

70 - BRAKES

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ELECTRONIC TRACTION CONTROL

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REPAIR

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BRAKE SERVO UNIT

Description

The power assistance for the brake system is provided by a twin diaphragm suspended vacuum servo.

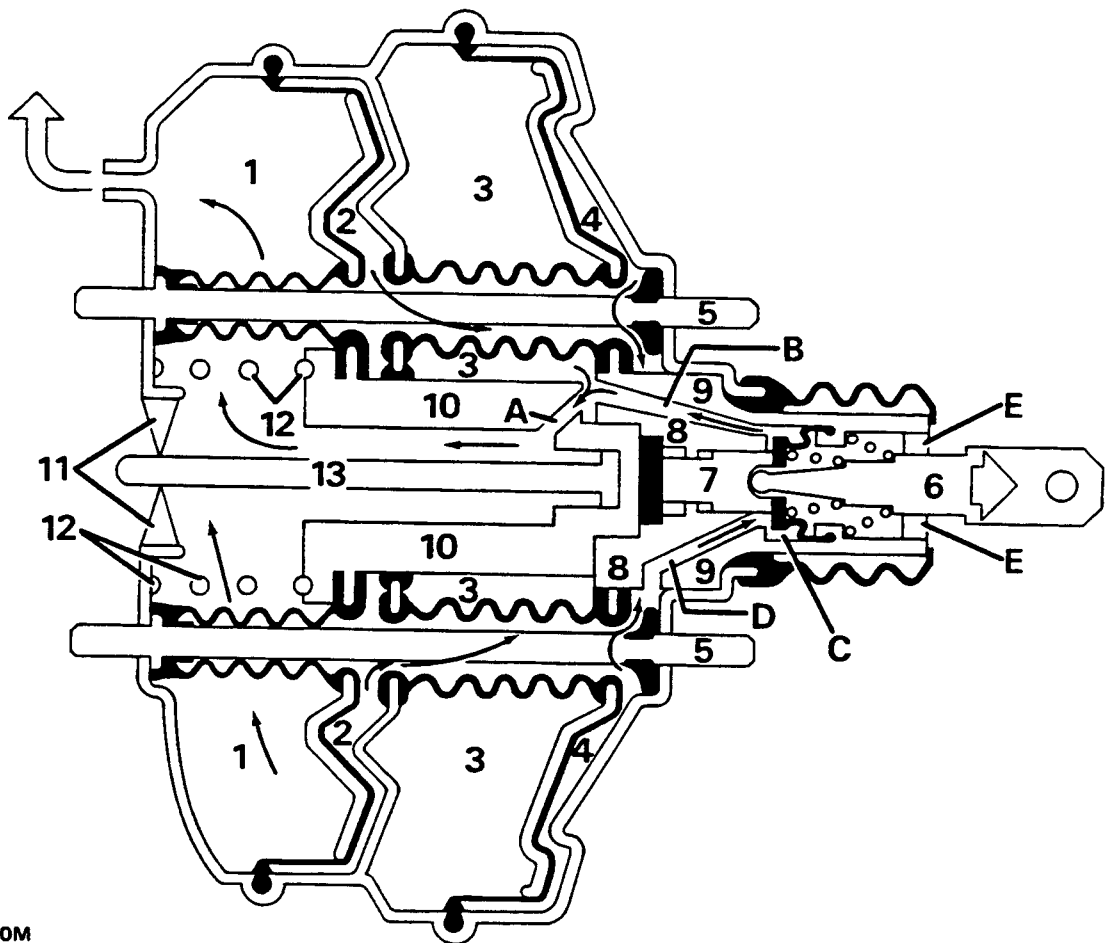
A 'Suspended Vacuum' servo is one where, with the engine running vacuum is present both sides of the diaphragm or diaphragms when the brakes are fully released or partially applied. The principal of having vacuum both sides of the diaphragm has two main advantages. First, it ensures instantaneous servo response to the brake being applied or released and second, it provides very accurate control of the position of the diaphragm and therefore, the degree of partial brake application.

At full pedal depression, vacuum is present in front of the diaphragm with atmospheric pressure on the rear.

Operation

Brakes released

With the brakes released depression is present both sides of the diaphragms, in chambers 1,2,3 and 4. The chambers communicate by ports A, B, D via the valve C which is shown fully released in RR3640M.



RR3640M

Brakes applied

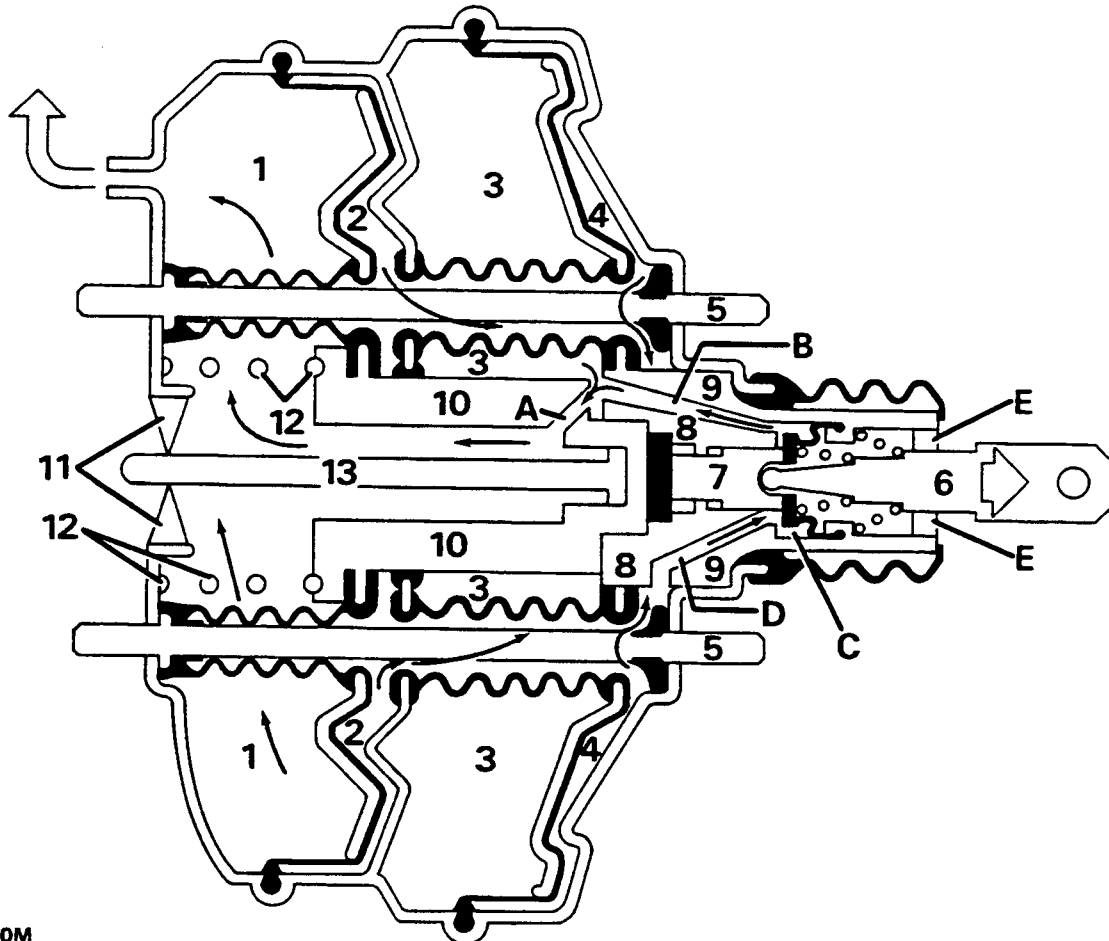
When the brake pedal is depressed the pedal pushrod operates valve C situated in the plastic diaphragm hub 9 and 10. Initial depression of the the brake pedal, push rod 6 and plunger 7 compress a rubber pad 8. This slight movement causes valve C to close port D sealing off the vacuum to chambers 2/4 and allows atmospheric pressure to enter the chambers through the air filter E.

With depression in chambers 1/3 and air pressure in chambers 2/4 the servo hub will apply the brakes via the master cylinder push rod 13.

Atmospheric pressure over the large area of the diaphragms multiples the force applied to the master cylinder piston, to provide the power assistance. If the brake pedal is only partially depressed, the servo hub, diaphragms and master cylinder push rod will stop moving, when valve C comes to rest on the plunger 7. At this point the valve will balance the pressure in all the chambers, to the applied effort at the pedal and provide proportional braking.

It is only when the brakes are fully applied that the valve does not balance the pressures in all the chambers, but ensures that maximum available depression is in chambers 1/3 and full atmospheric pressure enters chambers 2/4.

When the brake pedal is released, the pressure in all chambers is equalised and the servo is returned to the rest position by spring 12.



RR3640M



Petrol engine vacuum system

The vacuum necessary to operate the brake servo on petrol engine vehicles is provided by the engine inlet manifold. During normal operation of the brakes only a small volume of air is drawn from the servo and into the inlet manifold or plenum chamber. However any excessive air leaks due to damage in the brake servo system or manifold hose connection, will effect the mixture strength and ECU fuelling calculations on engines equipped with an EFI system. **See FUEL SYSTEM, Description and operation, Hot wire electronic fuel injection**

Diesel engine vacuum system

As the diesel engine inlet system does not produce depression sufficient to operate the brake servo, it is necessary to install an engine driven vacuum pump.

During normal operation of the brakes only a small volume of air is drawn from the servo by the vacuum pump. However as the pump exhausts air into the engine crankcase atmosphere, an air leak due to damage in the brake servo system or pump hose connection, may cause excessive crankcase pressure. **See ENGINE, Description and operation, Vacuum pump**

BRAKE SYSTEM

Description

The servo assisted hydraulic braking system is the dual line type, incorporating primary and secondary hydraulic circuits, see illustration RR2225M.



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 will immediately illuminate a warning light in the instrument binnacle indicating low fluid or sudden fluid loss.

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 independent 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 pads require renewal.



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) Use only the correct brake fluid.

USE ONLY the correct brake fluid if assembly fluid is required.



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. Wear a protective mask.**
- **Dust found on vehicle or produced during work on vehicle should be removed by vacuuming or by using a well dampened cloth 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 hand tools or low speed power tools used.**

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.

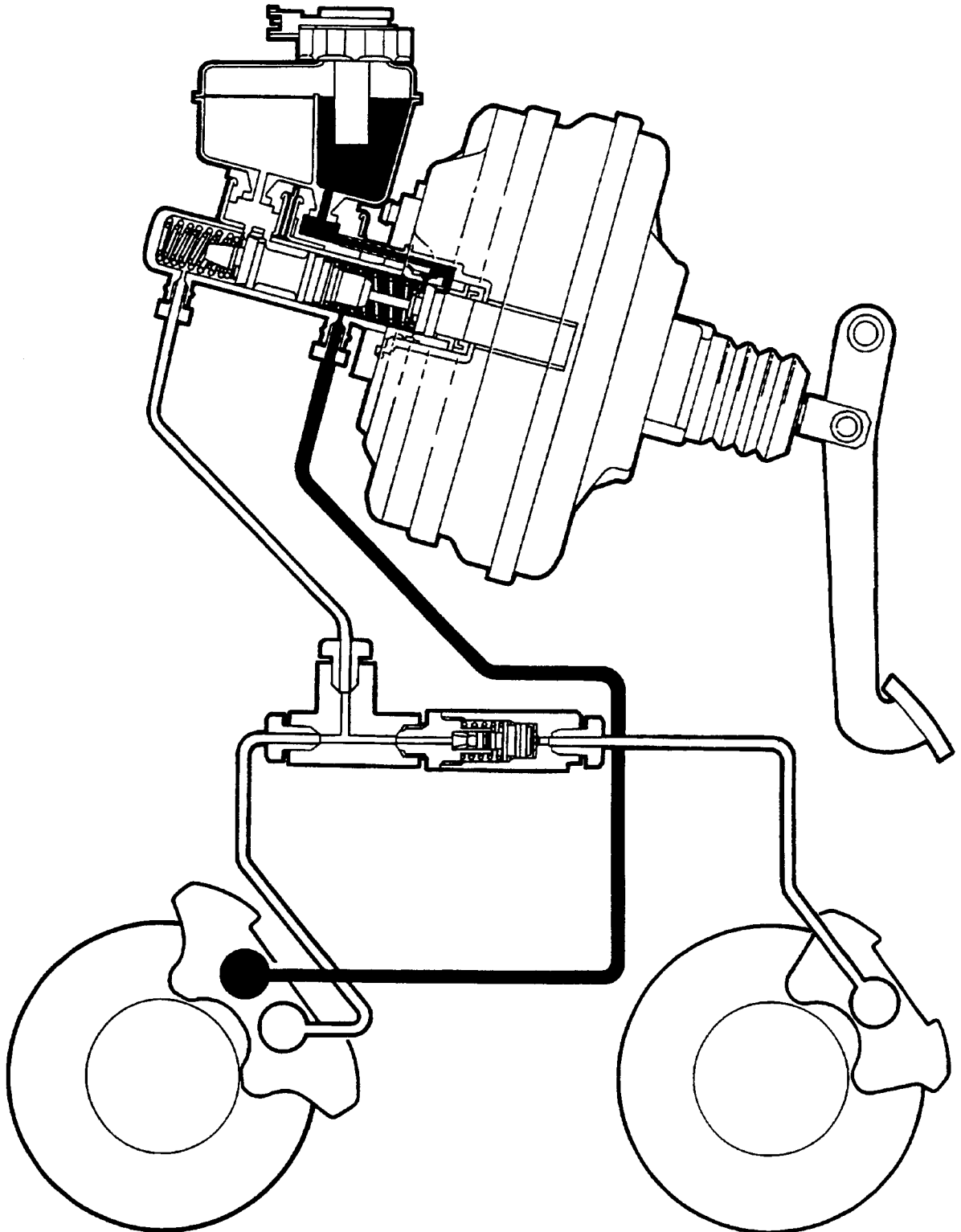
The brake system should be drained and flushed at the recommended service intervals.



