

**BRAKE SYSTEM • Description**

The brake system fitted to Range Rovers is of the I.H. split type.

Early 1987 Range Rover vehicles were fitted during manufacture with an Automotive Products (AP) master cylinder and servo assembly, together with associated brake pipes and pedal box assembly. The brake failure warning system on the AP type master cylinder is a Pressure Differential Warning Actuator (P.D.W.A.) switch, which is activated when the shuttle valve moves along its bore due to pressure differential in either the primary or secondary circuits caused by fluid loss or seal failure. The result of the shuttle valve movement is to illuminate a brake failure warning light in the instrument binnacle.

Later 1987 models are fitted with an uprated Lucas Girling type LSC 115 servo and 25.4mm AS/AS master cylinder plus associated brake pipes and pedal box assembly.

The brake failure warning system on the Lucas Girling type is a Fluid Level Warning Indicator (F.L.W.I.) which is incorporated into the fluid reservoir cap and is activated when fluid loss in the reservoir is sufficient so that the float in the switch drops and in turn illuminates a brake failure warning light in the instrument binnacle.

**NOTE:** It should be noted that the two systems are not interchangeable on a component by component basis but must be changed as a complete package, ie, servo, master cylinder, brake pipes and pedal box.

The AP system can be found on pages :  
1-19 inclusive.

The Lucas Girling system can be found on pages :  
31-42 inclusive.

**BRAKE SYSTEM • (Vehicles fitted with AP servo and master cylinder)****Description**

The hydraulic braking system fitted to the Range Rover is of the dual line type, incorporating primary and secondary hydraulic circuits.

**NOTE:** References made to primary and secondary do not imply main service brakes or emergency brakes but denote hydraulic line identification.

The brake pedal is connected to a vacuum-assisted mechanical servo which in turn operates a tandem master cylinder. The front disc brake calipers each house four pistons, the upper pistons are fed by the primary hydraulic circuit, the lower pistons by the secondary hydraulic circuit. The rear disc brake calipers each house two pistons and these are fed by the secondary hydraulic circuit via a pressure

reducing valve.

A brake failure switch incorporated in the master cylinder will illuminate a panel warning light if a failure occurs in either the primary or secondary hydraulic circuits.

The brake fluid reservoir is divided, the front section (section closest to the servo) feeds the primary circuit and the rear section feeds the secondary circuit. Under normal operating conditions both the primary and secondary hydraulic circuits operate simultaneously on brake pedal application. In the event of a failure in the primary circuit the secondary circuit will still function and operate front and rear calipers.

Alternatively, if the secondary circuit fails, the primary circuit will still function and operate the upper pistons in the front calipers.

If the servo should fail, both hydraulic circuits will still function but would require greater pedal pressure.

The hand-operated parking brake is completely independent of the hydraulic circuits.

Brake pad wear sensors are incorporated into the front right and rear left hand side, inboard brake pads. The sensors will illuminate a brake pad wear warning light in the instrument binnacle, when pad thickness has been reduced to approximately 3mm (0.118 in).

**CAUTION: THOROUGHLY CLEAN ALL BRAKE CALIPERS, PIPES AND FITTINGS BEFORE COMMENCING WORK ON ANY PART OF THE BRAKE SYSTEM. FAILURE TO DO SO COULD CAUSE FOREIGN MATTER TO ENTER THE SYSTEM AND CAUSE DAMAGE TO SEALS, AND PISTONS WHICH WILL SERIOUSLY IMPAIR THE BRAKE SYSTEM EFFICIENCY.**

To ensure the brake system efficiency is not impaired the following warnings must be adhered to:-

**WARNING:**

**DO NOT** use brake fluid previously bled from the system.

**DO NOT** use old or stored brake fluid.

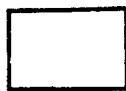
**ENSURE** that only new fluid is used and that it is taken from a sealed container:

**DO NOT** flush the brake system with any fluid other than the recommended brake fluid. (See Lubricants, Fluids and Capacities Section 09).

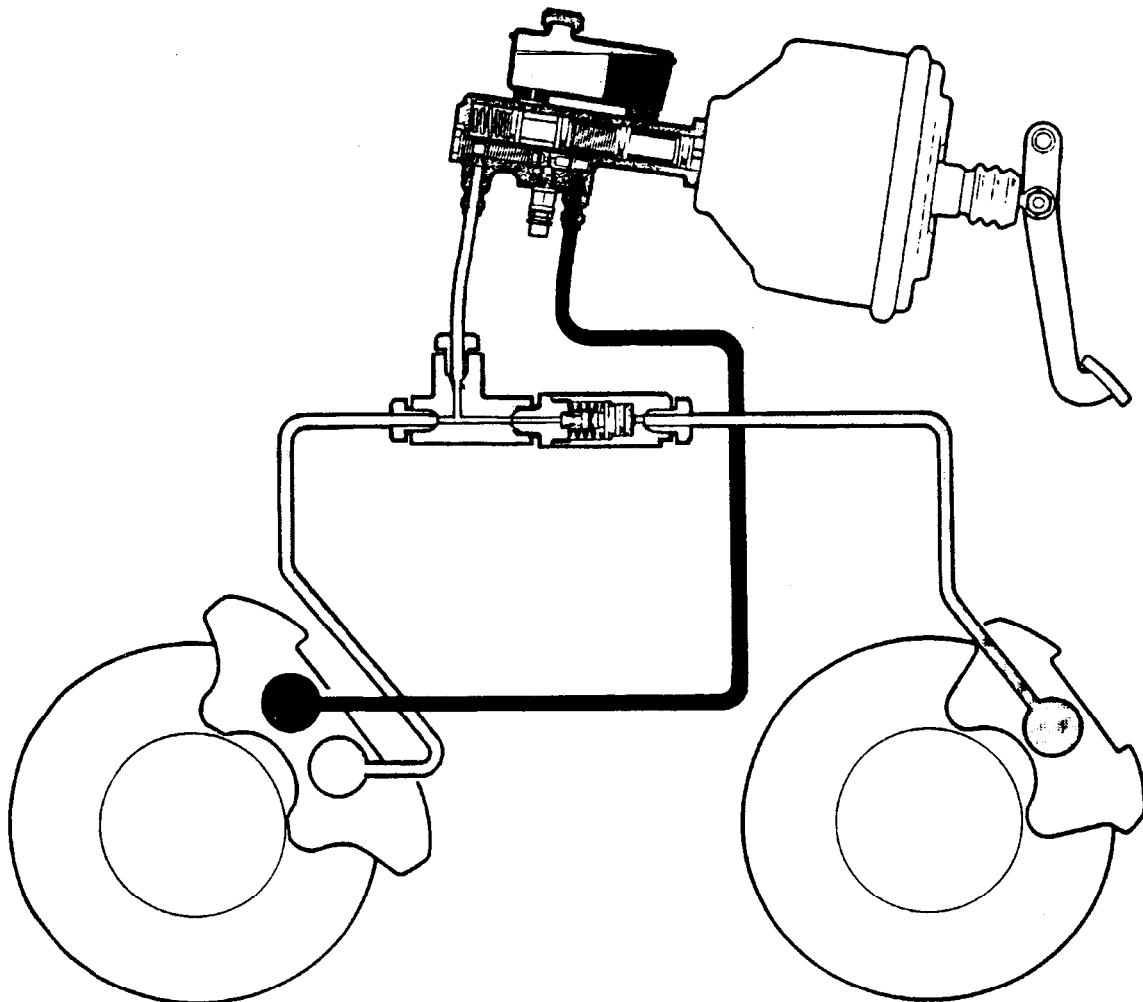
The brake system should be drained and flushed at the recommended service intervals. (See Maintenance Section 10).



PRIMARY HYDRAULIC CIRCUIT



SECONDARY HYDRAULIC CIRCUIT



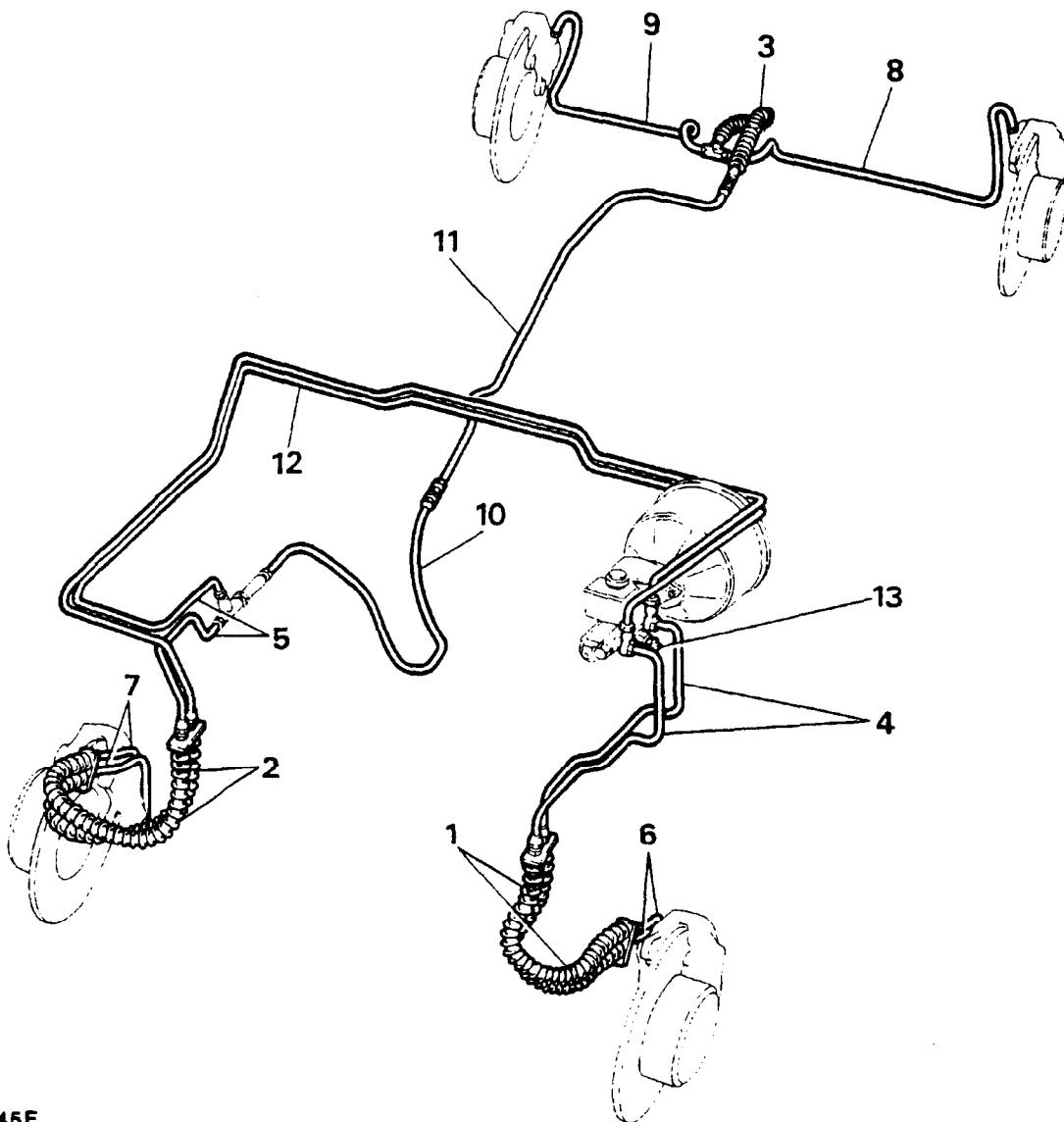
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**WARNING:** Some components on the vehicle, such as gaskets and friction surfaces (brake linings, clutch discs or automatic transmission brake bands), may contain asbestos. Inhaling asbestos dust is dangerous to your health and the following essential precautions must be observed:-

- Work out of doors or in a well ventilated area and wear a protective mask.

- Dust found on the vehicle or produced during work on the vehicle should be removed by vacuuming and not by blowing.
- Dust waste should be dampened, placed in a sealed container and marked to ensure safe disposal.
- If any cutting, drilling etc., is attempted on materials containing asbestos the item should be dampened and only hands tools or low speed power tools used.

## BRAKE SYSTEM LAYOUT



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## HOSES

1. Front left hand flexible hoses.
2. Front right hand flexible hoses.
3. Intermediate flexible hose.

## PIPES

4. Feed to front left hand hose connector.
5. Feed to front right hand hose connector.
6. Feed to front left hand caliper.

7. Feed to front right hand caliper.
8. Feed to rear left hand caliper.
9. Feed to rear right hand caliper.
10. Feed to two way connector.
11. Feed to intermediate hose.
12. Feed to pressure reducing valve.
13. Brake failure warning switch.

**BRAKES****Bleed**

The hydraulic system comprises two completely independent sections. The rear calipers and the lower pistons in the front calipers form the secondary section, while the upper pistons in the front calipers form the primary section. The following procedure covers bleeding the complete system, but it is permissible to bleed one section only if disconnections are limited to that section.

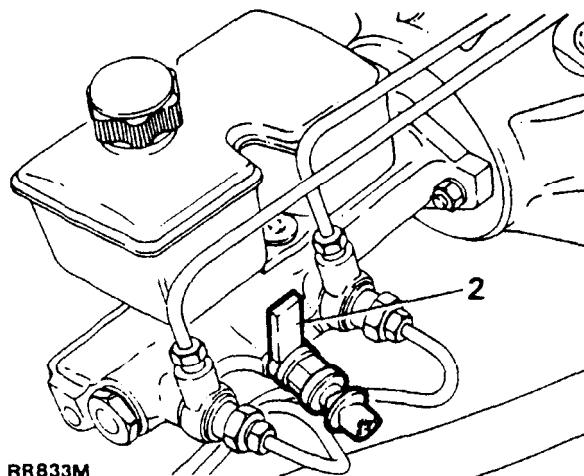
Bleeding will be assisted if the engine is run or a vacuum supply is connected to the servo.

**WARNING: IF THE ENGINE IS RUNNING DURING THE BRAKE BLEEDING PROCESS ENSURE THAT NEUTRAL GEAR IS SELECTED AND THAT THE PARKING BRAKE IS APPLIED.**

When bleeding any part of the secondary section, almost full brake pedal travel is available. When bleeding the primary section only, brake pedal travel will be restricted to approximately half.

**WARNING: Before commencing to bleed the system it is necessary to loosen off the brake failure warning switch to prevent the shuttle valve damaging the switch unit.**

1. Disconnect the leads from the switch.
2. Unscrew the switch and insert the 'C' washer between the switch and master cylinder before depressing the brake pedal.
3. After completion of bleeding, remove the 'C' washer and screw in the switch and tighten to the correct torque (see section 06-Torque values).



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**NOTE:** When bleeding the system commence with the caliper furthest from the master cylinder and bleed from the screw on the same side as the fluid inlet pipes, then close the screw and bleed from the screw on the opposite side of the same caliper. Tighten the bleed screws to the correct torque. (see section 06-Torque values).

**Bleeding**

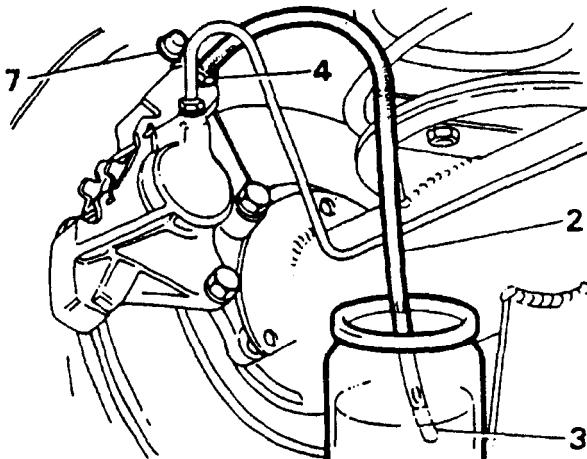
1. Fill the fluid reservoir with the correct fluid, see 'Data Section'.

**NOTE: The correct fluid level must be maintained throughout the procedure of bleeding**

2. Connect a bleed hose to the bleed screw on the rear caliper furthest from the master cylinder.
3. Submerge the free end of the bleed hose in a container of clean brake fluid.
4. Loosen the bleed screw.
5. Operate the brake pedal fully and allow to return.

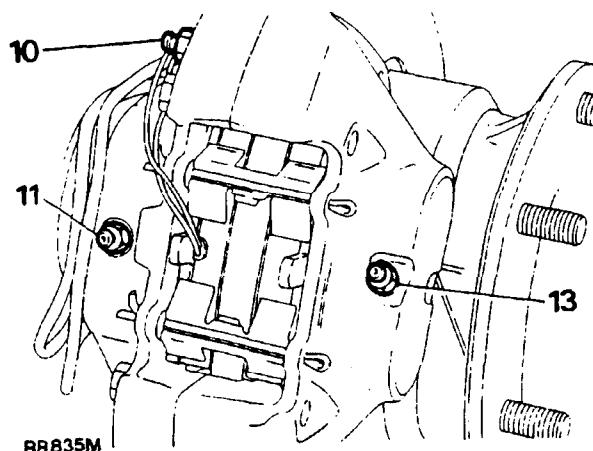
**NOTE: Allow at least five seconds to elapse with the foot right off the pedal to ensure that the pistons fully return before operating the pedal again.**

6. Repeat 5 until fluid clear of air bubbles appears in the container, then keeping the pedal fully depressed, tighten the bleed screw.
7. Remove the bleed hose and replace the dust cap on the bleed screw.



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8. Repeat 1 to 7 for the other rear caliper.
9. Remove the front wheel on the side furthest from the master cylinder.
10. Connect a bleed hose to the primary bleed screw on the front caliper furthest from the master cylinder.
11. Connect a bleed hose to the secondary bleed screw on the same side of the caliper as the primary screw.
12. Repeat 3 to 7 for the front caliper, bleeding from the two screws simultaneously.



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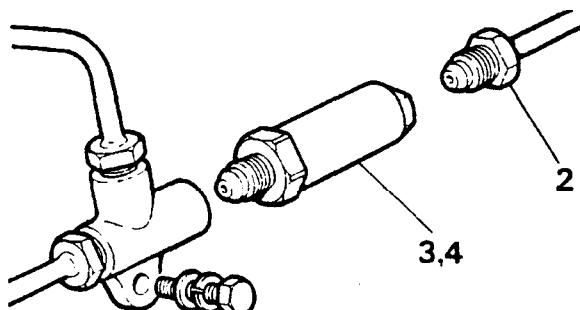
13. Connect a bleed hose to the other screw on the front caliper furthest from the master cylinder.
14. Repeat 3 to 7 for the second secondary screw on the front caliper.
15. Refit the front wheel.
16. Repeat 9 to 15 for the front caliper nearest the master cylinder.
17. Remove the 'C' washer and tighten the PDWA switch to the correct torque. (see section 06-Torque values).

#### BRAKE PRESSURE REDUCING VALVE

##### Remove and refit

##### Removing

1. Remove all dust, grime, etc., from the vicinity of the pressure reducing valve fluid pipe unions.
2. Disconnect the outlet fluid pipe from the pressure reducing valve. Plug the pipe and reducing valve port to prevent the ingress of foreign matter.
3. Remove the valve from the three-way connector and plug both openings.
4. Withdraw the pressure reducing valve from the engine compartment.



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##### Refitting

5. Reverse the removal instructions.
6. Bleed the brake systems.

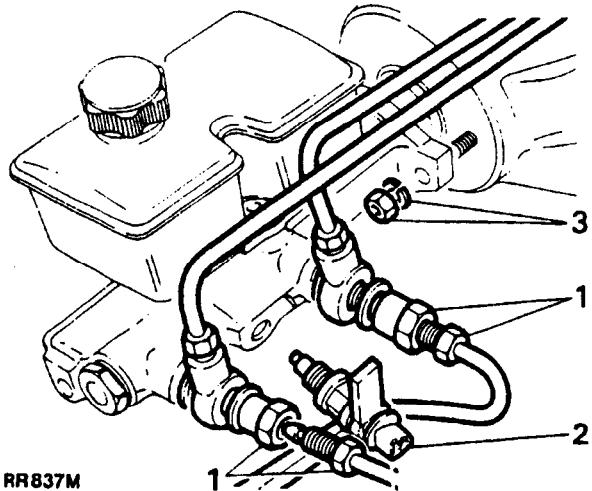
**NOTE:** The pressure reducing valve is not a serviceable item, in the event of failure or damage, a new unit must be fitted.

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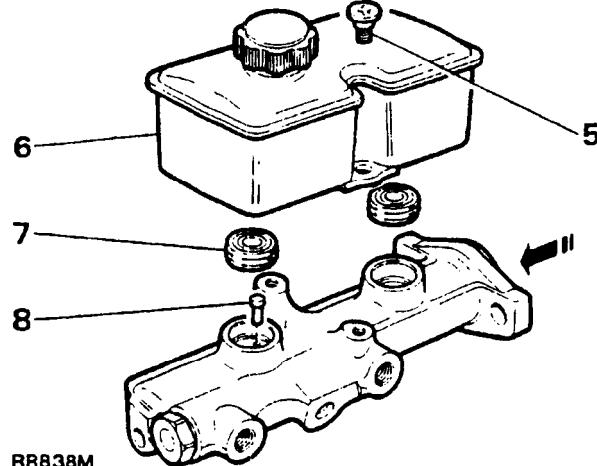
## MASTER CYLINDER-OVERHAUL

**CAUTION:** Brake fluid is corrosive, if any fluid comes into contact with body paintwork, immediately flush with a large quantity of water and wipe clean with a soft cloth.

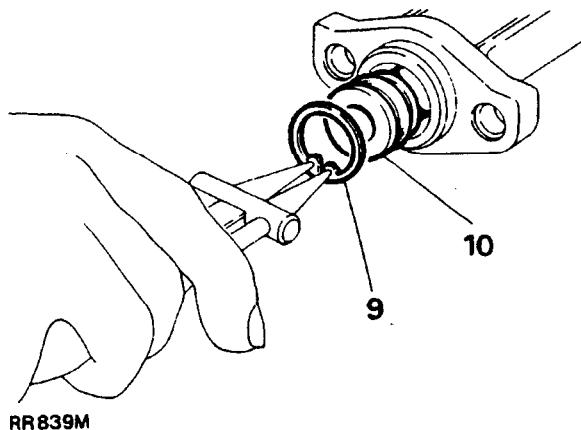
1. Disconnect the brake pipes from the side of the master cylinder and plug the outlet ports.
2. Disconnect the electrical plug from the PDWA switch.
3. Remove the two nuts and spring washers securing the cylinder to the servo unit.



4. Remove the reservoir filler cap and drain off the surplus fluid.
5. Remove the two screws securing the reservoir to the master cylinder.
6. Lift the reservoir off the master cylinder.
7. Carefully pry the two reservoir sealing rubbers from the master cylinder.
8. Secure the master cylinder in a vice and push the primary piston down the bore and withdraw the secondary piston stop pin.



9. Press down the primary piston and remove the circlip.
10. Withdraw the primary piston assembly.

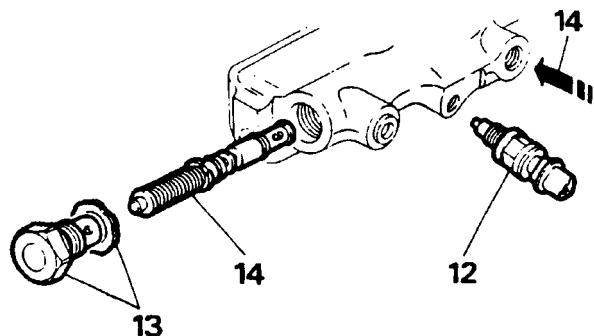


11. Apply a high pressure air line to the secondary outlet port to expel the secondary piston assembly.

**WARNING:** Safety glasses must be worn. Do not operate or direct the air line towards oneself or other personnel in the workshop. Apply a short burst of air only, if the secondary piston is not expelled from its bore repeat the above instruction.

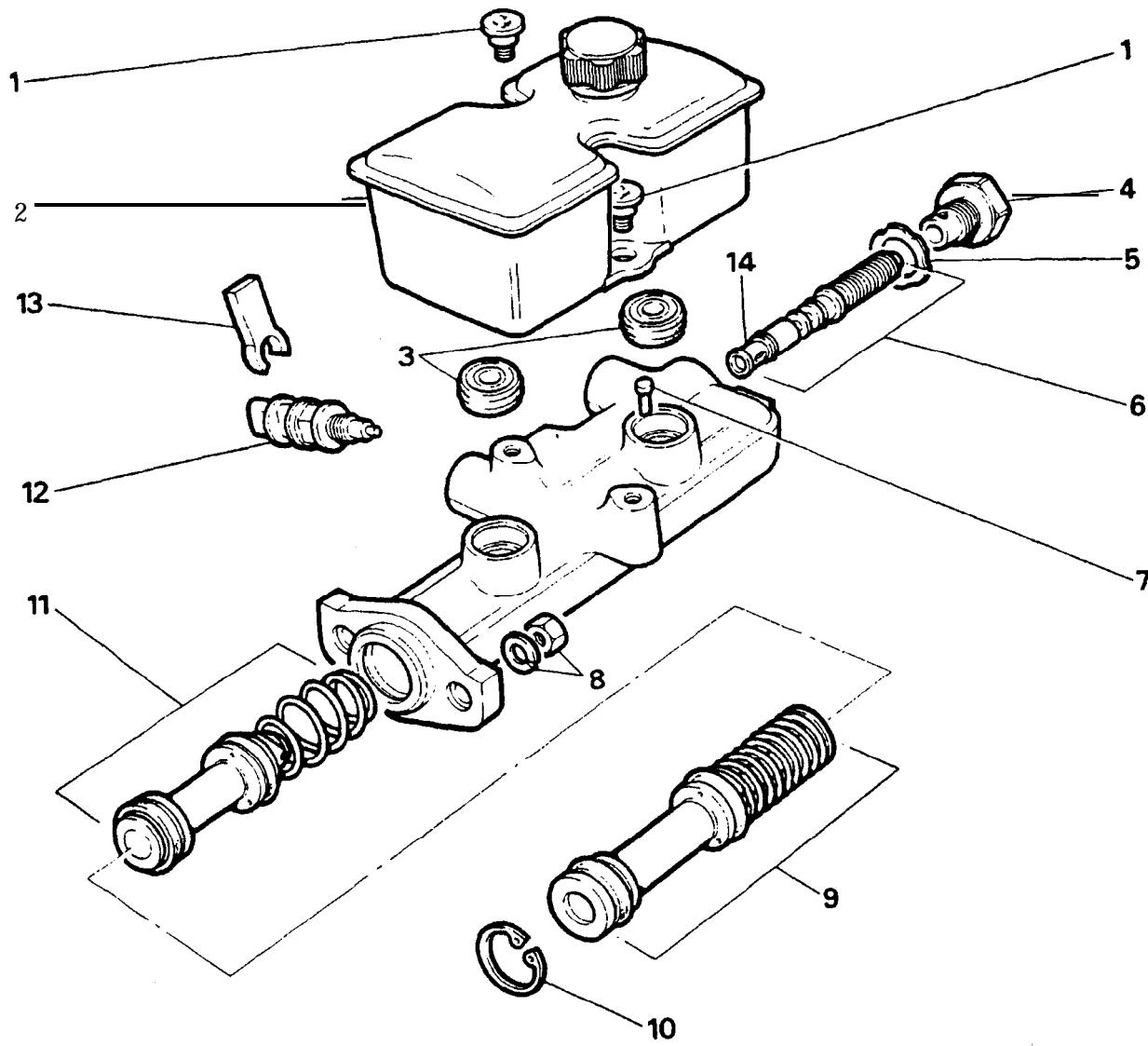
12. Remove the PDWA switch from the side of the master cylinder.
13. Remove the large end plug and copper washer retaining the shuttle valve in the master cylinder.
14. Apply a high pressure air line to the primary outlet port to expel the shuttle valve from its bore.

**WARNING:** Safety glasses must be worn. Do not operate or direct the air line towards oneself or other personnel in the workshop. Apply a short burst of air only, if the shuttle valve is not expelled from its bore repeat the above instruction.



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## KEY TO MASTER CYLINDER

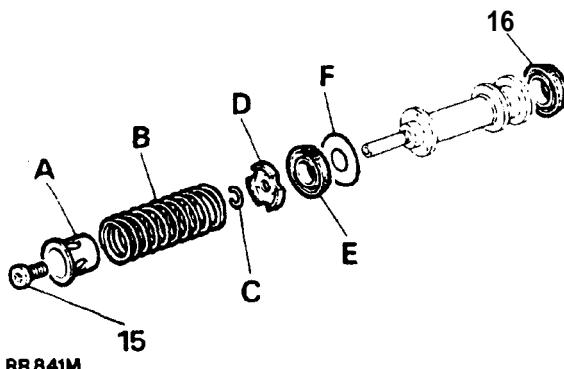
1. Securing screws
2. Reservoir
3. Reservoir seals
4. End plug
5. Copper washer
6. Shuttle valve
7. Secondary piston stop pin
8. Nuts and washers securing cylinder to servo
9. Primary piston
10. Circlip
11. Secondary piston
12. PDWA switch
13. 'C' washer
14. Plastic sleeve

## PRIMARY PISTON SEALS

15. Remove the retaining screw from the primary piston and remove the following items.

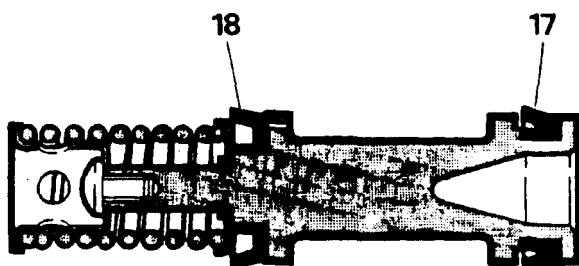
- (A) Spring retainer
- (B) Piston spring
- (C) Circlip
- (D) Seal retainer
- (E) Recuperating seal
- (F) Washer

16. Taking care not to damage the piston, pry off the outer seal.



17. Fit a new outer seal into its groove by squeezing the seal between the finger and thumb into an oval shape and press the raised part of the seal over the flange using the fingers of the other hand.

18. Fit a new recuperating seal and assemble the parts in reverse order of removal. Compress the spring and secure the assembly with the retaining screw. Tighten the screw securely.

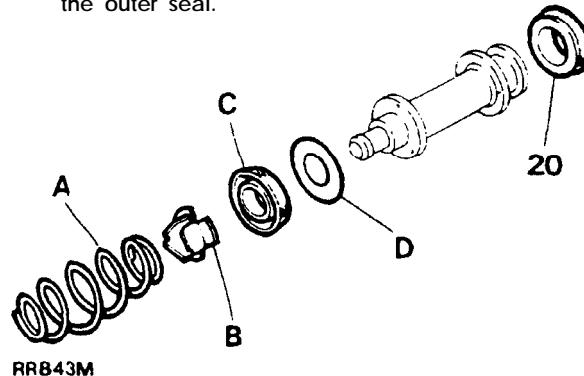


## SECONDARY PISTON SEALS

19. Remove the following items from the secondary piston:

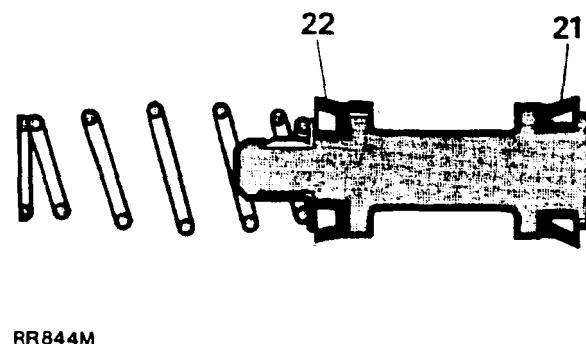
- (A) Spring
- (B) Seal retainer
- (C) Recuperating seal
- (D) Washer

20. Taking care not to damage the piston, pry off the outer seal.



21. Fit a new outer seal using the same procedure as for the primary piston outer seal by squeezing the seal between the finger and thumb into an oval shape and press the raised part of the seal over the flange using the fingers of the other hand.

