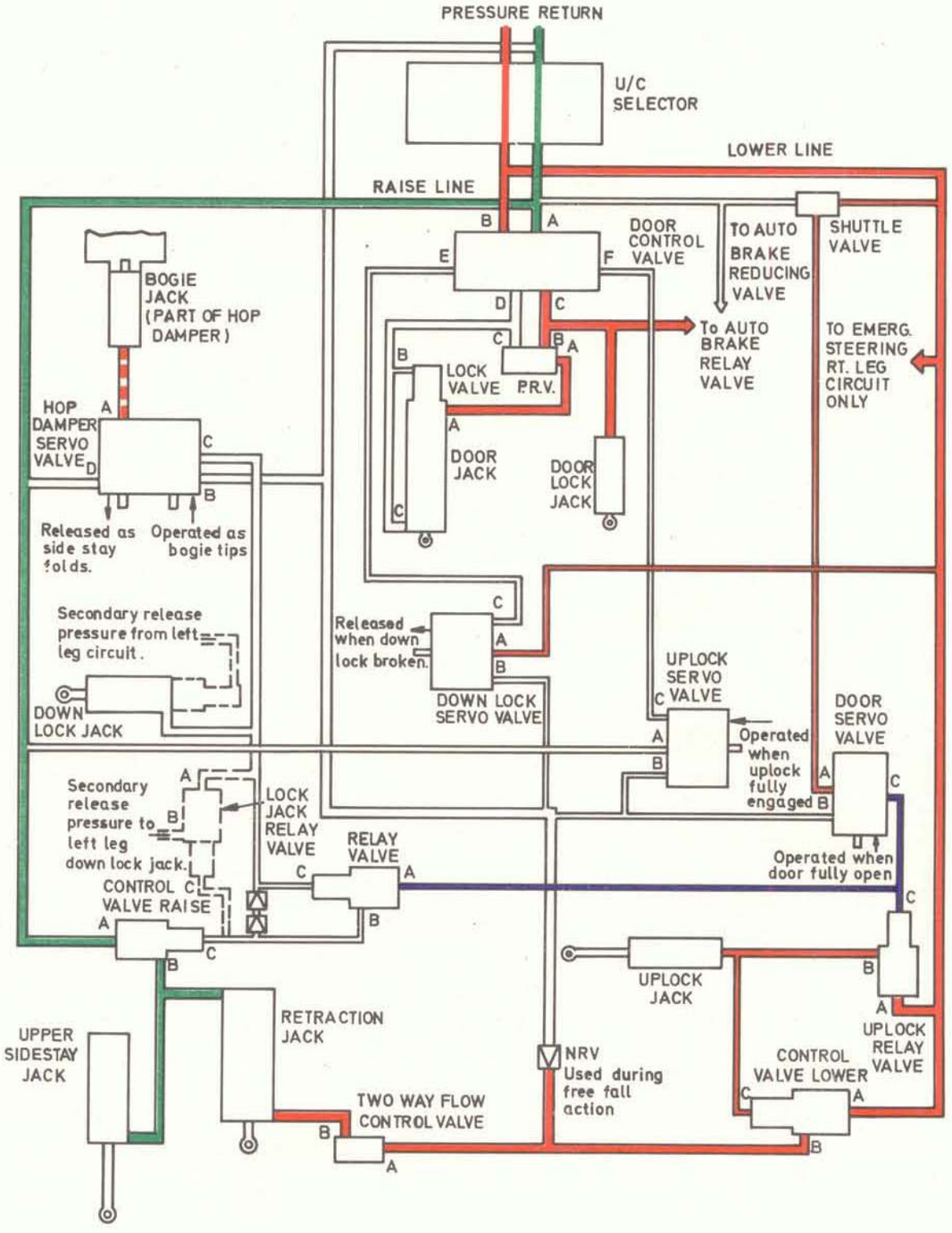
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/147B

2.18 Fig. 13. Main Undercarriage Extension (1)

Illustration Up-dated



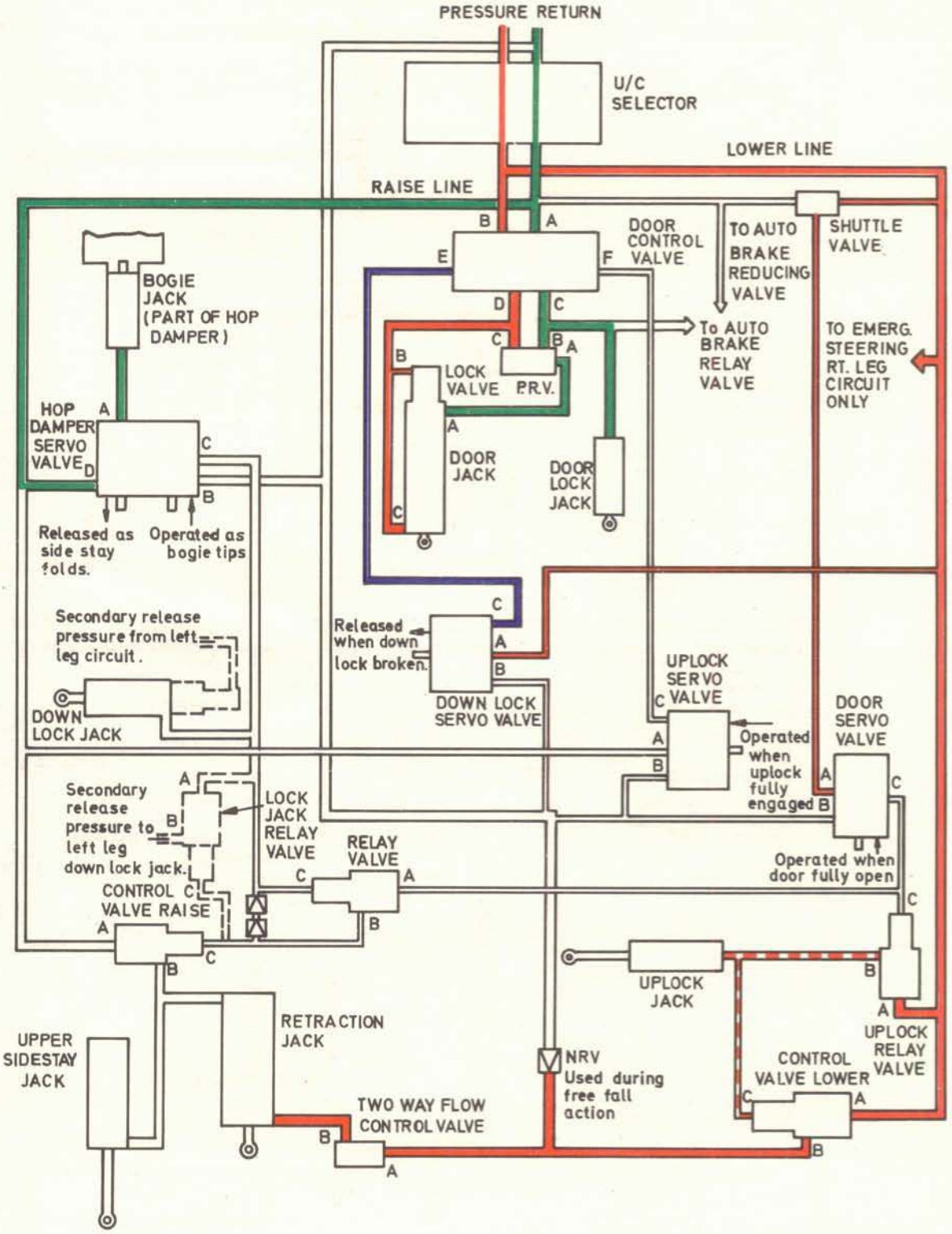
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/148B