PRIMARY HYDRAULIC
CIRCUIT



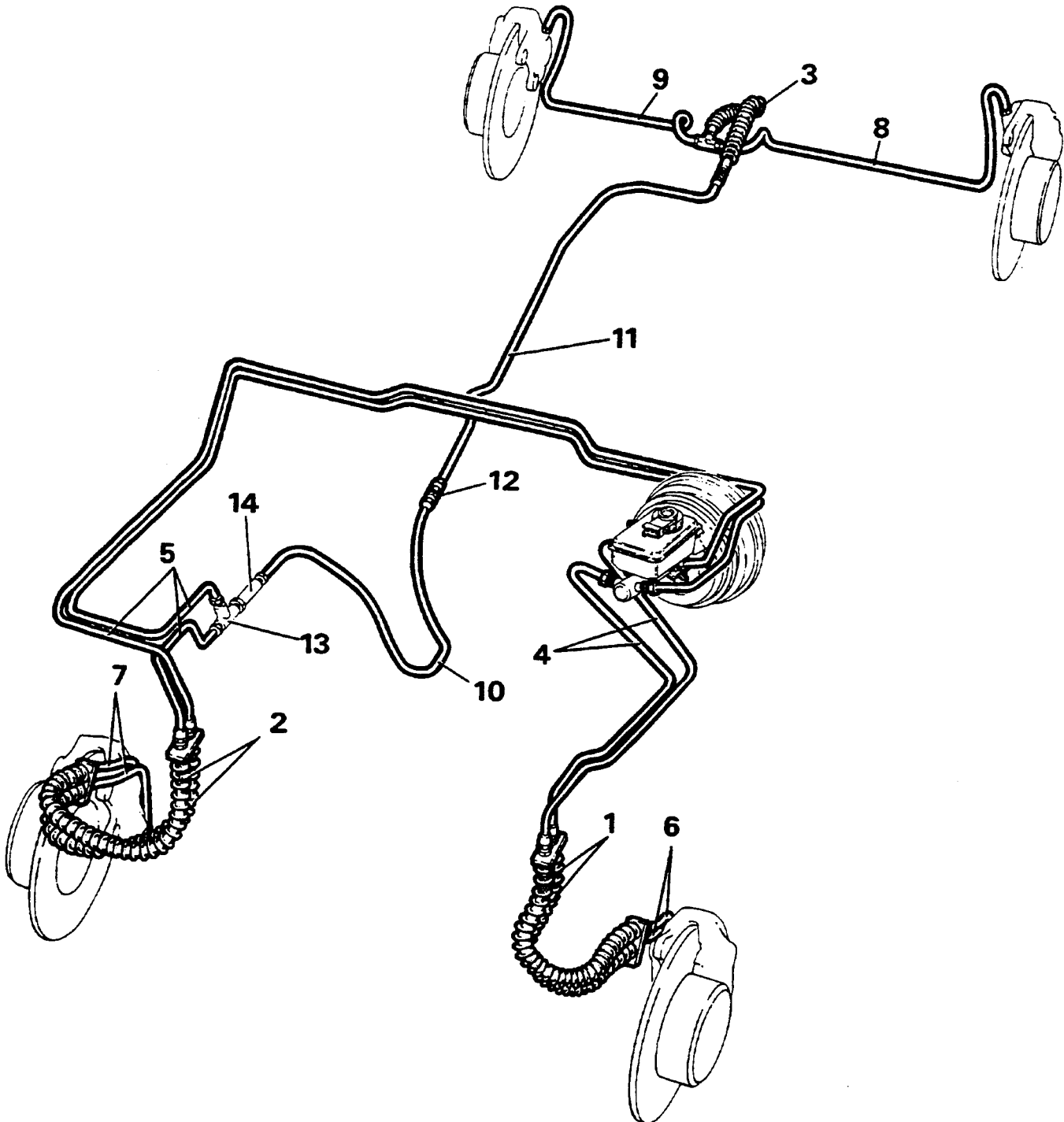
SECONDARY HYDRAULIC
CIRCUIT



RR2225M

BRAKE PIPE LAYOUT

Left hand drive



RR2222E

HOSES

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

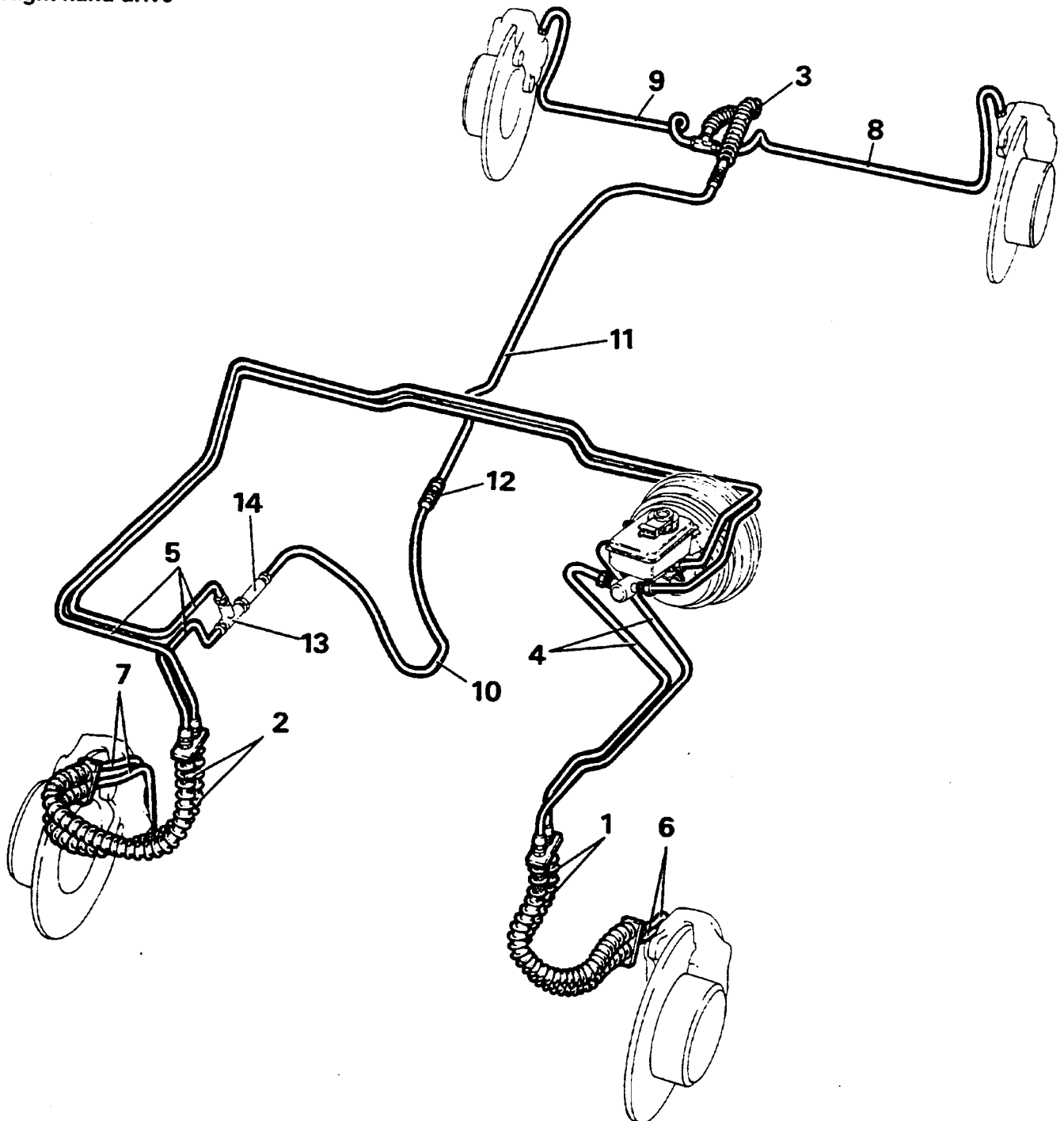


PIPES

- | | |
|---|-------------------------------------|
| 4. Feed to front left hand hose connector. | 9. Feed to rear right hand caliper. |
| 5. Feed to front right hand hose connector. | 10. Feed to two way connector. |
| 6. Feed to front left hand caliper. | 11. Feed to intermediate hose. |
| 7. Feed to front right hand caliper. | 12. Two way connector. |
| 8. Feed to rear left hand caliper. | 13. Three way connector. |
| | 14. Pressure reducing valve. |

BRAKE PIPE LAYOUT

Right hand drive



RR2222E



BRAKE SYSTEM BLEED

Service repair no - 70.25.02

Also See *Brake system bleed (ABS)*

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

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

WARNING: If engine is running during brake bleeding process ensure that neutral or park is selected in main gearbox and that park brake is applied.

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

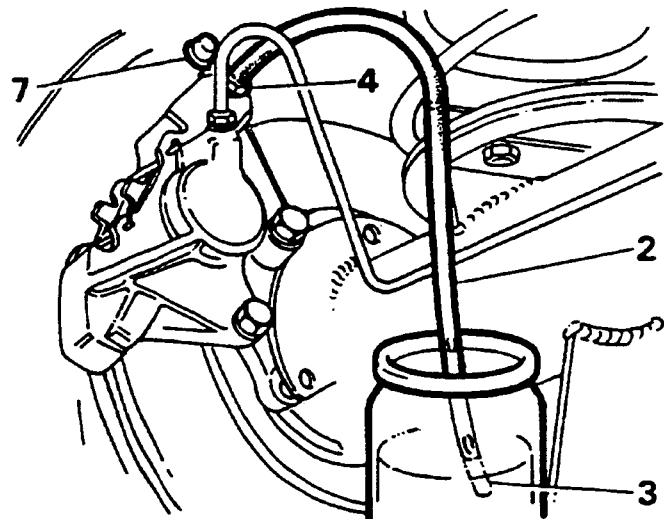
NOTE: When bleeding system commence with caliper furthest from master cylinder. Finally tighten bleed screws to 10 Nm.

Bleeding

1. Fill fluid reservoir with correct grade of fluid. See *LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids*

NOTE: Maintain correct fluid level throughout procedure of bleeding.