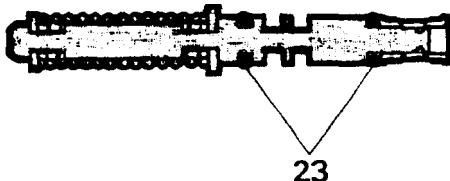
22. Fit the recuperating seal assembly parts in the reverse order of removal.



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## SHUTTLE VALVE 'O' RINGS

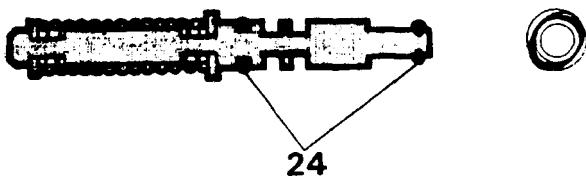
23. Withdraw the plastic sleeve and carefully remove the two 'O' rings from the valve taking care not to damage the piston.



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24. Fit a new 'O' ring into the 'O' ring groove at the centre of the valve. Fit the remaining 'O' ring into the small groove at the end of the valve. Do not fit the plastic sleeve at this stage.

**NOTE:** The 'O' rings should not be rolled along the piston, but should be stretched slightly and eased down the piston and into the grooves.

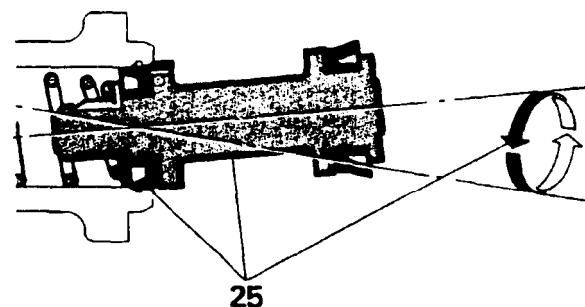


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## ASSEMBLING MASTER CYLINDER

It is important that the following instructions are carried out precisely, otherwise damage could be caused to the new seals when inserting the plungers into the cylinder bore. Generous amounts of new brake fluid should be used to lubricate the parts during assembly. Never use old fluid or any other form of cleaning and lubricating material. Cleanliness throughout is essential.

25. Clamp the cylinder in a vice and lubricate the secondary piston seals and cylinder bore. Place the piston assembly into the cylinder until the recuperation seal is resting centrally in the mouth of the bore. Gently insert the piston with a circular rocking motion, as illustrated. While ensuring that the seal does not become trapped, ease the seal into the bore and slowly push the piston down in one continuous movement.



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26. Slowly press the piston down the bore and fit the secondary piston stop-pin.  
 27. Fit the primary plunger assembly using the same method as for the secondary plunger. Press the plunger down and secure the assembly with the circlip.

**NOTE:** Insert the plastic sleeve into the shuttle valve bore, ensuring it seats at the bottom of the bore.

28. Lubricate the 'O' rings and fit the shuttle valve. Fit the end plug using a new copper sealing washer and tighten the plug securely.

**CAUTION: To prevent damage to the 'O' ring at the end of the valve ensure it remains in the small groove until the valve reaches the small plastic sleeve.**

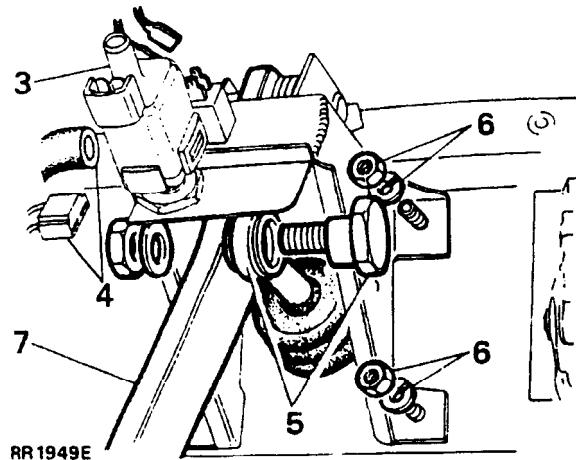
29. Fit the plastic 'C' washer to the end of the PDWA switch and screw the switch into the master cylinder.  
 30. Fit new seals to the bottom of the reservoir.  
 31. Press the reservoir into the top of the master cylinder and secure in position with the two retaining screws.  
 32. Fit the master cylinder to the servo and secure with the two nuts and spring washers and tighten to the correct torque (see section 06-Torque values).  
 33. Bleed the brakes. After final bleed remove the 'C' washer from the PDWA switch and tighten the switch to the correct torque (see section 06-Torque values).

#### PEDAL ASSEMBLY-OVERHAUL

##### Remove the pedal assembly

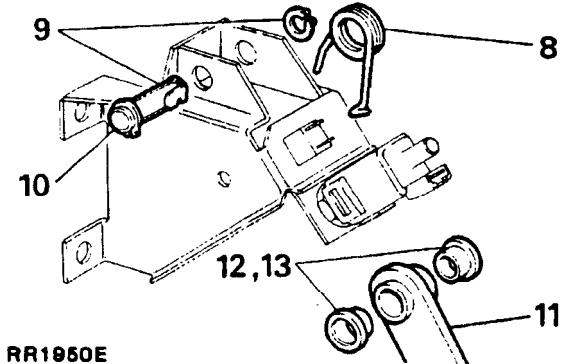
- 1 Disconnect the battery negative lead.
- 2 Remove the lower dash panel fixings, lower the panel to gain access to the electrical connections at the rheostat switch and bulb check unit. Disconnect the leads and remove the lower dash from the vehicle, detach the trim pad from around the pedal assembly.
- 3 Disconnect the electrical leads from the stop light switch.
- 4 Remove the vacuum hose and disconnect the electrical plug to the cruise control brake vent switch.

- 5 Disconnect the servo operating rod from the brake pedal.
- 6 Remove the four nuts and spring washers securing the brake pedal and servo assemblies to the engine compartment closure panel.
- 7 Withdraw the pedal assembly from the vehicle.



##### DISMANTLING

- 8 Disconnect the pedal return spring.
- 9 Remove the circlip from the 'D' shaped end of the pedal shaft.
- 10 Withdraw the pedal shaft.
- 11 Withdraw the pedal from the box.



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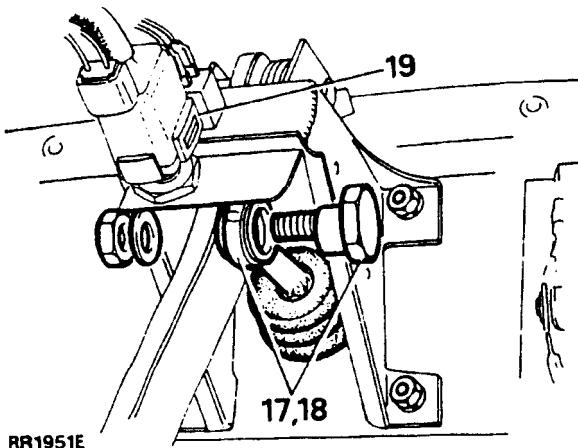
12. Remove the bushes from the pedal pivot tube.

#### Assembling

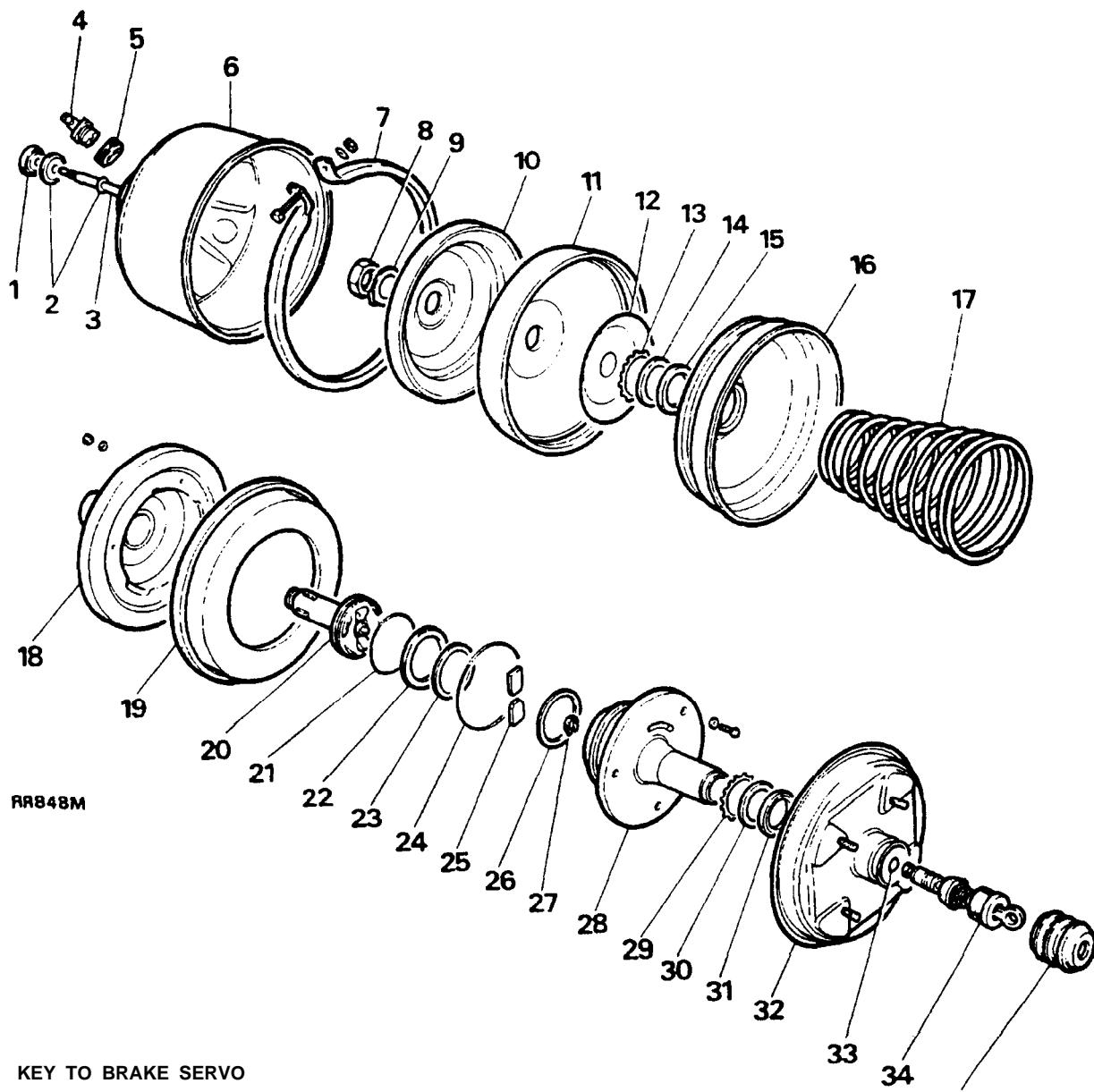
13. Press the new bushes into the pedal pivot hose. If necessary, ream the bushes to 15.87mm plus 0.05mm (.625 in plus .002 in).
14. Lightly oil the bushes and pedal shaft.

#### Refit the pedal assembly

15. Refit the assembly to the engine compartment closure panel, tighten the four nuts securely.
16. Connect the electrical leads to the stop light switch.
17. Connect the servo operating rod to the brake pedal with the pivot bolt eccentric, in the forward position. Do not fully tighten the pivot bolt nut.
18. Turn the pivot bolt to bring the brake pedal back until it just contacts the rubber buffer, then secure the pivot bolt nut.



19. Check the cruise control brake switch vent valve setting (see 'Setting Procedure' in Section 19 Cruise Control)
20. Clip the lower trim pad into position and refit the lower dash.
21. Re-connect the battery.



## KEY TO BRAKE SERVO

1. Push rod seal
2. Retainer
3. Push rod
4. Non-return valve
5. Seal
6. Servo shell
7. Clamp ring
8. Locknut
9. Lock washer
10. Support plate
11. Diaphragm
12. Backing washer
13. Bearing retainer
14. Nylon bearing
15. Seal
16. Separator shell
17. Spring
18. Diaphragm support and tube
19. Diaphragm
20. Reaction piston
21. Rubber 'O' ring
22. Sponge seal
23. Backing ring
24. Rubber 'O' ring
25. Levers
26. Bearing ring
27. Circlip
28. Valve body
29. Bearing retainer
30. Nylon bearing
31. Seal
32. Servo cover
33. Rubber 'O' ring
34. Valve/push rod assembly
35. Rubber boot

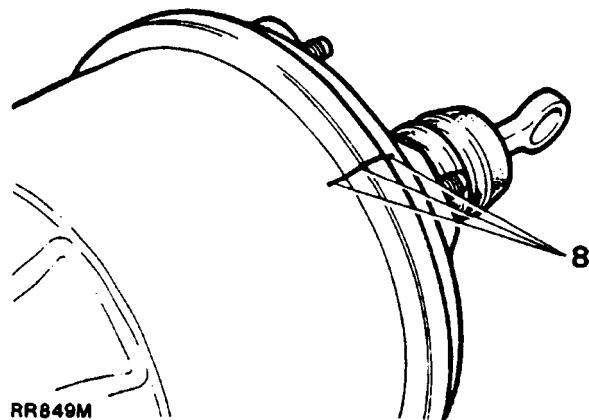
**BRAKE SERVO-Overhaul****REMOVING THE SERVO**

1. Remove the master cylinder from the servo.
2. Disconnect the servo vacuum hose from the non-return valve.
3. Remove the lower dash within the vehicle to gain access to the brake pedal linkage and servo retaining nuts located on the rear of the engine compartment closure panel.
4. Disconnect the brake pedal linkage.
5. Remove the four nuts with spring washers securing the servo to the closure panel.
6. Remove the servo from the engine compartment and place on a suitable clean bench.
7. Thoroughly clean the exterior of the servo.

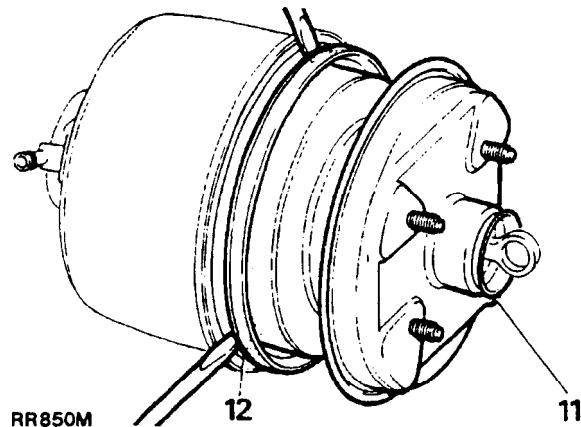
**CAUTION: CARE MUST BE TAKEN TO ENSURE THAT ALL COMPONENTS ARE SCRUPULOUSLY CLEAN BEFORE UNDERTAKING THE OVERHAUL PROCEDURE. ANY DIRT OR GRIT WITHIN THE SERVO COULD RESULT IN DAMAGE TO THE DIAPHRAGMS.**

**DISMANTLING THE SERVO**

8. Before dismantling the servo lightly scribe identification marks on the servo shell, clamp ring and cover plate to aid the assembly procedure.



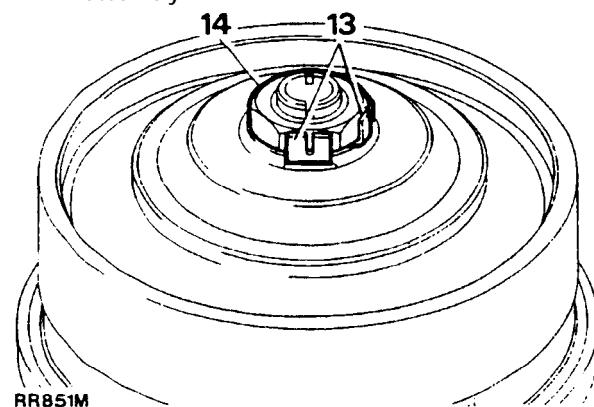
9. Remove the nut, bolt and plain washer securing the clamp to the servo.
10. Remove the rubber boot from the valve/push rod assembly.
11. Slide the servo cover off the valve body.
12. Using two screwdrivers inserted between the separator shell outer lip and servo shell, carefully lever the diaphragm assembly out of the shell.



13. Bend back the tabs of the locking washer.

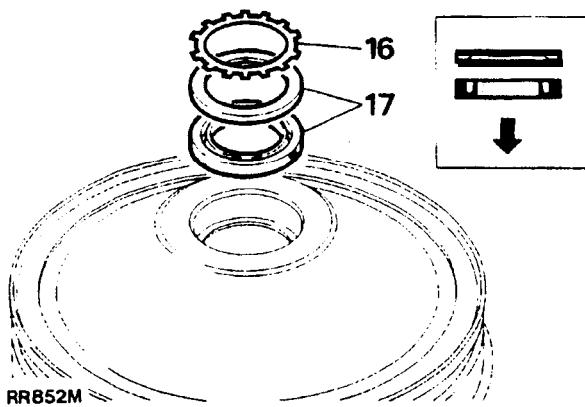
**WARNING:** Assistance may be required, to hold the diaphragm assembly together while the locknut is released, to prevent the unit separating due to internal spring pressure.

14. Remove the locknut and separate the assembly.

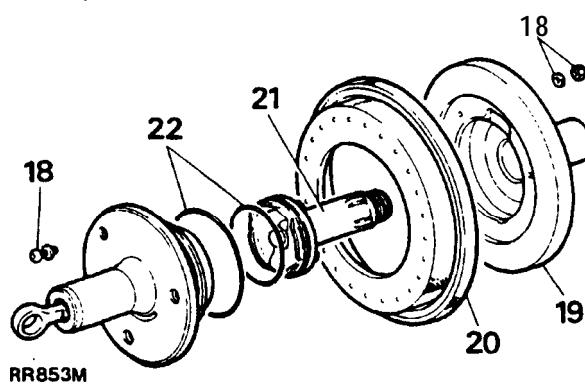


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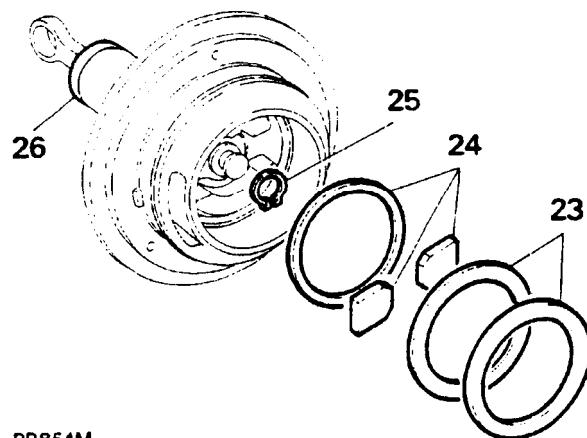
15. Remove the support plate, diaphragm and backing washer from the separator shell.
16. Pry the serrated bearing retainer out of the separator shell.
17. Remove the nylon bearing and rubber seal from the separator shell. Note their position for reassembly.



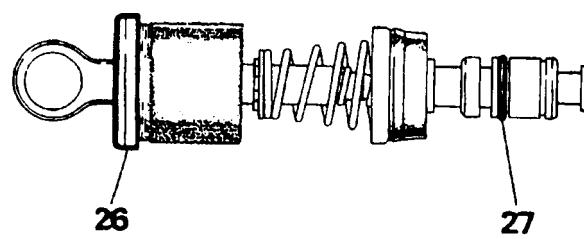
18. Remove the three screws, locknuts plain and fibre washers securing the diaphragm to the valve body.
19. Remove the diaphragm support and tube from the front of the diaphragm.
20. Remove the diaphragm from the valve body.
21. Pull the piston out of the valve body.
22. Remove the 'O' rings from the valve body and piston.



23. Remove the sponge seal and backing ring from the valve body.
24. Lift out the two levers and remove the bearing ring.
25. Release the circlip securing the valve/push rod assembly in the valve body.
26. Carefully pry the end cap from the opposite end of the valve body and withdraw the valve/push rod assembly complete.



27. Remove the small 'O' ring from the assembly.

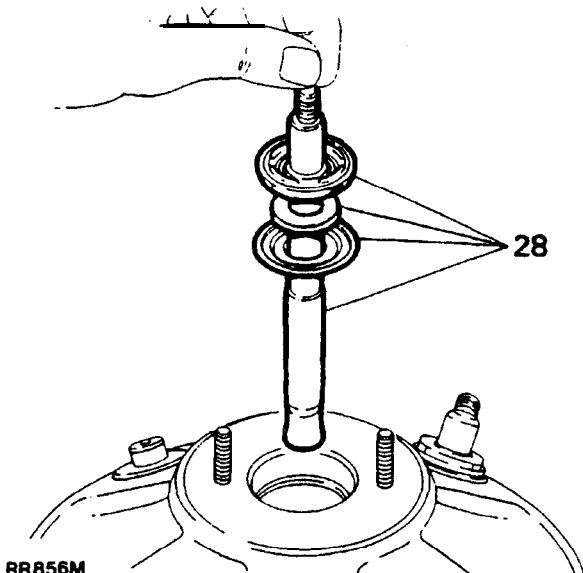


**NOTE:** The valve/push rod assembly cannot be further dismantled, if the seals and assembly are in a poor condition, fit a new assembly.

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28. Remove the push rod, seal, washer and retainer from the servo shell.

**NOTE:** If a new push rod is fitted the operating length must be set after the servo has been assembled, see assembling procedure instruction number 61.



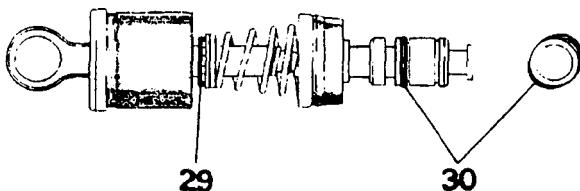
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#### ASSEMBLE THE SERVO

Carefully inspect all parts for wear and damage. Absolute cleanliness of all parts of the servo is essential.

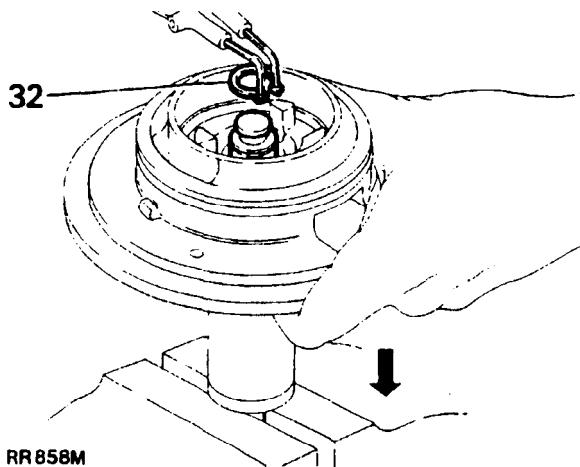
29. If a new valve/push rod assembly is being fitted it will be necessary to compress the spring located in the centre of the valve, to enable the circlip to be inserted into the groove, thus tensioning the seal.

30. Fit a new 'O' ring to the end of the valve. DO NOT ROLL THE 'O' RING INTO THE GROOVE. Carefully stretch the seal and ease it down the valve and into the groove.



RR857M

31. Lubricate the seals with a suitable disc brake lubricant and push the assembly fully into the bore of the valve body.  
 32. Clamp the eye of the assembly in a bench vice. Press the valve body down to expose the circlip groove at the end of the valve/push rod assembly and fit the circlip.

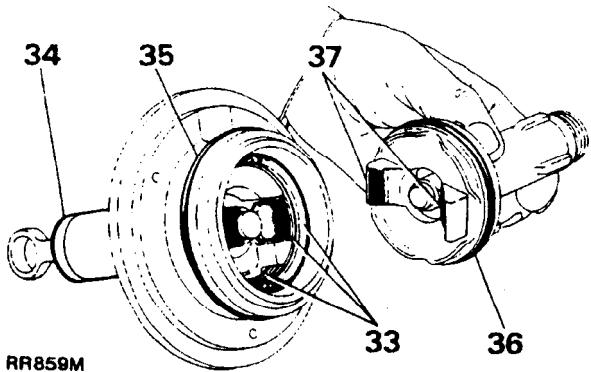


RR858M

33. Fit the bearing ring (thicker of the two rings), levers, backing ring and sponge seal to the valve body.

**NOTE:** Ensure that the chamfered edges of the levers are fitted firmly into the groove at the end of the push rod assembly.

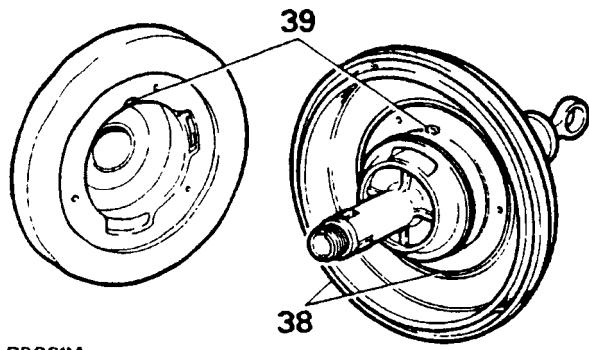
34. Feed the sponge filter and felt pad into the opposite end of the valve body and press the end cap into position.
35. Lightly coat the new valve body 'O' ring with disc brake lubricant and ease the seal into the groove.
36. Lightly coat the new reaction piston 'O' ring with disc brake lubricant and ease the seal into the groove.
37. Push the piston into the valve body ensuring that the two projections on the piston are located over the levers in the valve body, push the piston firmly into position.



38. Place the new diaphragm onto the valve body, locating the inner diaphragm bore onto the shoulder just outside the three bolt holes.

**N O T E : D O   N O T   L U B R I C A T E   T H E   D I A P H R A G M .**

39. Fit the diaphragm support plate and tube to the valve body ensuring that the indent in the support plate lines up with the corresponding projection on the valve body.



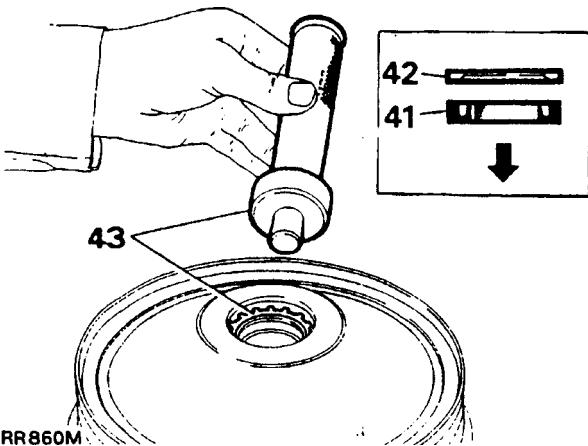
RR981M

40. Fit the three securing screws, washers and nuts, entering the bolts from the valve body side.

**NOTE:** The fibre washer is inserted behind the screw head.

Tighten to the correct torque see section 06-Torque values.

41. Coat the new nylon bearing and seal with a suitable disc brake lubricant and insert the seal into the separator shell, with the open edge of the seal facing upwards.
42. Fit the nylon bearing washer with the chamfered inner edge downwards.
43. Using a suitable service tool, example M5550, press in the new retaining ring, convex side first, until the retainer sits firmly on the nylon bearing.



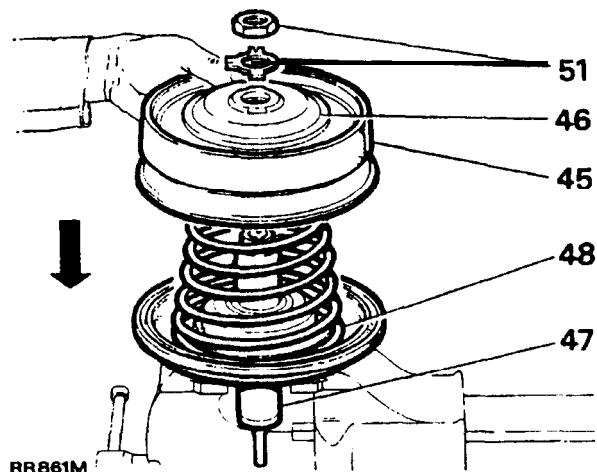
RR860M

Continued

44. Fit the backing washer to the concave side of the separator shell diaphragm.
45. Fit the diaphragm to the separator shell, concave side first, locate the sealing lip over the edge of the separator.
46. Place the support plate onto the face of the diaphragm.
47. Mount the valve body into a bench vice.

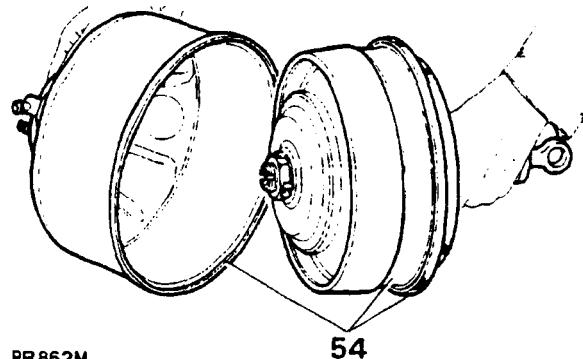
**CAUTION: DO NOT OVERTIGHTEN THE VICE. USE JAW PROTECTORS/COVERS. Coat the support plate tube with disc brake lubricant.**

48. Place the spring onto the valve body, largest diameter to sit on support plate and tube.
49. Holding the separator shell assembly together place it on to the top of the spring.
50. Compress the complete assembly until the thread on the end of the reaction piston protrudes beyond the separator shell assembly.
51. Fit a new tab washer and screw on the large nut.



52. Remove the complete assembly from the vice. Tighten the locknut to the correct torque (see section 06-Torque values).
53. Bend up the tabs on the lock washer.

54. Locate the outer edge of the valve body diaphragm into the indent around the separator shell and push the assembly into the servo vacuum shell, ensure that the diaphragm remains in position.



55. Coat the new nylon bearing and seal for the servo end cover with disc brake lubricant and press the seal into the cover.

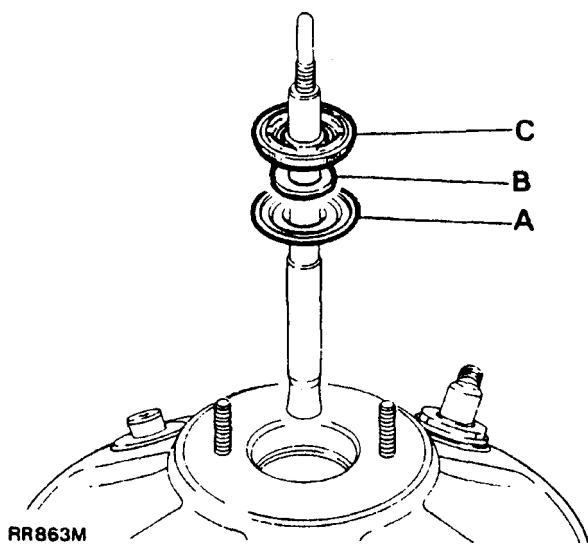
**NOTE: THE OPEN FACE OF THE SEAL DOWNWARDS.**

56. Fit the new bearing retainer using a suitable service tool example: MS550. Ensure the retainer sits firmly on top of the nylon bearing.
57. Lightly coat the valve body with disc brake lubricant ease the end cover onto the assembly and align the identification marks. Locate the beaded edge of the diaphragm between the end cover and servo shell.
58. Fit the clamp ring, bolt and nut, rotate the ring until the identification mark lines up with those on the servo unit. Tighten the clamp ring to the correct torque (see section 06-Torque values).
59. Fit a new rubber boot over the valve/push rod assembly.