2.18 Fig. 14. Main Undercarriage Extension (2)

Illustration Up-dated



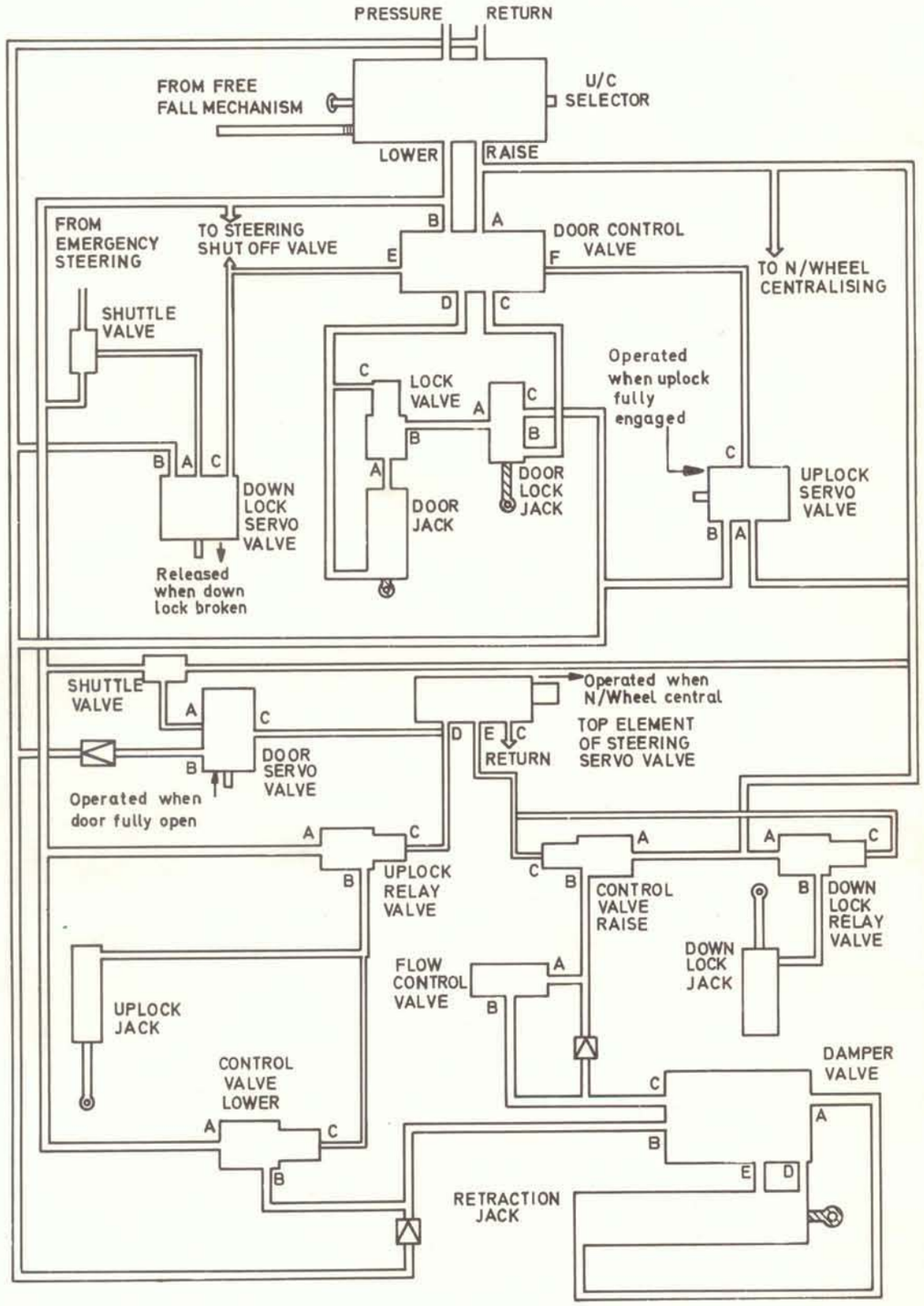
Legend

Red	=	Pressure	Blue	=	Servo pressure
Green	=	Return flow	White	=	Open to return
Red/white	=	Trapped fluid			

VC10/149B

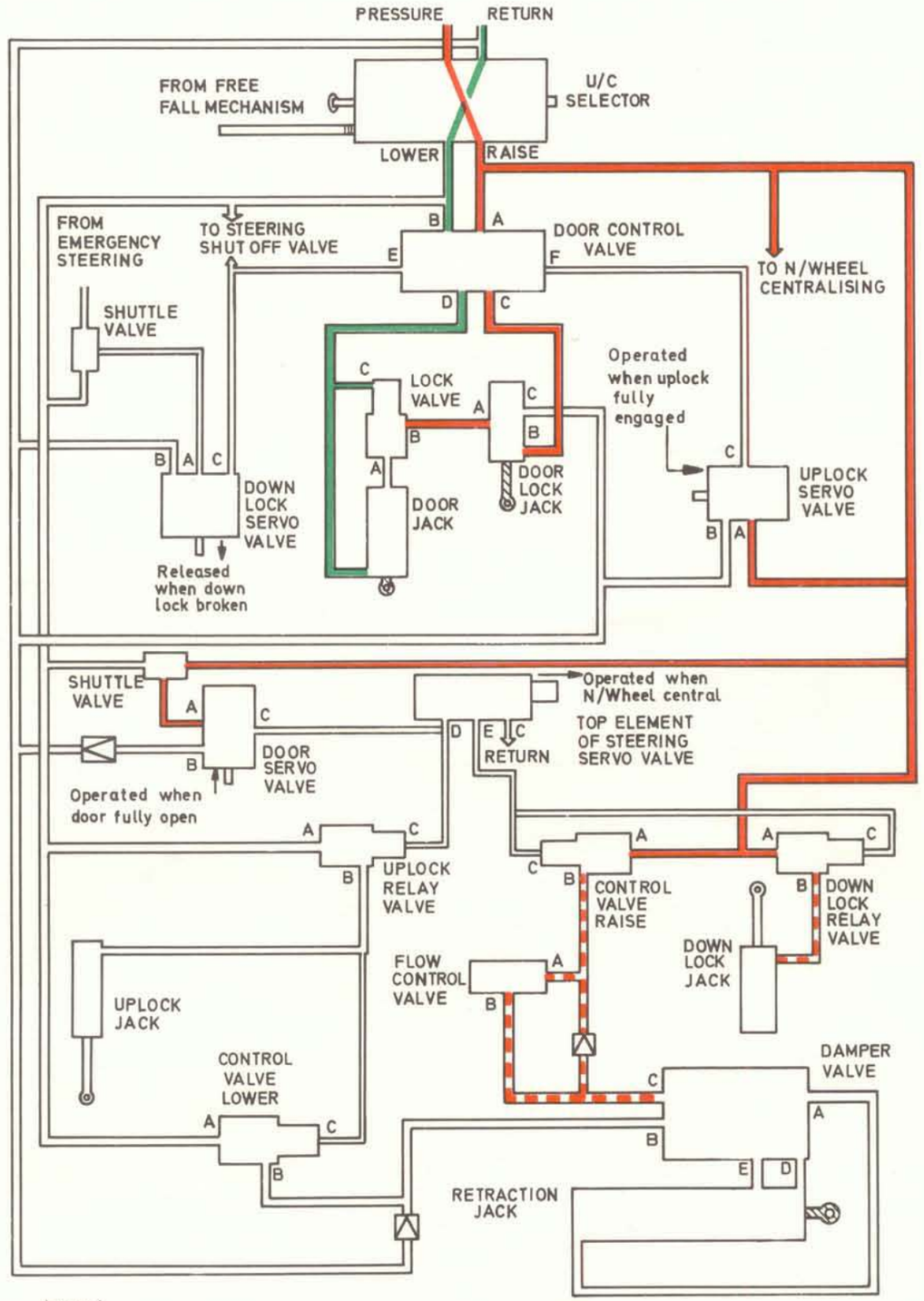
2.18 Fig. 15. Main Undercarriage Extension (3)