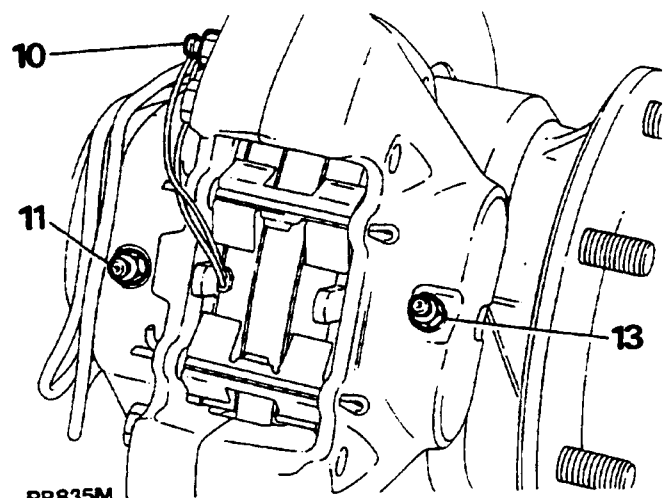
2. Connect bleed hose to bleed screw on rear caliper furthest from master cylinder.
3. Submerge free end of bleed hose in a container of clean brake fluid.
4. Loosen bleed screw 1/2-3/4 of a turn.
5. Operate brake pedal fully and allow to return.



RR1946E

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

6. Repeat 5 until fluid clear of air bubbles appears in container. Keeping pedal fully depressed, tighten bleed screw.
7. Remove bleed hose, replace dust cap on bleed screw.
8. Repeat 1 to 7 for other rear caliper.
9. Remove front wheel furthest from master cylinder
10. Connect a bleed hose to primary bleed screw on front caliper.
11. Connect a bleed hose to secondary bleed screw on same side of caliper as primary screw.



RR835M

12. Repeat 3 to 7 for front caliper, bleeding two screws simultaneously.
13. Connect a bleed hose to other screw on front caliper furthest from master cylinder.
14. Repeat 3 to 7 for second secondary screw on front caliper.
15. Refit front wheel.
16. Repeat 9 to 15 for front caliper nearest master cylinder.

MASTER CYLINDER

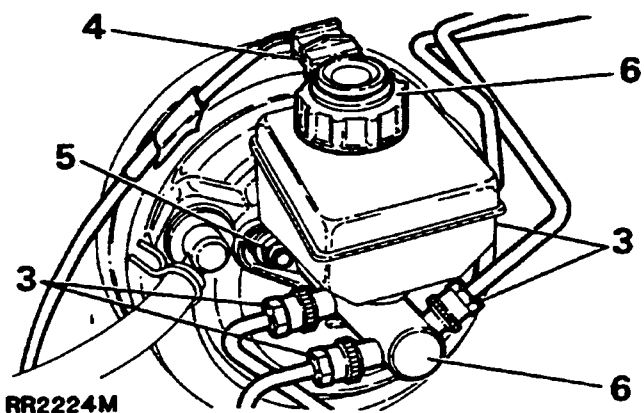
- Lucas Girling - Type 25.4mm AS/AS

Service repair no - 70.30.08 - Remove
 Service repair no - 70.30.09 - Repair

Remove, repair and refit

Remove

1. Disconnect the battery negative lead.
2. Place a suitable container under master cylinder to catch brake fluid from cylinder when brake pipes are disconnected.
3. Thoroughly clean immediate area around all outlet ports. Remove each brake pipe, sealing each pipe and outlet port with suitable plugs to prevent ingress of foreign matter.
4. Disconnect electrical plug from low fluid switch on reservoir cap.
5. Remove two nuts securing master cylinder to servo unit remove also spring and plain washers.



6. Detach master cylinder from servo, remove reservoir cap and drain brake fluid into a suitable container.



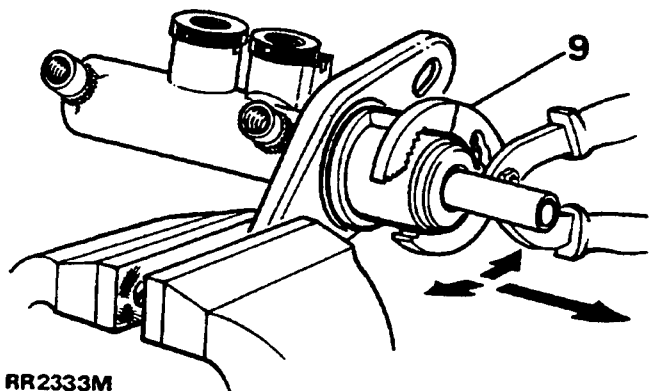
WARNING: Do not use brake fluid previously drained or bled from system. Carefully dispose of unwanted fluid, if stored in a sealed container, ensure that container is marked USED BRAKE FLUID.

Repair

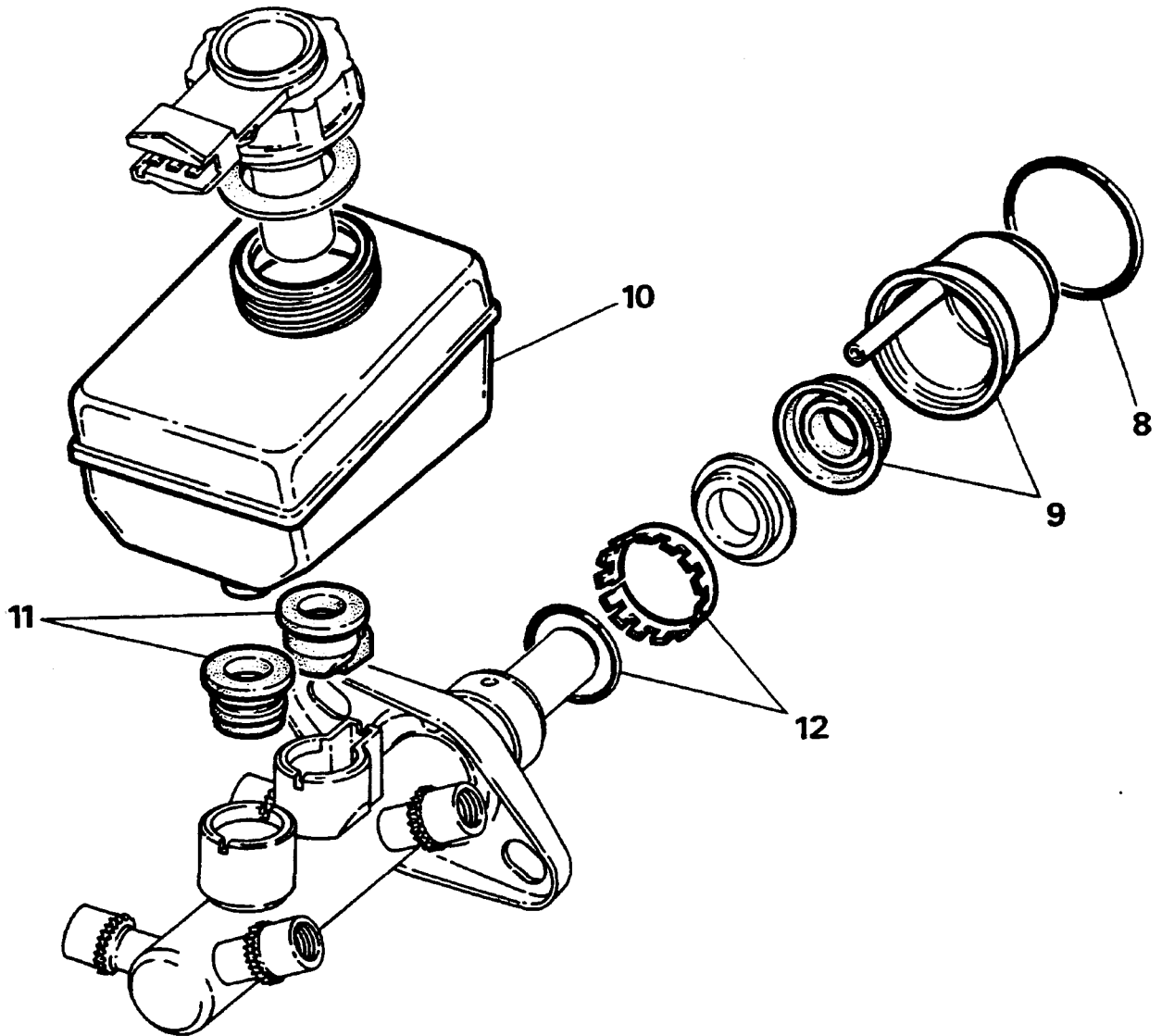


WARNING: Use only unused brake fluid to clean any part of brake system. DO NOT use petrol, kerosene or other mineral based fluids.

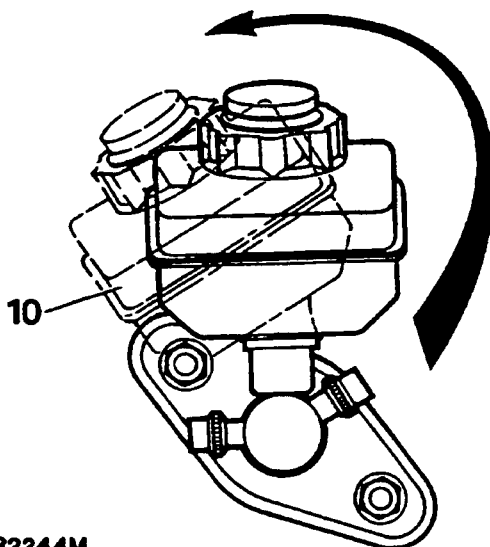
7. Thoroughly clean master cylinder and inspect outer surfaces for damage and condition, renew complete assembly if necessary.
8. Using two soft jaws, clamp master cylinder flange in a suitable vice. Remove water ingress 'O' ring seal from master cylinder to servo flange and discard.



9. Grip outside of transfer housing with a suitable pair of pliers, carefully pull, working pliers in a backwards and forwards rocking motion to ease housing off master cylinder. Discard housing and vacuum seal.



RR2237M



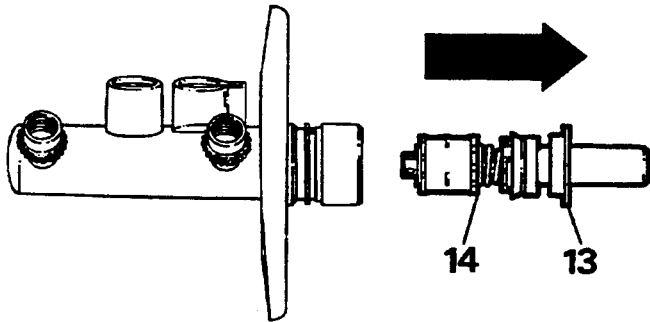
RR2244M

10. Ease reservoir out of master cylinder taking care to ensure that two outlet ports on bottom of reservoir do not become damaged during this process.
11. Withdraw two reservoir seals from master cylinder inlet ports. Note for reassembly these seals are different. Discard seals.
12. Remove retaining ring and 'O' ring seal from machined outer surface of master cylinder. Discard both seal and retaining ring.

13. Remove guide ring, which supports primary plunger assembly, from mouth of master cylinder. Place to one side for reassembly, note this component is not part of service kit.
14. Pull primary plunger assembly out of master cylinder.

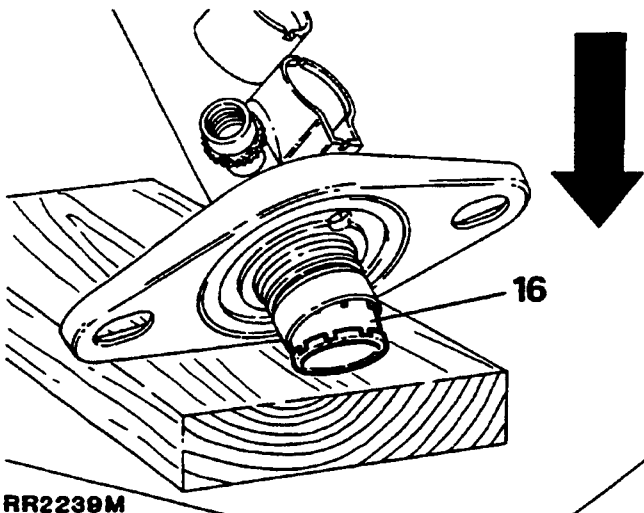


NOTE: The primary plunger assembly cannot be broken down any further and is serviced as a complete unit. Discard assembly.



RR2238M

15. The secondary plunger assembly will remain at bottom of master cylinder bore. Remove by tapping assembly on a piece of wood until plunger appears at cylinder mouth, carefully pull plunger out of master cylinder.



RR2239M

16. If swirl tube was not expelled at same time as secondary plunger, repeat above operation to remove it from bottom of master cylinder bore and discard.