60. Fit a new retainer, nylon washer and seal to the push rod, fit the push rod to the servo.

**NOTE: Flat face of the seal to the bottom of the seal recess in the servo shell.**

- (A) Retainer
- (B) Nylon washer
- (C) Seal

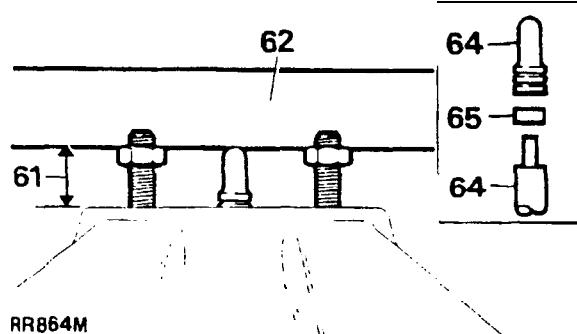


**NOTE: If a new push rod is fitted, the operating length must be checked, if adjustment to the rod is required, adjust as follows.**

61. Run two nuts down the studs at the master cylinder joint face of the servo. Set the top of the nuts to a dimension of 22.3-22.4 mm (0.876-0.881 inch).
62. Lay a straight edge across the top of the two nuts. Check the height of the push rod to the bottom of the straight edge.
63. If the push rod is out of the limits specified adjust as follows.
64. Remove the push rod from the servo, clamp the small domed end of the rod in a bench vice and detach the main stem.

65. Remove the small spacer. Increase or decrease the size of the spacer accordingly until the correct dimension is attained.

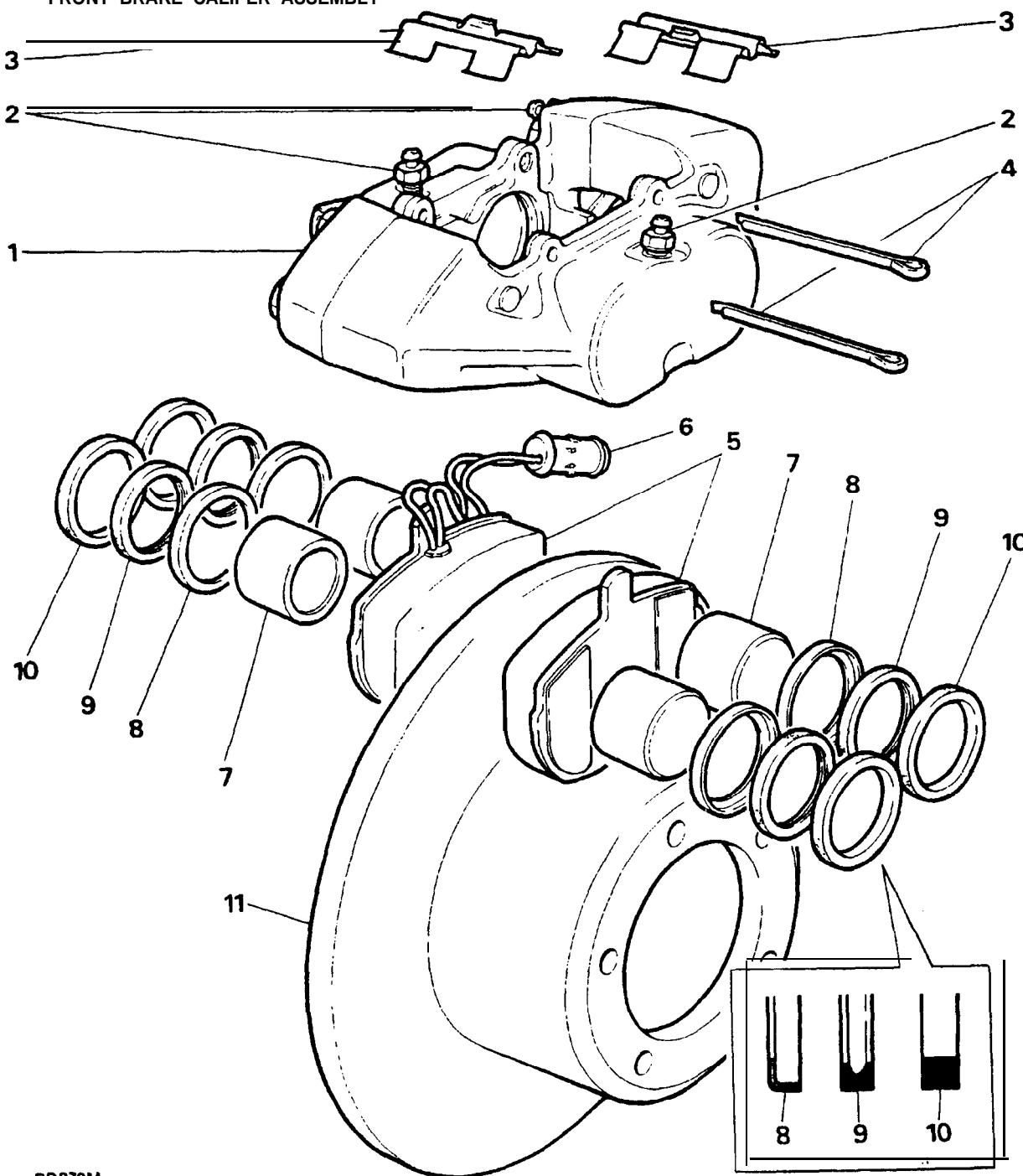
66. Coat the push rod seal with Lockheed disc brake lubricant and fit to the servo.



67. Carefully pry the non-return valve and seal out of the servo shell.
68. Fit new seal.
69. **Inspect** the non-return valve for condition, fit a new valve if necessary.
70. Fit non-return valve.
71. install the servo into the vehicle and tighten all bolts to the correct torque (see section 06-Torque values).
72. Reconnect the servo operating rod to the brake pedal with the pivot bolt eccentric in the forward position, do not fully tighten the pivot bolt nut.
73. Turn the pivot bolt to bring the brake pedal back until it just contacts the rubber then secure the pivot bolt nut.

**70 BRAKES**

FRONT BRAKE CALIPER ASSEMBLY



RR870M

## KEY TO CALIPER

- |                            |                        |
|----------------------------|------------------------|
| 1. Caliper                 | 7. Piston              |
| 2. Bleedscrews             | 8. Wiper seal retainer |
| 3. Pad retaining springs   | 9. Wiper seal          |
| 4. Retaining pins          | 10. Fluid seal         |
| 5. Friction pads           | 11. Brake disc         |
| 6. Pad wear indicator plug |                        |

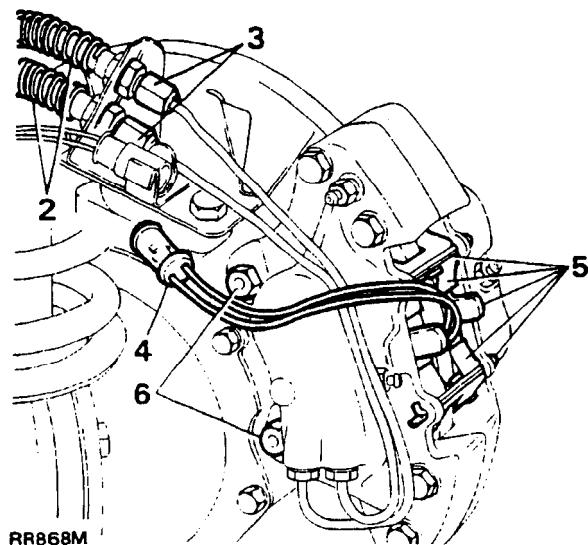
### REMOVE AND OVERHAUL FRONT BRAKE CALIPERS

**Service tool:**  
**18G672-Piston clamp**

**NOTE:** Pad wear warning indicators are incorporated into the front and rear right hand inboard pads.

#### Remove caliper

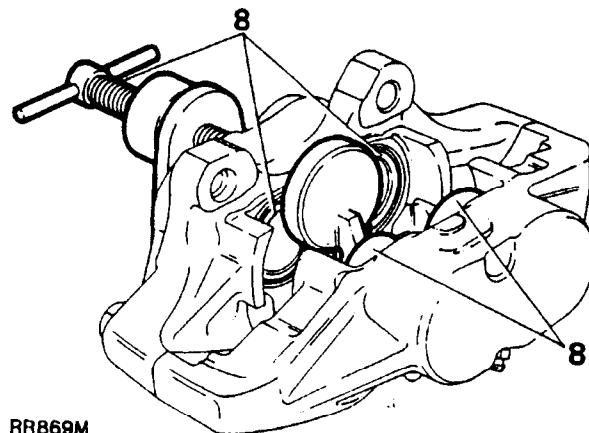
1. Loosen the front wheel retaining nuts, using a suitable hydraulic floor jack raise the front of the vehicle and lower onto axle stands and remove the wheels.
2. Expose the two flexible brake hoses by moving the coiled protective covering.
3. Using a recognised hose clamp, clamp both hoses to prevent loss of brake fluid, disconnect the rigid brake pipes from the flexible hoses, seal the ends of the hoses and pipe openings to prevent ingress of dirt. (If necessary the two rigid brake pipes to the caliper can be disconnected when the caliper is removed from the swivel pin housing).
4. Disconnect the pad wear warning indicator (front right hand side only).
5. Remove the retaining pins and springs, withdraw the pads. If the same pads are to be refitted, identify them for assembly to their original locations.
6. Remove the two bolts and withdraw the caliper from the disc.



#### DISMANTLE AND OVERHAUL

##### Do not separate the caliper halves

7. Clean the outer surfaces of the caliper with aerosol brake cleaner.
8. Using special tool 18G672, clamp the pistons in the inboard half of the caliper and gently, keeping fingers clear, and with **CAUTION**, apply air pressure to the fluid inlet port to expel the rim half pistons. Since it is unlikely that all pistons will expel at the same time, regulate the rate with a suitable piece of wood between the appropriate piston and caliper.



**Continued**

9. Finally, remove the pistons keeping them identified with their respective bores.
10. Remove the wiper seal retainer by inserting a blunt screwdriver between the retainer and the seal and pry the retainer carefully from the mouth of the bore.
11. Taking care not to damage the seal grooves, extract the wiper seal and fluid seal.
12. Clean the bores, pistons and particularly the seal grooves with clean brake fluid or aerosol brake cleaner only. If the caliper or pistons are corroded or if their condition is not perfect new parts must be fitted.

#### Assemble outboard pistons

13. Coat a new fluid seal with a suitable disc brake lubricant. Ease the seal into the groove in the bore using only the fingers and ensure that it is properly seated. The fluid seal and the groove are not the same in section so that when the seal is seated it feels raised to the touch at the edge furthest away from the mouth of the bore.
14. Coat the appropriate piston with disc brake lubricant and insert it squarely into the bore by hand only. Do not tilt the piston during insertion and leave approximately 8mm (0.312 inch) projecting from the bore.
15. Coat a new wiper seal with disc brake lubricant and fit it to a new seal retainer. Slide the assembly, seal first, over the protruding piston and into the bore recess. Remove the piston clamp from the mounting half and use the clamp to press home the seal retainer and piston.

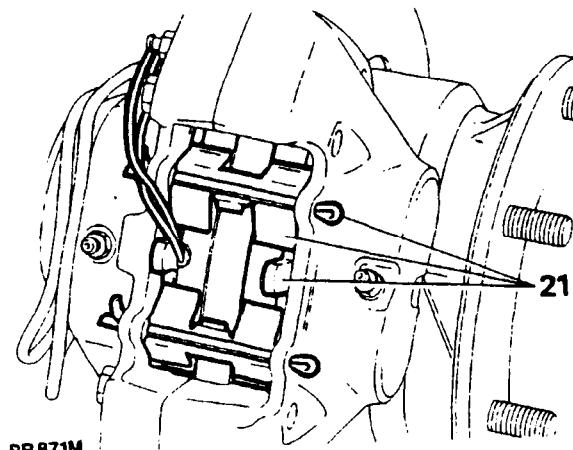
#### Mounting inboard pistons

16. Clamp the outboard pistons and carry out the same procedure as for removing and fitting the outboard pistons and seals, instructions 8 to 15.

#### Fit calipers and pads to vehicle

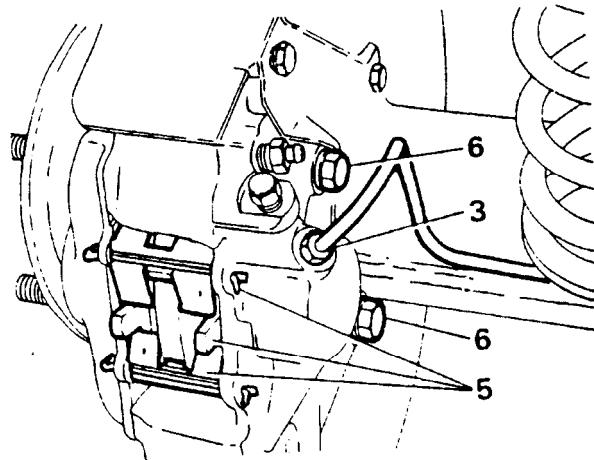
17. Fit the caliper to the axle and secure with the two bolts tightening evenly to the correct torque (see section 06-Torque values).
18. Connect the brake flexible hoses to the caliper and tighten to the correct torque (see section 06-Torque values).
19. Remove the clamps from the hoses.
20. Lightly coat the back and edges of the pads with a suitable disc brake lubricant carefully avoiding the friction material.
21. Insert the pads and retaining springs, secure in position using new retaining pins and open out the ends. Note the correct position of the retaining springs.

**NOTE:** Ensure that the friction pad with the wear indicator is fitted to the inboard side of the front right hand caliper



RR871M

22. Reconnect the pad wear indicator electrical plug.
23. Bleed both the primary and secondary brake systems. (Refer to page 4 for the brake bleeding procedure).
24. When the foregoing instructions have been completed on all calipers, press the brake pedal firmly several times to locate the friction pads.
25. Fit the road wheels, remove the axle stands and finally tighten the road wheel nuts.
26. Road test the vehicle, remembering that if new friction pads have been fitted they are not 'bedded-in' and may take several hundred miles before the brakes are at maximum efficiency.



RR2007E

#### REMOVE AND OVERHAUL REAR BRAKE CALIPERS

##### Service tool:

**18G672-Piston clamp**

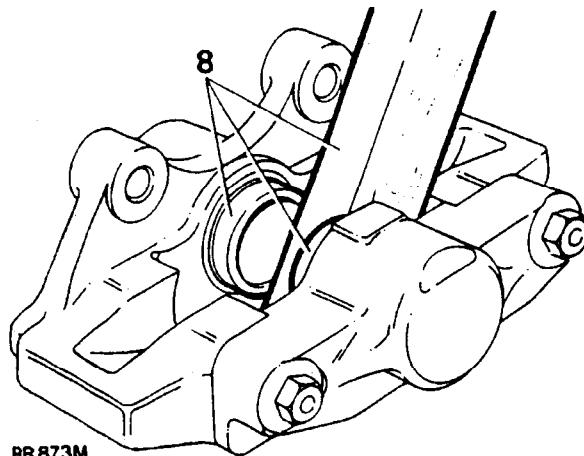
##### Remove caliper

1. Loosen the rear road wheel nuts and jack up the rear of the vehicle, lower onto axle stands and remove the wheels.
2. Using a **recognised** hose clamp, clamp the flexible brake hose above the rear axle, to prevent loss of fluid.
3. Remove the brake pipe(s) from the rear brake caliper(s). Seal the ends of the pipe to prevent ingress of dirt.
4. Rear right hand caliper only, disconnect the pad wear indicator.
5. Remove the retaining pins and springs and withdraw the pads. If the same pads are to be refitted, identify them for assembly to their original locations.
6. Remove the two bolts and withdraw the caliper from the axle.

##### Dismantle and overhaul

###### Do not separate the caliper halves

7. Clean the outer surfaces of the caliper with aerosol brake cleaner.
8. **WITH CAUTION** expel the pistons from their bores by applying air pressure to the fluid inlet port. Since it is unlikely that both pistons will expel at the same time, regulate the rate with a suitable piece of wood inserted between the two pistons.



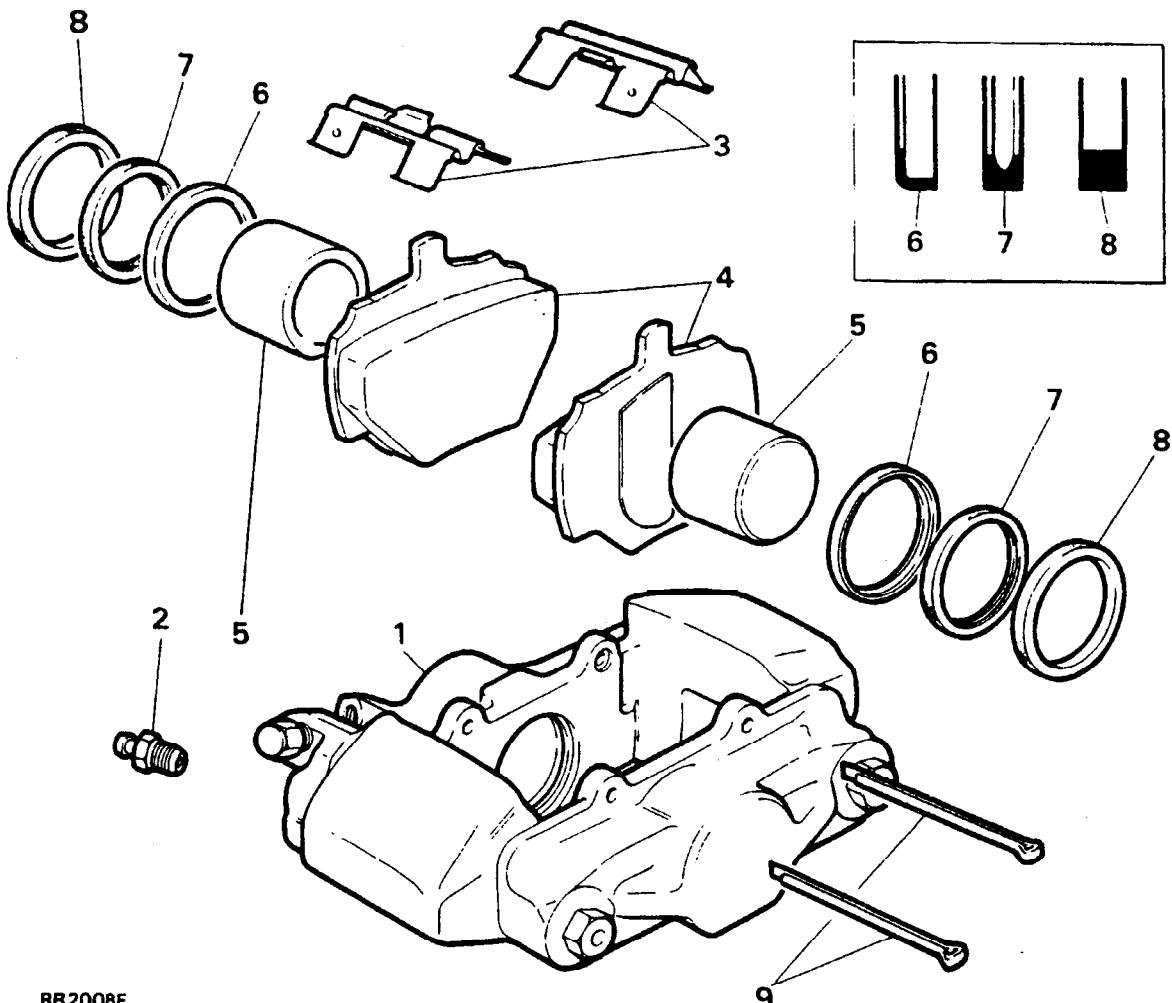
9. Finally, remove the **pistons** keeping them identified with their respective bores.

**Continued**

10. Remove the wiper seal retainer by inserting a blunt screwdriver between the retainer and the seal and pry the retainer carefully from the mouth of the bore.
11. Taking care not to damage the seal grooves, extract the wiper seal and fluid seal.
12. Clean the bores, pistons and particularly the seal grooves with clean brake fluid or aerosol brake cleaner only. If the caliper or pistons are corroded or their condition is not perfect new parts must be fitted.

#### REAR BRAKE CALIPER ASSEMBLY

##### LH Rear Caliper illustrated



RR2008E

##### KEY TO CALIPER

- |                          |                        |
|--------------------------|------------------------|
| 1. Caliper               | 6. Wiper seal retainer |
| 2. Bleed screw           | 7. Wiper seal          |
| 3. Pad retaining springs | 8. Fluid seal          |
| 4. Friction pads         | 9. Retaining pins      |
| 5. Piston                |                        |

13. Coat a new fluid seal with a suitable disc brake lubricant. Ease the seal into the groove in the bore using only the fingers and ensure that it is properly seated. The fluid seal and the groove are not the same in section so that when the seal is seated it feels raised to the touch at the edge furthest away from the mouth of the bore.
14. Coat the appropriate piston with a suitable disc brake lubricant and insert it squarely into the bore by hand only. Do not tilt the piston during insertion and leave approximately 8mm (0.312 inch) projecting from the bore.
15. Coat a new wiper seal with a suitable disc brake lubricant and fit it to a new seal retainer. Slide the assembly, seal first, over the protruding piston and into the bore recess.
16. Using special tool 18G672-piston clamp, press home the seal retainer and piston.

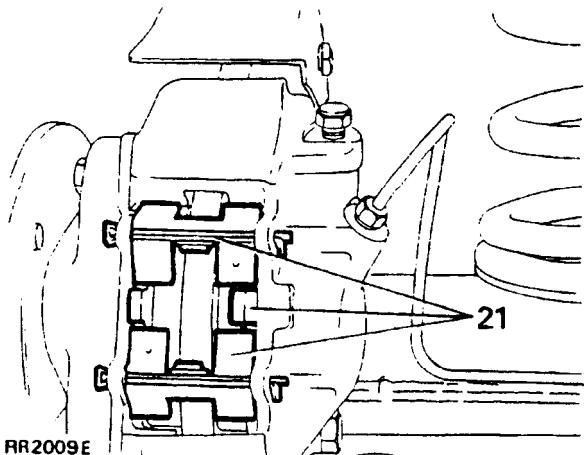
#### Mounting inboard piston

17. Carry out the same procedure as for removing and fitting the outboard piston and seals, instructions 8 to 16.

#### Fit calipers and pads to vehicle

18. Fit the caliper to the axle and secure with the two bolts tightening evenly to the correct torque (see section 06-Torque values).
19. Connect the brake pipes to the calipers and remove the clamp from the flexible brake hose above the rear axles, see section 06-Torque values for brake pipe to caliper tightening torque.
20. Lightly coat the back and edges of the pads with disc brake lubricant carefully avoiding the friction material.

21. Insert the pads and retaining springs, secure in position with new retaining pins and spread the ends. Note the correct position of the retaining springs.

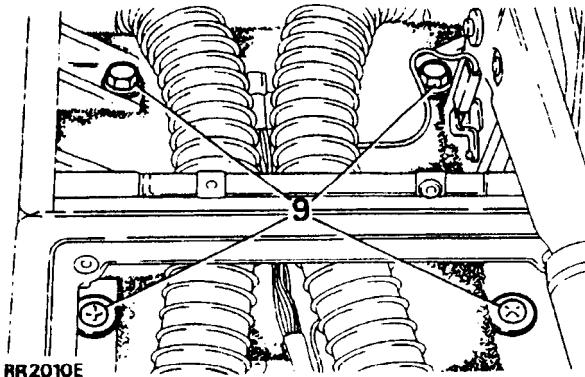


**NOTE:** Ensure that the friction pad with the wear indicator is fitted to the inboard side of the rear right hand, brake caliper.

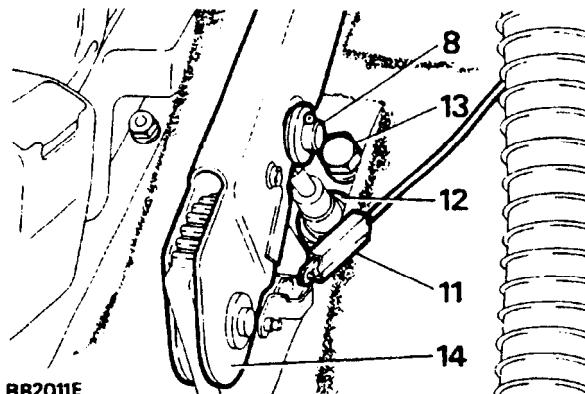
22. Reconnect the pad wear indicator electrical multi-plug.
23. Bleed the secondary brake system at the rear calipers, starting at the caliper furthest away from the master cylinder.
24. When the foregoing instructions have been completed on both calipers, press the brake pedal firmly several times to locate the friction pads.
25. Fit the road wheels, remove the axle stands and finally tighten the road wheel nuts, (see section 06 - Torque values).
26. Road test the vehicle, remembering that if new friction pads have been fitted they are not 'bedded-in' and may take several hundred miles before the brakes are at maximum efficiency.

**PARKING BRAKE LEVER****Remove and refit****Removing**

1. Disconnect the battery negative terminal.
2. Chock the road wheels and release the parking brake.
3. Open the glove box lid and remove the four screws securing the glove box liner to the outer surround and lift out the liner.
4. Remove the two electrical leads at the rear of the glove box cigar lighter and release the two heater hoses from their retaining clamps.
5. Carefully pry the window lift switch panel away from the front of the glove box. Maneuver the panel through the opening and into the inside of the glove box.
6. Remove the main gear selector knob and transfer gearbox knob.
7. Carefully pry the centre panel out of the gearbox tunnel mounted console, and disconnect the electrical multi-plug to the inset graphics panel, withdraw the panel off the main gearbox selector.
8. Remove the cotter pin, plain washer and clevis pin securing the parking brake cable to the parking brake lever.
9. Remove the four bolts and plain washers. Two are located immediately behind the parking brake lever accessible from inside the glove box. The remaining two bolts are located forward of the parking brake lever accessible from the floor mounted console opening.



10. Raise the parking brake lever to its uppermost position and ease the glove box and console assembly rearwards to release the location tab from the radio housing, lift the assembly off the gearbox tunnel.
11. Disconnect the electrical lead from the parking brake warning switch.
12. Release the parking brake cable outer retaining nut.
13. Remove the remaining single bolt with plain washer securing the front of the parking brake mounting bracket.
14. Withdraw the parking brake lever assembly off the parking brake outer cable.

**Refitting**

15. Fit the parking brake lever to the gearbox tunnel and secure in position with the single bolt (with plain washer) forward of the lever mounting bracket.
16. Secure the outer parking brake cable to the mounting plate and tighten the nut securely.
17. Refit the glove box/console assembly and secure in position, tightening the remaining bolt and two screws securely.
18. Fit the inner parking brake cable to the parking brake lever using a new cotter pin.
19. Reverse the remaining removal instructions, ensuring that the electrical wiring in the glove box assembly is arranged to prevent it from becoming trapped between any mating faces.

**OVERHAUL PARKING BRAKE**

**WARNING:** Do not use an air line to remove dust from the brake assembly. Asbestos dust from the brake linings can be a serious health risk, if inhaled.

**DISMANTLING**

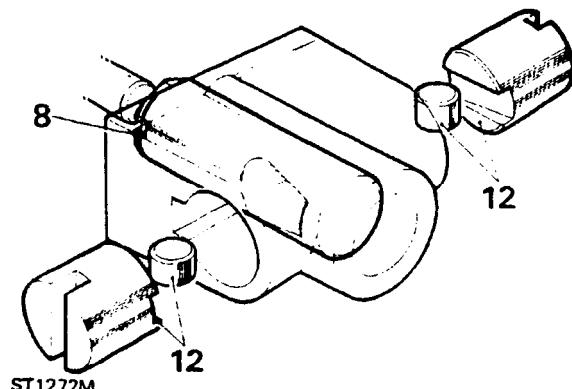
1. Disconnect the battery negative terminal and chock the road wheels for safety. Release the parking brake, select 'P' in main gearbox and release the parking brake.
2. Disconnect the drive shaft from the output flange.
3. Loosen off the brake adjuster, remove the two screws and withdraw the brake drum. Inspect the friction surface of the drum, turn if excessively scored or oval.

**NOTE:** If drum requires skimming the maximum diameter is 255.65 mm (10.06 in).

4. Remove the cotter pin and clevis pin connecting the parking brake inner cable to the brake actuating lever.
5. Remove the brake shoes complete with pull-off springs. Note position of springs in relation to the shoes.
6. Remove the four bolts securing back plate to transfer box and withdraw the back plate complete with oil catcher.

**Remove and overhaul expander assembly**

7. Remove the rubber dust cover.
8. Remove the expander and drawlink.
9. Remove the retainer spring plate.
10. Remove the locking plate.
11. Remove the packing plate and withdraw the expander assembly from the back plate.
12. Remove the two plungers and rollers.



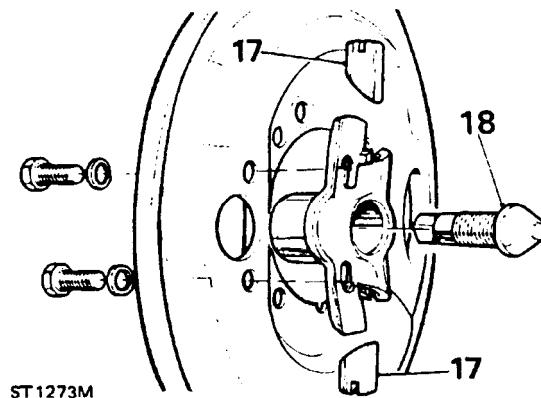
13. Clean all parts in aerosol brake cleaner and allow to dry. Examine the components for wear and discard if unsatisfactory.

**Assemble expander assembly**

14. Grease and fit the expander and drawlink.
15. Grease and fit the plungers and rollers, fitting the plungers with the highest end of the roller groove towards the backplate.

**Remove and overhaul adjuster assembly**

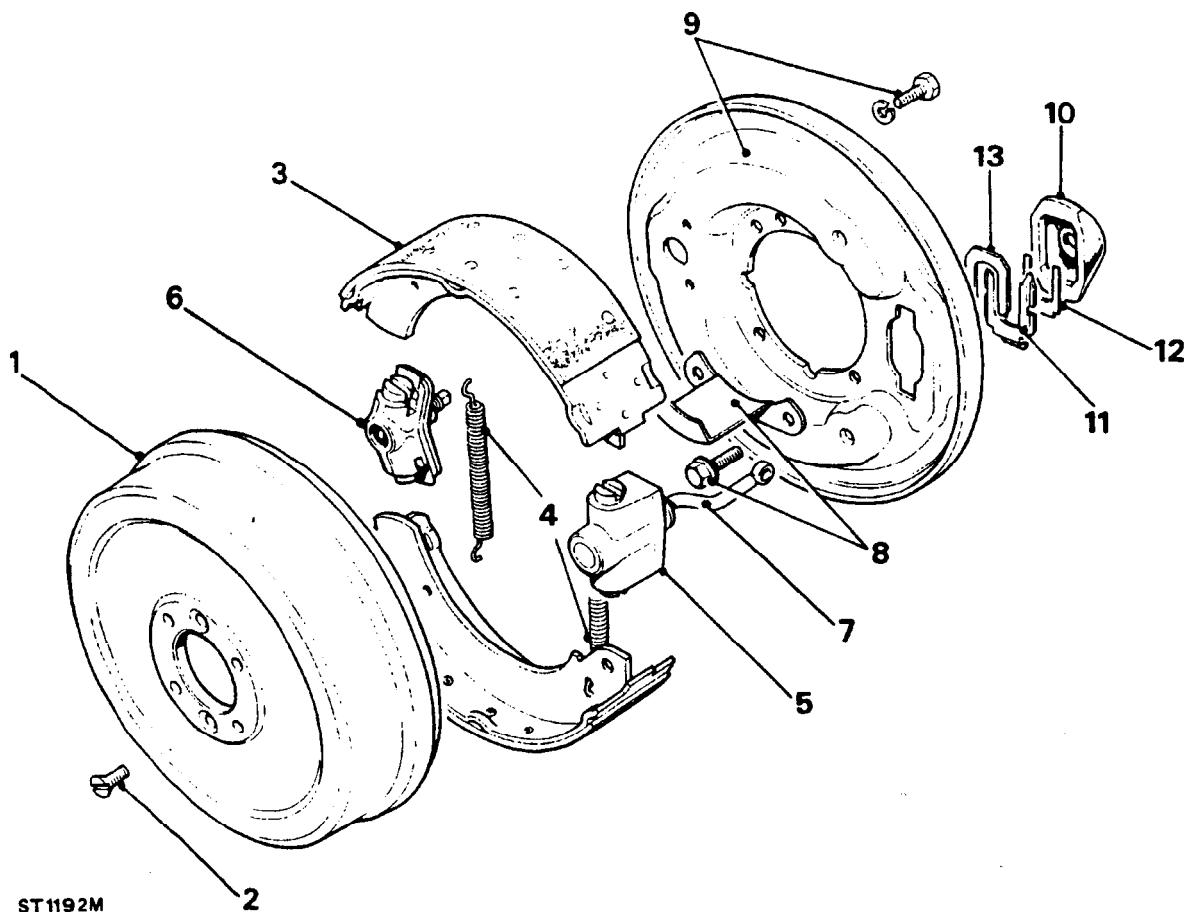
16. Remove the two bolts and withdraw the adjuster assembly from the back plate.
17. Remove the plungers.
18. Screw the adjuster cone inwards to remove from the housing.