◀ *Illustration Up-dated* ▶



VC10/234A

2.18 Fig. 15A. Nose Undercarriage System



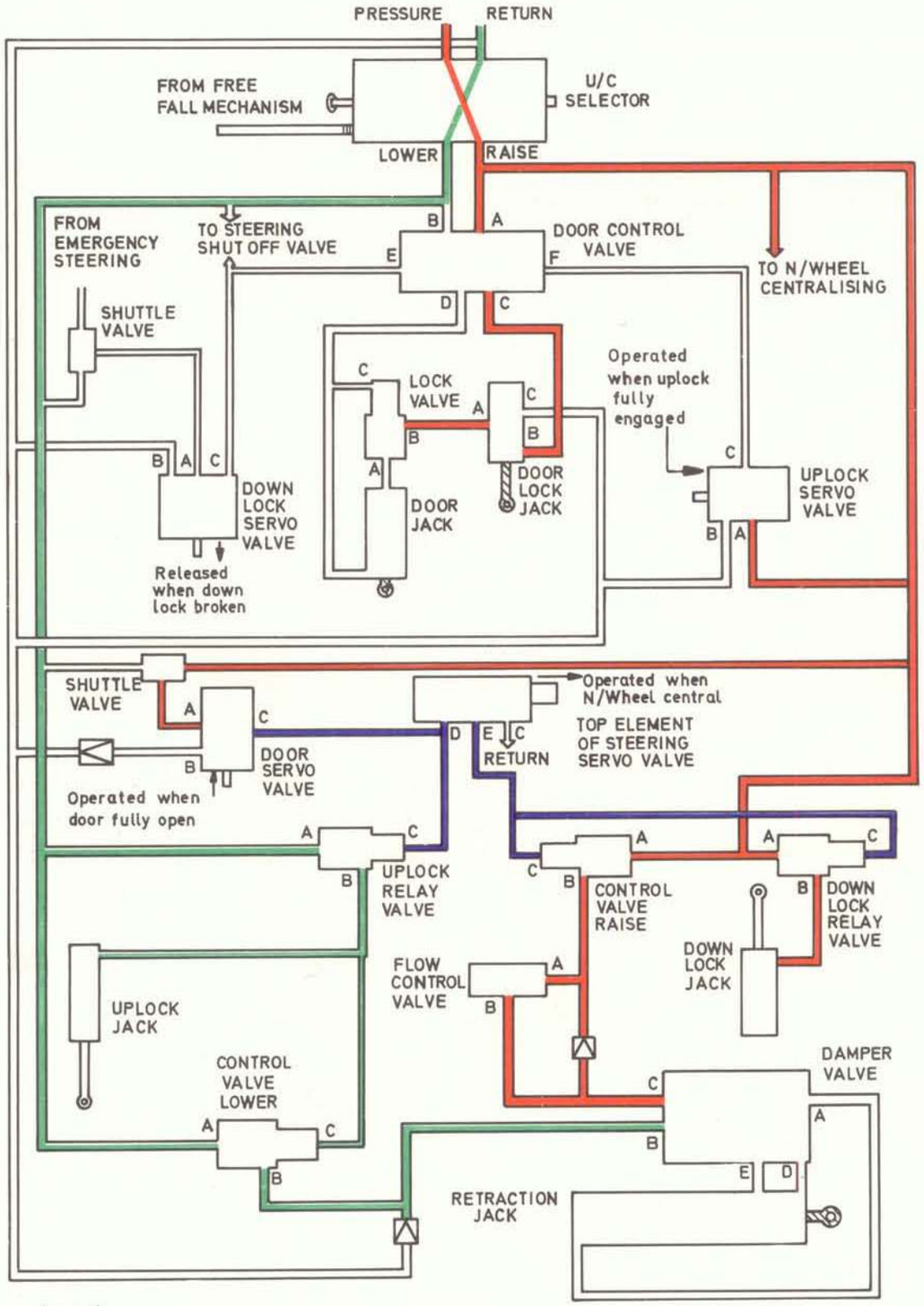
Legend

Red	= Pressure	Blue	= Servo pressure
Green	= Return flow	White	= Open to return
Red/white	= Trapped fluid		