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

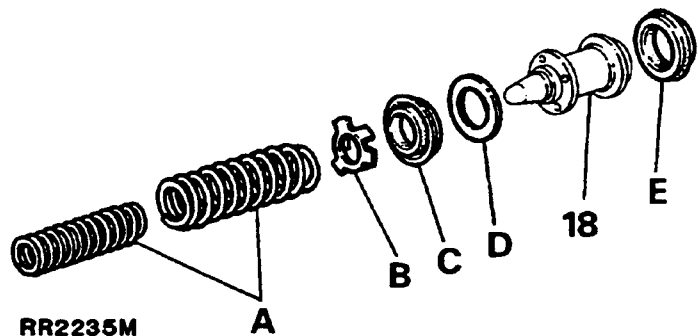
Renewing secondary plunger seals

18. Remove following components from secondary plunger and discard:



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

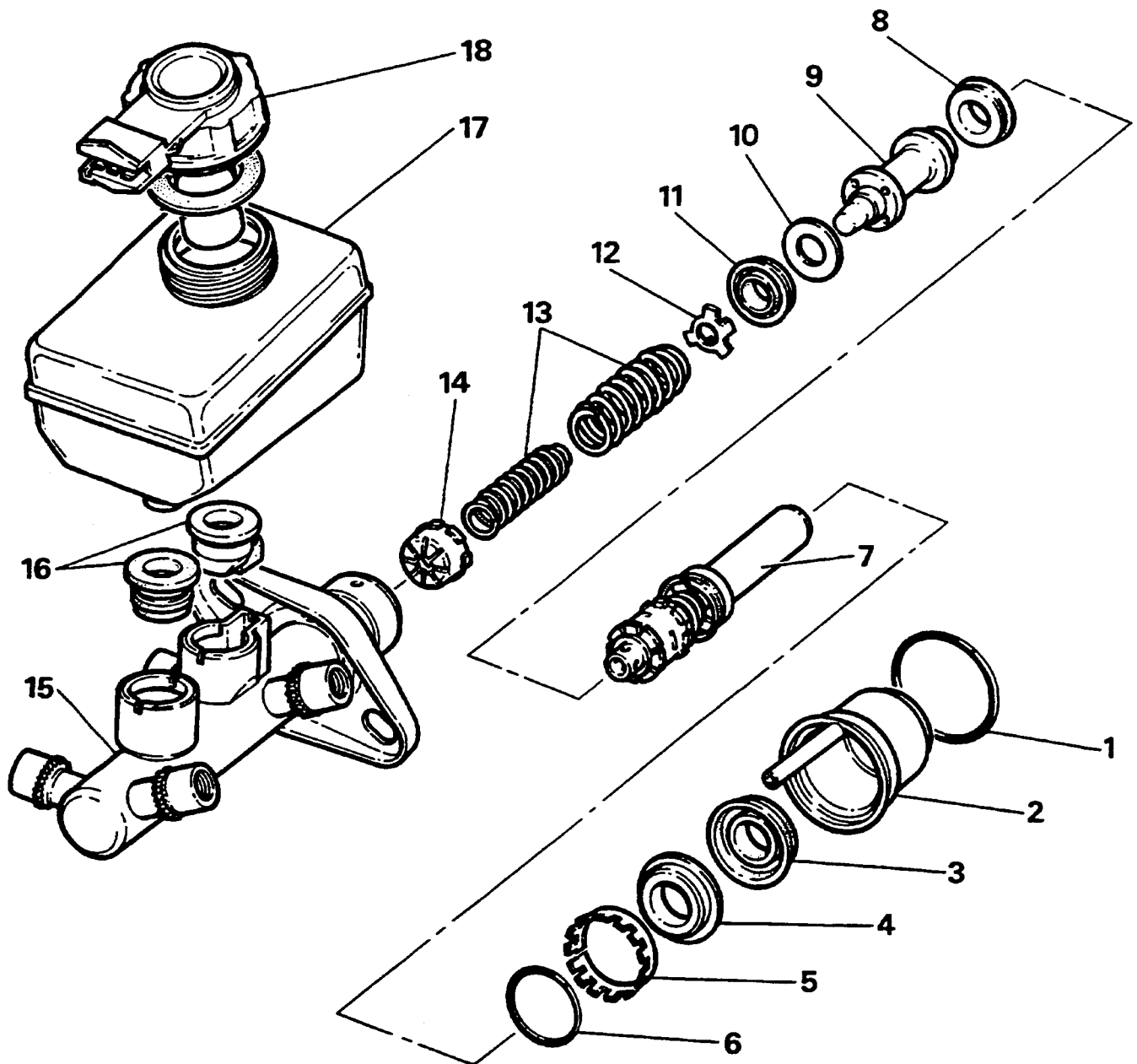
- (A) Springs
- (B) Seal retainer
- (C) Recuperating seal (primary cup)
- (D) Washer
- (E) 'L' seal



RR2235M



MASTER CYLINDER ASSEMBLY



RR2234M

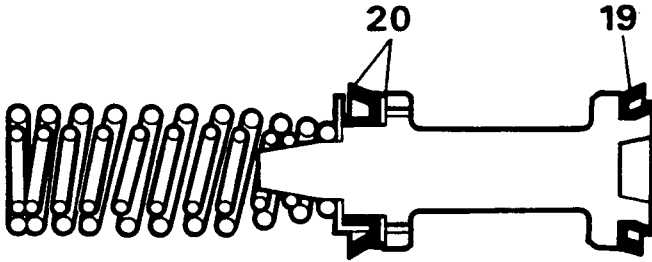
Key to master cylinder

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



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

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

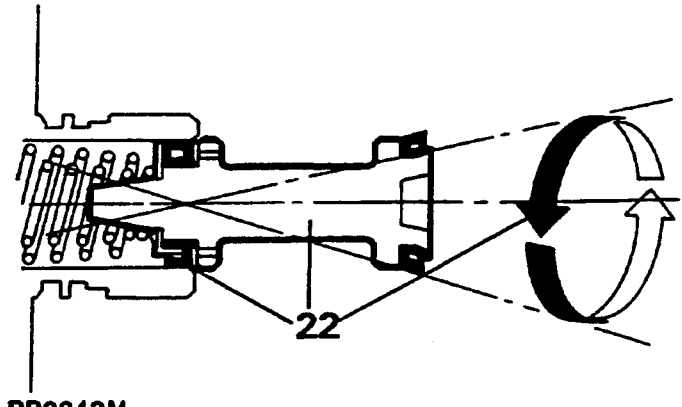


RR2236M

ASSEMBLING MASTER CYLINDER

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

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



RR2240M

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

NOTE: DO NOT ROLL 'O' ring down outer location surface of master cylinder. It should be slightly stretched and eased down cylinder and into its groove. DO NOT OVER STRETCH SEAL.

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



Refit

32. Fit master cylinder to servo. Secure in position with two nuts, plain and spring washers. Tighten to **26 Nm**.
33. Fit brake pipes to master cylinder. Tighten to **10 Nm**.
34. Top-up master cylinder with correct grade of brake *See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids*
35. Bleed system. *See Brake system bleed*

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

36. Fit cap, reconnect electrical lead to fluid level switch. Reconnect the battery negative lead.

SERVO ASSEMBLY

Service repair no - 70.50.01

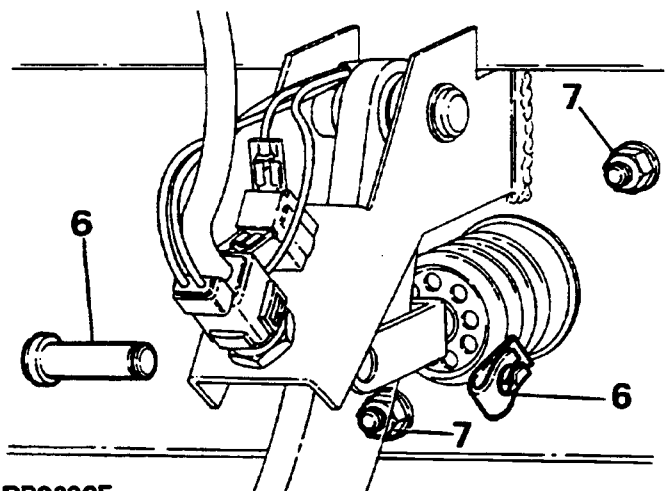
Remove and refit

Remove



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

1. Disconnect the battery negative lead.
2. Disconnect electrical plug to low fluid level switch.
3. Thoroughly clean immediate area around all master cylinder outlet ports. Remove each brake pipe, sealing each pipe and outlet port with suitable plugs to prevent ingress of foreign matter.
4. Disconnect vacuum supply hose to servo.
5. Remove lower dash panel to gain access to servo push rod to brake pedal.
6. Remove clevis pin securing servo push rod to brake pedal.
7. Remove two nuts and plain washers securing servo.



RR2232E

8. Remove servo and master cylinder assembly.
9. Drain brake fluid into a suitable container. (If master cylinder is kept horizontal it is not necessary to drain fluid).

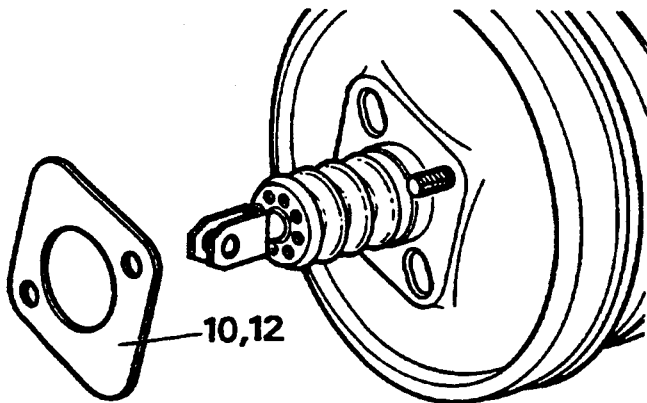


WARNING: Do not use brake fluid previously drained or bled from system. Carefully dispose of unwanted fluid, if stored in a sealed container, ensure that container is marked **USED BRAKE FLUID**.

10. Detach spacer from pedal box mounting face of servo.



NOTE: Retain spacer reassembly. The spacer ensures stringent pedal to servo operating dimensions are maintained.



RR2233M

11. Remove master cylinder from existing servo and refit to new servo, if fitting new unit.

Refit

12. Fit spacer to servo.
13. Fit servo to pedal box.
14. Lightly grease brake pedal around area servo push rod pivots.
15. Fit push rod to brake pedal. Fit clevis pin and clip.

16. Secure servo with two nuts and plain washers. Tighten to **24 Nm**.
17. Refit lower dash panel.
18. Fit master cylinder to servo, refit nuts, plain and spring washers. Tighten to **26 Nm**.
19. Remove all sealing plugs. Refit brake pipes to respective ports. Tighten brake pipes to **10 Nm**.
20. Refit vacuum supply hose.
21. Fill master cylinder to correct level using correct grade of brake fluid. *See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids*
22. Bleed brake system. *See Brake system bleed*



PEDAL ASSEMBLY

Service repair no - 70.35.01 - remove
Service repair no - 70.35.02

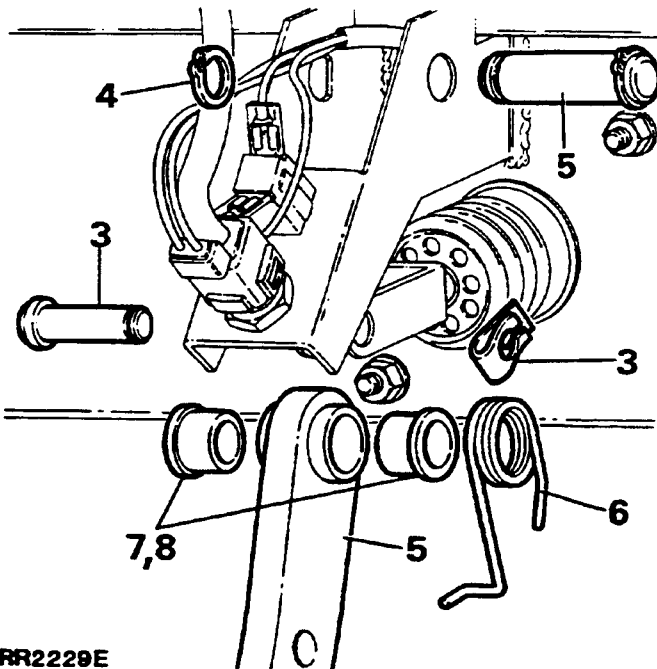
Remove and refit

Remove

1. Disconnect the battery negative lead.
2. Remove lower dash panel to gain access to pedal assembly.
3. Remove spring clip and clevis pin.
4. Remove circlip from 'D' shaped end of pedal shaft.
5. Remove pedal shaft and withdraw pedal.
6. Remove return spring from pedal.