19. Thoroughly clean the parts in aerosol brake cleaner and discard any unsatisfactory components.

## KEY TO PARKING BRAKE

1. Brake drum
2. Brake drum retaining screws
3. Brake shoes
4. Brake shoes pull-off springs
5. Expander assembly
6. Adjuster assembly
7. Drawlink
8. Oil catcher
9. Back plate and retaining bolts
10. Dust cover
11. Locking plate
12. Packing plate
13. Spring plate



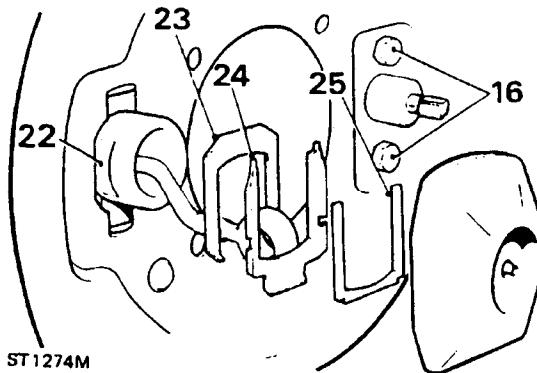
## Assembly adjuster assembly

20. Grease and screw in the adjuster cone.
21. Grease and fit the adjuster plungers and align the chamfered ends with the adjuster cone. Note that the two plungers are identical and can be fitted to either bore. Secure the assembly with a rubber band to prevent the plungers falling out.

## ASSEMBLE

NOTE: If the brake linings are oil-soaked, fit new brake shoes. Check and if necessary fit a new output shaft oil seal.

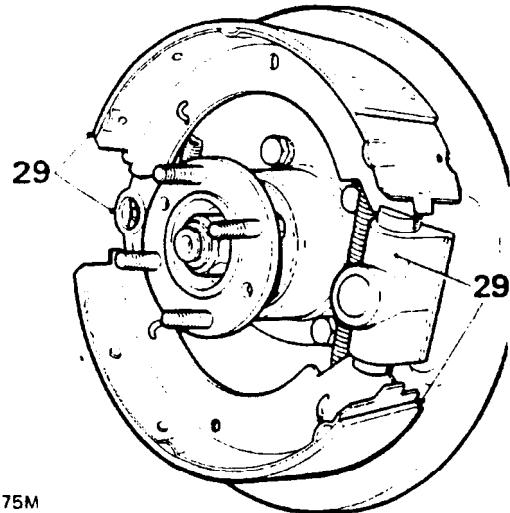
22. Position the expander assembly on the inside of the back plate and secure with the following plates at the rear of the back plate.
23. Spring plate.
24. Locking plate.
25. Packing plate.
26. Fit the rubber dust cover.



27. Fit the adjuster assembly to the back plate with the two bolts but do not fully tighten at this stage.
28. Fit the back plate assembly and oil catcher to the transfer box with the four bolts and tighten to the correct torque (see section 06-Torque values).

29. Fit new pull-off springs to the brake shoes and fit to the back plate.

NOTE: That the fully lined end of the lower shoe must be toward the expander assembly and the fully lined end of the upper shoe towards the adjuster assembly.



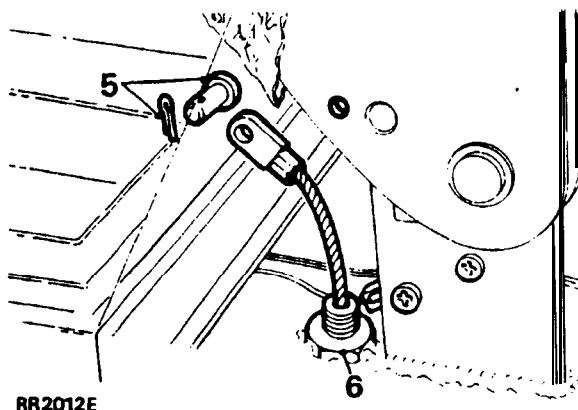
30. Fit the brake drum and tighten the two screws to the correct torque (See Section 06 Torque Values)
31. Connect the actuating lever to the inner parking brake cable using a new clevis pin, washer and cotter pin.
32. Turn the adjuster cone fully in and tighten the two retaining bolts left loose in instruction 27.
33. Loose off the adjuster two 'clicks' and firmly apply and release the parking brake lever to centralise the shoes. The drum should then rotate freely.
34. Adjust the parking brake cable lock nuts until the parking brake lever is fully operational on the second or third notch of the parking brake ratchet.
35. Connect the drive shaft and evenly tighten the retaining nuts to the correct torque (see section 06-Torque values).
36. Remove chocks from wheels and connect the battery.

**PARKING BRAKE CABLE****Remove and refit****Removing**

1. Set the vehicle on a level surface and chock the road wheels and select 'P' in the main gearbox.
2. Disconnect the battery negative terminal and release the parking brake.

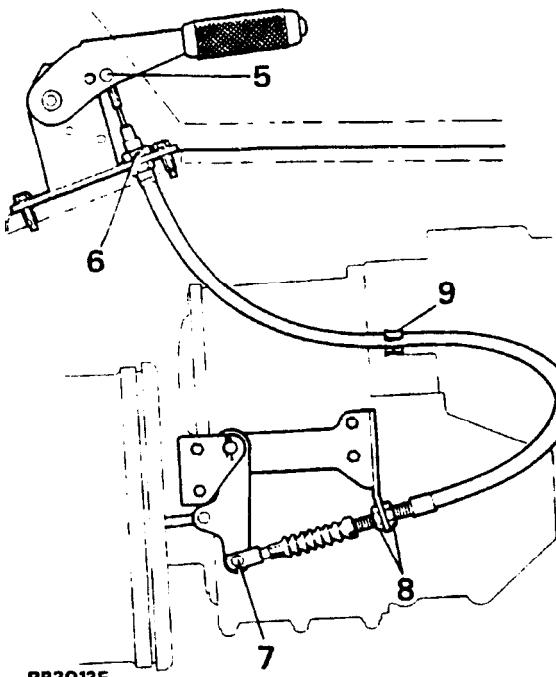
**From inside the vehicle**

3. Remove the four screws securing the liner in the glove box.
4. Lift out the liner to gain access to the bottom of the parking brake pivot bracket.
5. Remove the cotter pin and clevis pin from the parking brake lever.
6. Release the nut securing the parking brake outer cable to the top of the parking brake mounting bracket. Slide the nut up the cable and push the inner and outer cable through the floor panel to the underside of the vehicle.

**From underneath the vehicle**

7. Remove the cotter pin, plain washer and clevis pin securing the adjustment link to the brake drum actuating lever.

8. Release the locknuts securing the parking brake outer cable to the retaining bracket.
9. Release the outer cable from the 'P' clamp located on top of the transfer gearbox, and withdraw the cable assembly from the vehicle.

**Fit new cable**

10. Feed the parking brake cable assembly through the floor opening and secure the outer cable in position with the retaining nut.
11. Secure the cable to the parking brake lever, using a new cotter pin.
12. Secure the outer cable into the 'P' clamp.
13. Position the outer cable into the retaining bracket bolted to the side of the transfer gearbox and loosely secure in position with the two outer cable lock nuts.
14. Reconnect the outer cable to the brake drum actuating lever. Fit the clevis pin, plain washer and new cotter pin.
15. Rotate the brake drum adjuster clockwise until the brake shoes are fully expanded against the drum.
16. Tighten the two brake cable outer lock nuts to secure the cable to its mounting bracket.
17. Apply the parking brake, and loosen the brake drum adjuster until the parking brake lever fully operates the brake shoes on the second or third notch of the parking brake ratchet.
18. Refit the glove box liner.

**BRAKE SYSTEM-(Vehicles fitted with Lucas Girling master cylinder and servo)****Description**

The hydraulic braking system fitted to Range Rovers is the dual line type, incorporating primary and secondary hydraulic circuits.

**NOTE:** References made to primary or secondary do not imply main service brakes or emergency brakes but denote hydraulic line identification.

The brake pedal is connected to a vacuum assisted mechanical servo which in turn operates a tandem master cylinder. The front disc brake calipers each house four pistons, the upper pistons are fed by the primary hydraulic circuit, the lower pistons by the secondary hydraulic circuit. The rear disc brake calipers each house two pistons, these are fed by the secondary hydraulic circuit via a pressure reducing valve.

A brake fluid level switch is incorporated into the reservoir cap assembly, the switch having detected either low or sudden fluid loss will immediately illuminate a warning light in the instrument binnacle.

The brake fluid reservoir is divided, the section closest to the servo feeds the primary circuit and the section furthest from the servo feeds the secondary circuit. Under normal operating conditions both the primary and secondary circuits operate simultaneously on brake pedal application. In the event of a failure in the primary circuit the secondary circuit will still function and operate front and rear calipers. Alternatively, if the secondary circuit fails the primary circuit will still function and operate the lower pistons in the front calipers, allowances should be made and vehicle speed adjusted accordingly to allow for the lack of full braking efficiency.

If the servo should fail, both hydraulic circuits will still function but would require greater pedal effort due to the lack of vacuum assistance.

The hand operated parking brake acts on a brake drum at the rear of the transfer gearbox and is completely independant of the hydraulic circuits.

Brake pad wear sensors are incorporated in the front and rear right hand side inboard brake pads. The sensors will illuminate a brake pad wear warning light in the instrument binnacle, when pad thickness has been reduced to approximately 3mm (0.118 in).

**CAUTION: THOROUGHLY CLEAN ALL BRAKE CALIPERS, PIPES AND FITTINGS BEFORE COMMENCING WORK ON ANY PART OF THE BRAKE SYSTEM. FAILURE TO DO SO COULD CAUSE FOREIGN MATTER TO ENTER THE SYSTEM AND CAUSE DAMAGE TO SEALS AND PISTONS WHICH WILL SERIOUSLY IMPAIR THE EFFICIENCY OF THE BRAKE SYSTEM.**

To ensure the brake system efficiency is not impaired the following warnings must be adhered to :-

**DO NOT** use any petroleum (gasoline) based cleaning fluids or any proprietary fluids containing petroleum (gasoline). The preferred fluids are clear methylated spirits, industrial alcohol or a proprietary aerosol brake cleaning product.

**DO NOT** use brake fluid previously bled from the system.

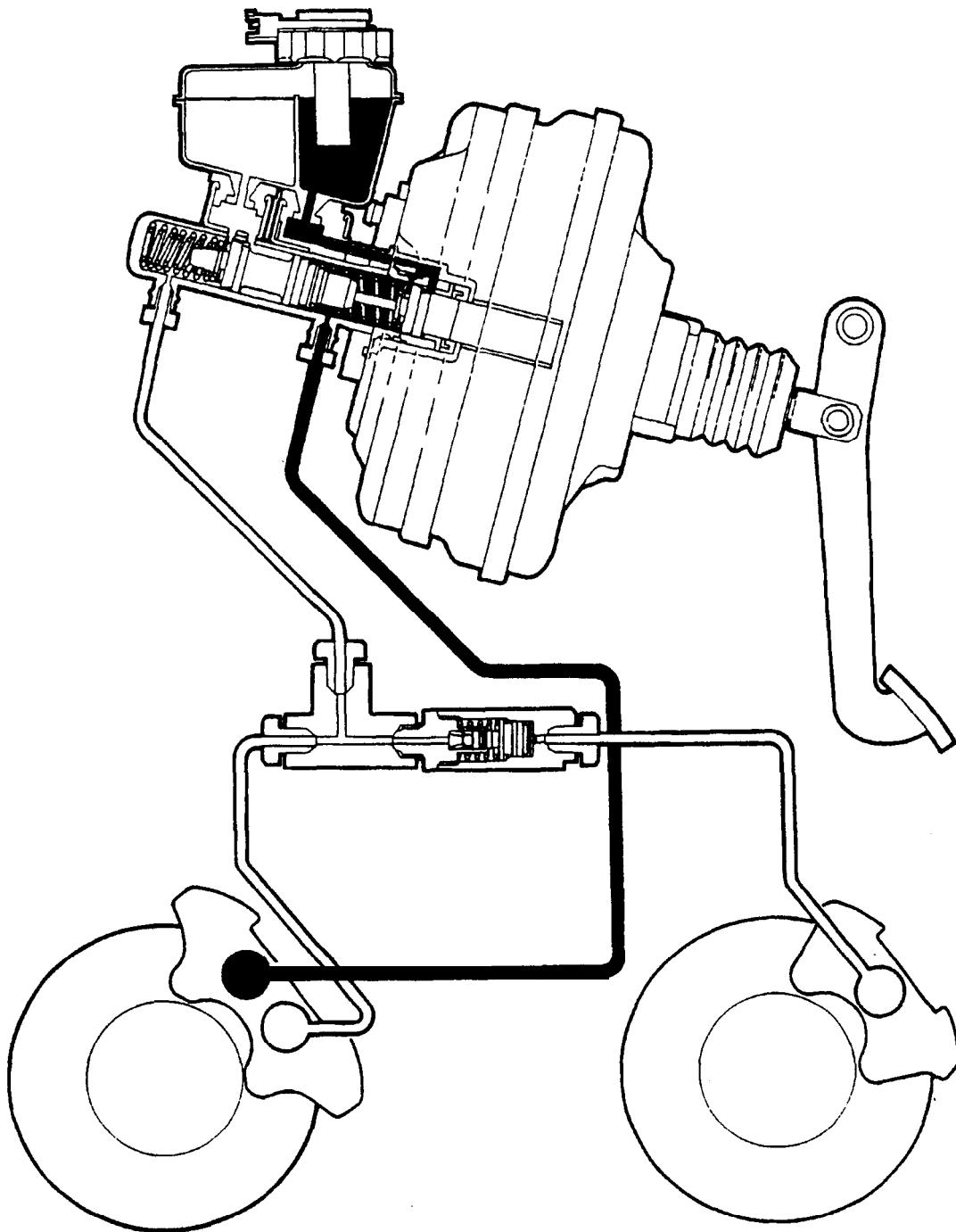
**DO NOT** use old or stored brake fluid.

**ENSURE** that only new fluid is used and that it is taken from a sealed container.

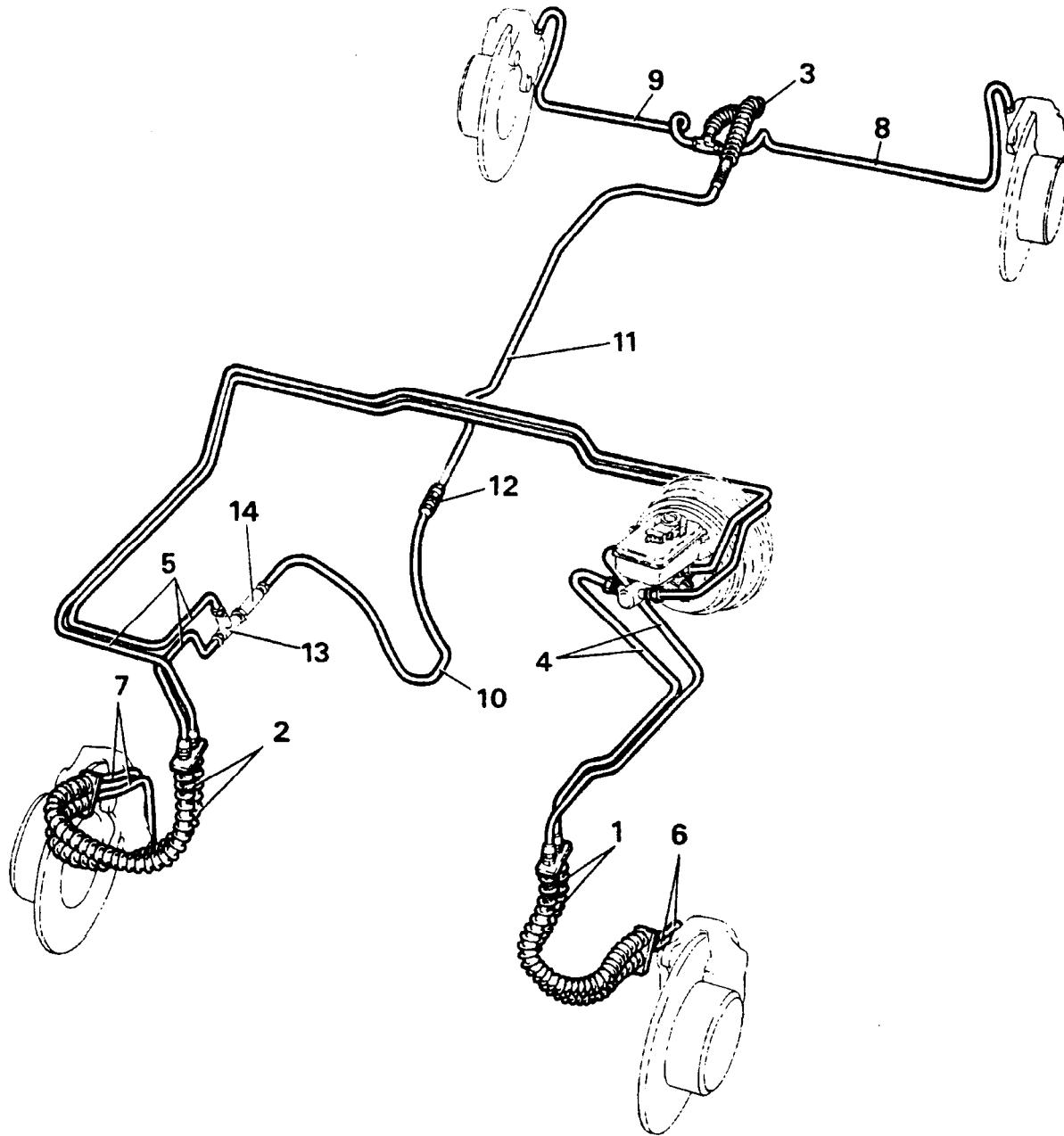
**DO NOT** flush the brake system with any fluid other than the recommended brake fluid.

The brake system should be drained and flushed at the recommended service intervals.

Continued-

  
PRIMARY HYDRAULIC CIRCUIT  
SECONDARY HYDRAULIC  
CIRCUIT

RR2226M

**RR2222E**

**BRAKE PIPE LAYOUT**  
Left hand drive

**HOSES**

1. Front left hand flexible hoses.
2. Front right hand flexible hoses.
3. Intermediate flexible hose.

**PIPES**

4. Feed to front left hand hose connector.
5. Feed to front right hand hose connector.
6. Feed to front left hand caliper.

7. Feed to front right hand caliper.
8. Feed to rear left hand caliper.
9. Feed to rear right hand caliper.
10. Feed to two way connector.
11. Feed to intermediate hose.
12. Two way connector.
13. Three way connector.
14. Pressure reducing valve.

**Continued**

**WARNING:** Some components on the vehicle such as gaskets and friction surfaces (brake linings, clutch discs, or automatic transmission brake bands), may contain asbestos. Inhaling asbestos dust is dangerous to your health and the following essential precautions must be observed :-

- \* Work out of doors or in a well ventilated area and wear a protective mask.
- \* Dust found on the vehicle or produced during work on the vehicle should be removed by vacuuming or by using a well damped cloth and not by blowing.
- \* Dust waste should be damped, placed in a sealed container and marked to ensure safe disposal.
- \* If any cutting, drilling etc, is attempted on materials containing asbestos the item should be damped and only hand tools or low speed power tools used.

#### BRAKES

##### Bleed

The hydraulic system comprises two completely independent circuits. The rear calipers and the lower pistons in the front calipers form the secondary circuit, while the upper pistons in the front calipers form the primary circuit. The following procedure covers bleeding the complete system, but it is permissible to bleed one circuit only if disconnections are limited to that circuit.

Bleeding will be assisted if the engine is run or a vacuum supply is connected to the servo.

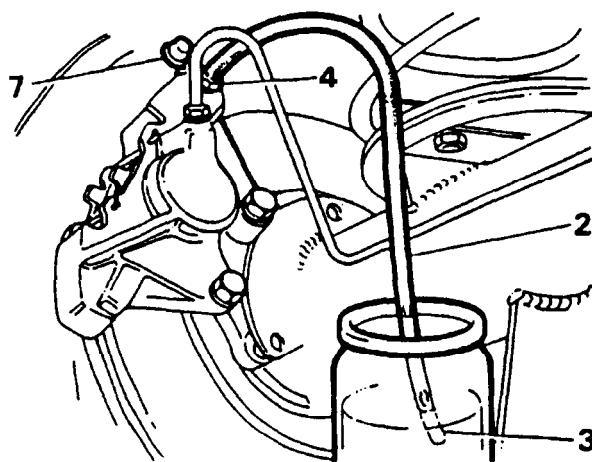
**WARNING: IF THE ENGINE IS RUNNING DURING THE BRAKE BLEEDING PROCESS ENSURE THAT NEUTRAL OR PARK IS SELECTED IN THE MAIN GEARBOX AND THAT THE PARKING BRAKE IS APPLIED.**

When bleeding any part of the secondary circuit, almost full brake pedal travel is available. When bleeding the primary circuit only, brake pedal travel will be restricted to approximately half.

**NOTE:** When bleeding the system commence with the caliper furthest from the master cylinder and bleed from the screw on the same side as the fluid inlet pipes, then close the screw and bleed from the screw on the opposite side of the same caliper. Tighten the bleed screws to the correct torque value. See section 06

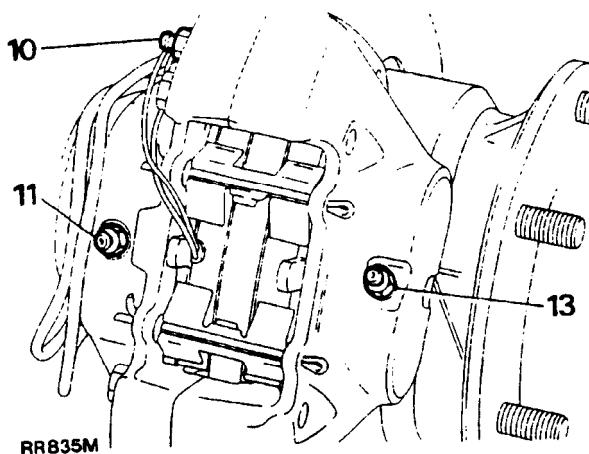
##### Bleeding

1. Fill the fluid reservoir with the correct grade of fluid, see section 09 lubricants and fluids.  
**NOTE:** The correct fluid level must be maintained throughout the procedure of bleeding.
2. Connect a bleed hose to the bleed screw on the rear caliper furthest from the master cylinder.
3. Submerge the free end of the bleed hose in a container of clean brake fluid.
4. Loosen the bleed screw 1/2-3/4 of a turn.
5. Operate the brake pedal fully and allow to return.  
**NOTE:** Allow at least five seconds to elapse with the foot right off the pedal to ensure that the pistons fully return before operating the pedal again.
6. Repeat 5 until fluid clear of air bubbles appears in the container, then keeping the pedal fully depressed, tighten the bleed screw.
7. Remove the bleed hose and replace the dust cap on the bleed screw.



RR1946E

8. Repeat 1 to 7 for the other rear caliper.
9. Remove the front wheel on the side furthest from the master cylinder.
10. Connect a bleed hose to the primary bleed screw on the front caliper furthest from the master cylinder.
11. Connect a bleed hose to the secondary bleed screw on the same side of the caliper as the primary screw.
12. Repeat 3 to 7 for the front caliper, bleeding from the two screws simultaneously.
13. Connect a bleed hose to the other screw on the front caliper furthest from the master cylinder.



14. Repeat 3 to 7 for the second secondary screw on the front caliper.
15. Refit the front wheel.
16. Repeat 9 to 15 for the front caliper nearest the master cylinder.

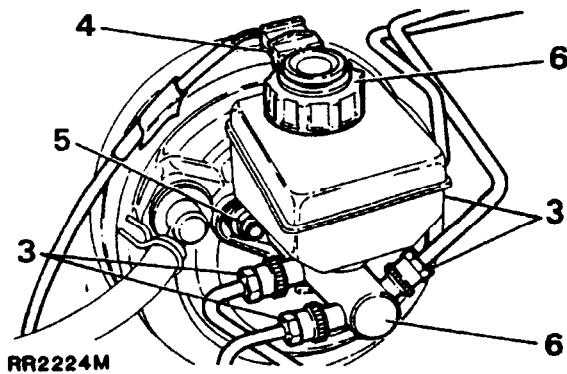
#### MASTER CYLINDER • Lucas Girling

- Type 25.4mm AS/AS

#### Remove, overhaul and refit

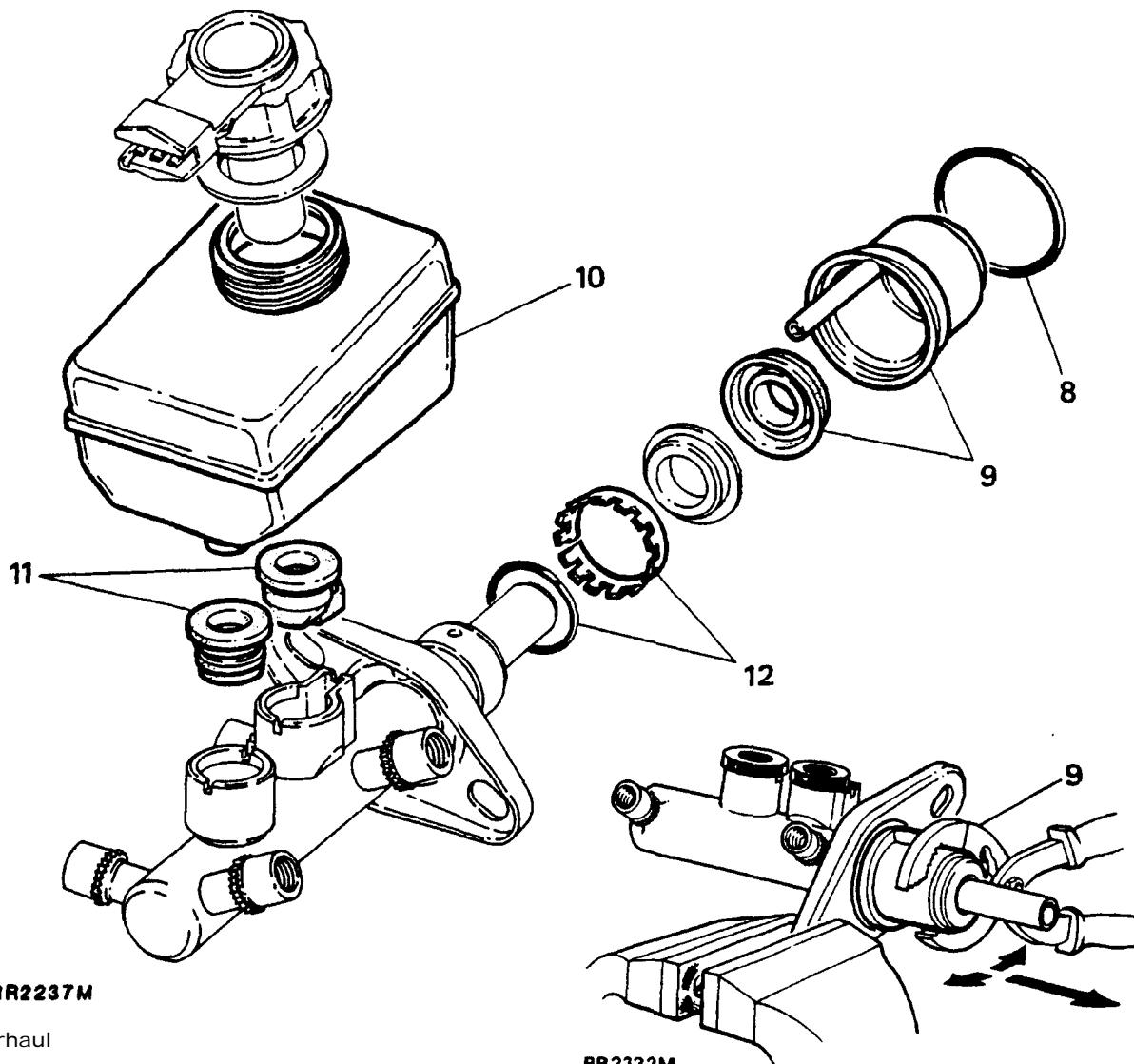
##### Removing

1. Disconnect the battery negative terminal.
2. Place a suitable container under the master cylinder to catch any brake fluid which may seep from the cylinder when the brake pipes are disconnected from the outlet ports.
3. Thoroughly clean the immediate area around all outlet ports. Remove each of the brake pipes from the master cylinder in turn, sealing each pipe and outlet port with suitable plugs as they are disconnected, to prevent ingress of foreign matter and excessive fluid loss.
4. Disconnect the electrical plug from the low fluid switch located on the reservoir cap.
5. Remove the two nuts securing the master cylinder to the servo unit remove also the spring and plain washers.
6. Detach the master cylinder from the servo, remove the reservoir cap and drain the brake fluid into a suitable container.



**WARNING:** Do not use brake fluid previously drained or bled from the system. Carefully dispose of unwanted fluid, if stored in a sealed container, ensure that the container is marked USED BRAKE FLUID.

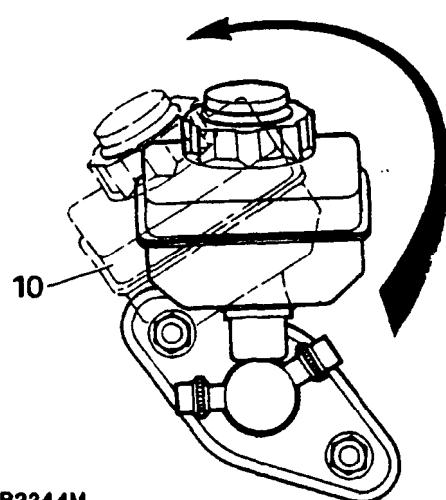
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**WARNING:** Use only clear methylated spirit or unused brake fluid to clean any part of the brake system. DO NOT use petrol, kerosene or other mineral based fluids.

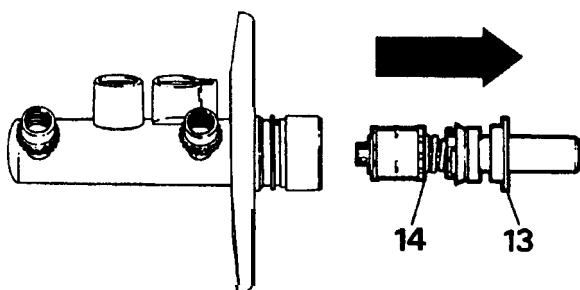
7. Before commencing the overhaul procedure thoroughly clean the master cylinder and inspect the outer surfaces for damage and condition, renew the complete assembly if necessary.
8. Using two soft jaws, one either side of the master cylinder flange, clamp the flange in a suitable vice. Remove the water ingress 'O' ring seal from the master cylinder to servo flange and discard.
9. Grip the outside of the transfer housing with a suitable pair of pliers, carefully pull, while working the pliers in a backwards and forwards rocking motion to ease the housing off the master cylinder, discard the housing and vacuum seal.

10. Ease the reservoir out of the master cylinder taking care to ensure that the two outlet ports on the bottom of the reservoir do not become damaged during this process.