VC10/150B

2.18 Fig. 16. Nose Undercarriage Retraction (1)

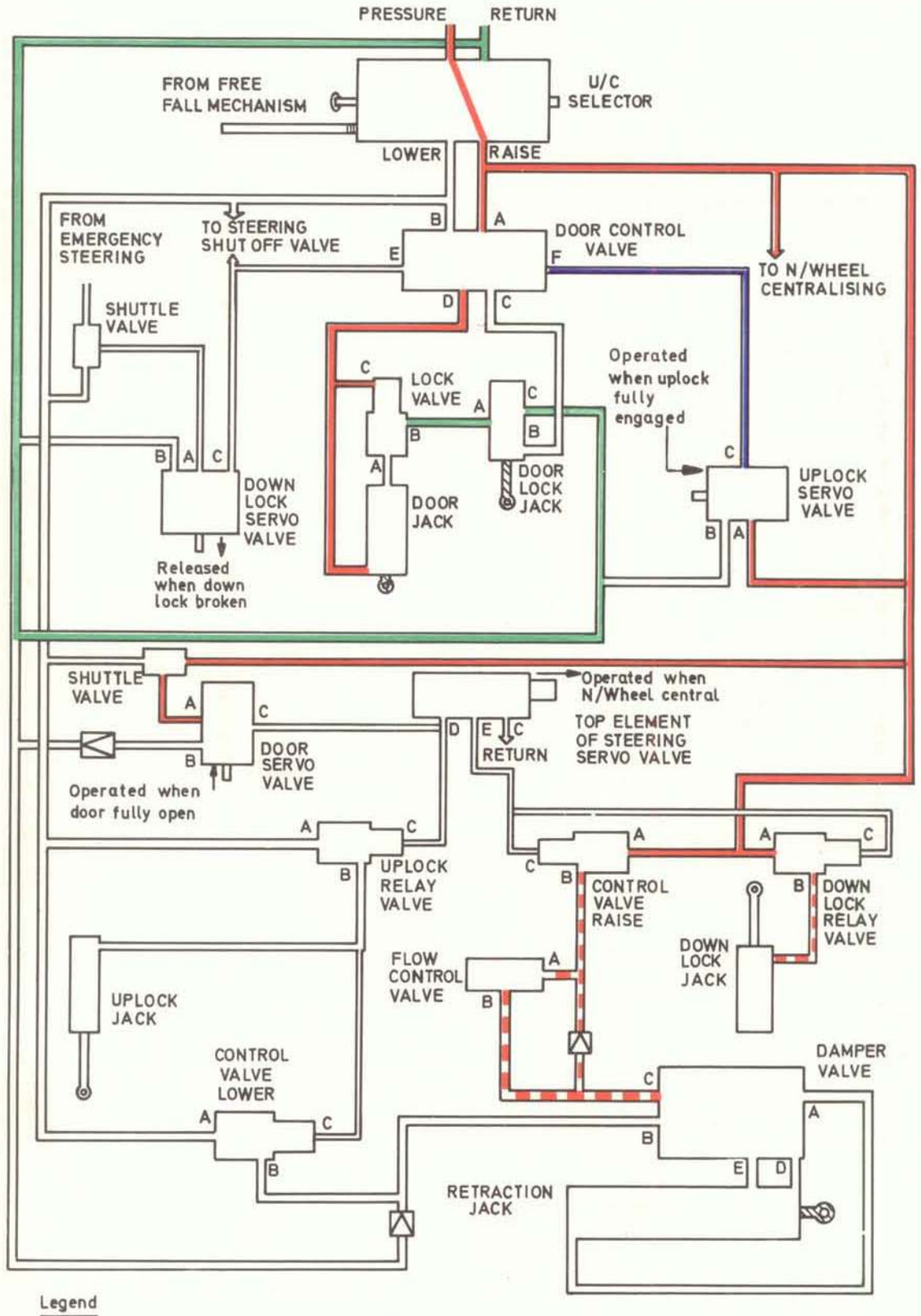
Illustration Up-dated



VC10/151B

2.18 Fig. 17. Nose Undercarriage Retraction (2)

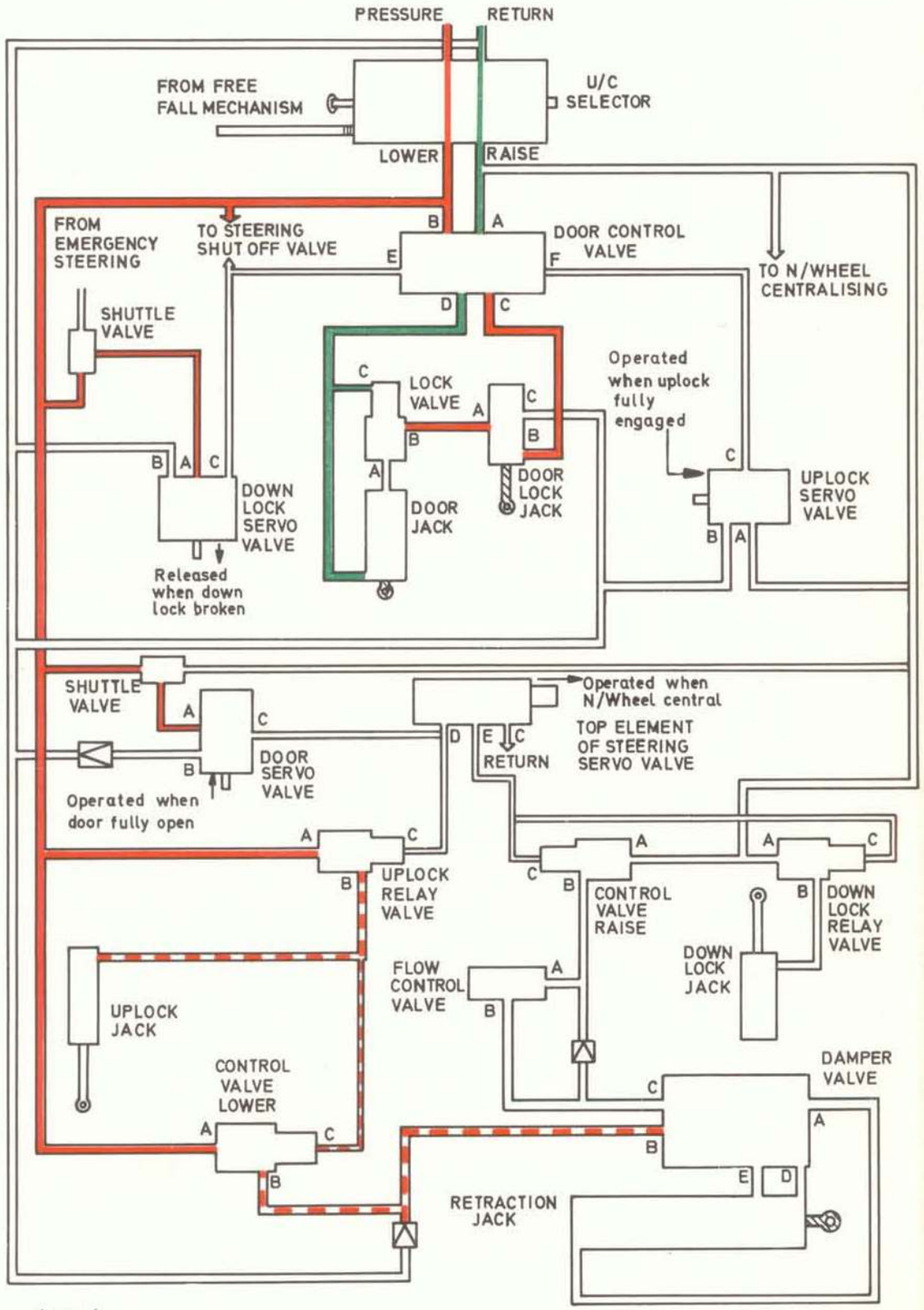
Illustration Up-dated



VC10/152B

2.18 Fig. 18. Nose Undercarriage Retraction (3)

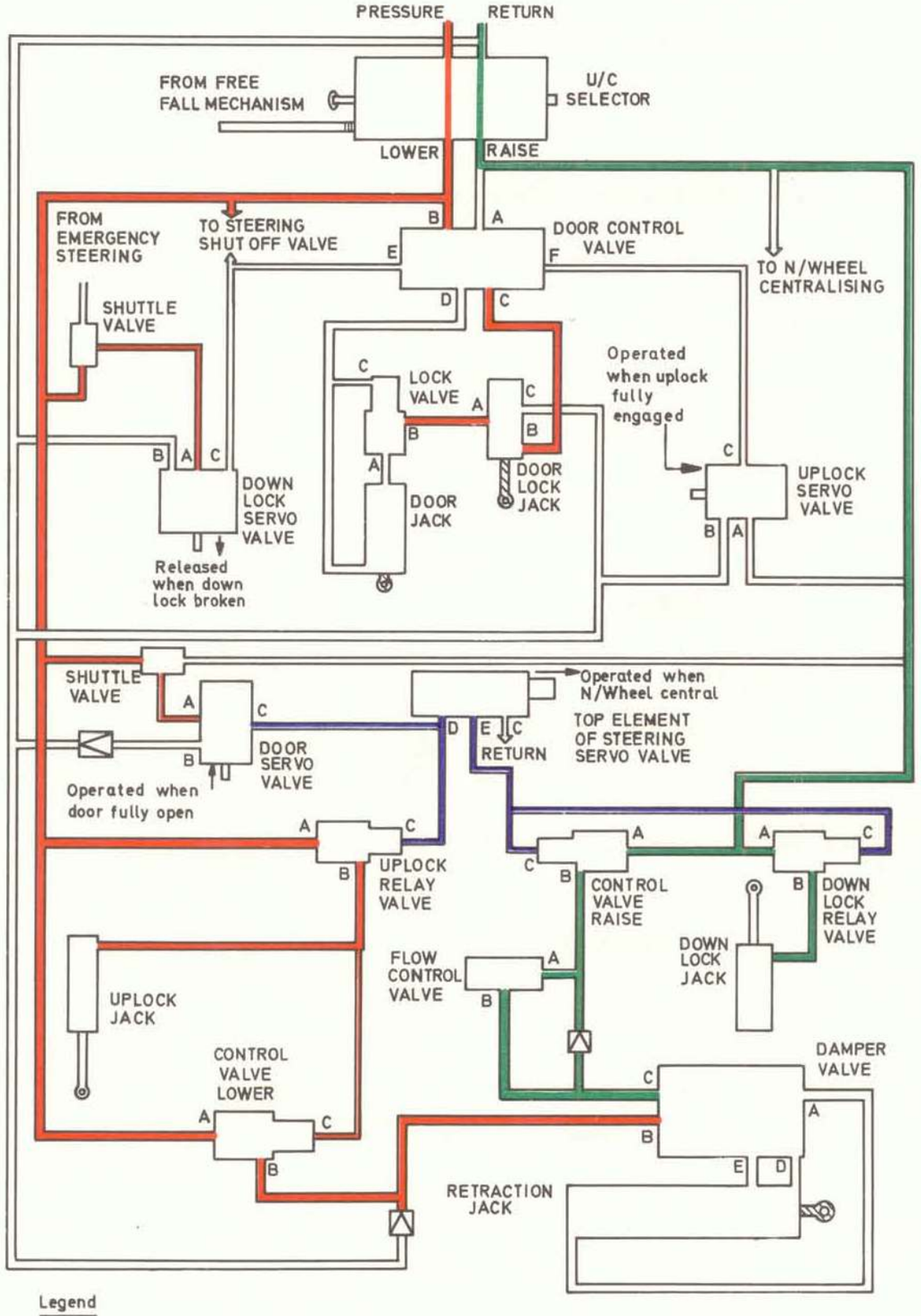
Illustration Up-dated