Renew bushes

7. Remove bushes from pedal pivot tube.
8. Press new bushes into pedal pivot tube. If necessary ream out bushes to 15,87mm plus 0,05mm.
9. Lightly grease bushes.



RR2229E

Refit

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

FRONT BRAKE PADS

Service repair no - 70.40.02

Service tool:
LRT.70-500 - Piston clamp

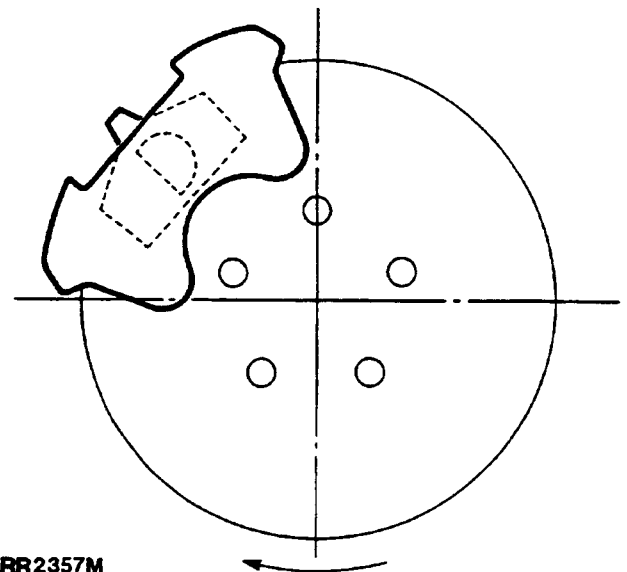
Remove and refit

Remove

Brake pad identification

From side of vehicle, looking through disc and caliper at inboard pad, 'D' shaped material on rear of inboard pad should face direction of forward rotation of road wheel with curved part of 'D' always at trailing end of caliper.

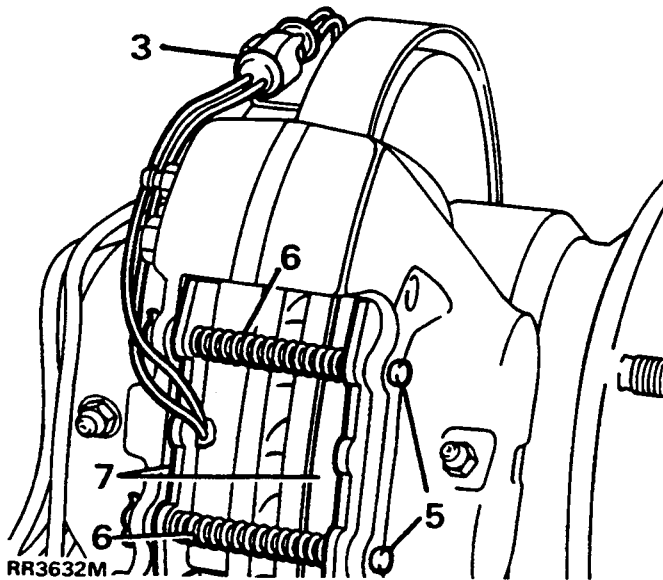
Brake pad wear sensed at right hand wheels



RR2357M

Direction of rotation

1. Remove front road wheels. *See WHEELS AND TYRES, Repair, Wheels*
2. Disconnect the battery negative lead.
3. Disconnect pad wear sensor plug (front right hand side only).

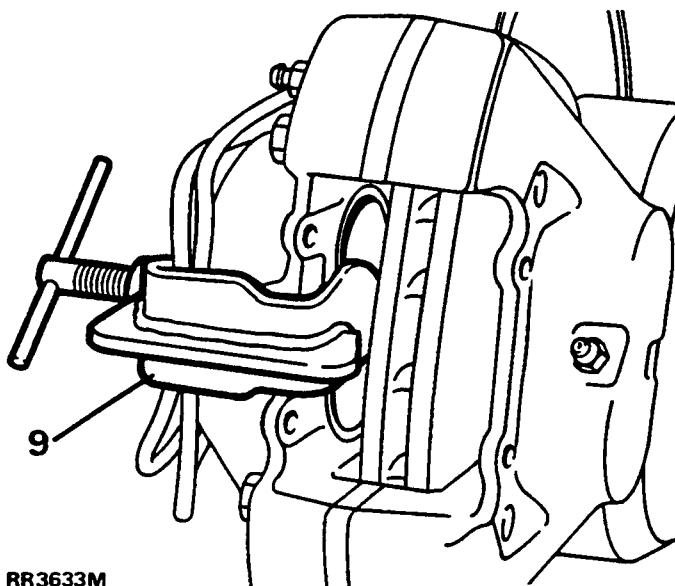


8. Clean exposed parts of pistons, using new brake fluid.
9. Using piston clamp LRT-70-500 press each piston back into its bore. Ensure that displaced brake fluid does not overflow from reservoir.
10. Coat faces of pistons with brake fluid, keeping it away from lining material.

Refit

11. Insert brake pads, ensuring pad with wear indicator is fitted to inboard side right hand caliper.
12. Fit pad retaining pins and anti-rattle springs. Secure with new split pins. Reconnect pad sensor wear plug.
13. Apply service brake pedal several times to locate pads.
14. Check fluid reservoir. Top up if necessary, using correct grade of fluid. *See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids*

4. Clean exterior of calipers.
5. Remove split pins from retaining pins.
6. Remove pad retaining pins and anti-rattle springs.
7. Remove brake pads.





REAR BRAKE PADS

Service repair no - 70.40.03

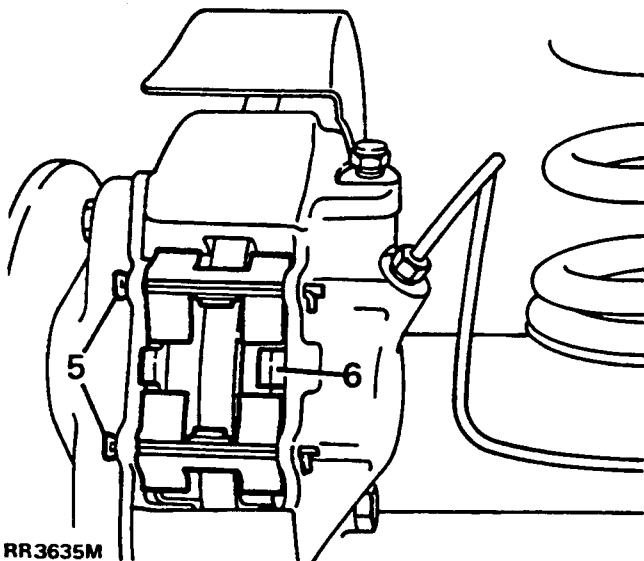
Service tool:

LRT-70-500 - Piston clamp

Remove and refit

Remove

1. Remove rear road wheels. *See WHEELS AND TYRES, Repair, Wheels*
2. Disconnect the battery negative lead.
3. Disconnect pad wear sensor plug (rear right hand side only).
4. Clean exterior of calipers.
5. Remove pad retaining pins and springs.
6. Remove brake pads.

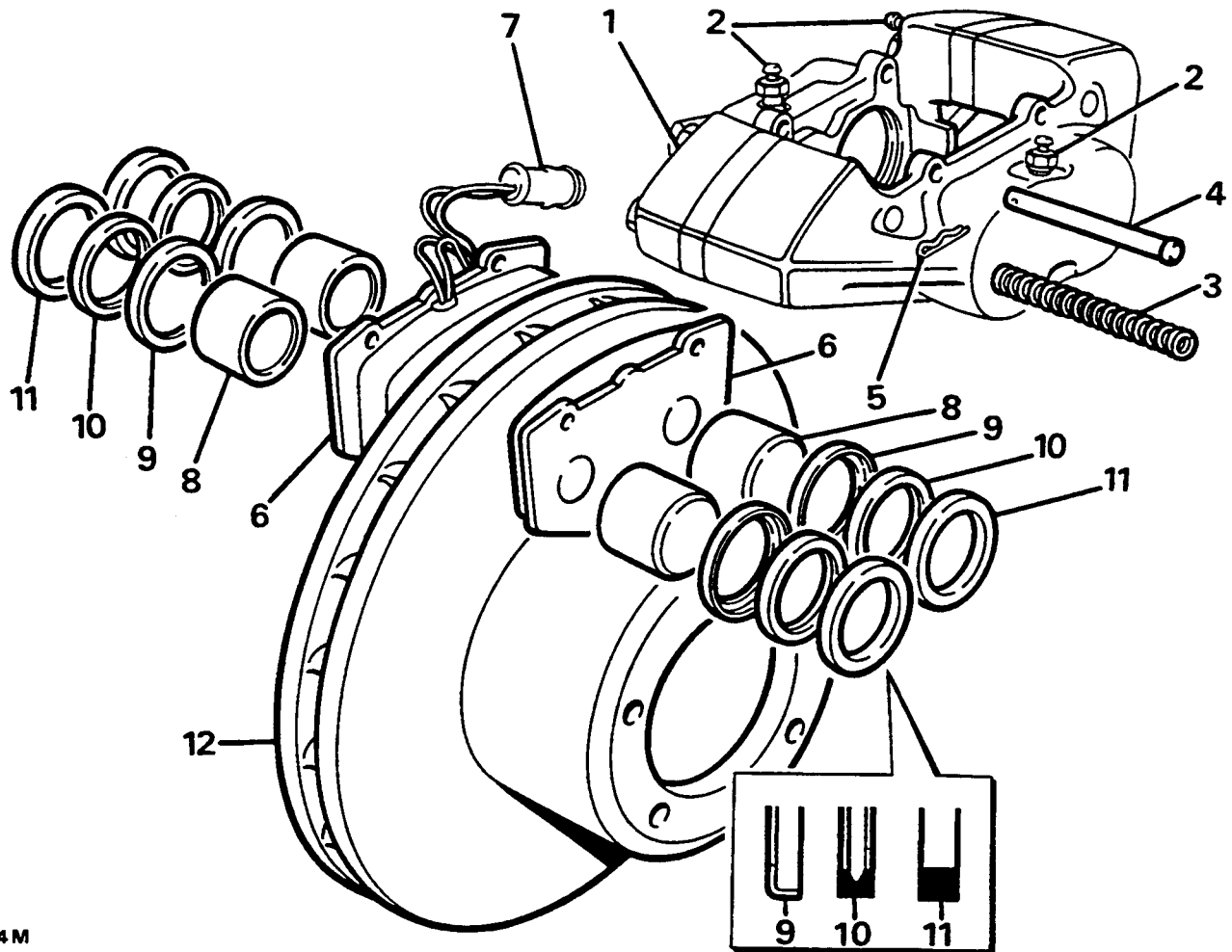


7. Clean exposed parts of pistons, using new brake fluid.
8. Using piston clamp LRT-70-500 press each piston back into its bore. Ensure that displaced brake fluid does not overflow from reservoir.
9. Coat faces of pistons with brake fluid, keeping it away from lining material.