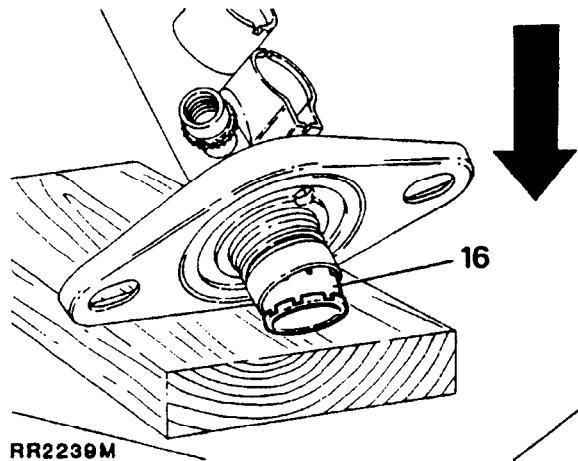
11. Withdraw the two reservoir seals from the master cylinder inlet ports the seals are different and should be noted for assembly, discard both of the seals.
12. Remove the retaining ring and 'O' ring seal from the machined outer surface of the master cylinder, discard both the seal and retaining ring.
13. Remove the guide ring from the mouth of the master cylinder which supports the primary plunger assembly and place to one side, this component is not part of the master cylinder service kit and is to be refitted on assembly of the unit.
14. Pull the primary plunger assembly out of the master cylinder.

**NOTE:** The primary plunger assembly cannot be broken down any further and is serviced as a complete unit. Discard the assembly.



RR2238M

15. The secondary plunger assembly will remain at the bottom of the master cylinder bore, the plunger can be easily expelled by tapping the assembly on a piece of wood until the plunger appears at the cylinder mouth, carefully pull the plunger out of the master cylinder.
16. If the swirl tube was not expelled at the same time as the secondary plunger, repeat the above operation to expel it from the bottom of the master cylinder bore and discard.



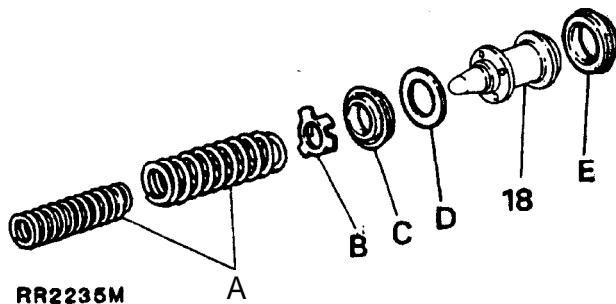
17. Clean all parts with Cirling cleaning fluid or unused brake fluid and place the cleaned parts onto a clean sheet of paper. Inspect the cylinder bore and plungers for signs of corrosion, ridges and score marks. Provided the working surfaces are in perfect condition, new seals from a Cirling Service repair kit may be used.

#### Renewing secondary plunger seals

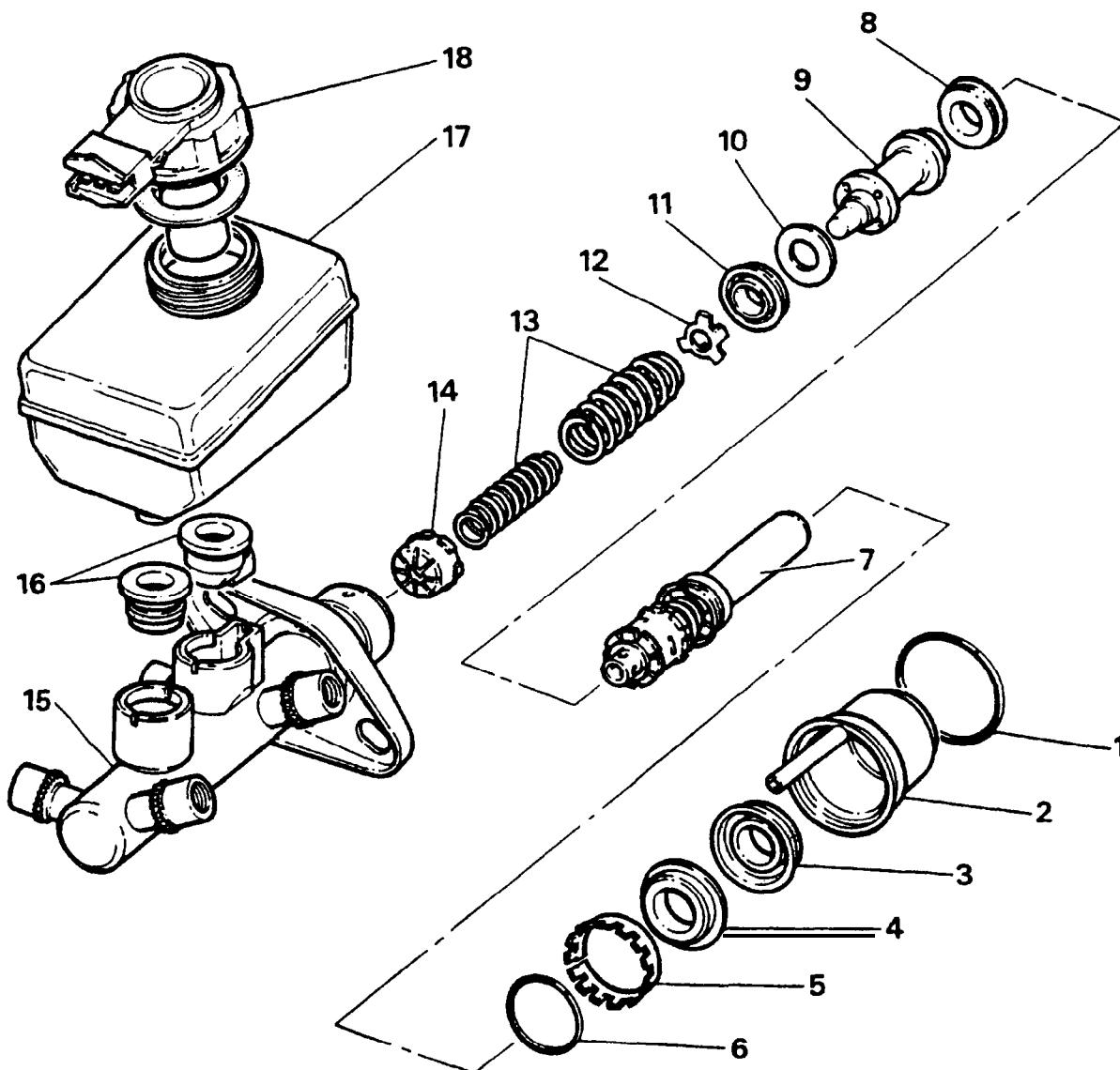
18. Remove from the following components from the secondary plunger and discard:

**NOTE:** A small screwdriver with the end rounded off and polished is required to remove the 'L' seal. DO NOT damage secondary plunger.

- (A) Springs
- (B) Seal retainer
- (C) Recuperating seal (primary cup)
- (D) Washer
- (E) 'L' seal



Continued



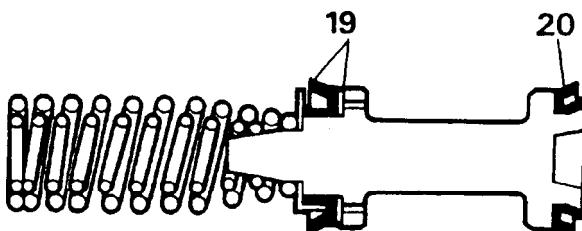
RR2234M

## KEY TO MASTER CYLINDER

- |                             |                                     |
|-----------------------------|-------------------------------------|
| 1. Water ingress seal       | 10. Washer                          |
| 2. Transfer housing         | 11. Recuperating seal (primary cup) |
| 3. Vacuum seal              | 12. Seal retainer                   |
| 4. Guide ring               | 13. Springs (2 off)                 |
| 5. Retaining ring           | 14. Swirl tube                      |
| 6. 'O' ring seal            | 15. Master cylinder body            |
| 7. Primary plunger assembly | 16. Reservoir seals                 |
| 8. 'L' seal                 | 17. Reservoir                       |
| 9. Secondary plunger        | 18. Low fluid level switch and cap  |

**NOTE:** Thoroughly check that no debris of any description is lodged in any of the fluid passageways and drillings. If debris is found, carefully remove, re-clean the cylinder and re-check.

19. Coat the new seals in unused brake fluid and firstly fit the 'L' seal to the plunger.
20. Fit the washer followed by the recuperating seal. Fit the seal retainer and springs, ensure the springs are correctly seated.

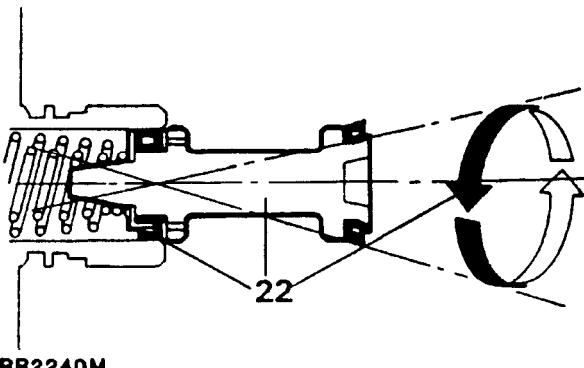


RR2236M

#### ASSEMBLING THE MASTER CYLINDER

**CAUTION:** It is important that the following instructions are carried out precisely, otherwise damage could be caused to the new seals when inserting the plungers into the cylinder bore. Generous amounts of new brake fluid should be used to lubricate the parts during assembly. Never use old fluid or any other form of cleaning and lubricating material. Cleanliness throughout is essential.

21. Fit the new swirl tube to the bottom of the cylinder bore.
22. Lubricate the secondary plunger and cylinder bore. Offer the plunger assembly to the cylinder until the recuperation seal is resting centrally in the mouth of the bore. Gently introduce the plunger with a circular rocking motion, as illustrated. Ensuring that the seal does not become trapped, ease the seal into the bore and slowly push the plunger down the bore in one continuous movement.



23. Fit the primary plunger assembly using the same method as for the secondary plunger, push the plunger down the bore.
24. Fit the original guide ring to support the primary plunger.
25. Coat a new 'O' ring with brake fluid and fit to its respective groove on the outer location surface of the master cylinder.

**NOTE:** The 'O' ring should not be rolled down the outer location surface of the master cylinder but should be slightly stretched and eased down the cylinder and into its groove. DO NOT OVER STRETCH THE SEAL.

26. Fit a new retaining ring on the outer surface of the master cylinder ensuring that the serrations of the ring are facing the mounting flange.
27. Fit the two new reservoir seals in their respective ports.
28. Fit a new vacuum seal to either the primary plunger or to the bottom of the transfer housing bore, open face of the seal towards the primary plunger guide ring.
29. Lubricate the vacuum seal with brake fluid, fit the transfer housing to the master cylinder, push the housing fully upto the cylinder mounting flange, DO NOT ADJUST THE TRANSFER HOUSING AFTER FITTING.
30. Lubricate a new water ingress seal with brake fluid, slightly stretch the seal and ease it down the housing until the seal is in the correct position between the housing and flange.
31. Roll the reservoir into the top of the master cylinder, reversing the procedure described in instruction 10.

32. Fit the master cylinder to the servo fit the plain and spring washers and secure in position with the two nuts. Tighten to the specified Torque value- see section 06.
33. Fit the brake pipes to the master cylinder and tighten to the specified Torque value- see section 06
34. Top-up the master cylinder with the correct grade of brake fluid (see section 09) bleed the brake systems.

**WARNING:** Do not use brake fluid previously drained or bled from the system. Carefully dispose of unwanted fluid, if stored in a sealed container, ensure that the container is marked USED BRAKE FLUID.

35. Fit the cap with combined low level fluid switch and reconnect the electrical lead. Re-connect the battery.

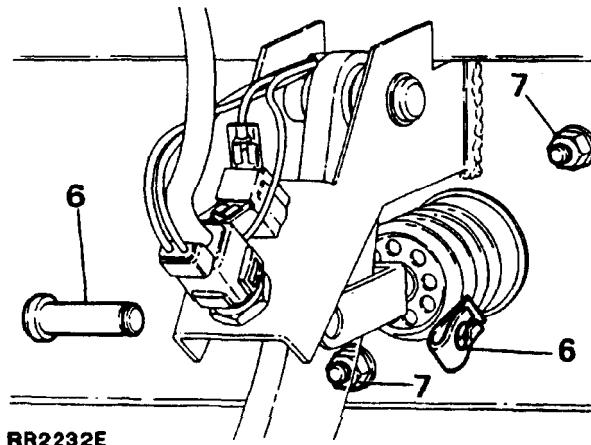
#### SERVO ASSEMBLY

##### Remove and refit

**NOTE:** Other than replacing the filter, non-return valve and grommet, the servo is not a serviceable component, in the event of failure or damage fit a new unit.

##### Removing

1. Disconnect the battery negative terminal.
2. Disconnect the electrical plug to the low fluid level switch.
3. Thoroughly clean the immediate area around all master cylinder outlet ports. Remove each of the brake pipes from the master cylinder in turn, sealing each pipe and outlet port as they are disconnected with suitable plugs, to prevent ingress of foreign matter and excessive fluid loss.
4. Disconnect the vacuum supply hose to the servo.
5. From inside the vehicle remove the lower dash panel to gain access to the spring clip securing the servo push rod to the brake pedal assembly.
6. Release the spring clip and remove the clevis pin securing the servo push rod to the brake pedal.
7. Remove the two nuts and plain washers securing the servo to the bulkhead pedal box.

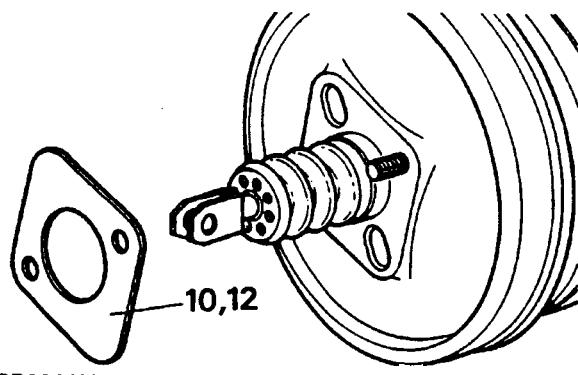


8. From within the engine compartment withdraw the servo and master cylinder assembly.
9. Remove the cap from the reservoir and drain the brake fluid into a suitable container. If the master cylinder assembly can be kept horizontal it will not be necessary to drain the fluid.

**WARNING:** Do not use brake fluid previously drained or bled from the system. Carefully dispose of unwanted fluid, if stored in a sealed container, ensure that the container is marked USED BRAKE FLUID.

10. Detach the spacer from the pedal box mounting face of the servo, it is important that the spacer is fitted to the mounting face of the new servo to ensure that stringent pedal to servo operating dimensions are maintained.

16. Fit the plain washers and secure the servo with the two nuts. Tighten the nuts to the specified Torque value-see section 06.
17. Refit the lower dash panel.
18. Fit the master cylinder to the servo, refit the plain and spring washers and secure the master cylinder to the servo with the two nuts. Tighten the nuts to the specified torque-see section 06 -Torque values.
19. Remove the sealing plugs, fitted to the master cylinder outlet ports during the removal procedure and refit the brake pipes to their respective ports. Tighten the brake pipes to the correct torque-see section 06-Torque values.
20. Refit the vacuum supply hose.
21. Fill the master cylinder to between the 'MAX' and 'MIN' level markings with the correct grade of brake fluid-see section 09.
22. Bleed the brake systems.



11. If a new servo is being fitted it will be necessary to remove the master cylinder from the existing servo and refitted to the new unit.

#### Refitting

12. Fit the spacer previously removed from the old servo, to the new servo.
13. Fit the servo to the pedal box assembly.
14. From inside the vehicle lightly grease the brake pedal around the area that the servo push rod pivots.
15. Fit the push rod to the brake pedal and secure in position with the clevis pin and clip.

**PEDAL ASSEMBLY****Remove, overhaul and refit****Remove**

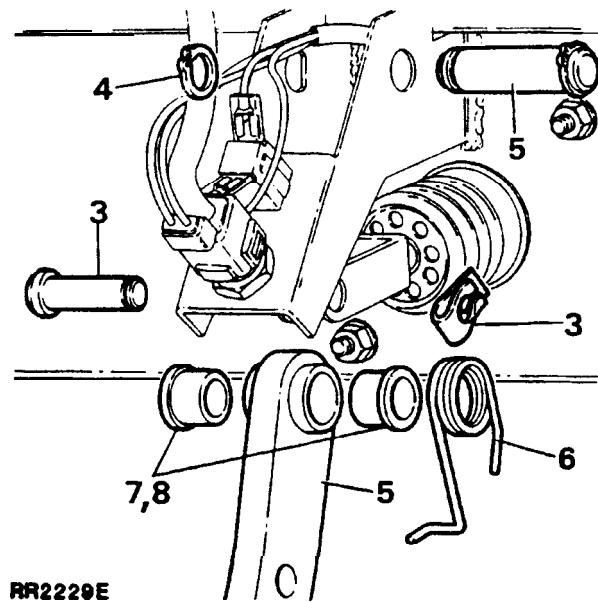
1. Disconnect the battery negative terminal.
2. From inside the vehicle remove the lower dash panel to gain access to the pedal assembly.
3. Release the spring clip ad remove the clevis pin securing the servo push rod to the brake pedal.
4. Remove the circlip from the 'D' shaped end of the pedal shaft.
5. Remove the pedal shaft from the pedal assembly and withdraw the pedal from the pedal box.
6. Remove the return spring from the pedal.

**Overhaul**

7. Remove the bushes from the pedal pivot tube.
8. Press new bushes into the pedal pivot tube. If necessary ream out the bushes to 15.87mm plus 0.05mm (.625 in plus .002in).
9. Lightly grease the bushes.

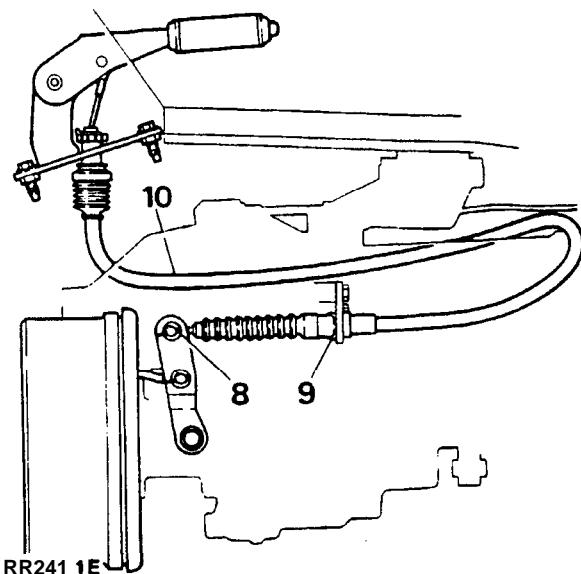
**Refitting**

10. Fit the return spring to the pedal.
11. Fit the pedal to the pedal box assembly and refit the pedal shaft. Secure the pedal assembly in position with a new circlip.
12. Lightly grease the servo push rod and secure in position with the clevis pin and clip.
13. Refit the lower dash panel and reconnect the battery.



**PARKING BRAKE CABLE****Remove and refit****Removing****Inside the vehicle**

1. Set the vehicle on level ground or place on a hoist, select 'P' in main gearbox. Disconnect the battery negative terminal.
2. Chock the road wheels.
3. Fully release the parkbrake lever.
4. Remove the four retaining screws and lift out the glove box liner to gain access to the bottom of the parkbrake lever.
5. Remove the cotter pin and withdraw the clevis pin and washer securing the cable to the parkbrake lever.
6. Remove the clip from above the adjustment thumbwheel, push the inner and outer cable to the underside of the vehicle.
7. Pull the thumbwheel from the outer sleeve.



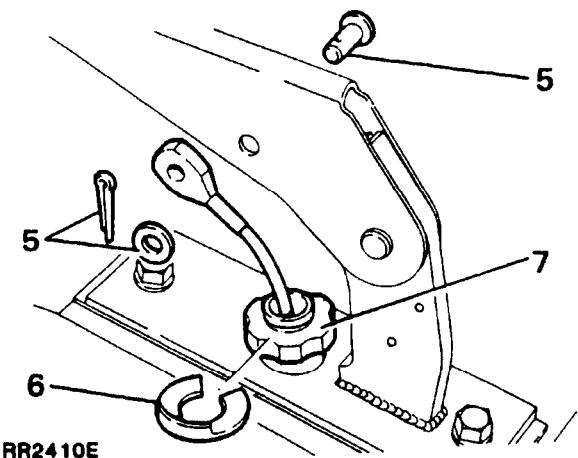
11. Withdraw the cable.

**Fit new cable**

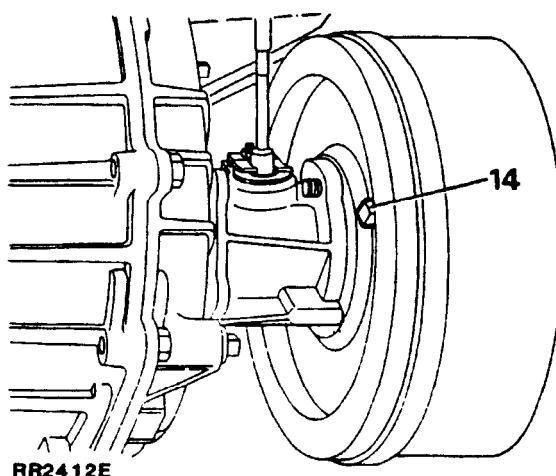
12. Reverse instructions 5 to 11 when fitting a new cable.

**Adjust parkbrake**

13. Ensure that the parkbrake lever is fully released.
14. From underneath the vehicle, rotate the adjuster on the brake drum back plate clockwise until the brake shoes are fully expanded against the brake drum.

**Underneath the vehicle**

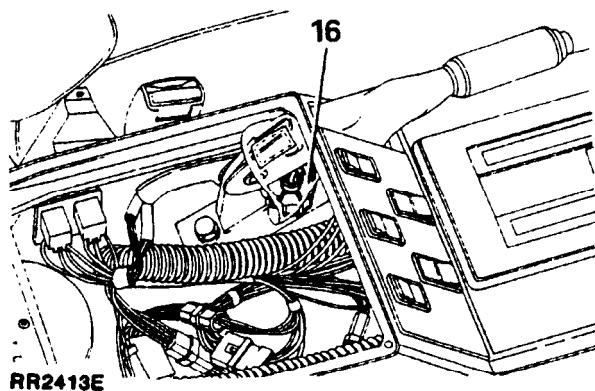
8. Remove the cotter pin and withdraw the clevis pin and washer.
9. Detach the retaining clip securing the outer cable to the support bracket located on the front cover of the transfer gearbox.
10. Release the cable from the 'P' clip located on the left hand side of the transfer gearbox.



**Continued**

15. Back off the adjuster until the drum is free to rotate.
16. Rotate the adjustment thumbwheel below the parkbrake lever until the parking brake is fully operational on the third notch of the ratchet.

**NOTE: The parking brake adjustment thumbwheel must only be used for initial setting and to compensate for cable stretch, it must not be used to take up brake shoe wear, which must continue to be adjusted at the brake drum.**



17. Operate the parkbrake once or twice to settle the brake shoes, recheck that the parkbrake is fully operational on the third notch of the ratchet. Re - adjust as necessary.
18. Refit the glove box liner.
19. Reconnect the battery and remove the wheel chocks.

**CLAYTON DEWANDRE - WABCO POWER ASSISTED HYDRAULIC BRAKE SYSTEM WITH INTEGRATED ANTI-LOCK BRAKE SYSTEM - ABS**

**INTRODUCTION**

The purpose of ABS is to prevent the vehicle wheels locking during brake application, thus maintaining vehicle steerability and stability. This allows the vehicle to be steered whilst the brakes are applied, even under emergency conditions, and to avoid obstacles where there is sufficient space to redirect the vehicle.

**WARNING: ABS IS AN AID TO RETAINING STEERING CONTROL AND STABILITY WHILE BRAKING.**

- ABS CANNOT DEFY THE NATURAL LAWS OF PHYSICS ACTING ON THE VEHICLE.
- ABS WILL NOT PREVENT ACCIDENTS RESULTING FROM EXCESSIVE CORNERING SPEEDS, FOLLOWING ANOTHER VEHICLE TOO CLOSELY OR AQUAPLANING, I.E. WHERE A LAYER OF WATER PREVENTS ADEQUATE CONTACT BETWEEN THE TYRE AND ROAD SURFACE.
- THE ADDITIONAL CONTROL PROVIDED BY ABS MUST NEVER BE EXPLOITED IN A DANGEROUS OR RECKLESS MANNER WHICH COULD JEOPARDISE THE SAFETY OF THE DRIVER OR OTHER ROAD USERS.

**SYSTEM DESCRIPTION**

The brake system is hydraulically power assisted with an integrated, electronically controlled four channel anti-lock brake system (ABS). The use of a power assisted brake system means that during brake application, additional hydraulic energy is provided by a hydraulic power unit. This hydraulic power unit consists of an electrically driven pump and an accumulator which stores hydraulic energy in readiness for brake application. A pressure switch controls the hydraulic pump to maintain fluid pressure in the accumulator.

The hydraulic system comprises two completely independent circuits. The rear calipers and upper pistons of the front calipers form the POWER CIRCUIT. The lower pistons in the front calipers form the COMBINED POWER/HYDROSTATIC CIRCUIT.

**CAUTION: THOROUGHLY CLEAN ALL BRAKE COMPONENTS, CALIPERS, PIPES AND FITTINGS BEFORE COMMENCING WORK ON THE BRAKE SYSTEM. FAILURE TO DO SO COULD CAUSE FOREIGN MATTER TO ENTER THE SYSTEM AND DAMAGE SEALS AND PISTONS, WHICH WILL SERIOUSLY IMPAIR BRAKE SYSTEM EFFICIENCY.**

**WARNING:**

**DO NOT use brake fluid previously bled from the system.**

**DO NOT use old or stored brake fluid.**

**ENSURE that only new fluid is used and that it is taken from a clean sealed container.**

**DO NOT flush the brake system with any fluid other than the recommended brake fluid.**

The brake system must be drained and flushed at the recommended service intervals.

Fluid pressures of 170 bar (2466 psi) are produced by the hydraulic pump. It is essential that the procedure for depressurising the system is carried out where instructed.

**COMPONENT DESCRIPTION**

- Numbers refer to RR2705

**Hydraulic booster unit (1)**

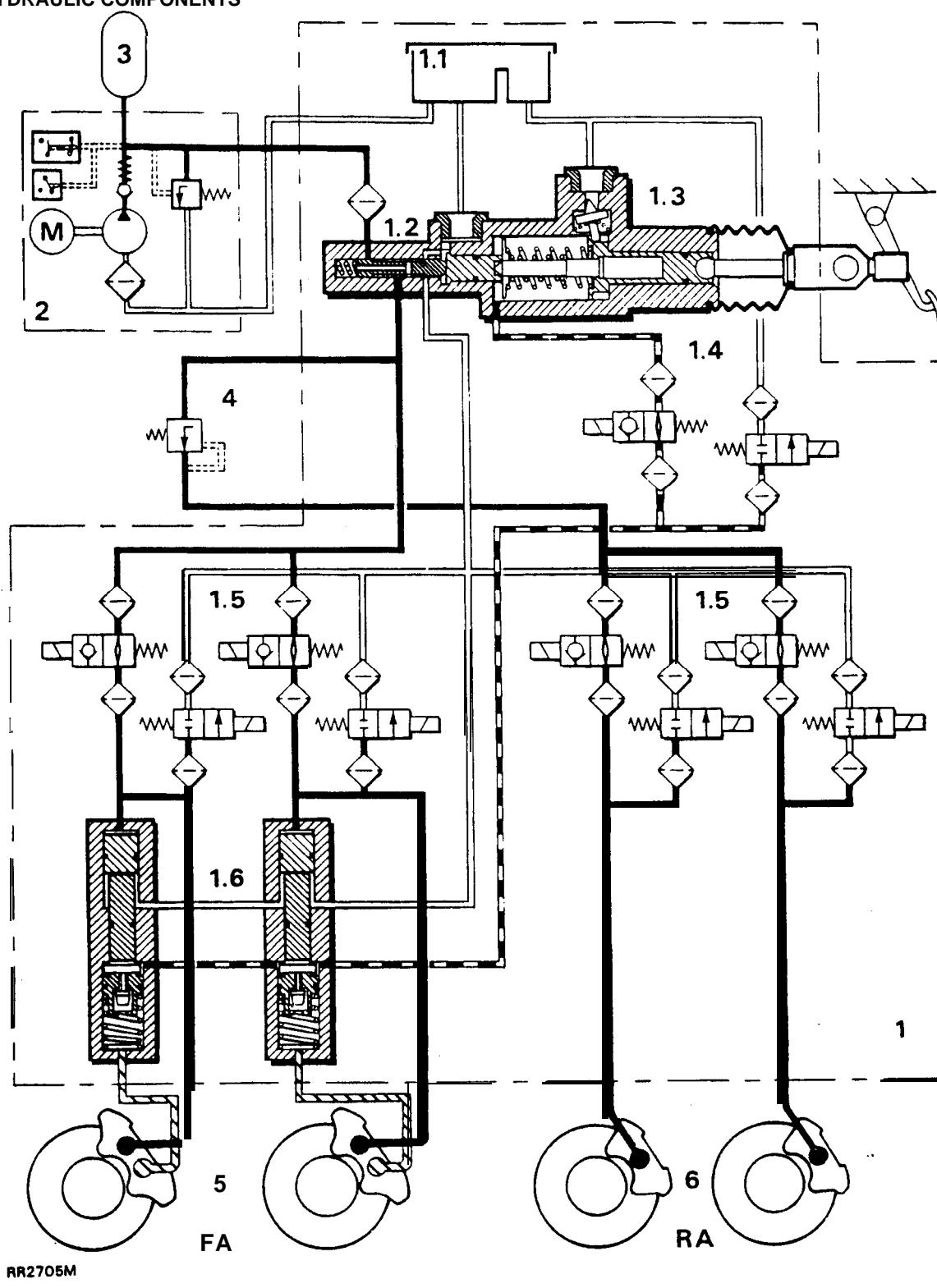
Mounted in the same position as the conventional master cylinder/servo unit, the booster unit contains the following components: Fluid reservoir, power valve, master cylinder, isolating valve, ABS solenoid control valves, servo cylinder.

**NOTE: The hydraulic booster unit is not a serviceable item, if internal failure occurs a new unit must be fitted. The fluid reservoir and its seals may be changed in the event of damage. Extreme care must be taken when changing seals to avoid ingress of debris.**

**Fluid reservoir (1.1)**

Mounted on top of the booster unit, the plastic reservoir is subdivided internally to provide separate capacity for the brake fluid used in the hydrostatic and power circuits. A central tube incorporates a filter and a low fluid warning level switch.

## HYDRAULIC COMPONENTS



RR2705M

A —————

B —————

C - - -

D - - -

E - - -

C - Hydrostatic (master cylinder) circuit

D - Combined hydrostatic/power circuit

E - Component enclosure

## Key to diagram

- A - Fluid feed/return  
 B - Power circuit

**Power valve (1. 2)**

The power valve is an extension of the master cylinder, it controls fluid pressure in the power circuit in direct proportion to pressure in the master cylinder. The power valve is of spool valve design.

**Master cylinder (1.3)**

Operation of the master cylinder displaces a volume of brake fluid into the servo cylinders and increases fluid pressure. Piston movement inside the master cylinder will also activate the power valve. A tilt valve is incorporated to supply fluid to the master cylinder from the reservoir connection.

**Isolating valve (1. 4)**

The isolating valve consists of two solenoid valves controlling fluid inlet and outlet. Their function is to disconnect the master cylinder from the servo cylinder and to connect the servo cylinder to the reservoir return during ABS function.

**ABS solenoid control valves • 8 off (1. 5)**

Each pair, comprising inlet and outlet solenoid valves, controls ABS braking to each wheel. In response to signals from the ECU, the valves decrease, hold or increase brake pressure according to the need to retain wheel rotation and obtain optimum braking. The solenoid valves are designed to respond rapidly to ECU signals.