VC10/153B

2.18 Fig. 19. Nose Undercarriage Extension (1)

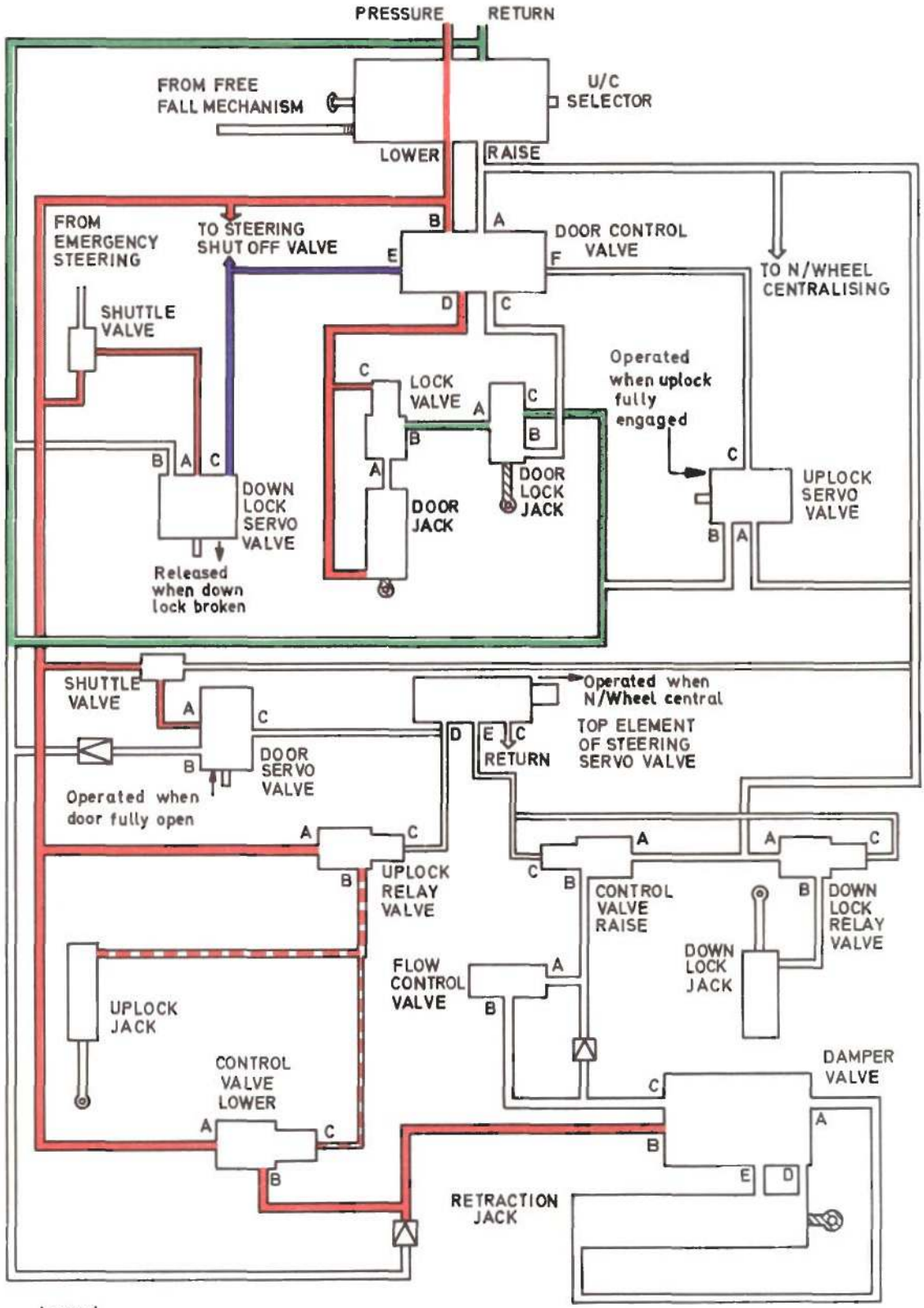
Illustration Up-dated



VC10/154B

2.18 Fig. 20. Nose Undercarriage Extension (2)

Illustration Up-dated



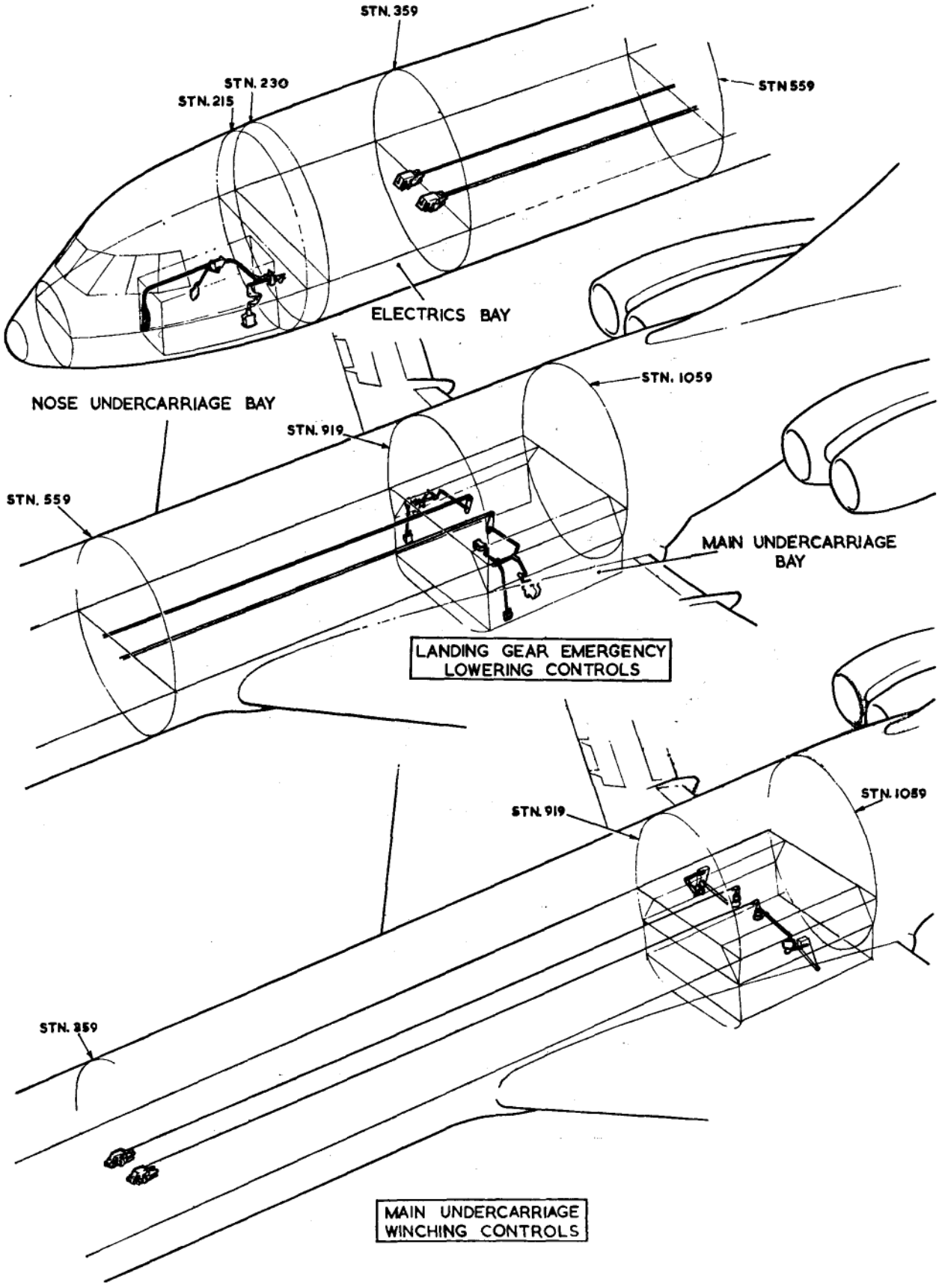
Legend

Red	= Pressure	Blue	= Servo pressure
Green	= Return flow	White	= Open to return
Red/white	= Trapped fluid		