Refit

10. Insert brake pads, ensuring pad with wear indicator is fitted to inboard, right hand side caliper.
11. Position pad retaining springs, fit new pins and spread ends. Reconnect pad sensor wear plug.
12. Apply service brake pedal several times to locate pads.
13. Check fluid reservoir, top up if necessary, using correct grade of fluid. *See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids*

FRONT BRAKE CALIPER ASSEMBLY



RR3634 M

Key to caliper

- | | |
|------------------------|----------------------------|
| 1. Caliper | 7. Pad wear indicator plug |
| 2. Bleedscrews | 8. Piston |
| 3. Anti-rattle springs | 9. Wiper seal retainer |
| 4. Pad retaining pins | 10. Wiper seal |
| 5. Split pins | 11. Fluid seal |
| 6. Friction pads | 12. Brake disc |



FRONT BRAKE CALIPERS

Service repair no - 70.55.03

Service repair no - 70.55.16

Service tool:

LRT-70-500 - Piston clamp

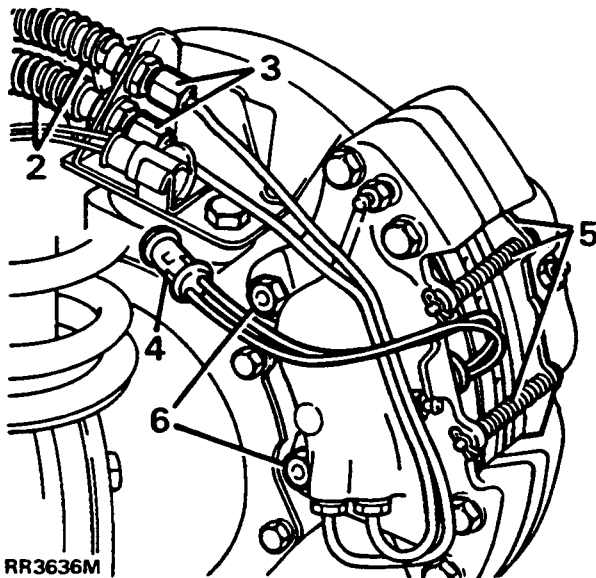
Remove, repair and refit



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

Remove caliper

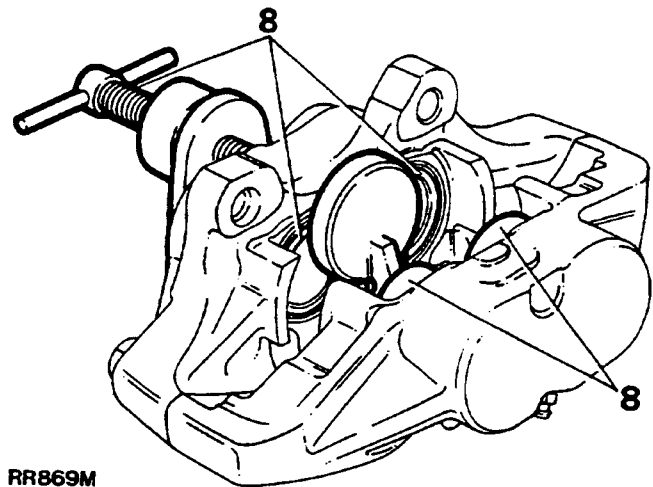
1. Loosen front wheel retaining nuts, raise front of vehicle, lower onto axle stands, remove wheels.
2. Expose flexible brake hoses by moving coiled protective covering. Using a recognised hose clamp, clamp both hoses to prevent loss of brake fluid.
3. Disconnect rigid brake pipes from flexible hoses, seal exposed ends to prevent ingress of dirt. (If necessary rigid brake pipes to caliper can be disconnected when caliper is removed).
4. Disconnect pad wear warning indicator (front right hand side only).
5. Remove split pins, retaining pins and springs, withdraw pads. If refitting pads, identify them for assembly to original locations.
6. Loosen bolts and remove caliper.



DISMANTLE AND REPAIR

Do not separate caliper halves

7. Clean outer surfaces of caliper using aerosol brake cleaner.
8. Using special tool LRT-70-500, clamp pistons in inboard half of caliper. Gently, keeping fingers clear, and with **CAUTION**, apply air pressure to fluid inlet port to expel pistons. It is unlikely that pistons will expel at same time, regulate rate with a suitable piece of wood between appropriate piston and caliper.



RR869M

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

Assemble outboard pistons

13. Coat new fluid seal with brake fluid. Ease seal into groove in bore using only fingers, ensuring it is properly seated. Fluid seal and groove are not same in section, so when seal is seated it feels raised to touch at edge furthest away from mouth of bore.
14. Coat appropriate piston with brake fluid. Insert it squarely into bore by hand only. Do not tilt piston during insertion, leave approximately 8mm projecting from bore.
15. Coat new wiper seal with brake fluid and fit to new seal retainer. Slide assembly, seal first, over protruding piston and into bore recess. Use piston clamp to press home seal retainer and piston.

Mounting inboard pistons

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

Refit calipers and pads

17. Fit caliper, tighten bolts evenly to, **82 Nm**.
18. Connect brake flexible hoses to caliper. Tighten to **10 Nm**.
19. Remove hose clamps.
20. Lightly coat back and edges of pads with brake fluid, avoid friction material.
21. Insert pads. Fit pins and springs, secure using new split pins.



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

22. Reconnect pad wear indicator plug.
23. Bleed brake system. *See Brake system bleed*
24. Press brake pedal firmly several times to locate friction pads.
25. Fit road wheels, remove axle stands. Finally tighten road wheel nuts.
26. Road test vehicle. Note that new friction pads require 'bedding-in', this may take several hundred miles before brakes are at maximum efficiency.

REAR BRAKE CALIPERS

Service repair no - 70.55.06

Service repair no - 70.55.17

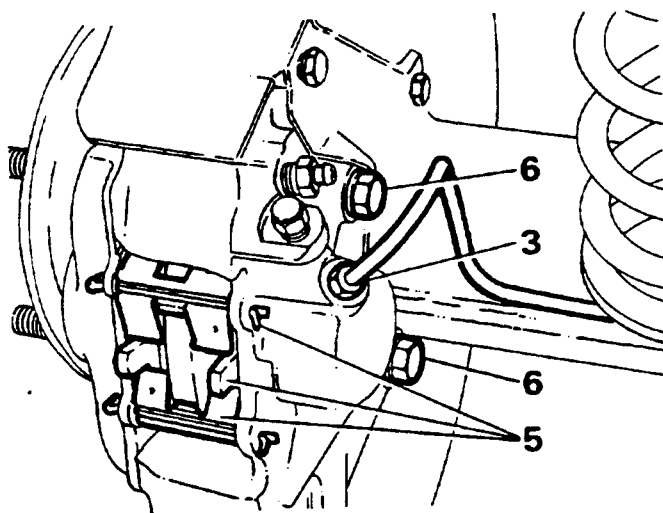
Service tool:

LRT-50-700 - Piston clamp

Remove, repair and refit

Remove caliper

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



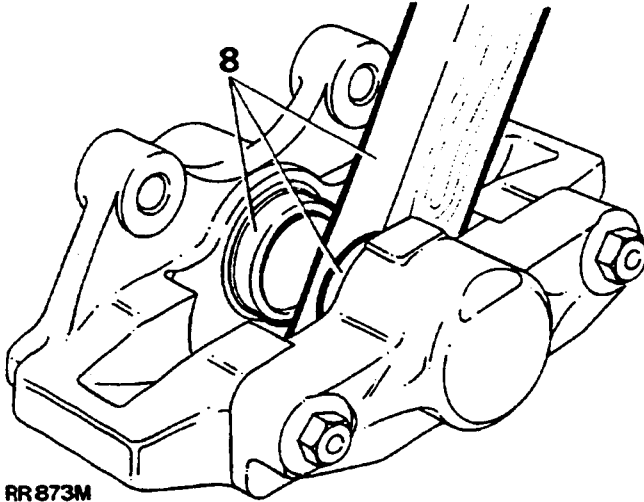
RR2007E



DISMANTLE AND REPAIR

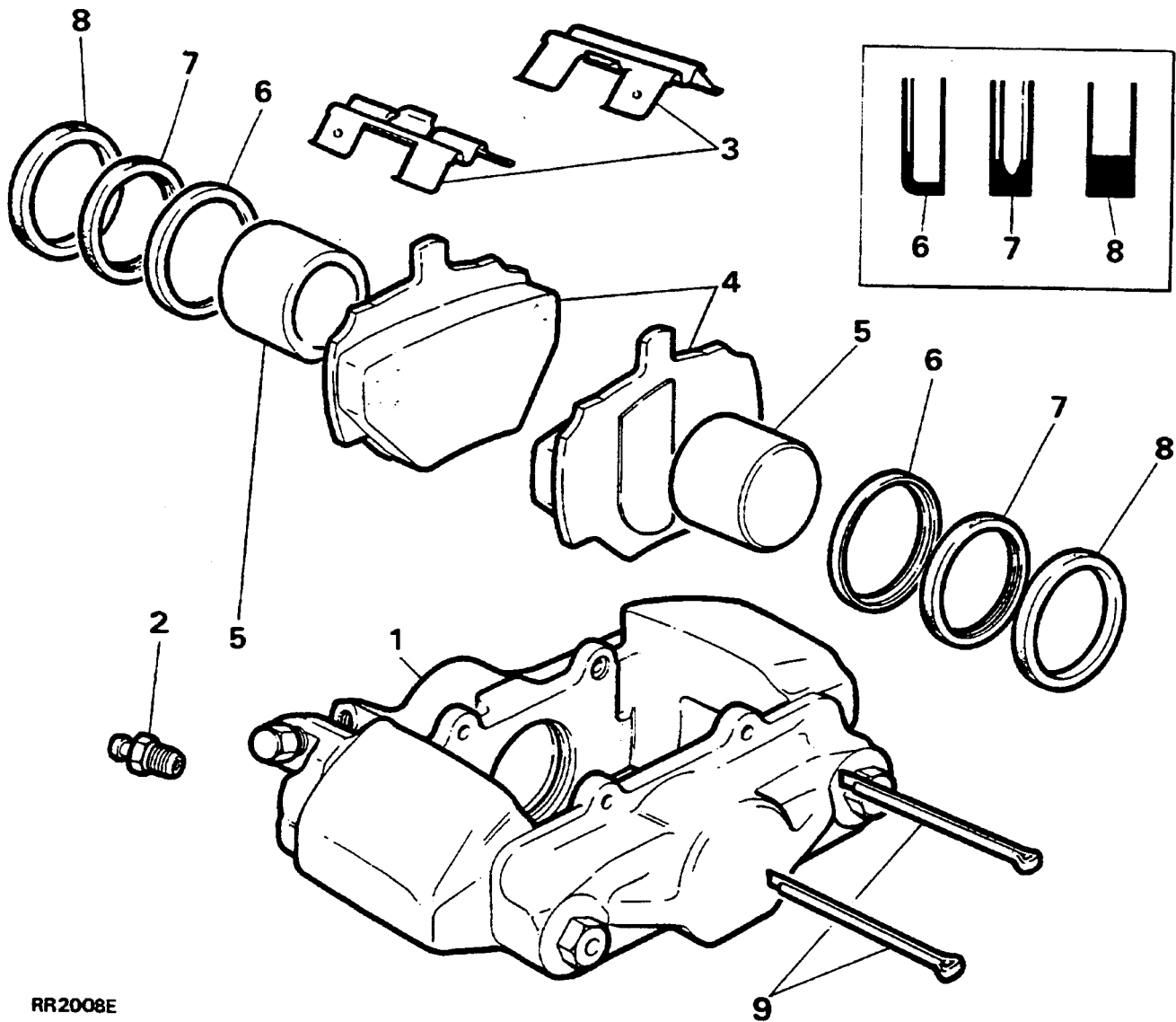
Do not separate caliper halves

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



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

REAR BRAKE CALIPER ASSEMBLY



RR2008E

LH Rear Caliper illustrated

Key to caliper

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



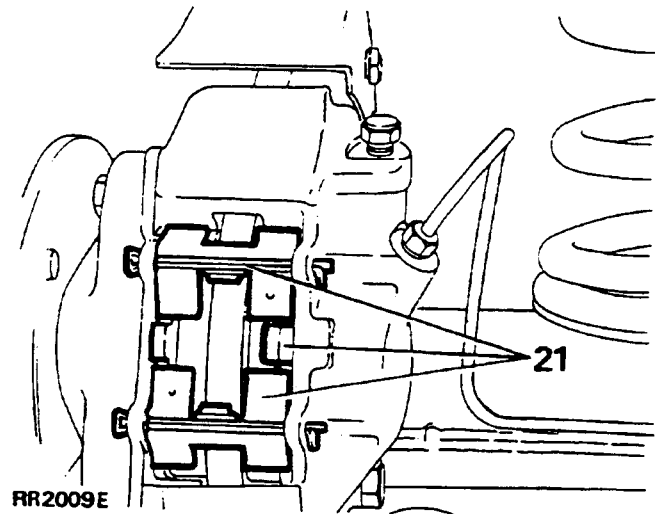
13. Coat a new fluid seal using brake fluid. Ease seal into groove in bore using only fingers and ensure that it is properly seated. The fluid seal and groove are not same in section so that when seal is seated it feels raised to touch at edge furthest away from mouth of bore.
14. Coat appropriate piston with brake fluid. Insert it squarely into bore by hand only. Do not tilt piston during insertion and leave approximately 8mm projecting from bore.
15. Coat a new wiper seal with brake fluid and fit to new seal retainer. Slide assembly, seal first, over protruding piston into bore recess.
16. Using special tool LRT-70-500 - piston clamp, press home seal retainer and piston.