**Servo cylinders • 2 off (1. 6)**

The servo cylinders have four functions.

1. To provide combined energy from both the hydrostatic and the power circuit to the brake calipers.
2. To provide 'brake feel' at the brake pedal.
3. To provide hydrostatic (master cylinder) braking through the servo cylinder to the calipers in the event of no power circuit pressure to the servo cylinder.
4. To provide braking from both the power circuit and from hydrostatic fluid remaining in the servo cylinder, in the event of no hydrostatic circuit pressure from the master cylinder.

**Hydraulic power unit (2)**

The hydraulic power unit comprises an electrically driven pump and a pressure switch. The pressure switch incorporates three electro-mechanical switches: one for the pump, another, at a different pressure setting, to illuminate the pressure warning light, The latter switch plus the third switch inform the ECU of low pressure and that ABS function should cease whilst pressure remains low.

The pump also incorporates a non-return valve, a low pressure inlet filter, and a pressure relief valve to protect the system.

**Accumulator (3)**

The diaphragm accumulator is precharged with nitrogen, its function is to store hydraulic energy.

**Pressure conscious reducing valve (PCRV) (4)**

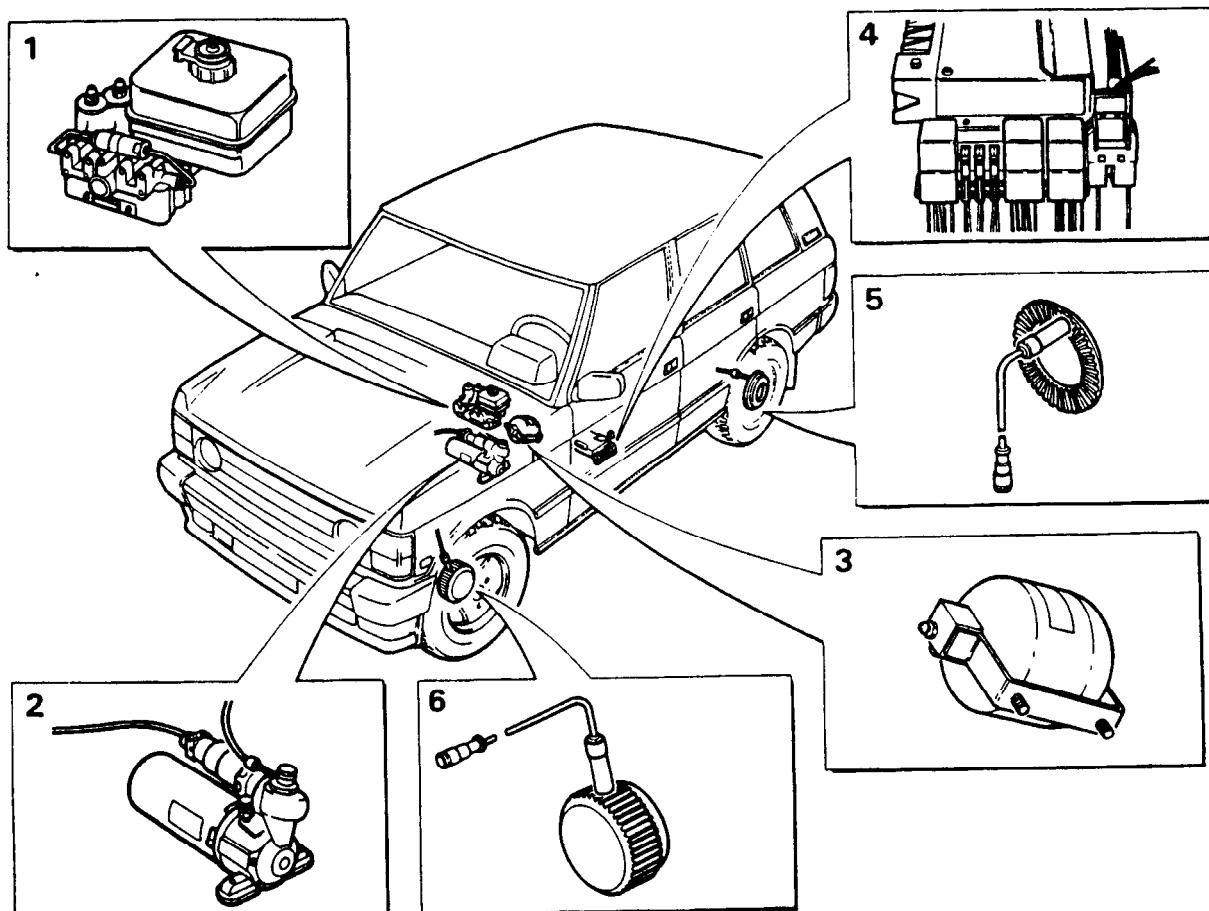
The PCRV valve is located between the power valve and the ABS solenoid valves for the rear axle. Its function is to limit the brake pressure to the rear axle.

**Brake calipers • front • (5) rear • (6)**

**NOTE:** To identify the separate hydraulic circuits, they are referred to as Hydrostatic and Power circuits.

**Power circuit** • The rear calipers and the upper pistons in the front calipers form one circuit, supplied by direct hydraulic power from the power valve.

**Hydrostatic circuit** • The lower pistons in the front calipers form the other circuit, supplied with hydraulic energy from the servo cylinders comprising a combination of master cylinder pressure and direct hydraulic power.



RR2706M

**LOCATION OF COMPONENTS (RR2706M)**

1. Hydraulic booster unit.
2. Power unit - hydraulic pump.
3. Accumulator.
4. Electronic control unit (ECU), relays and fuses.
5. Rear sensors/exciter rings.
6. Front sensors/exciter rings.

**Electronic control unit - ECU**

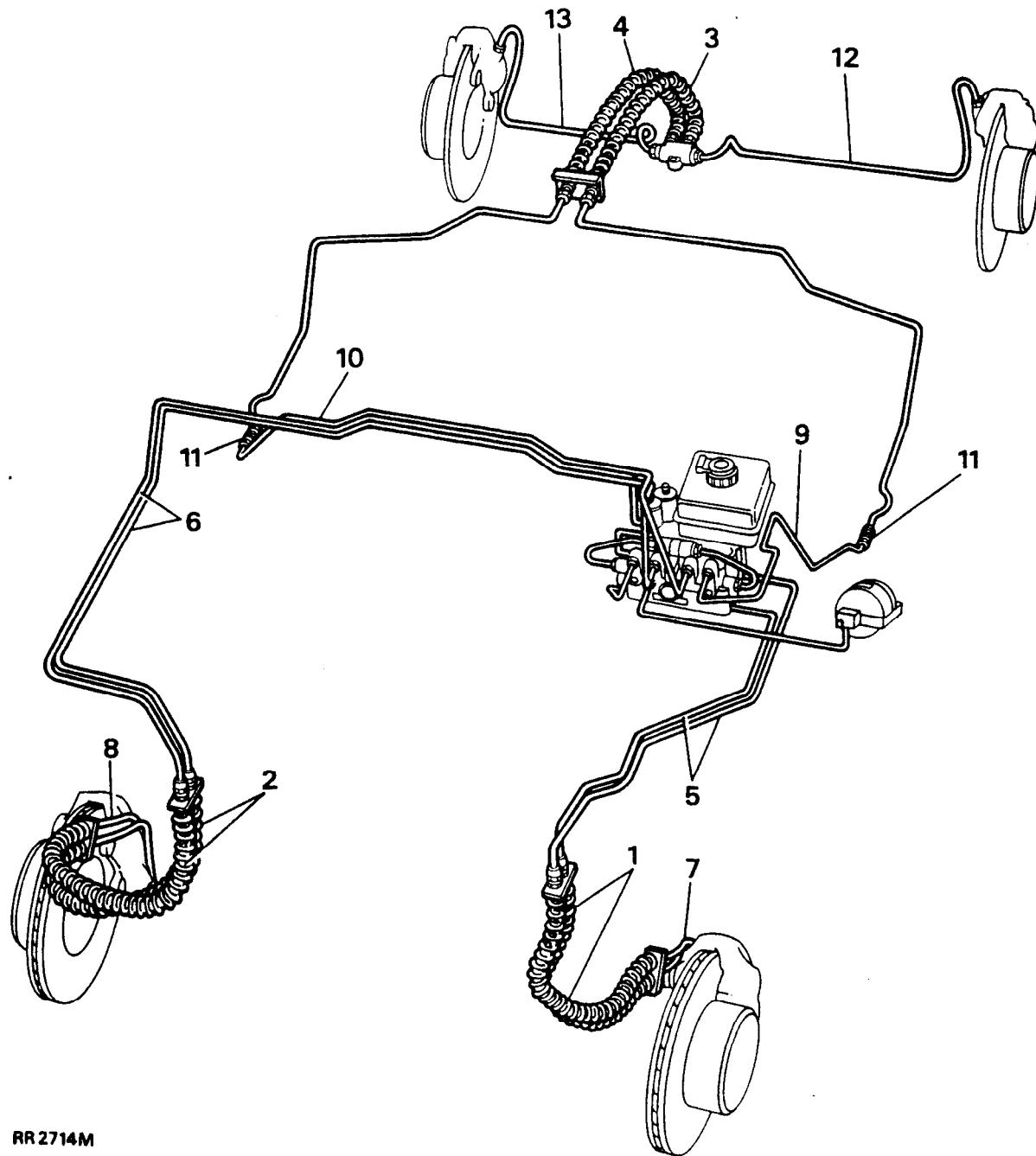
ABS operation is controlled by the ECU located under the left hand front seat, and earthed to the centre tunnel.

The ECU is connected to the ABS harness by a 35 way connector.

The ECU is a non-serviceable item, it must be replaced if failure occurs.

**Sensors, exciter rings - 4 off**

A sensor is mounted at each wheel, sensing a 60 tooth exciter ring. When the vehicle is in motion the inductive sensors send signals to the ECU. The front exciter ring is fitted to the outside diameter of the constant velocity joint in each front hub. The rear exciter ring is bolted to the rear of each brake disc bell.



RR 2714M

**Brake pipe layout - left hand drive****HOSES**

1. Front left hand flexible hoses.
2. Front right hand flexible hoses.
3. Left hand intermediate hose
4. Right hand intermediate hose

**PIPES**

5. Feed to front left hand hose connector.
6. Feed to front right hand hose connector.
7. Feed to front left hand caliper.
8. Feed to front right hand caliper.
9. Feed to left hand intermediate hose.
10. Feed to right hand intermediate hose.
11. Two way connector.
12. Feed to rear left hand caliper.
13. Feed to rear right hand caliper.

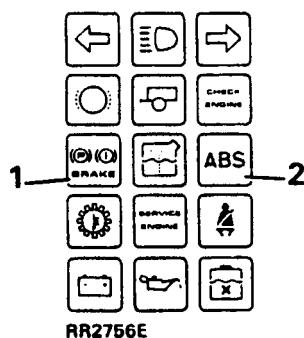
**WARNING LIGHTS**

**Brake fluid pressure/level and parking brake warning light - (red) - 1**

The warning light situated in the instrument binnacle indicates that there is insufficient pressure in the system and/or the fluid level is too low. The light will illuminate when ignition is switched ON as part of initial bulb check, and when the parking brake is applied.

If the pressure in the hydraulic system is lower than the cut-in pressure for the warning light, the light will illuminate. When the light is on the hydraulic pump will start. Therefore, if the light remains illuminated after bulb check and releasing handbrake, DO NOT drive the vehicle until the light extinguishes.

**WARNING: IF THE LIGHT ILLUMINATES WHILE THE VEHICLE IS IN MOTION, THE FAULT MUST BE INVESTIGATED IMMEDIATELY. BRAKING WILL BE AVAILABLE AFTER A LOSS OF PRESSURE, BUT GREATER FORCE WILL BE REQUIRED AT THE PEDAL TO SLOW THE VEHICLE.**

**ABS warning light - (amber) - 2**

**WARNING: Power assisted braking is not available if the ignition is switched off. An increase in effort at the pedal will be required to apply the brakes.**

The ABS warning light situated in the instrument binnacle indicates that there is a failure in the ABS system. The light will illuminate when the ignition is switched ON, and will extinguish when the vehicle exceeds 7 km/h (5 mph). This indicates that the system self monitoring check was successful, and the system performs correctly.

If the light remains on or subsequently illuminates with the ignition ON a fault in the ABS system is indicated. The self monitoring procedure is repeated frequently while the ignition is ON. If a fault is detected during self monitoring, the light will illuminate indicating that one or more wheels are not under ABS control.

**WARNING: Reduced ABS control is possible with the ABS warning light illuminated depending on the severity and type of fault. If both ABS and brake failure warning lights are illuminated, loss of system pressure or hydraulic pump failure is indicated.**

**IT IS ESSENTIAL THAT THE DRIVER HAS THE FAULT INVESTIGATED IMMEDIATELY.**

**DRIVING THE VEHICLE**

**WARNING: On surfaces which are soft and deep, for example deep powdery snow, sand or gravel, braking distance may be greater than with non ABS braking. In these conditions wheel lock and the build up of snow or gravel under the wheels may be an aid to shorter stopping distance. However it is still an advantage to maintain the stability and manouevrability available with ABS control.**

1. Switch on ignition, the system will automatically carry out its self test function. This will be felt as a slight movement in the brake pedal and a short, rapid series of clicks indicating that the solenoid valves have been checked.

2. Observe the warning lights, check that the parking brake/fluid pressure/level warning light extinguishes after initial bulb check or when the parking brake is released, indicating that power assistance is available. Note that the time taken to pressurise the system is approximately 20 seconds.
3. Start the vehicle and drive away, at 7 km/h (5 mph) the ABS warning light must be extinguished - see Warning Lights.
4. In road conditions where surface friction is sufficient to slow or stop the vehicle without wheel lock, the ABS does not operate.
5. In an emergency braking situation, if one or more wheels begin to slow rapidly in relation to vehicle speed, ABS will detect the wheel locking tendency and will regulate the brake pressure to maintain wheel rotation.
6. ABS operation will be felt as a vibration through the pedal, at the same time the solenoid cycling will be heard.

**NOTE:** Constant pressure on the foot pedal whilst ABS is operating is more effective than cadence braking. Do not pump the brake pedal as this may reduce ABS efficiency and increase stopping distance.

7. Downward travel of the pedal will also feel hard at the point at which ABS operates. little further pedal travel is possible at this point, BUT, force on the pedal can be varied to influence braking while ABS retains control.

#### BRAKE APPLICATION WITH PARTIAL FAILURE

**WARNING: IF A FAULT DEVELOPS IN THE BRAKE SYSTEM IT IS ESSENTIAL THAT THE DRIVER HAS THE FAULT INVESTIGATED IMMEDIATELY.**

**NOTE:** If, during braking, a drastically reduced resistance is detected at the pedal and braking effectiveness is very much reduced, failure of the non-powered (master cylinder) portion of the system is indicated. When this occurs DO NOT PUMP THE BRAKE PEDAL. Push the pedal through the free movement to obtain braking effort. For this reason it is essential that brake pedal travel is not obstructed by the addition of items such as extra footwell mats.

1. When power assistance is not available, ABS braking is not operative. Both warning lights are illuminated. Braking effort is available from the master cylinder only. This results in longer pedal travel and greater pedal effort required to decelerate the vehicle.

**WARNING: FOOT PRESSURE ON THE PEDAL, USING MASTER CYLINDER ONLY, WILL NOT ACHIEVE THE SAME DEGREE OF BRAKING AS THAT AVAILABLE FROM POWER ASSISTANCE.**

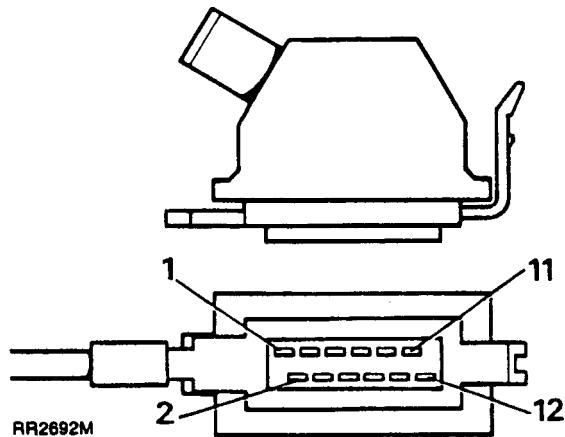
2. If the master cylinder fails, i.e. there is insufficient fluid in the master cylinder to create pressure, braking to all four wheels is retained and ABS remains operative. The red warning light will be illuminated if the cause of the master cylinder failure is a fluid leak and the level in the master cylinder is low enough to actuate the fluid level switch.

**WARNING: LONGER PEDAL TRAVEL IS REQUIRED, BUT POWER ASSISTED BRAKING IS AVAILABLE AT A REDUCED EFFICIENCY.**

3. If brake failure occurs due to a fractured brake pipe between a servo unit and a wheel, there will be no pressure in the reservoir. The fluid warning light will be illuminated when the level in the master cylinder is low enough to actuate the fluid level switch. The master cylinder and power valve will operate as for master cylinder failure. BUT, fluid from the power circuit will push all the moving parts in the servo cylinder associated with the failure to the limit of their travel. No pressurised fluid passes to those brake pistons served by the servo cylinder, but all other pistons in front and rear calipers will be supplied with direct pressure from the power valve. The pistons served by the other servo cylinder retain braking as fluid from the master cylinder is retained in the servo cylinder not associated with the leakage.

**WARNING: BRAKE PEDAL TRAVEL WILL BE GREATER AND EXTRA PEDAL EFFORT WILL BE REQUIRED, ACCCOMPANIED BY THE VEHICLE PULLING TO ONE SIDE.**

## Booster harness plug wiring details



## RR2692M

- |                  |                  |
|------------------|------------------|
| 1. Slate/yellow. | 7. Slate/orange. |
| 2. Not used.     | 8. Slate/brown.  |
| 3. Slate/white.  | 9. Slate/blue.   |
| 4. Slate/green.  | 10. Slate/pink.  |
| 5. Slate/black.  | 11. Slate/red.   |
| 6. Slate/purple. | 12. Not used.    |

## CIRCUIT DIAGRAM . RR2689M

- ST1. Battery
- ST2. Terminal post
- ST5. Ignition switch
- AB1. 30 amp MAXI fuse - pump relay
- AB2. Pump relay - black
- AB3. Hydraulic pump
- AB4. Hydraulic pump pressure cut off switch
- AB5. Pump low pressure warning switch
- AB6. Reservoir fluid level switch
- AB7. Diode
- AB8. Brake fluid pressure/level warning light
- AB9. ABS warning light
- AB10. 5 amp fuse, pump relay
- AB11. 5 amp fuse, pin 9 ECU, diagnostic plug, brake light switch
- AB12. ABS warning light relay - green
- AB13. 25 amp fuse, valve relay
- AB14. Valve relay - black
- AB15. Diagnostic plug
- AB16. Electronic control unit (ECU)
- AB17. 35 way connector to ECU
- AB18. Brakelight switch
- AB19. Brakelights
- AB20. Multiplug to booster unit

## Booster unit components AB21-25

IV Inlet valve  
OV Outlet valve

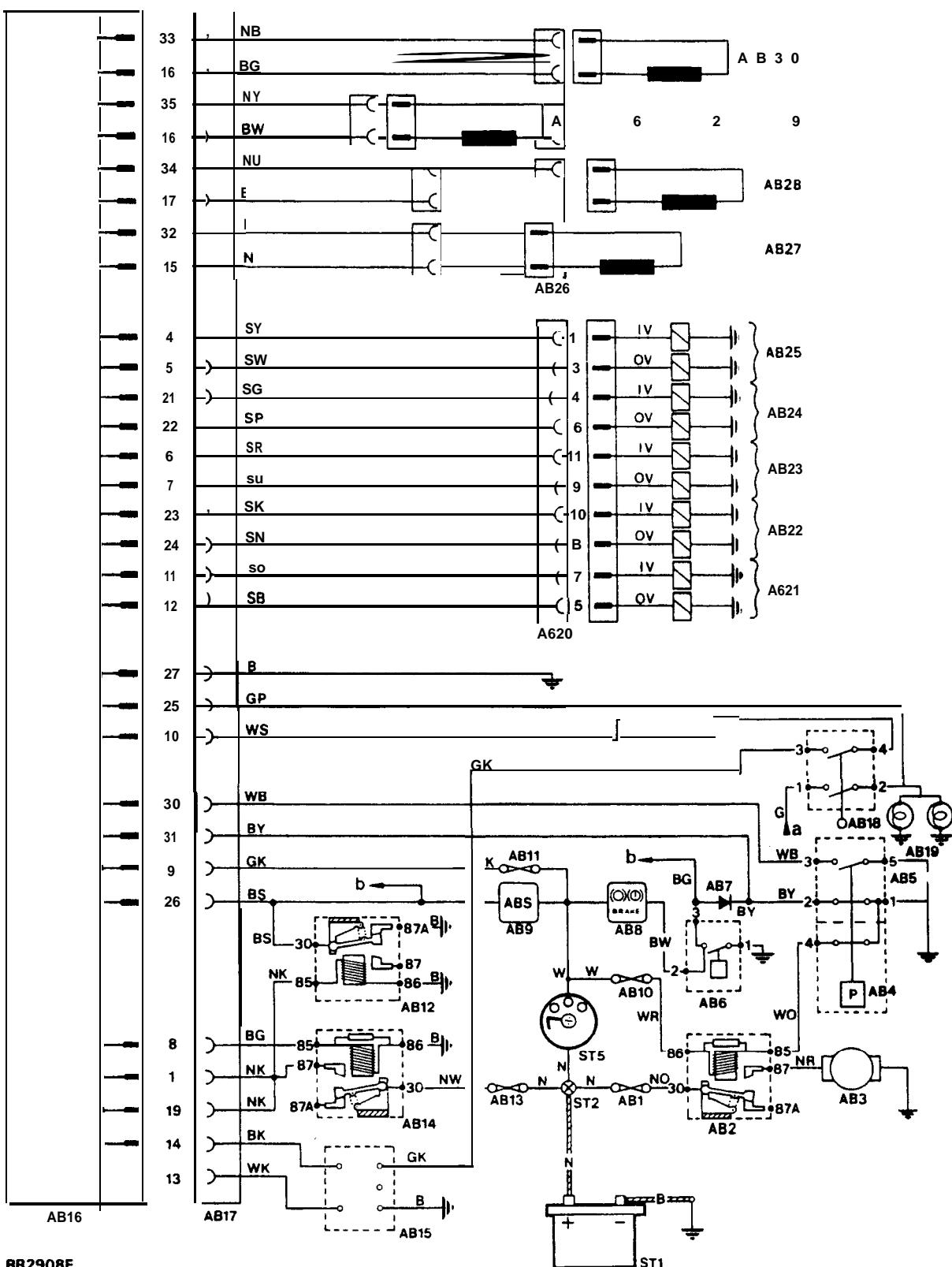
- AB21. Isolating valve
- AB22. Front left solenoid valves
- AB23. Front right solenoid valves
- AB24. Rear left solenoid valves
- AB25. Rear right solenoid valves
- AB26. Sensor connectors (4)
- AB27. Front left sensor
- AB28. Front right sensor
- AB29. Rear left sensor
- AB30. Rear right sensor

- 12 volts from fuse A5
- To bulb check unit

## CABLE COLOUR CODE

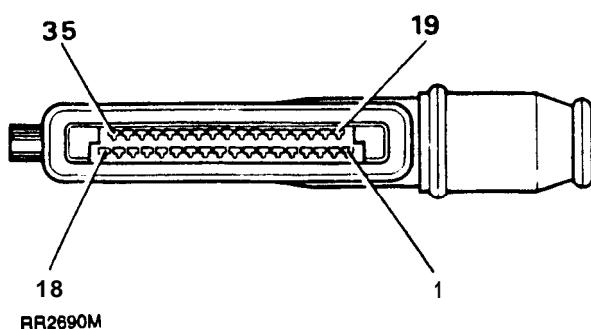
B Black	G Green
U Blue	S Grey
N Brown	O Orange
K Pink	W White
P Purple	Y Yellow
R Red	

## **ABS - Circuit diagram**



**RR2908E**

## ECU HARNESS PLUG

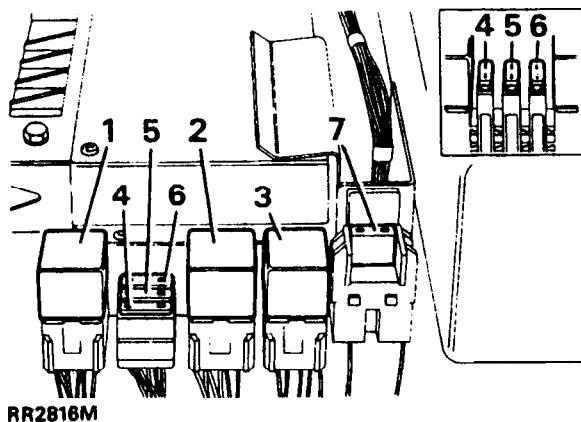


## ECU harness plug wiring details • RR2690M

- |                  |                   |
|------------------|-------------------|
| 1. Brown/pink.   | 19. Brown/pink.   |
| 2. Not used.     | 20. Not used.     |
| 3. Not used.     | 21. Slate/green.  |
| 4. Slate/yellow. | 22. Slate/purple. |
| 5. Slate/white.  | 23. Slate/pink.   |
| 6. Slate/red.    | 24. Slate/brown.  |
| 7. Slate/blue    | 25. Green/purple. |
| 8. Black/green   | 26. Black/slate.  |
| 9. Green/pink    | 27. Black.        |
| 10. White/slate  | 28. Not used      |
| 11. Slate/orange | 29. Not used      |
| 12. Slate/black  | 30. White/black.  |
| 13. White/pink.  | 31. Black/yellow. |
| 14. Black/pink.  | 32. Black/orange. |
| 15. Brown.       | 33. Brown/black.  |
| 16. Black/green. | 34. Brown/blue.   |
| 17. Black/brown. | 35. Brown/yellow. |
| 18. Black/white. |                   |

## RELAYS AND FUSES

Incorporated in the ABS electrical system are three relays, located beneath the left hand front seat adjacent to the ABS ECU. Access to the relays is gained by removing the seat side trim.



Inset shows fuse position on early 1990 vehicles.

## Relay and fuse identification (RR2816M)

1. ABS warning light relay, green base - AB12
2. Valve relay, black base - AB14
3. Hydraulic pump relay, black base - AB2
4. Hydraulic pump relay fuse, 5amp tan - AB10
5. Stop light switch, diagnostic plug, ECU pin 9 fuse, 5 amp tan - AB11
6. Valve relay fuse, 25 amp white - AB13
7. Hydraulic pump relay fuse 30 amp green MAXI type fuse - AB1

## GENERAL SERVICE INFORMATION

**NOTE:** ABS components ARE NOT! serviceable. Replace components that are found to be faulty.

## Brake fluid precautions

**WARNING:** Do not allow brake fluid to come into contact with eyes or skin.

**CAUTION:** Brake fluid can damage paintwork, if spilled wash off immediately with plenty of clean water.

**CAUTION:** Use only the correct brake fluid. If an assembly fluid is required use brake fluid. Do NOT use mineral oil, i.e. engine oil etc.

## Check/top up fluid level

1. Park the vehicle on level ground.
2. Turn ignition ON, to activate hydraulic pump. If pump does not activate depress brake pedal several times until it is heard to operate.
3. When the pump stops, check that the level is between the 'MIN' and 'MAX' marks.
4. If the level is below the 'MIN' mark top up fluid level to the 'MAX' mark on reservoir, using the correct fluid, - see Section 09, Lubricants and Fluids.

**WARNING:** Clean reservoir body and filler cap before removing the cap. Use only fluid from a sealed container.

## DO NOT OVER FILL THE RESERVOIR

## DEPRESSURISE

**WARNING:** Before bleeding the system or working on any component in the brake system the following procedure MUST be carried out to depressurise the accumulator.

1. Switch off ignition.
2. Operate the brake pedal 30 times. Pedal travel will increase slightly and reduced resistance will be felt as pressure decreases.
3. Wait for 60 seconds, press the brake pedal four more times. This procedure will ensure that all pressure is evacuated from the system.

## SYSTEM BLEED

**EQUIPMENT:** Bleed the system using a bleed tube and a clean bottle containing a small amount of clean liquid.

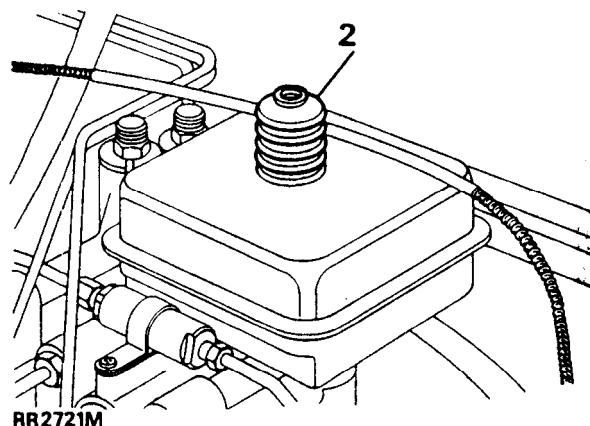
**CAUTION:** Clean all bleed screws, filler cap and connections thoroughly using clean brake fluid only. DO NOT USE MINERAL OIL I.E. ENGINE OIL ETC.

## MAINTAIN CLEANLINESS THROUGHOUT.

**NOTE:** During bleed procedure the reservoir fluid level must not fall below the 'MIN' level. Regularly check level and keep topped up to 'MAX' level.

**WARNING:** Do not use previously used brake fluid. Ensure that only new fluid is used and that it is taken from a clean sealed container. Carefully dispose of unwanted fluid in a sealed container, marked USED BRAKE FLUID.

1. Switch off ignition and depressurise the system. Ensure that ignition remains OFF until instruction 7.
2. Fill the fluid reservoir with the specified fluid to the 'MAX' level.

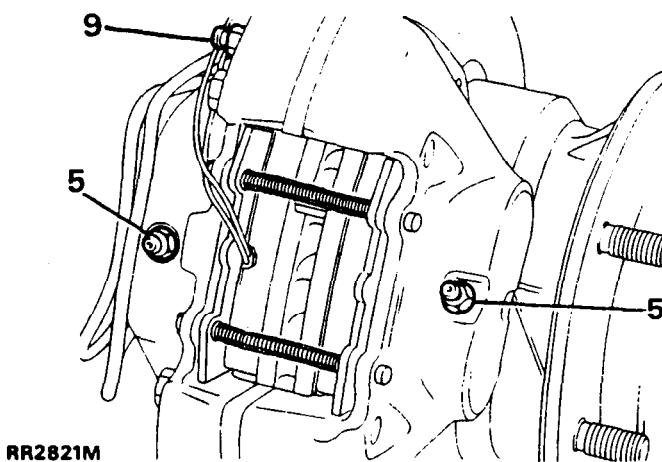


**NOTE:** Time consumed in filling the booster may be reduced by fitting a rubber bellows unit to the filler neck, and using hand pressure to pressurise the reservoir. A spare bellows unit from the booster push rod is suitable for this purpose.

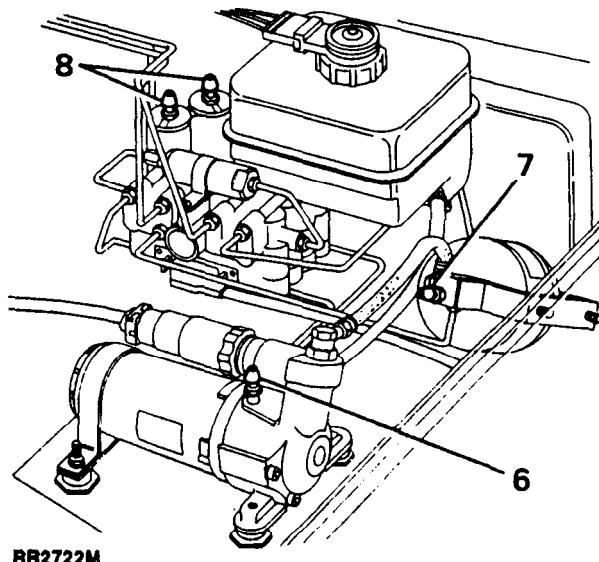
Ensure the bellows unit is perfectly clean to avoid foreign matter entering the system. Raising the rear of the vehicle will assist the fill procedure.