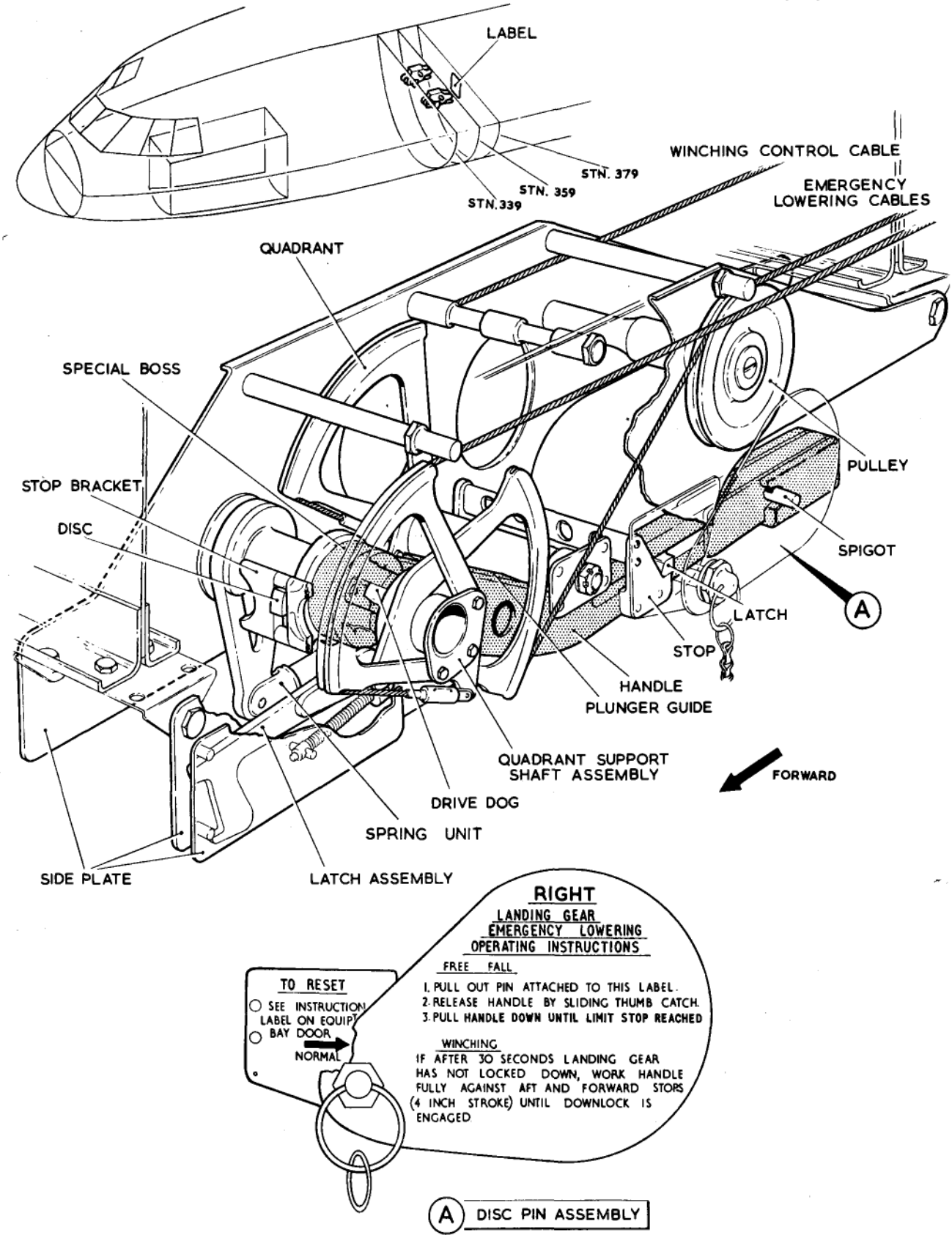
VC10/155B

2.18 Fig. 21. Nose Undercarriage Extension (3)

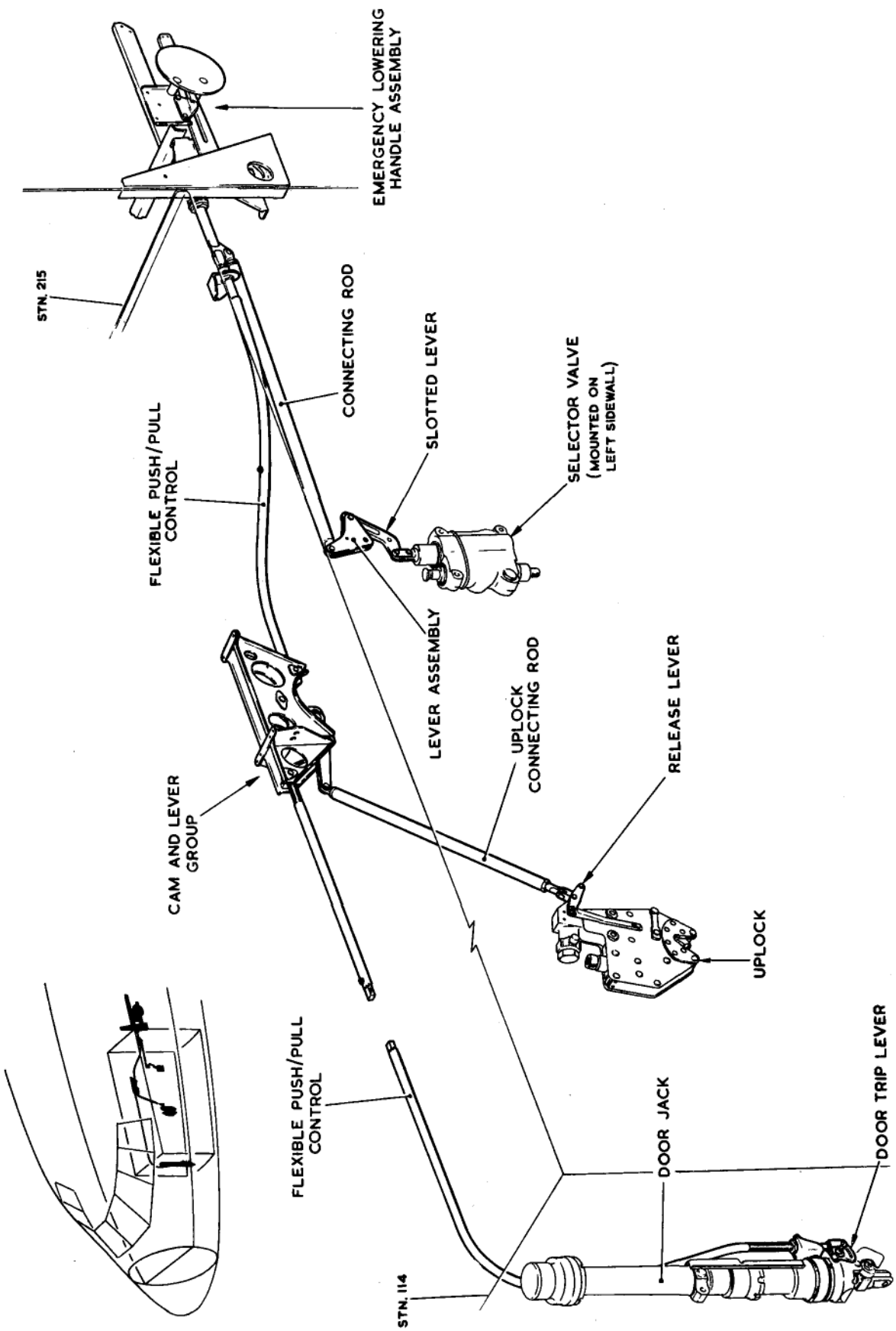
◀ *Illustration Up-dated* ▶



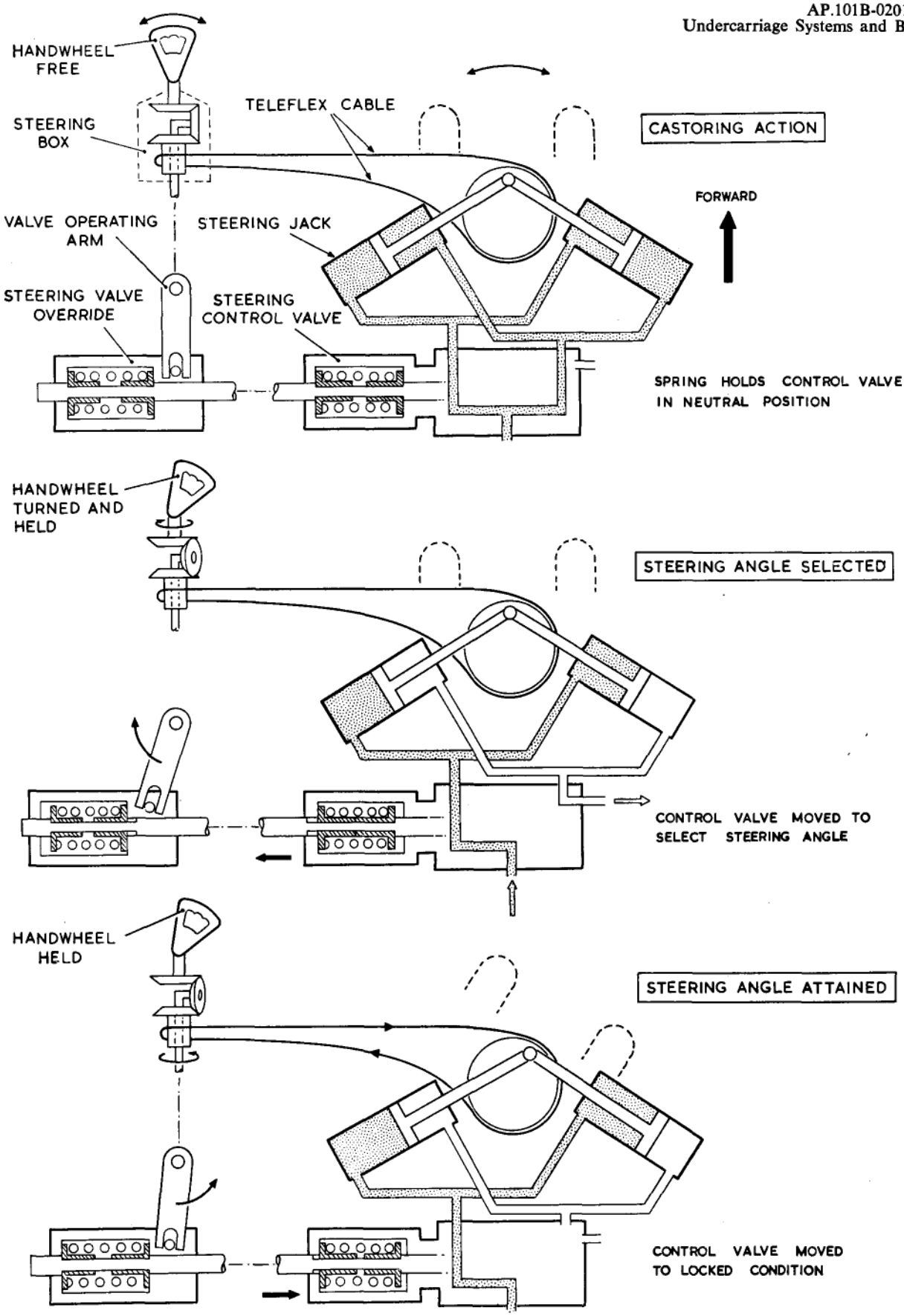
2.18 Fig. 22. Emergency Lowering Controls



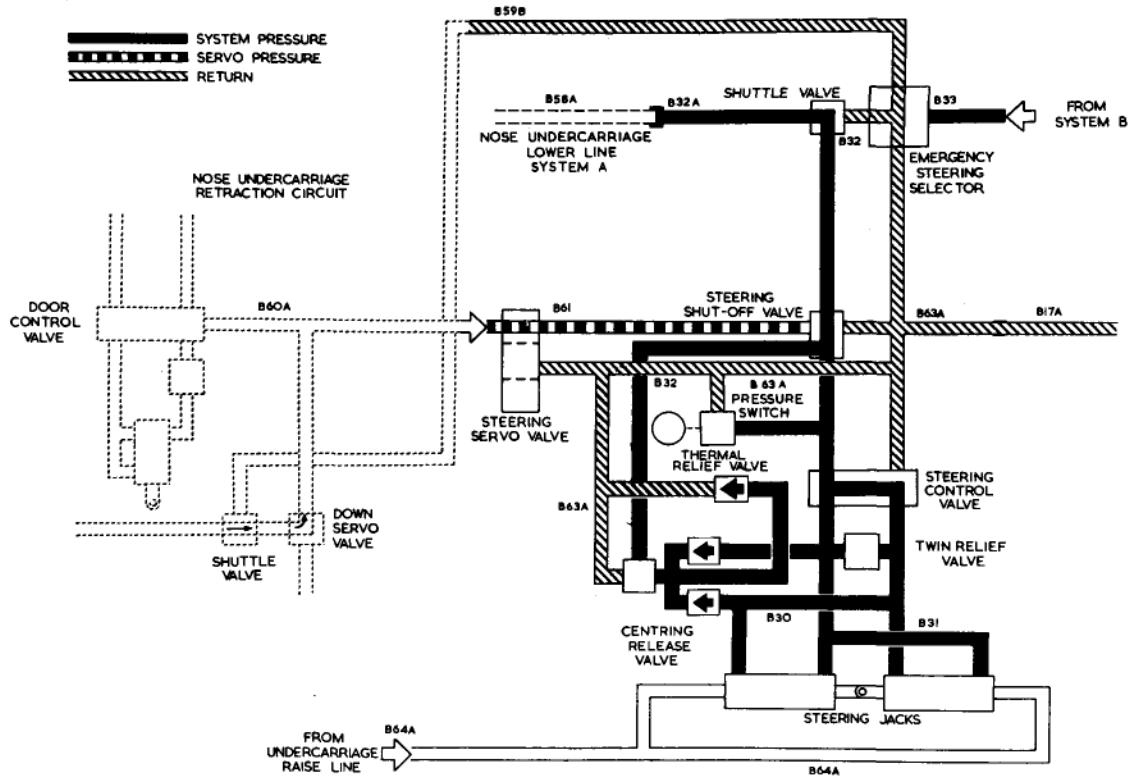
2.18 Fig. 23. Main Undercarriage Emergency Lowering Control