Mounting inboard piston

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

Refit calipers and pads

18. Fit caliper to axle, tighten two bolts evenly to **82 Nm**.
19. Connect brake pipe to caliper. Tighten to **12 Nm**. Remove clamp from flexible brake hose.
20. Lightly coat back and edges of pads using brake fluid, avoid friction material.
21. Insert pads and retaining springs, secure in position with new retaining pins and spread ends. Note correct position of retaining springs.



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

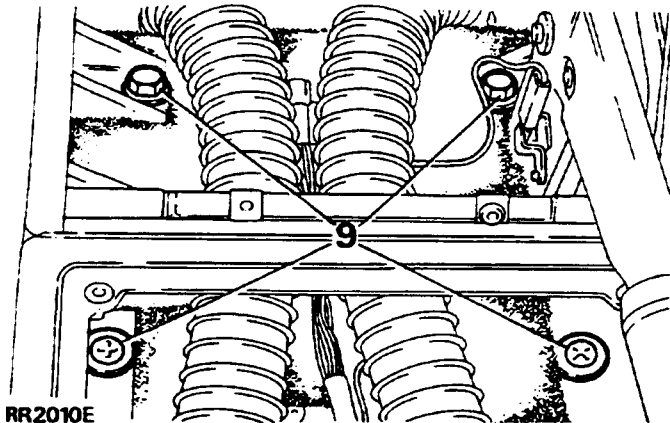
22. Reconnect pad wear indicator electrical plug.
23. Bleed secondary brake system at rear calipers, starting at caliper furthest away from master cylinder.
24. Press brake pedal firmly several times to locate pads.
25. Fit road wheels, remove axle stands and finally tighten road wheel nuts,
26. Road test vehicle. Note new brake pads require 'bedding-in', for several hundred miles before brakes are at maximum efficiency.

PARKING BRAKE LEVER

Service repair no - 70.45.01

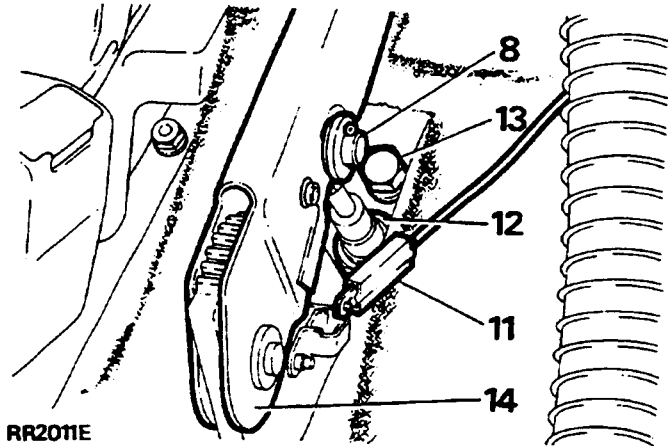
Remove and refit**Remove**

1. Disconnect the battery negative lead.
2. Chock road wheels and release parking brake.
3. Open glove box lid, remove four screws securing glove box liner and remove liner.
4. Remove two electrical leads from glove box cigar lighter. Release two heater hoses from clamps.
5. Carefully pry window lift switch panel away from front of glove box. Manoeuvre panel through opening into inside of glove box.
6. Remove gear selector and transfer gearbox knobs.
7. Carefully pry centre panel out of console. Disconnect electrical multi-plug to inset graphics panel, withdraw panel off main gearbox selector.
8. Remove split pin, plain washer and clevis pin.
9. Remove four bolts and plain washers.



10. Raise parking brake lever. Ease glove box and console assembly rearwards to release from radio housing. Remove assembly.
11. Disconnect electrical lead from parking brake warning switch.
12. Release parking brake cable outer retaining nut.

13. Remove remaining single bolt and plain washer securing parking brake mounting bracket.
14. Remove parking brake lever assembly from parking brake outer cable.



RR2011E

Refit

15. Position parking brake lever, secure in position with single bolt and plain washer, forward of lever mounting bracket.
16. Secure outer cable to mounting plate, tighten nut securely.
17. Refit glove box/console assembly, secure in position, tightening remaining bolt and two screws securely.
18. Fit inner parking brake cable to parking brake lever using a new split pin.
19. Reverse remaining removal instructions. Ensure electrical wiring does not become trapped between mating faces.



PARKING BRAKE REPAIR



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

Dismantling

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

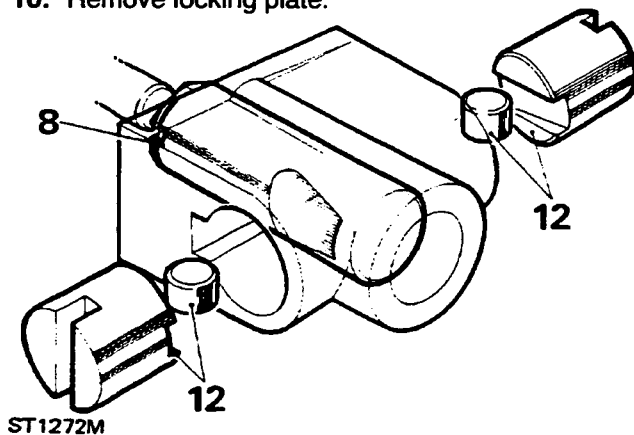


NOTE: If drum requires skimming maximum diameter is 255.65 mm.

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

Remove expander assembly

7. Remove rubber dust cover.
8. Remove expander and drawlink.
9. Remove retainer spring plate.
10. Remove locking plate.



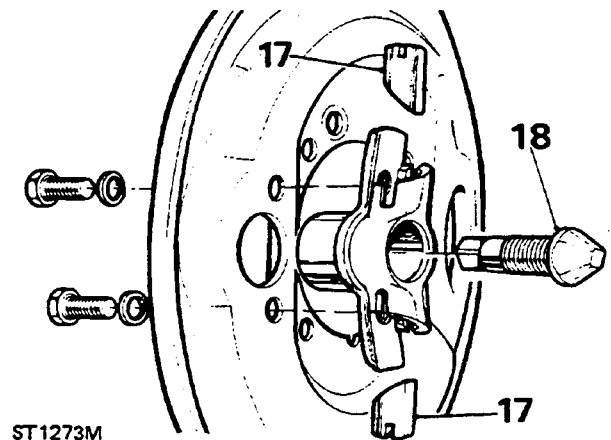
11. Remove packing plate and withdraw expander assembly from back plate.
12. Remove two plungers and rollers.
13. Clean all parts in aerosol brake cleaner, allow to dry. Examine components for wear, discard if unsatisfactory.

Assemble expander assembly

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

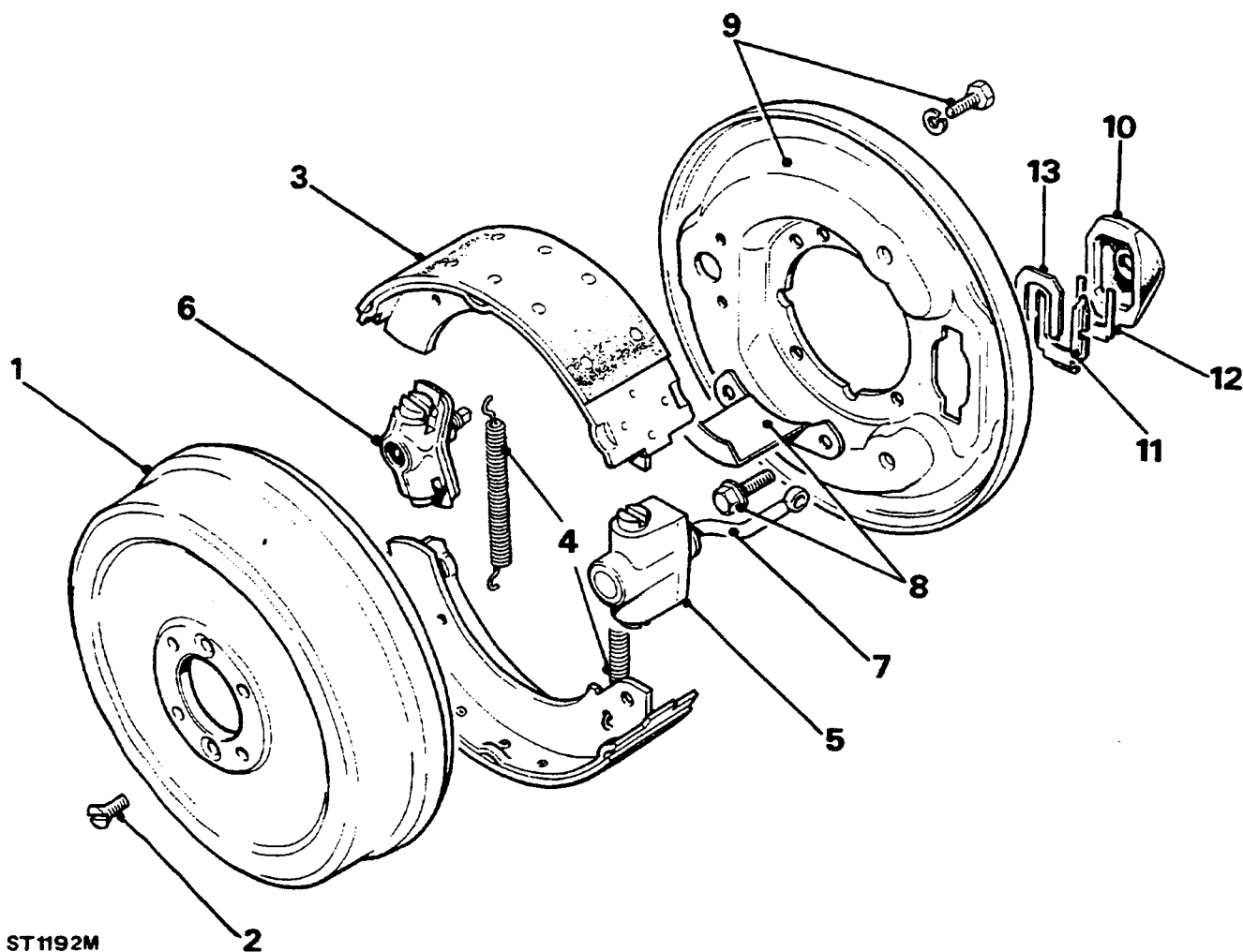
Remove adjuster assembly

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



19. Clean parts in aerosol brake cleaner and discard any unsatisfactory components.

PARKING BRAKE ASSEMBLY



ST1192M

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

Adjuster assembly

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

Assemble

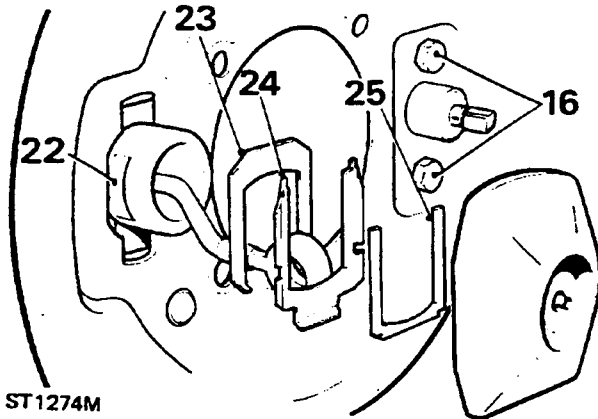


NOTE: If brake linings are oil-soaked, fit new brake shoes. Check output shaft oil seal, fit a new seal if necessary.