3. Depress brake pedal slowly and progressively five times, using full pedal stroke. Release the pedal for five to ten seconds, during this time air bubbles will rise into the reservoir.

4. Repeat instruction 3. until some resistance is felt. If no resistance is felt check that the clevis pin is connected to the correct (UPPER) hole in the brake pedal.
5. Bleed the four front caliper lower (hydrostatic) bleed screws in the conventional manner. Proceed in the order: outer bleed screw on the driver's side, opposite caliper outer bleed screw, inner bleed screw, inner bleed screw driver's side. Depress the brake pedal slowly and progressively. Lock the bleed screw at the bottom of each stroke.



6. Bleed the hydraulic pump - open the bleed screw on the pump and allow fluid to flow until it is clear of air bubbles. Do not use the bleed bottle, use a clean absorbant cloth to prevent fluid spillage.



7. Bleed the accumulator - open the bleed screw. Switch on ignition, run pump for 3-4 secs, switch off and repeat procedure until no further air bubbles enter bleed bottle. Switch off ignition. Close the bleed screw.
8. Bleed the two hydraulic booster bleed screws. Open one bleed screw, depress the brake pedal, switch on ignition, run pump until no further air bubbles enter the bleed bottle. Close booster bleed screw, switch off ignition and release pedal. Repeat for other bleed screw.
9. Bleed power circuit at four calipers in turn. Depress pedal, open bleed screw, (upper bleed screw on front calipers). Switch on ignition, run pump for 3-4 secs, switch off and repeat procedure until no further air bubbles enter bleed bottle. Switch off ignition, close caliper bleed screw, release pedal.
10. Bleed master cylinder - switch ignition on. System pressure will increase until pump cuts out. If pump does not cut out after running for 45 secs, check system for leaks.
11. Bleed hydrostatic circuit calipers - open one front lower caliper bleed screw. Actuate brake pedal several times, using only the lower two thirds of pedal travel, until no further air bubbles enter the bleed bottle. Stop actuation if fluid warning light comes on and allow pressure to build up.
12. Close caliper bleed screw before releasing pedal, repeat for remaining three hydrostatic bleed screws.
13. Check/top up reservoir fluid level - see Check/top up fluid level.
14. Dry all connections, fully pressurise system and check for leaks. If two full brake applications switch on pump, from fully charged, rebleed system.

#### CALIPERS - Front and rear

Refer to main workshop manual for caliper remove and refit. Use a recognised hose clamp, using the approved procedure. If one caliper has been removed, and the use of a brake hose clamp has been effective in preventing fluid level falling below the minimum mark in the reservoir, bleed the brakes as follows:

**Front caliper** - bleed the front caliper at both power and hydrostatic circuits.

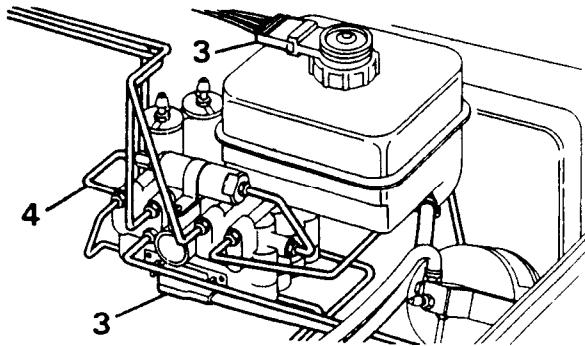
**Rear caliper** - bleed the rear caliper.

**NOTE: If the excessive fluid loss has occurred, ...** bleed the complete brake system.

**HYDRAULIC BOOSTER UNIT****Remove and refit****Removing**

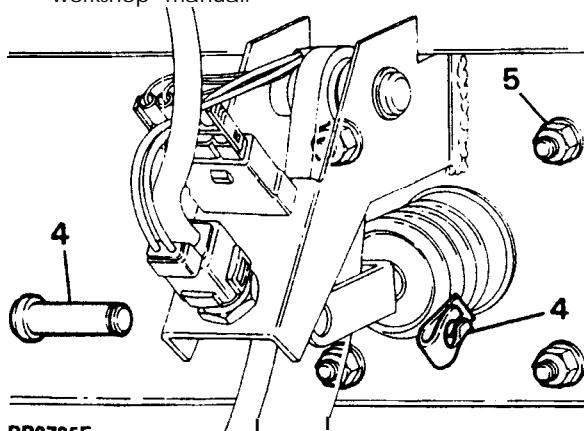
**CAUTION:** Do not allow the booster unit to be dropped or rested on its front face. Damage to the plastic tangs of the multiplug could occur which will require the fitting of a new booster unit

1. Disconnect battery negative lead, and depressurise the system.
2. Thoroughly clean the immediate area around the booster unit outlet ports and electrical connector.
3. Disconnect the electrical multiplug from the booster, and the connector to the low fluid switch located in the reservoir cap. Remove the booster earth strap.



RR2723M

4. Remove brake pipes from booster unit including hydraulic pipes to the accumulator and hydraulic power unit. Note that each booster outlet port is numbered, and each brake pipe is marked with the corresponding number to aid reassembly. Seal each pipe and outlet port, as they are disconnected, with suitable plugs, to prevent ingress of foreign matter.
5. Working inside the vehicle remove the lower dash panel - see Body Section 76, main workshop manual.



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4. Release the spring clip from the clevis pin securing the booster push rod to the brake pedal.
5. Remove the four nuts and plain washers securing the booster unit to the bulkhead.
6. Remove the booster unit.

**Refitting**

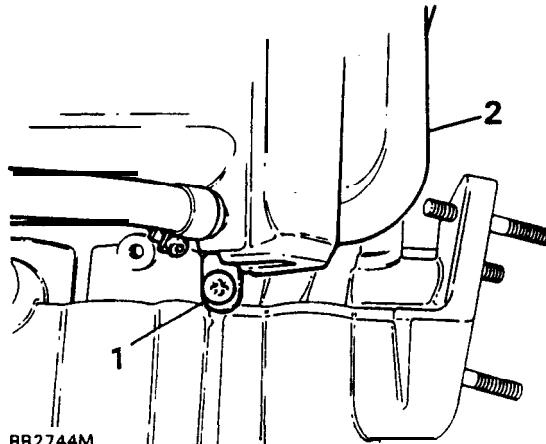
**NOTE:** New booster units are supplied in a sealed pack marked with a 'use by' date. DO NOT fit a booster if the date has elapsed, or if the pack is not sealed. DO NOT open the sealed pack until ready to fit the unit.

7. Reverse the removal procedure, ensuring correct fitment of pipes to booster unit. Finally tighten booster fixings and pipes to the correct torque value. Ensure that the clevis pin is fitted into the UPPER of the two holes in the brake pedal.
8. Adjust the brake light switch, pull out the black plunger, pull the brake pedal back fully to reset the switch.
9. Carry out the brake bleeding procedure.

**RESERVOIR SEALS • Renew**

With the booster unit removed, and brake fluid drained, is possible to fit new reservoir seals. Clean the unit thoroughly before removing the reservoir.

1. Remove the reservoir bracket securing bolt adjacent to the low pressure suction hose outlet.
2. Carefully ease the reservoir away from the booster unit.



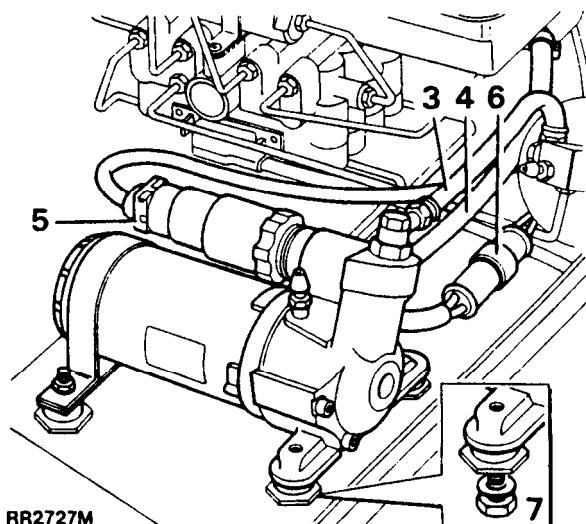
3. Remove the two seals located in the top of the booster unit. Avoid damage to the seals which could result in rubber particles entering the system.
4. Fit new seals and refit the reservoir, tightening the securing bolt to the correct torque.
5. Carry out the booster refitting procedure.

## HYDRAULIC POWER UNIT

Remove and refit

## Removing

1. Disconnect battery negative lead.
2. Depressurise the system.
3. Disconnect the braided hose to the accumulator, and the power unit multiplug.
4. Loosen the hose clip and disconnect the low pressure suction hose to the reservoir, clamp the hose to prevent fluid and ingress of debris.



5. Disconnect the pressure switch plug.
6. Disconnect the power unit connector.
7. Working from below the unit remove four nuts and plain washers.
8. Remove the hydraulic power unit complete with mountings.

## Refit

7. Reverse removal procedure. Check condition of sealing washers on high pressure hose. Fit new washers if necessary.
8. Bleed system, finally top up fluid reservoir.

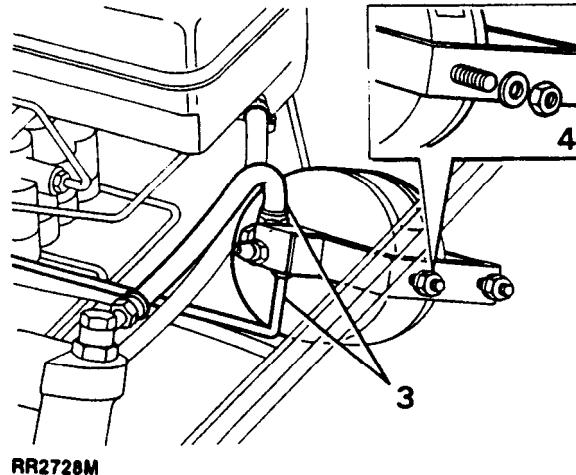
## ACCUMULATOR

**WARNING:** The accumulator is precharged with nitrogen. Handle with extreme caution. DO NOT puncture or burn if disposal is necessary.

Remove and refit

## Removing

1. Disconnect battery negative lead.
2. Depressurise the system.
3. Remove the fluid inlet and outlet pipes from the accumulator.



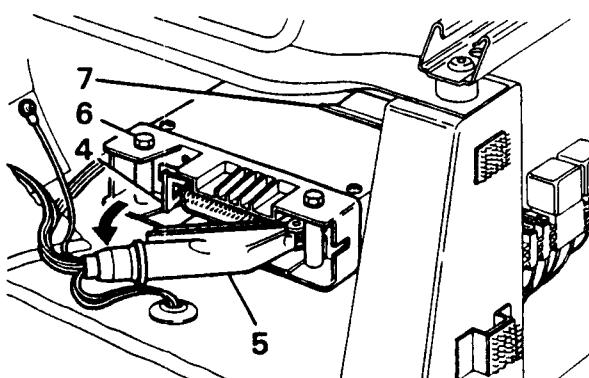
4. Remove the wheelarch inner liner and remove the two nuts and plain washers securing the accumulator.
5. Remove accumulator.

## Refitting

6. Reverse removal procedure. Check condition of sealing washers on high pressure hose. Fit new washers if necessary.
7. Carry out brake bleed procedure.

**ELECTRONIC CONTROL UNIT - ECU****Remove and refit****Removing**

1. Remove the front and side trim from the left hand front seat.
2. Adjust the seat to its most rearward position and raise the seat cushion height to allow access to the ECU.
3. Disconnect the battery negative lead.
4. Release the ECU plug retaining clip.
5. Manoeuvre the plug in the direction of the arrow and detach the hooked end of the plug from the retaining post.
6. Remove the two screws securing the ECU to the mounting bracket.
7. Withdraw the ECU from the retaining clip and remove it from the vehicle.



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**Refitting**

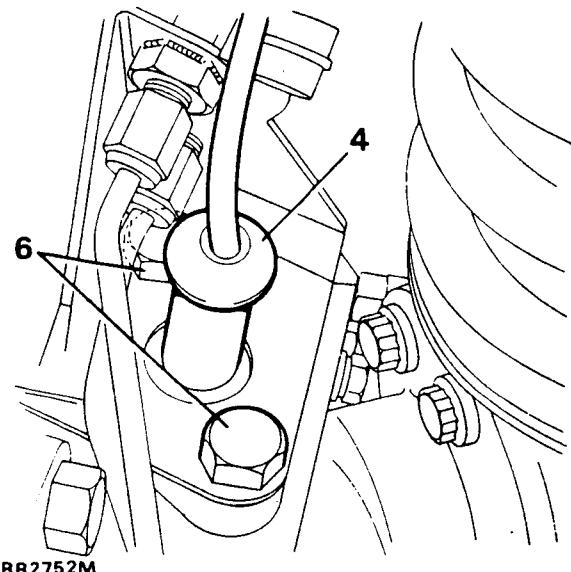
8. Refit the ECU securely in the retaining bracket, fit and tighten the two screws.
9. Reconnect the ECU harness plug. Ensure that the plug is pushed firmly in to its location and that the retaining clip secures the plug in position.
10. Reverse the remaining removal procedure.

**SENSORS - front**

**CAUTION:** If a sensor is removed for any reason, a NEW sensor bush and seal must be fitted.

**Remove and refit****Removing**

1. Disconnect the battery negative lead.
2. Disconnect the required sensor electrical connection, located on the inner wing panel adjacent to the decker panel.
3. Remove the sensor lead and pad wear harness plug from locating clips.
4. Thoroughly clean the area surrounding the sensor to prevent ingress of dirt. Using a suitable lever prise the sensor from its mounting bush.
5. Release the harness cable ties, remove the sensor lead from vehicle.
6. Remove the top swivel retaining bolts complete with brake jump hose bracket. Remove the sensor seal, and remove the sensor bush.

**Refitting**

7. Insert the new sensor bush and seal.
8. Refit the brake jump hose bracket, coating the bolts with Loctite 270.
9. Lightly coat the new sensor using EP 90 oil. Push the sensor through the bush until it contacts the exciter ring. Rotate the wheel, at the same time turn the steering from lock to lock to set the sensor air gap.

10. Ensure that the original routing is used for the sensor lead. Secure the lead in position.
11. Reconnect the sensor electrical connection.
12. Clear the error code - see FAULT DIAGNOSIS PROCEDURE. Drive the vehicle to ensure the ABS warning light is extinguished.

#### SENSORS - rear

**CAUTION:** If a sensor is removed for any reason, a NEW sensor bush must be fitted.

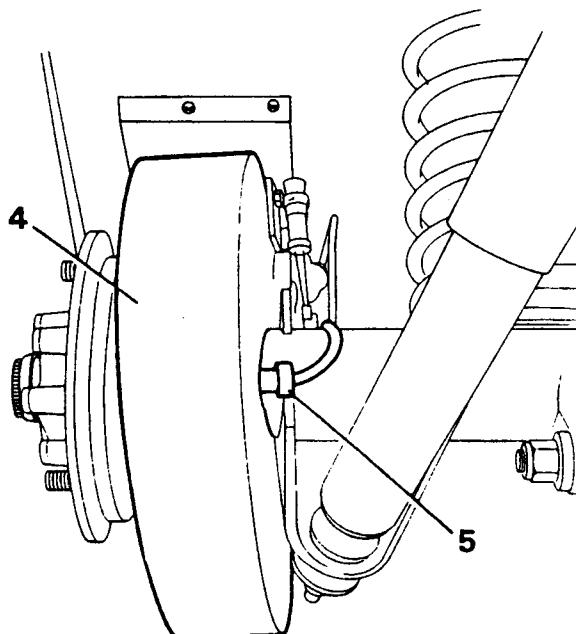
#### Remove and refit

##### Removing

1. Disconnect the battery negative lead.
2. Disconnect the required sensor electrical connection, located above the rear axle.
3. Remove the sensor from its locating clip.
4. Remove the bolts securing the mudshield.
5. Using a suitable lever prise the sensor from its mounting bush.
6. Release the harness cable ties, remove the sensor lead from vehicle.

**NOTE:** The two rear sensor leads are integral with the pad wear harness. In the case of sensor failure the complete harness must be changed.

7. Remove the sensor bush.



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#### Refitting

8. Fit the new sensor bush.
9. Lightly grease the new sensor using silicone grease - see section 09 for correct grease specification. Push the sensor through the bush until it touches the exciter ring. The sensor will be 'knocked back' to its correct position when the vehicle is driven.
10. Ensure that the original routing is used for the sensor lead. Secure the lead in position.
11. Reconnect the sensor electrical connection.
12. Clear the error code - see FAULT DIAGNOSIS PROCEDURE. Drive the vehicle to ensure the ABS warning light is extinguished.

#### STOP LIGHT SWITCH

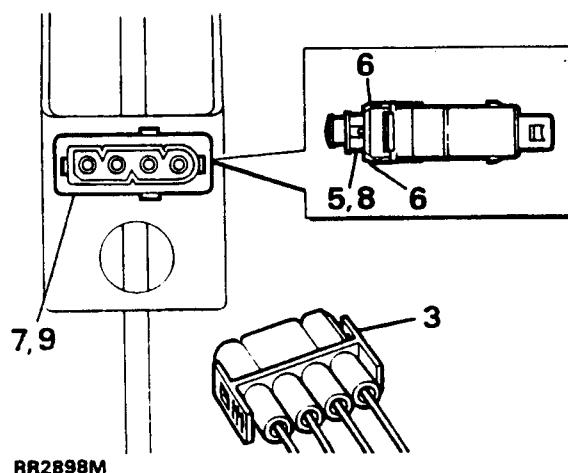
#### Remove and refit

##### Removing

1. Turn ignition off and disconnect the battery negative lead.
2. Remove the lower fascia panel.
3. Disconnect the electrical connection to the switch.
4. Depressurise the system.
5. While depressing the brake pedal, pull the red sleeve and the black plunger of the switch FULLY forward.
6. Release the switch retaining clips.

**NOTE:** If clips are difficult to release, check that the red sleeve is FULLY forward.

7. Remove the switch.



RR2898M

**Refitting**

8. Pull the red sleeve and the black plunger of the switch fully forward.
9. While depressing the brake pedal, fit the switch, ensuring the retaining clips are FULLY located.
10. While holding the switch firmly in place, pull the brake pedal back fully, to set the switch.
11. Check operation of the switch using the diagnostic box.
12. Reverse the remaining removal instructions.

**EXCITER RINGS SEE AXLE SECTION OF MANUAL****ABS FAULT DIAGNOSIS**

If a fault has occurred, or has been identified by the ECU self diagnostic function and the ABS warning light is illuminated, the system and components must be checked to locate and rectify the fault, enabling the faulty component or harness to be replaced.

**NOTE: If the warning lamp has indicated a fault in the system, and no fault code has been stored in the memory, the cause of the fault is:**

- a) Failure in electrical supply
- b) Loss of hydraulic pressure
- c) Faulty pressure switch
- d) Bad ECU earth
- e) Faulty warning light relay
- f) System not fully charged before driving away
- g) ECU not connected

Before commencing the fault diagnosis procedure the following items must be checked:

1. Inspect all exposed cables for damage or abrasion.
2. Check earths on ABS system.
3. Battery - state of charge.
4. Fluid level in reservoir.
5. All ABS fuses and electrical connections.
6. Check hub end-float.

**Fault rectification**

1. The complete harness must be replaced if faults are found in the wiring harness.
2. DO NOT use unspecified cables or connectors, as this could jeopardise the safe function of the ABS.
3. DO NOT attempt to open the sealed 35 way connector to ECU.

**Recommended equipment**

**Wabco diagnostic controller**  
• 446 300 300 0

**FAULT DIAGNOSIS PROCEDURE**

If diagnostic equipment is not available the following procedure can be carried out using the 'Blink Code' and a multi-meter. Faults are stored in the ECU memory in code form. The information can be retrieved by initiating and reading a series of flash and pause sequences on the ABS warning light.

Use of the blink code will determine the location of the fault prior to carrying out a multi-meter check, thus reducing multi-meter checking time.

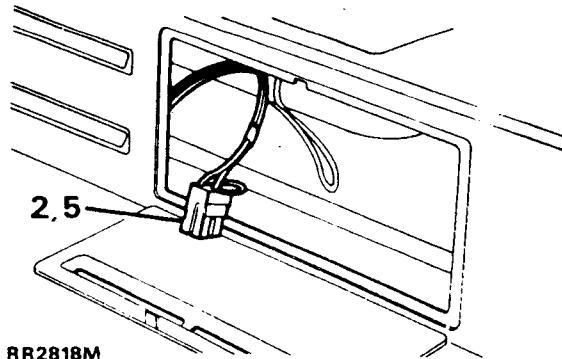
Additionally the blink code can be used exclusively where a fault has occurred, and no other diagnostic equipment is available.

**Recommended equipment**

A female plug to fit the diagnostic plug, prewired to connect ECU pin 14 to earth by bridging the black/pink and black diagnostic plug wires.

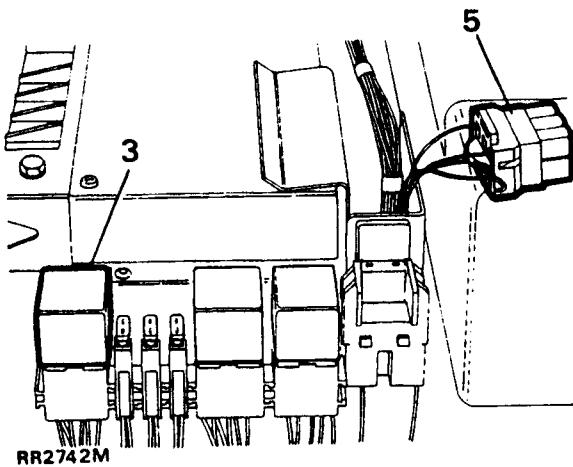
**To initiate the blink code carry out the following procedure:**

1. Switch off ignition.
2. Remove the seat side trim to gain access to the ECU and relays, and on early vehicles the diagnostic plug. Unclip the access plate from the seat base front trim panel. Pull the blue diagnostic plug from its clip through the opening. Note that the diagnostic plug and fuse condition on early vehicles is shown in RR2742M.

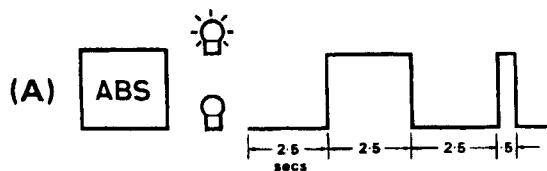


RR2818M

3. Remove the ABS warning light relay.



4. Switch on ignition, ABS warning light will illuminate.  
 5. Connect the prewired plug to the diagnostic plug.  
 6. Five seconds after connecting diagnostic plug the ABS warning light will extinguish, indicating the start of the blink code cycle.  
 7. **Start phase:** Observe the ABS warning light, the start phase consists of:  
 Pause - 2.5 secs (long)  
 Flash - 2.5 secs (long)  
 Pause - 2.5 secs (long)  
 Flash - 0.5 secs (short)
- (A) shows flash sequence at start of blink cycle.**

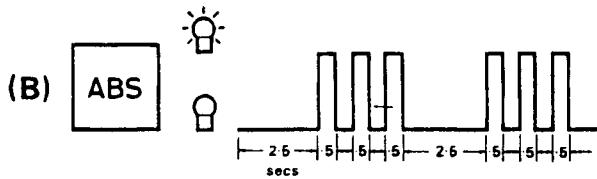


RR2719M

8. **First part of code number:** A pause of 2.5 secs precedes a series of short flashes. Count the flashes until the next long pause occurs, the number obtained is the first part of the code number.

9. **Second part of code number:** A pause of 2.5 secs occurs between first and second parts, before a second series of short flashes occurs. The number of flashes forms the second part of the code number.

(B) shows flash sequence for code number 3 - 3.



RR2720M

10. The sequence of start phase, first and second parts will continue until terminated by the operator, thus allowing the code obtained to be rechecked.

11. To terminate the sequence disconnect the prewired plug from the diagnostic plug. Wait for cycle to end before code will clear.

**NOTE: Termination will clear the memory of that particular fault. Do not terminate the sequence if unsure of the code number.**

12. The memory is capable of storing more than one fault. To search the memory, reconnect the diagnostic plug, and await the next start phase.  
 13. Repeat procedure until no further faults are stored in the memory. The memory is cleared when a long pause of 7.5 secs occurs after start phase.
- WARNING: Be sure to reconnect the relay after completing test.**

FAULT CODE /LOCATION	CAUSE	REMEDY
<b>NOTE: If the ABS warning light illuminates due to a large sensor air gap, the fault will be retained by the ECU memory. Where the wheel sensors have been pushed fully home prior to test, the blink code will indicate a fault that has been rectified.</b>		
2-12 front right 2-13 rear left 2-14 front left 2-15 rear right	Sensor air gap too large -sensor has been pushed outwards by exciter ring	Run-out on sensor rings due to rough roads/potholes, installation Check bearing freeplay, or failure fit new sensor bush, refit sensor
5-12 front right 5-13 rear left 5-14 front left 5-15 rear right	Sensor or wiring has intermittent contact	Carry out multi-meter check -check and repair If rough road causing fault - test vehicle on rough road.
6-12 front right 6-13 rear left 6-14 front left 6-15 rear right	No sensor output  Sensor has extremely large air gap	Check sensor installation, bearings, disc mounting fit new sensor bush, refit sensor
4-12 front right 4-13 rear left 4-14 front left 4-15 rear right	Sensor wiring broken or impedance of sensor too high	Check wiring with multi-meter if OK, fit new sensor
2-6 brake light switch	Brake light switch failed, fault in wiring to switch or not connected  Fuse A5 blown or not fitted	Check pedal is set back to rear resting position, slowly operate pedal by hand, two clicks must be heard from switch (brake lights on at first click) prior to hissing noise of booster If OK continue with multi-meter check, if not OK check switch and installation. Check fuse A5
2-7	Continuous supply to ECU, with ignition off, faulty valve relay AB14 or wiring	Carry out multi-meter check
2-8	No voltage to ABS solenoid valves, faulty valve relay AB14 or wiring	Carry out multi-meter check

**NOTE: After any steering adjustment, bearing replacement/adjustment, brake disc replacement: Check hub end-float and sensor clearance.**

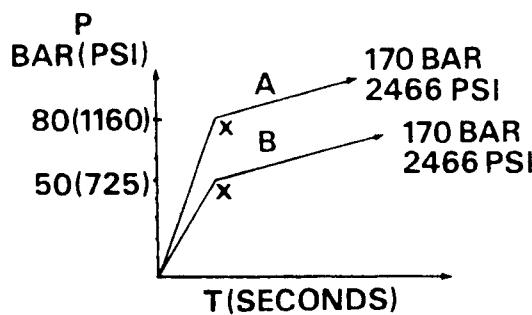
**NOTE: Having fixed faults clear ALL memory codes and road test vehicle.**

FAULT CODE /LOCATION	CIRCUIT DIAGRAM ITEM NUMBER	CAUSE/REMEDY
3-0 inlet front right 3-1 outlet front right 3-2 inlet front left 3-3 outlet front left 3-4 inlet rear right 3-5 outlet rear right 3-6 inlet rear left 3-7 outlet rear left 3-8 inlet isolating 3-9 outlet isolating	AB 23 IV AB 23 OV AB 22 IV AB 22 OV AB 25 IV AB 25 OV AB 24 IV AB 24 OV AB 21 IV AB 21 OV	Open circuit in connection ECU to solenoid valve in booster, or inside ECU - possibly intermittent  Carry out multi-meter check to: Wiring harness including connectors, booster  Renew defective component, if all OK fit new ECU. Road test vehicle.
4-0 inlet front right 4-1 outlet front right 4-2 inlet front left 4-3 outlet front left 4-4 inlet rear right 4-5 outlet rear right 4-6 inlet rear left 4-7 outlet rear left 4-8 inlet isolating 4-9 outlet isolating	AB 23 IV AB 23 OV AB 22 IV AB 22 OV AB 25 IV AB 25 OV AB 24 IV AB 24 OV AB 21 IV AB 21 OV	Short circuit to ground in connection ECU to solenoid valve in booster - possibly intermittent  Carry out multi-meter check to: Wiring harness including connectors, booster  Renew defective component, if all OK fit new ECU. Road test vehicle.
5-0 inlet front right 5-1 outlet front right 5-2 inlet front left 5-3 outlet front left 5-4 inlet rear right 5-5 outlet rear right 5-6 inlet rear left 5-7 outlet rear left 5-8 inlet isolating 5-9 outlet isolating	AB 23 IV AB 23 OV AB 22 IV AB 22 OV AB 25 IV AB 25 OV AB 24 IV AB 24 OV AB 21 IV AB 21 OV	Short circuit to 12V in connection ECU to solenoid valve in booster - possibly intermittent  Carry out multi-meter check to: Wiring harness including connectors, Booster Possible earth fault Renew defective component, if all OK fit new ECU. Road test vehicle
6-0 inlet front right 6-1 outlet front right 6-2 inlet front left 6-3 outlet front left 6-4 inlet rear right 6-5 outlet rear right 6-6 inlet rear left 6-7 outlet rear left 6-8 inlet isolating 6-9 outlet isolating	AB 23 IV AB 23 OV AB 22 IV AB 22 OV AB 25 IV AB 25 OV AB 24 IV AB 24 OV AB 21 IV AB 21 OV	Short circuit between two connections ECU to solenoid valve in booster - possibly intermittent  <b>NOTE: Failure codes for both affected valves will be stored</b>  Carry out multi-meter check to: a) Wiring harness, plug connectors, b) Booster  Renew defective component, if all OK fit new ECU. Road test vehicle

**Accumulator - check precharge**

The accumulator, of the diaphragm type, is precharged with nitrogen at 80 bar, its function is to store hydraulic energy. If a problem is suspected, the following procedure will indicate if the precharge pressure has fallen.

1. Depressurise the brake system fully.
2. Connect a pressure gauge, capable of reading at least 170 bar (2466 psi), to the M10 thread of the accumulator after removing the bleed screw.
3. Switch ignition on and observe the pressure gauge.



RR2743M

4. There should be a rapid rise in pressure to accumulator precharge of 80 bar (1160 psi), then a slowing down in the rate of increase as the pressure rises to system pressure, 170 bar (2466 psi) - see graph A.
5. If point x is low as in graph B, ie. 50 bar (725 psi) it indicates that the accumulator has lost its precharge.
6. If faulty, fit a new accumulator.

**CONTINUITY TEST USING A MULTI-METER****Recommended equipment**

**CAUTION:** USE ONLY a multi-meter with compatible male blades to match female spring sockets. Damaged female sockets will necessitate unnecessary component replacement.

To avoid damage to the contacts of the 35 way connector, the manufacturers recommend the use of the adaptor plug shown in the illustrations. When this adaptor is fully engaged with the 35 way connector, multimeter probes can be inserted into the numbered contacts on the face of the adaptor. The adaptor plug is supplied as a spares item.