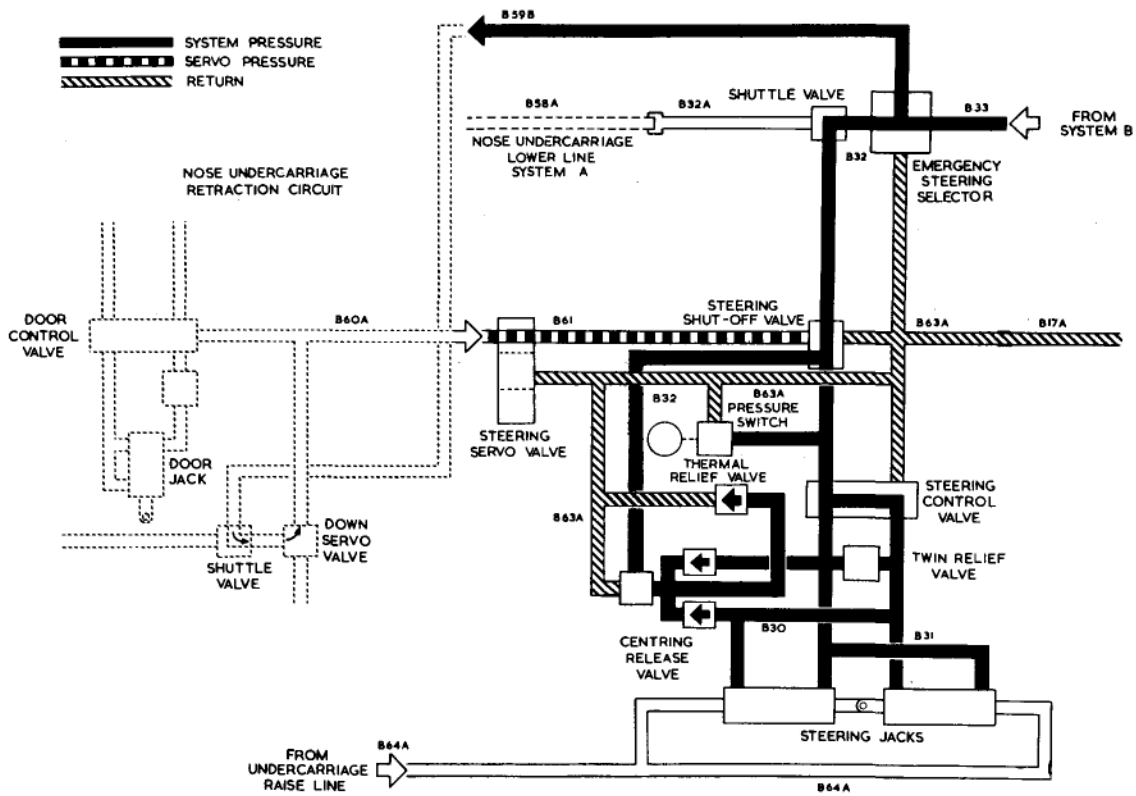
2.18 Fig. 24. Nose Undercarriage Emergency Lowering Control