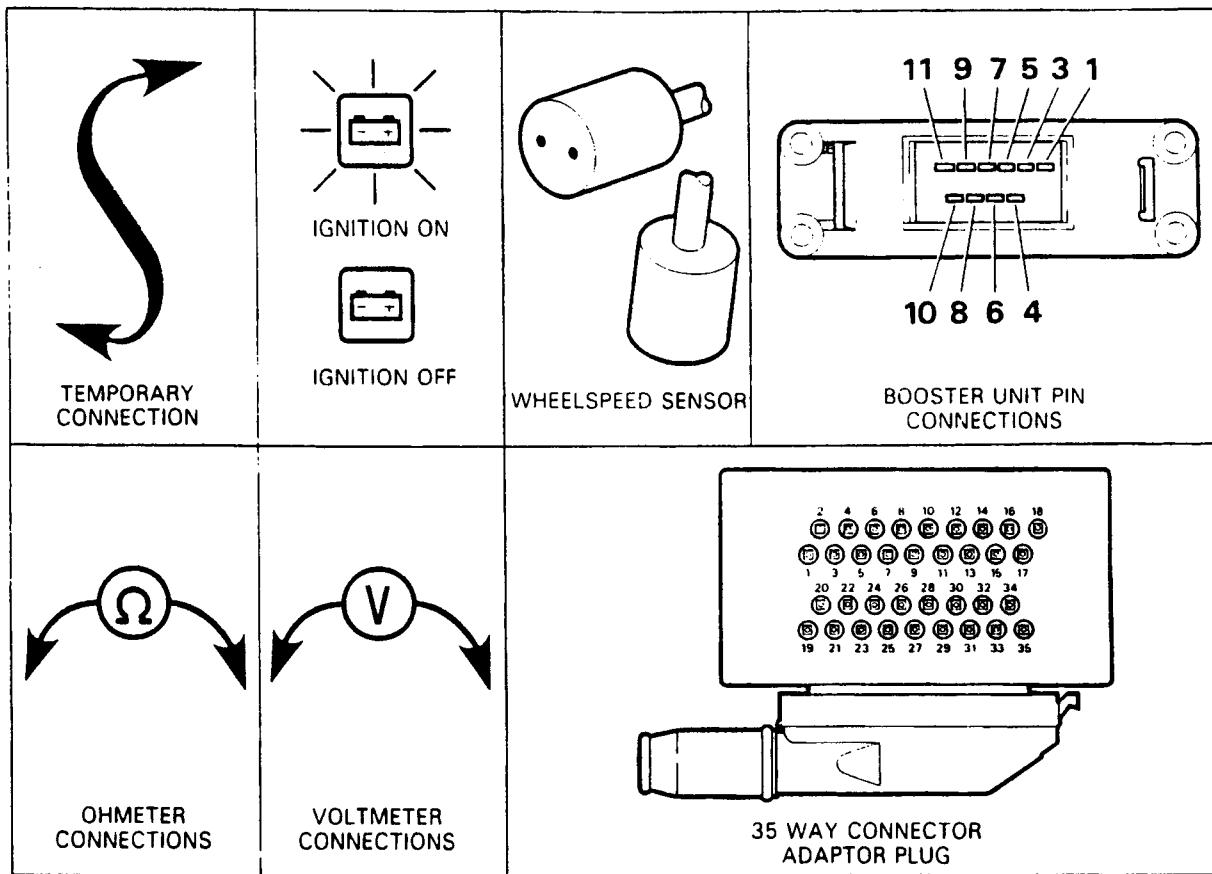
**MULTI-METER CHECK PROCEDURE**

**CAUTION:** Ensure the multi-meter is correctly set to volts or ohms, dependant on which test is being carried out. Ensure ignition is switched ON or OFF as test requires.

1. Disconnect 35 way connector from ECU, connect adaptor plug. Commence check at appropriate pin on 35 way on wiring harness.
2. Check harness wires for continuity, check fuses and relays.
3. Test related components.
4. If intermittent contact is suspected, attempt to locate the fault by flexing the harness and cables or moving contacts.

**TESTS - using a multi-meter**

THE following tests are intended as a guide to locating a fault within a circuit. Refer to the ABS circuit diagram for full circuit information.

**Key to symbols**

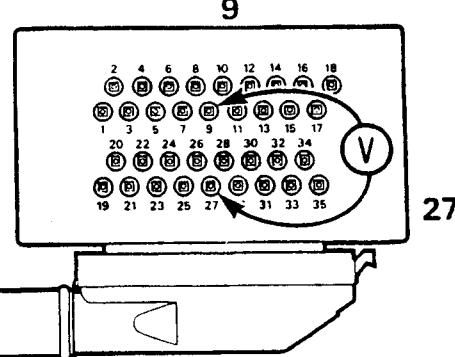
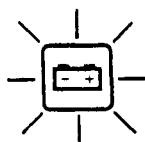
RR2838M

**NOTE:** If the correct reading is obtained at the component connector and NOT at the 35 way connector, the harness is at fault.

**TEST PROCEDURE**

- 1 Check battery voltage.

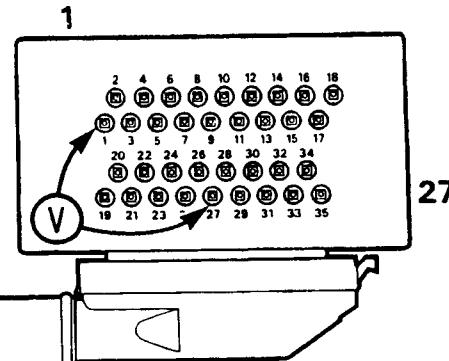
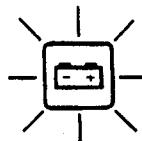
1



RR2839M

- 2a Check valve relay AB14.

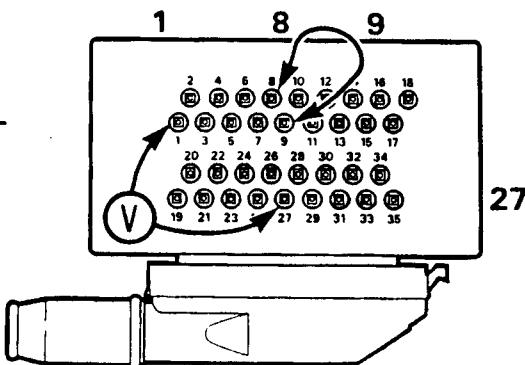
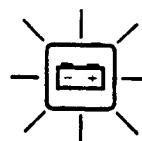
2a



RR2840M

- 2b Check valve relay power supply.

2b



RR2841M

**RESULTS/CHECKS**

Correct result: 10V + Incorrect result: Check fuse AB11, wiring from ignition switch and earth.

9

27

Correct result: 0V If voltage reading obtained check relay

27

27

**TEST PROCEDURE**

- 3a Check front left wheelspeed sensor resistance.

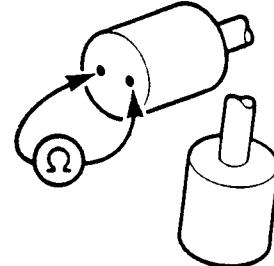
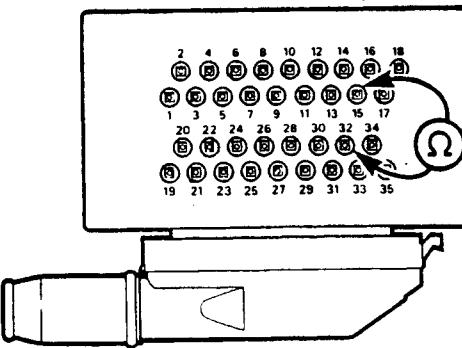
**RESULTS/CHECKS**

Correct result: 1.5 to 2kOhm Incorrect result at sensor plug. Fit new sensor.

3a

15

32



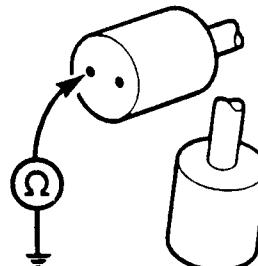
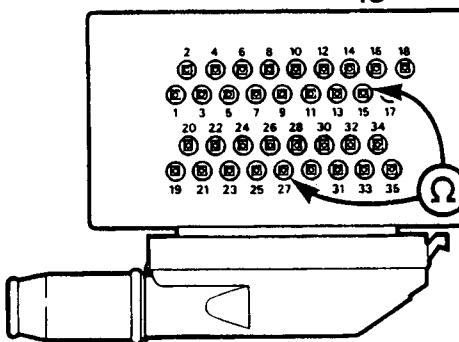
RR2842M

- 3b Check front left wheelspeed sensor insulation. Correct result: 100kOhm + Incorrect result at sensor plug: Fit new sensor.

3b

15

27



RR2843M

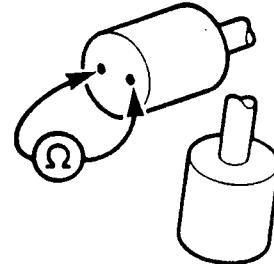
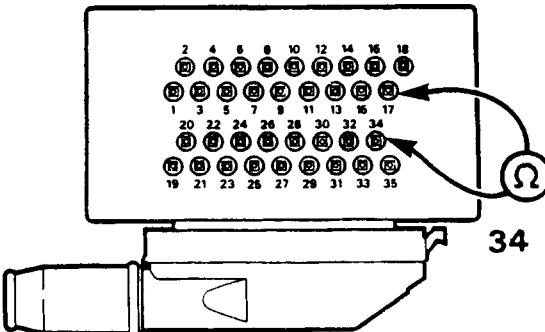
- 4a Check front right wheelspeed sensor resistance.

Correct result: 1.5 to 2kOhm Incorrect result at sensor plug: Fit new sensor.

4a

17

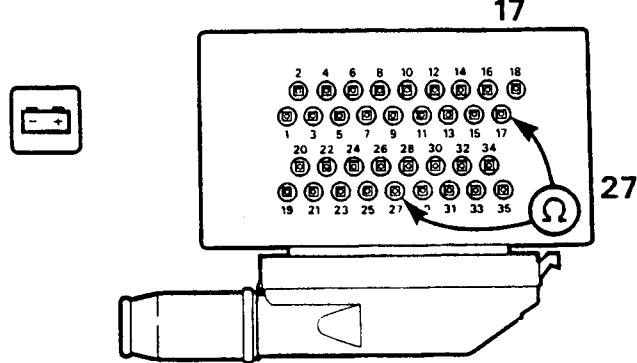
34



RR2844M

## TEST PROCEDURE

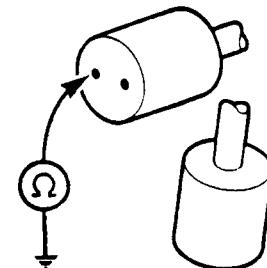
- 4b Check front right wheelspeed sensor insulation.

**4b**

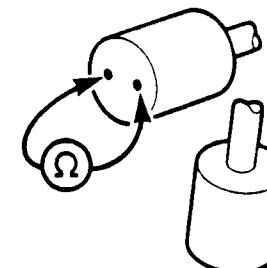
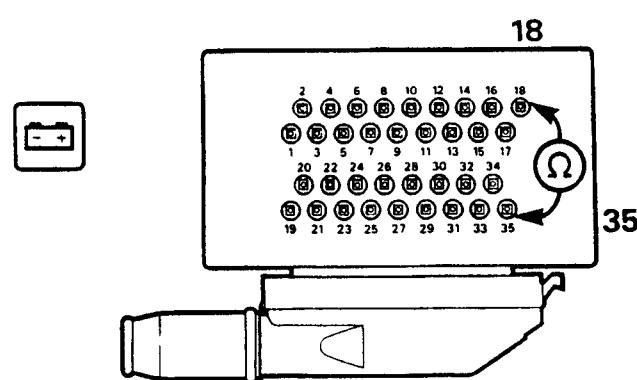
RR2845M

## RESULTS/CHECKS

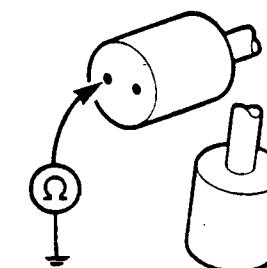
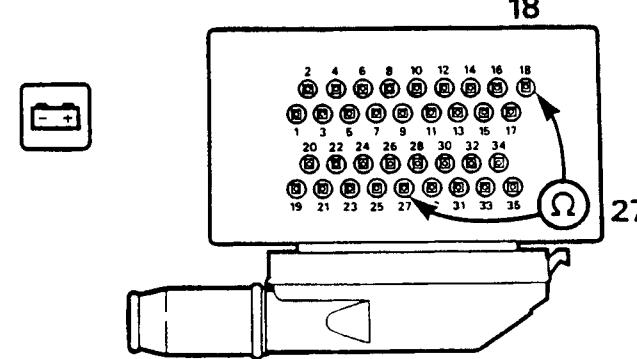
Correct result: 100kOhm +  
Incorrect result at sensor plug: Fit new sensor.



- 5a Check rear left wheelspeed sensor resistance.

**5a**

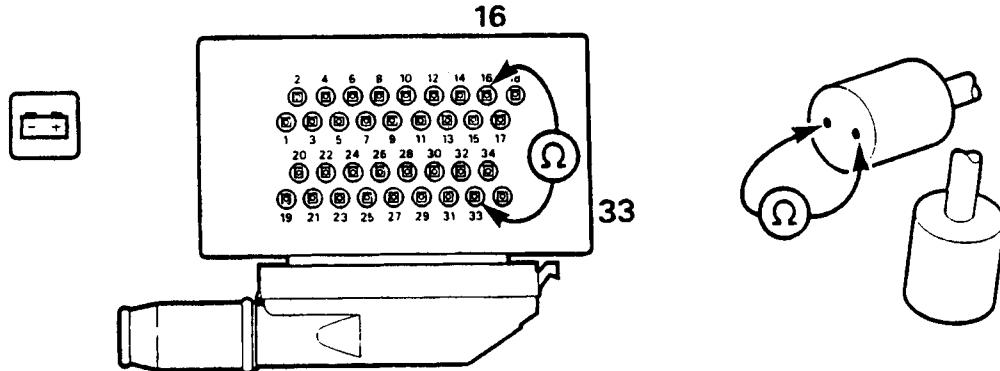
- 5b Check rear left wheelspeed sensor insulation.

**5b**

RR2847M

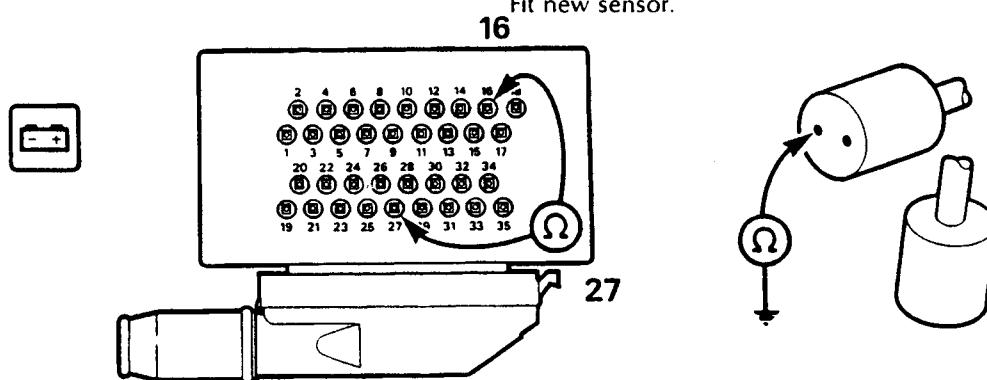
**TEST PROCEDURE****RESULTS/CHECKS**

- 6a Check rear right wheelspeed sensor resistance.      Correct result: 1.5 to 2kOhm  
 Incorrect result at sensor plug:  
 Fit new sensor.

**6a**

RR2848M

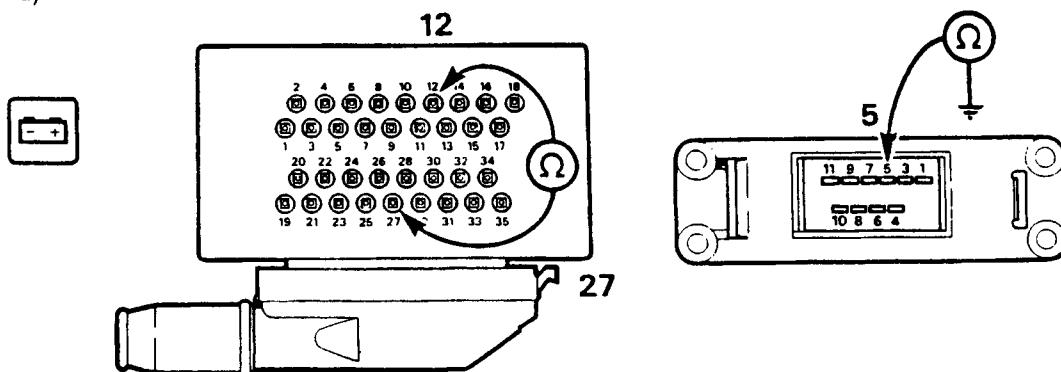
- 6b Check rear right wheelspeed sensor insulation.      Correct result: 100kOhm +  
 Incorrect result at sensor plug:  
 Fit new sensor.

**6b**

RR2849M

- 7a Check isolation valve outlet.      Correct result: 5 to 7 Ohm

- (1) Remove booster harness plug, carry out check  
 at booster  
 (2) Refit booster harness plug, carry out check at      Incorrect result at booster: fit new booster  
 35 way

**7a**

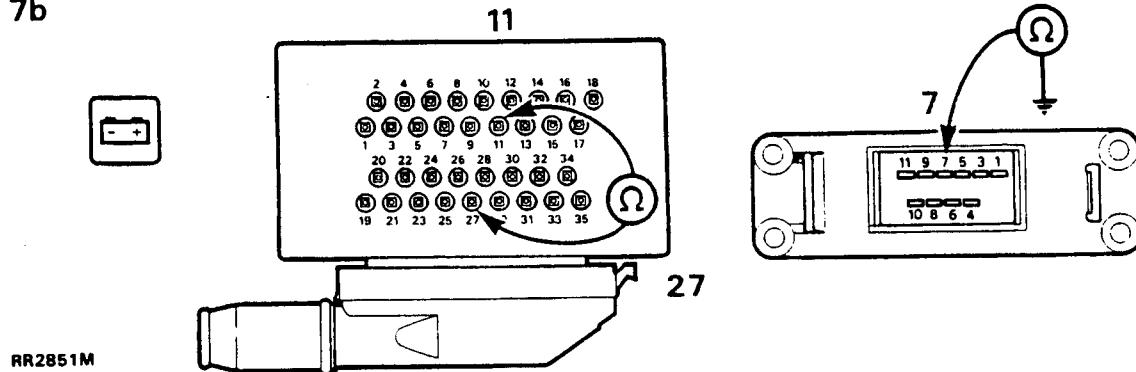
RR2850M

**TEST PROCEDURE**

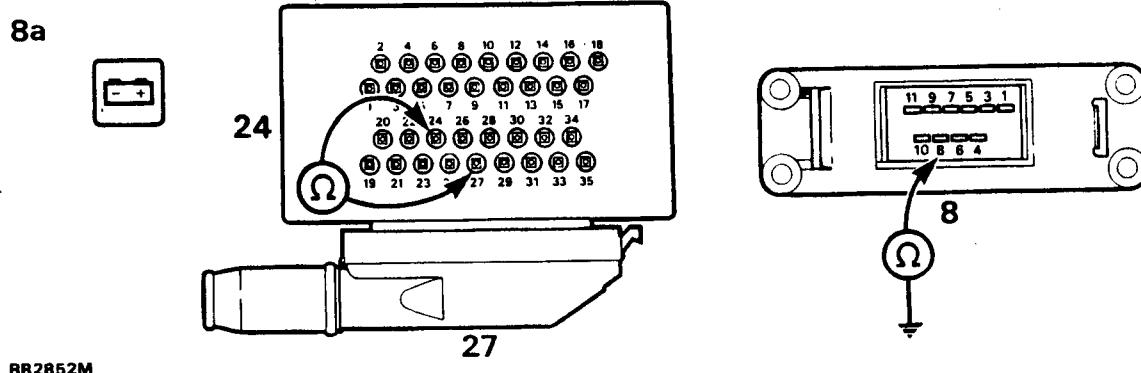
- 7 Check isolation valve, inlet.  
 (1) Remove booster harness plug, carry out check at booster  
 (2) Refit booster harness plug, carry out check at 35 way Incorrect result at booster: fit new booster

**RESULTS/CHECKS**

Correct result: 5 to 7 Ohm

**7b**

- 8a Check ABS solenoid valve front left, outlet.      Correct result: 2.5 to 4.5 ohm  
 (1) Remove booster harness plug, carry out check at booster  
 (2) Refit booster harness plug, carry out check at 35 way      Incorrect result at booster: fit new booster

**8a**

**TEST PROCEDURE****RESULTS/CHECKS**

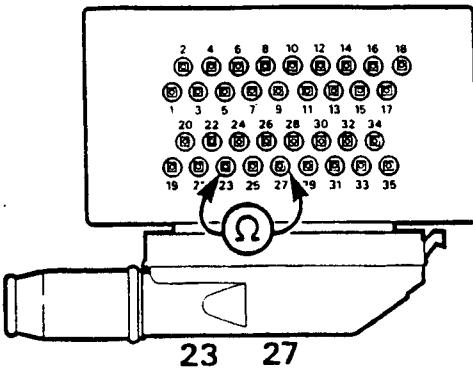
**8b** Check ABS solenoid valve front left, inlet.

Correct result: 5 to 7 Ohm

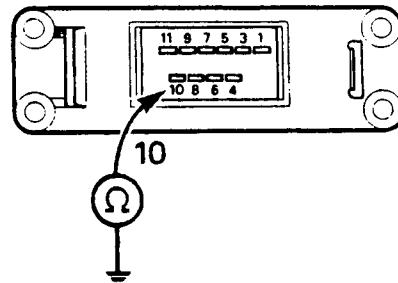
(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at 35 way

Incorrect result at booster: fit new booster

**8b**

RR2853M



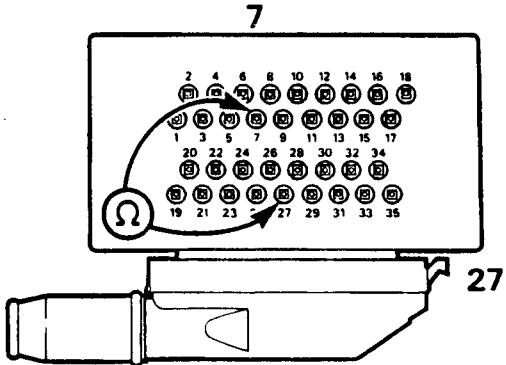
**9a** Check ABS solenoid valve front right, outlet.

Correct result: 2.5 to 4.5 Ohm

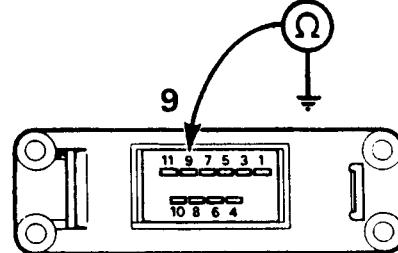
(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at 35 way

Incorrect result at booster: fit new booster

**9a**

RR2854M



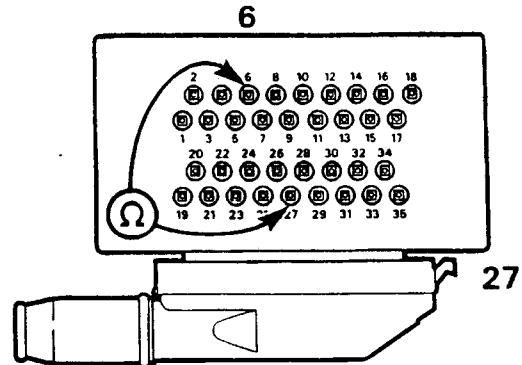
**9b** Check ABS solenoid valve front right, inlet.

Correct result: 5 to 7 Ohm

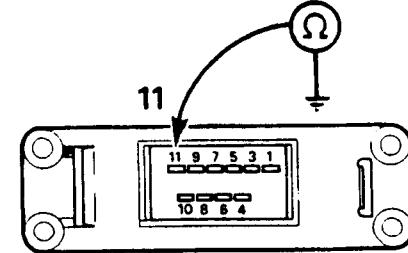
(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at 35 way

Incorrect result at booster: fit new booster

**9b**

RR2855M



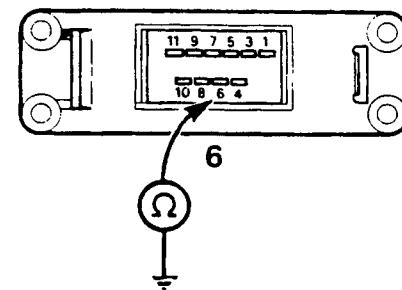
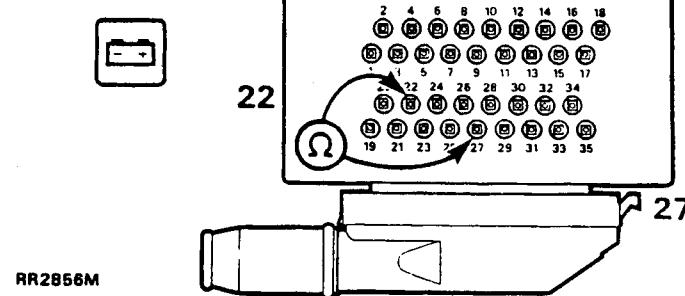
**TEST PROCEDURE****RESULTS/CHECKS**

10a Check ABS solenoid valve rear left, outlet.      Correct result: 2.5 to 4.5 Ohm

(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at Incorrect result at booster: fit new booster  
35 way

10a

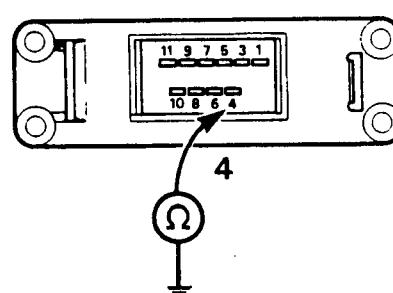
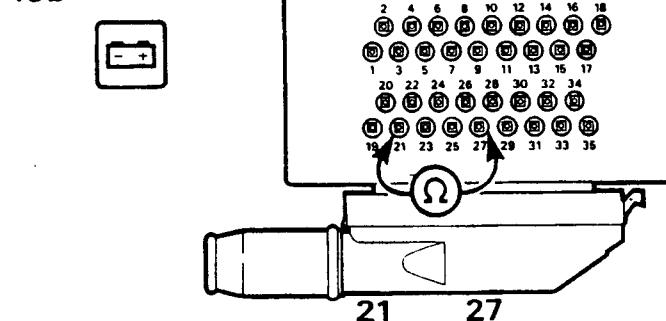


10b Check ABS solenoid valve rear left, inlet.      Correct result: 5 to 7 Ohm

(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at Incorrect result at booster: fit new booster  
35 way

10b



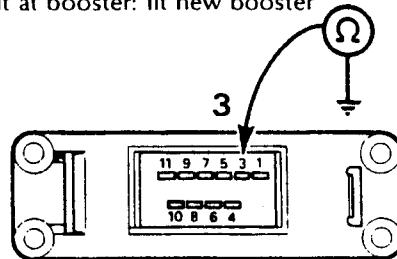
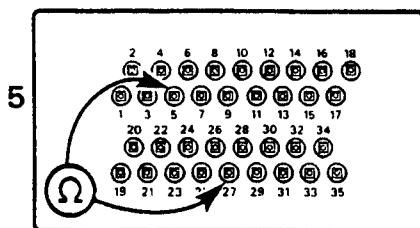
**TEST PROCEDURE****RESULTS/CHECKS**

11a Check ABS solenoid valve rear right, outlet.      Correct result: 2.5 to 4.5 Ohm

(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at 35 way

**11a**



RR2858M

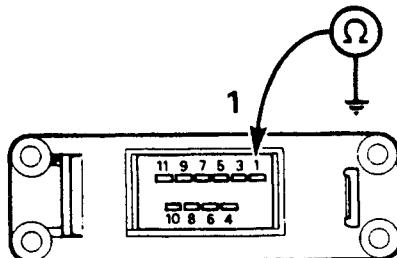
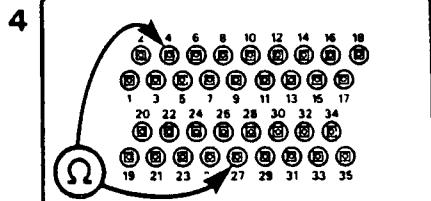
**27**

11b Check ABS solenoid valve rear right, inlet.      Correct result: 5 to 7 Ohm

(1) Remove booster harness plug, carry out check at booster

(2) Refit booster harness plug, carry out check at 35 way

**11b**



RR2859M

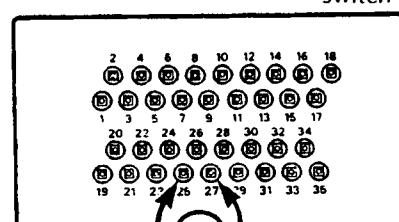
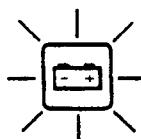
**27**

12a Check brake light switch - pedal down.

Correct result: 10V +

This contact must operate first and switch the brake lights. Incorrect reading: fit new brake light switch and recheck. Check cable if fault persists.

**12a**



**25 27**

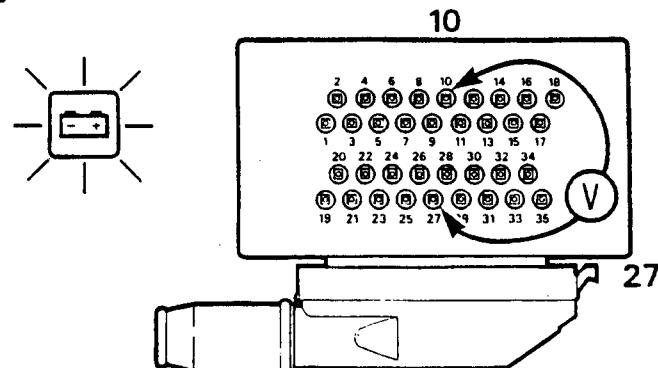
RR2860M

**TEST PROCEDURE**

12 Check brake light switch - pedal down.

**RESULTS/CHECKS**

Correct result: 10V + Incorrect reading: fit new  
brake light switch and recheck.  
Check cable if fault persists.

**12b**

RR2919M

## FAULT DIAGNOSIS

SYMPTOM	POSSIBLE CAUSE	CHECK	REMEDY
ABS warning light on	ABS electrical fault High sensor air gaps	Check ABS electrical circuit to identify fault	Change component if necessary Push in sensors
Both warning lights ON. Pedal travel and pedal force increased	No booster pressure (fluid loss) No booster pressure (pump not operating) Pump faulty	Check reservoir fluid level and inspect system for leaks Check electrical supply to pump	Rectify as necessary and refill reservoir Rectify electrical supply if necessary Change hydraulic pump
Both warning lights ON (no additional symptoms)	Malfunction of pressure switch	Disconnect pressure switch  a) If light remains illuminated vehicle wiring faulty b) If lights extinguish pump defective	a) Test wiring change harness if necessary  b) Change pump
Brake fluid warning light ON	Fluid loss  Reservoir fluid level switch malfunction Pressure switch malfunction	Check reservoir fluid level and inspect system for leaks Check fluid level switch  Check switch with pressure gauge a) If wiring faulty b) If switch faulty	Rectify leakage, refill reservoir  Change reservoir cap/switch  a) Replace harness b) Change hydraulic pump
Brake fluid warning light ON. Pedal travel increased, foot pressure normal	Fluid loss from hydrostatic circuit	Check reservoir level and inspect system for leaks	Rectify leakage and refill reservoir Rebleed as necessary

**Fault Diagnosis - continued**

SYMPTOM	POSSIBLE CAUSE	CHECK	REMEDY
Brake fluid warning light OFF. Pedal travel increased, foot pressure normal	Insufficient bleeding  Master cylinder malfunction		Rebleed master cylinder circuit  Change booster and bleed system
Hydraulic pump runs constantly	Fluid loss  Pump non-return valve faulty	Check reservoir level and inspect system for leaks	Rectify leakage as necessary, refill reservoir Change hydraulic pump
Hydraulic pump runs constantly with warning lights OFF. Pedal travel normal.	Malfunction of pressure switch  Relay switch malfunction	Disconnect pressure switch  a) If pump stops b) If pump continues running	a) Change hydraulic pump b) Change relay or cable
Pedal can be moved downwards under constant pressure	Seal leaking in master cylinder  Seal leaking in servo unit	Inspect system for leaks	Change booster unit  Change booster unit