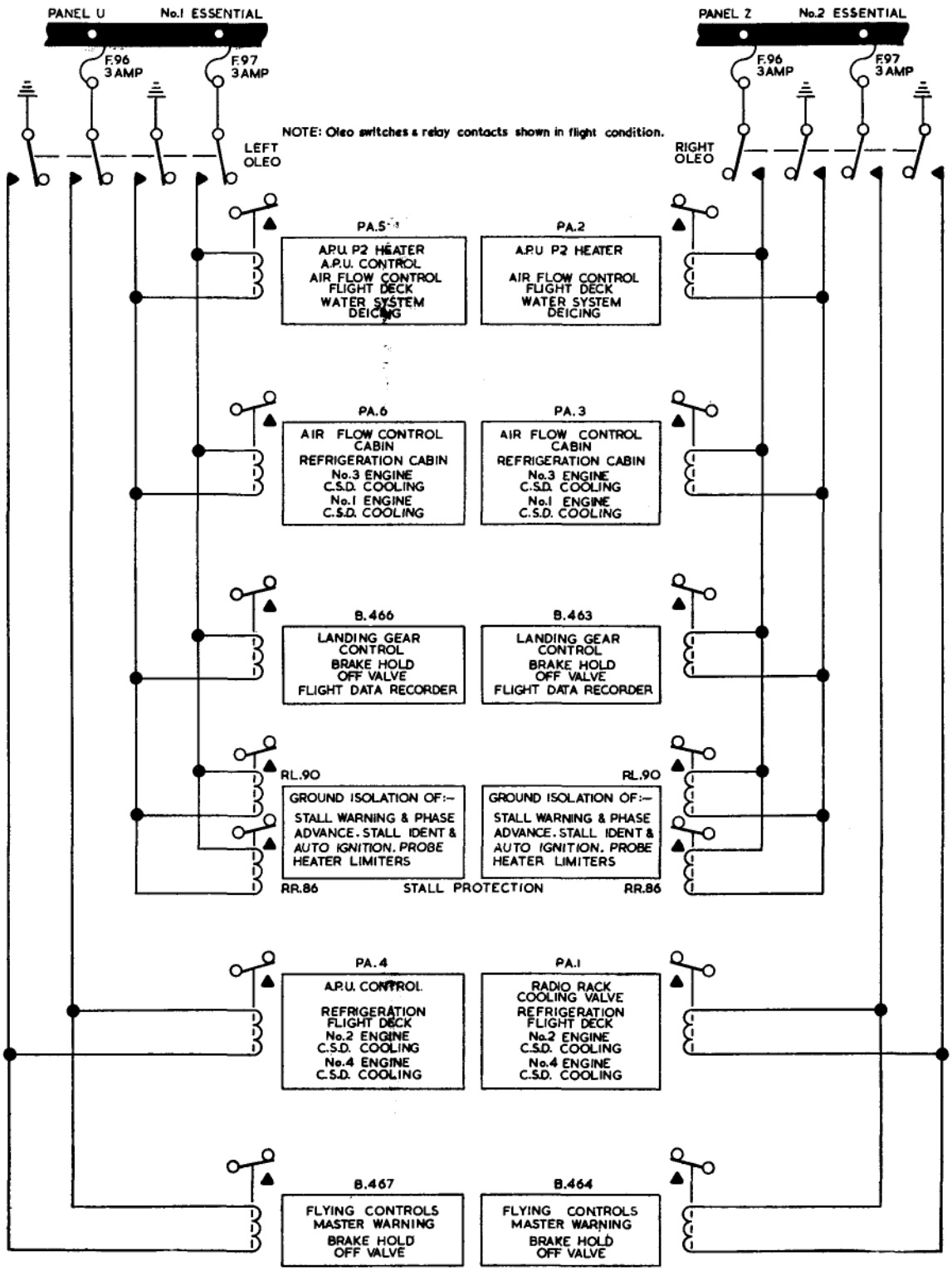
2.18 Fig. 25. Nosewheel Steering System



2.18 Fig. 26. Nosewheel Steering System A — Normal Operation

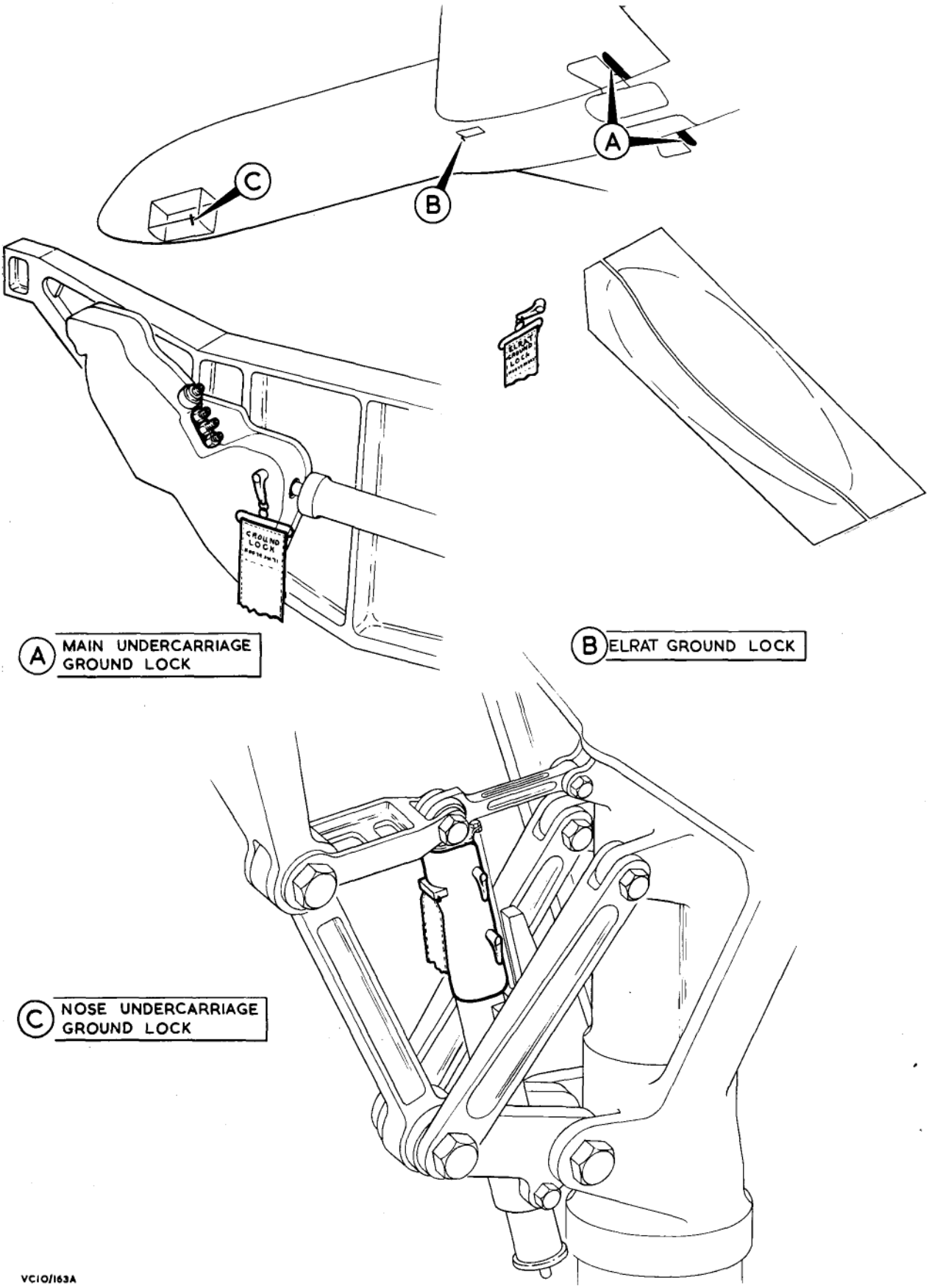


2.18 Fig. 27. Nosewheel Steering System B — Emergency Operation



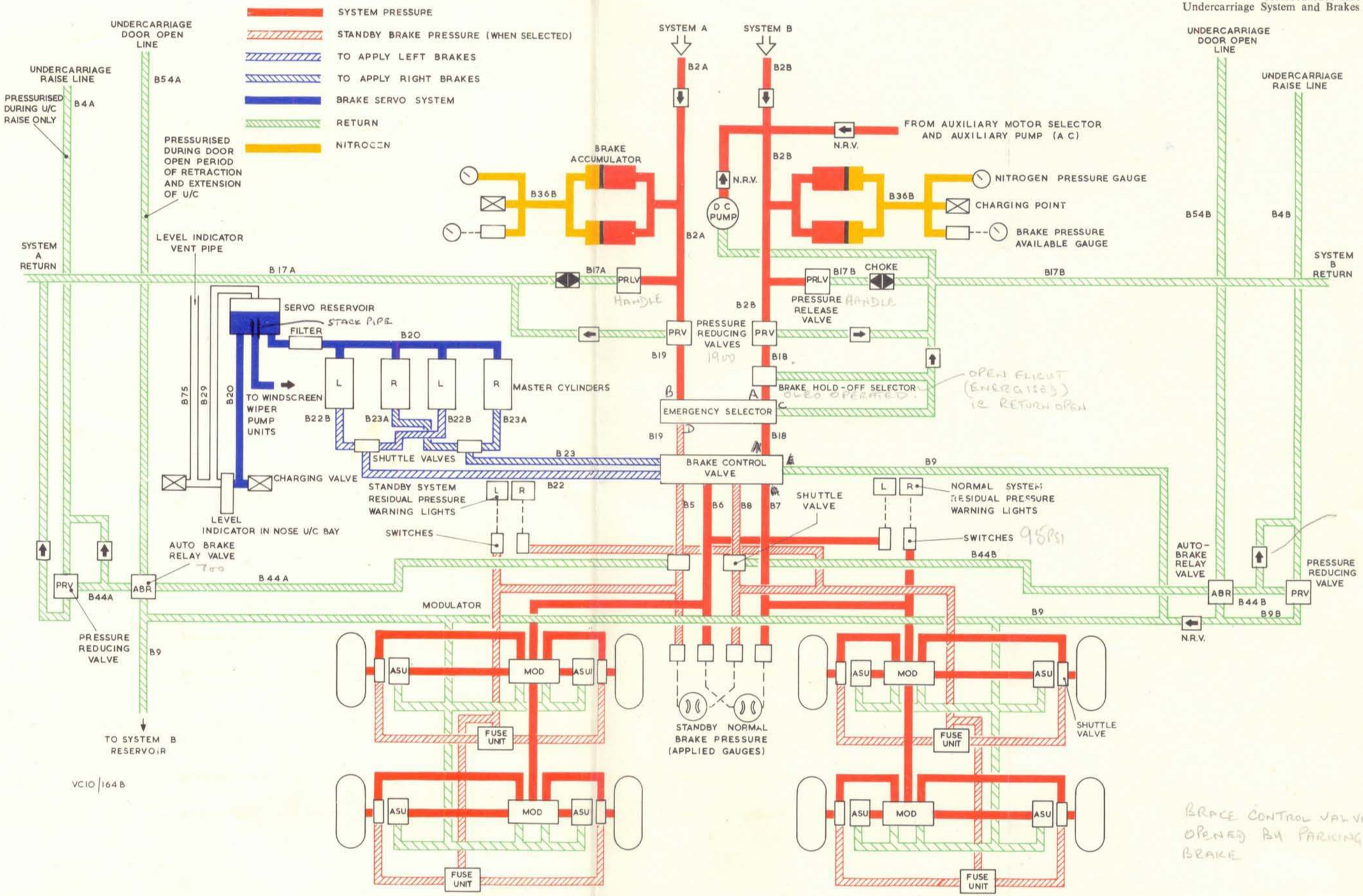
VC10/162A

2.18 Fig. 28. Oleo-controlled Services



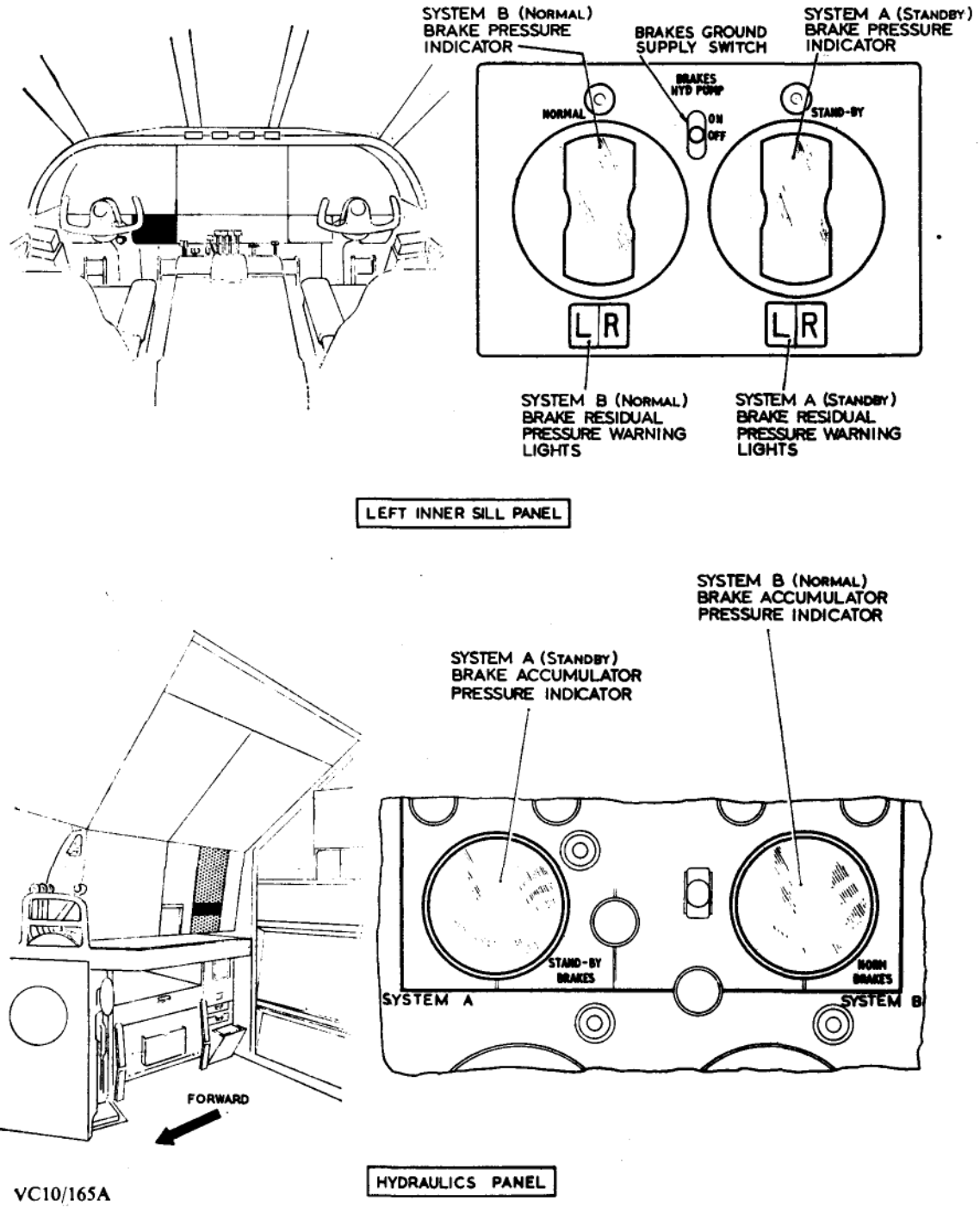
2.18 Fig. 29. Ground Locks

Minor Amendments



2.18 Fig. 30 Wheelbrakes Hydraulic System

◀Brake System Lines Re-routed▶



VC10/165A

2.18 Fig. 31 Wheelbrakes Hydraulic Supplies and Indicators