22. Position expander assembly on back plate. Secure using following plates on rear of back plate.



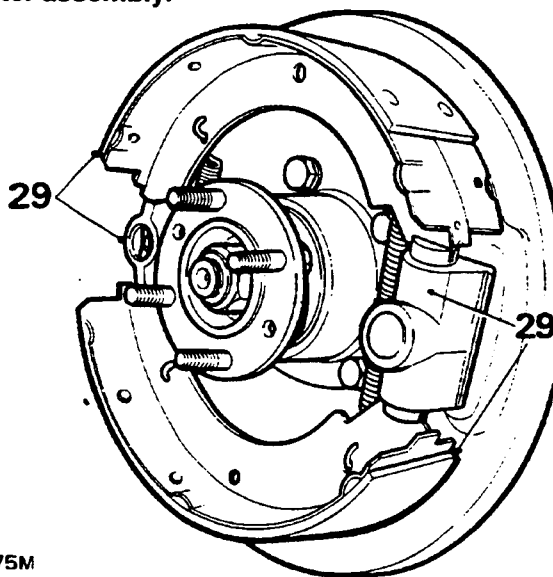
- 23. Spring plate.
- 24. Locking plate.
- 25. Packing plate.
- 26. Fit rubber dust cover.



- 27. Fit adjuster assembly to back plate with two bolts. Do not fully tighten.
- 28. Fit back plate assembly and oil catcher to transfer box with four bolts. Tighten to **75 Nm**.
- 29. Fit new pull-off springs to brake shoes and fit to back plate.



NOTE: Fully lined end of **LOWER SHOE** must be toward expander assembly with fully lined end of **UPPER SHOE** towards adjuster assembly.



- 30. Fit brake drum and tighten two screws to **25 nm**.
- 31. Connect actuating lever to brake cable using a new split pin.

- 32. Turn adjuster cone fully in, finally tighten two retaining bolts.
- 33. Loosen adjuster two 'clicks', firmly apply and release parking brake lever to centralise shoes. Drum should rotate freely.
- 34. Adjust parking brake cable lock nuts until parking brake lever is fully operational on second or third notch of parking brake ratchet.
- 35. Connect propeller shaft, evenly tighten retaining nuts to **45 Nm**.
- 36. Remove chocks from wheels, reconnect battery.

PARKING BRAKE CABLE

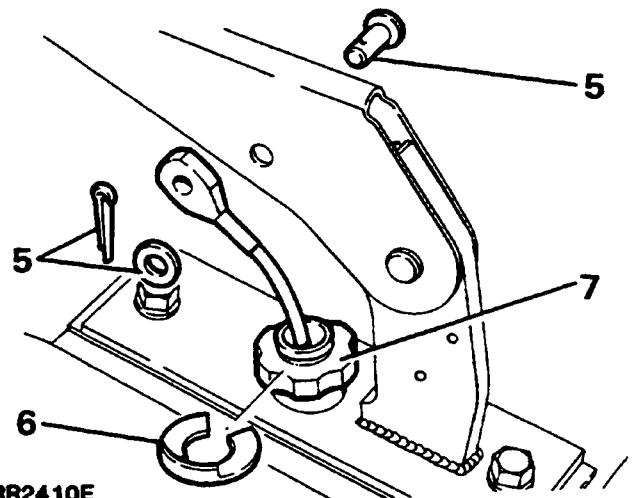
Service repair no - 70.35.25

Remove, refit and adjust

Remove

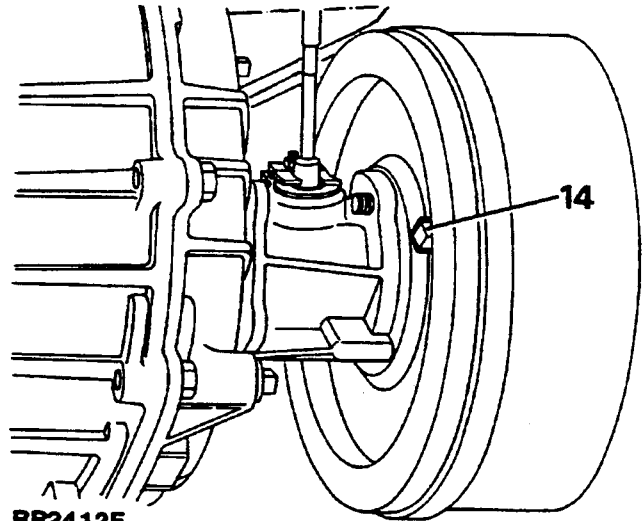
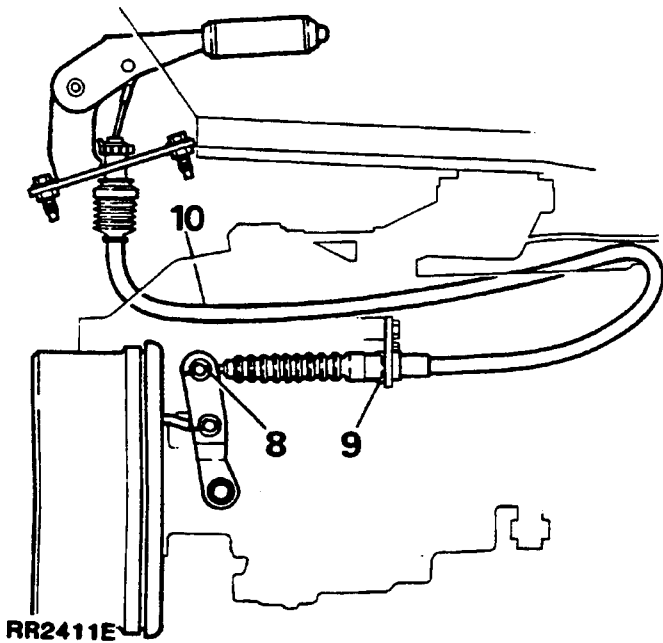
Inside vehicle

- 1. Place vehicle on level ground or ramp. Select a gear or 'P' in main gearbox. Disconnect the battery negative lead.
- 2. Chock road wheels.
- 3. Release parkbrake lever.
- 4. Remove four retaining screws and lift out glove box liner.
- 5. Remove split pin, clevis pin and washer from parkbrake lever.
- 6. Remove clip from adjustment thumbwheel, push inner and outer cable to underside of vehicle.
- 7. Pull thumbwheel from outer sleeve.



Underneath vehicle

8. Remove split pin, clevis pin and washer.
9. Detach retaining clip from transfer gearbox.
10. Release cable from retaining clip.



RR2412E

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

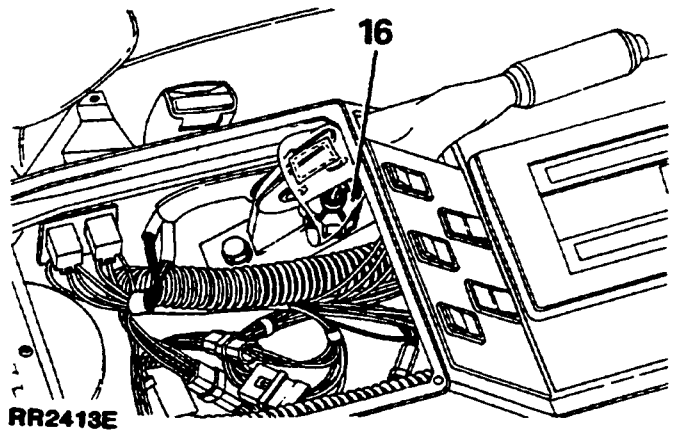
NOTE: Adjustment thumbwheel must **ONLY** be used for initial setting and to compensate for cable stretch. It **MUST NOT** be used to take up brake shoe wear, which **MUST** be adjusted at brake drum.

Refit

12. Reverse removal procedure. 5 to 11.

Parkbrake adjust

13. Ensure parkbrake lever is fully released.
14. Underneath vehicle, rotate brake adjuster clockwise until brake shoes are fully expanded against drum.



RR2413E

17. Operate parking brake to settle shoes. Recheck parkbrake is fully operational on third notch of ratchet. Readjust if necessary.
18. Refit glove box liner.
19. Reconnect the battery negative lead. Remove wheel chocks.



ANTI-LOCK BRAKE SYSTEM - ABS

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

Introduction

The purpose of ABS is to prevent vehicle wheels locking during brake application, thus maintaining vehicle steerability and stability. This allows vehicle to be steered whilst 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 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 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 hydraulic pump to maintain fluid pressure in accumulator.

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



CAUTION: Thoroughly clean all brake components, calipers, pipes and fittings before commencing work on brake system. Failure to do so could cause foreign matter to enter system and damage seals and pistons, which will seriously impair brake system efficiency.

WARNING:

DO NOT use brake fluid previously bled from system.

DO NOT use old or stored brake fluid.

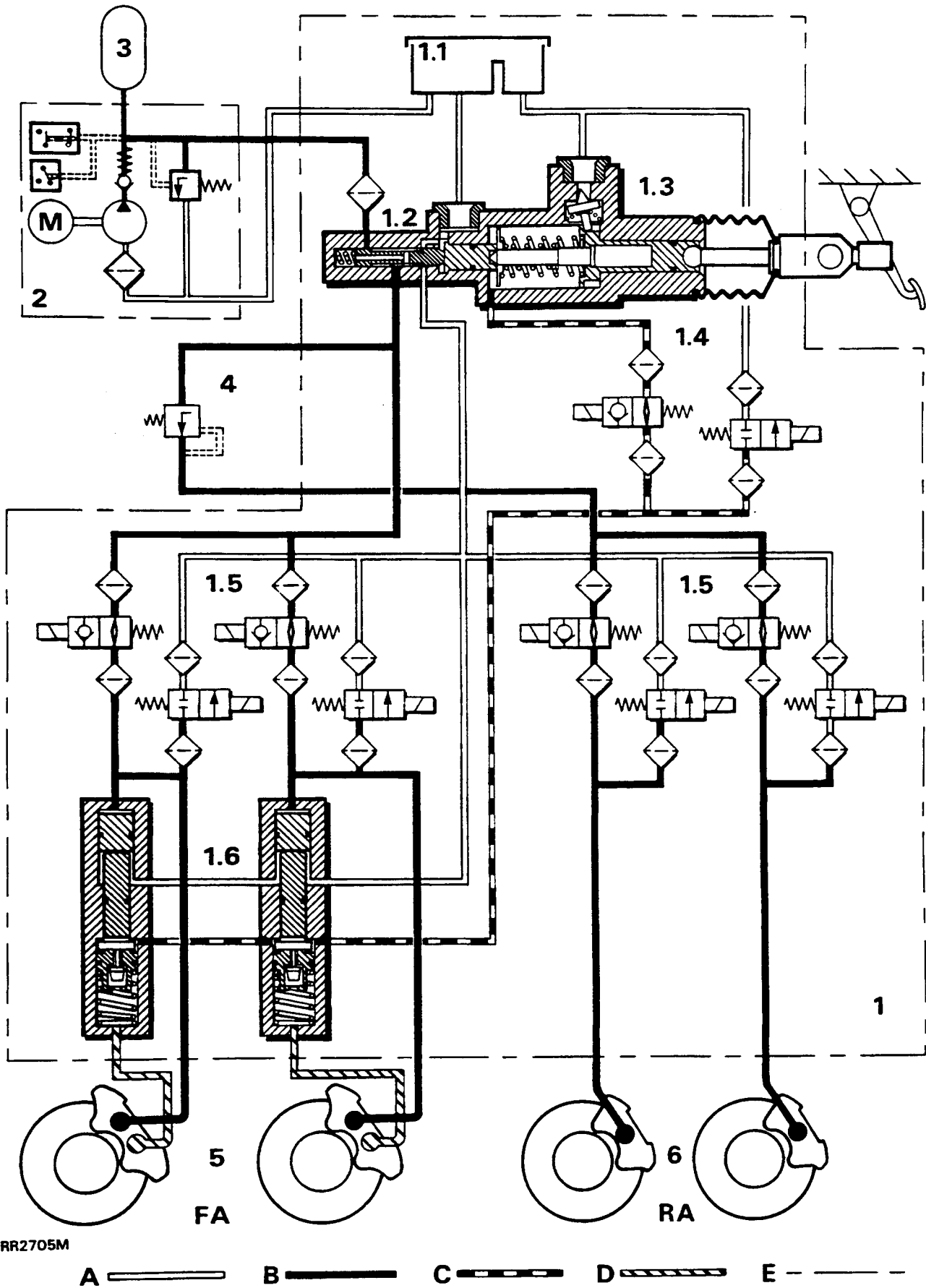
ENSURE that only new fluid is used and that it is taken from a clean sealed container.

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

Brake system must be drained and flushed at recommended service intervals.

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

HYDRAULIC COMPONENTS



RR2705M



Hydraulic circuits - RR 2705M

Key to diagram

- A - Fluid feed/return
- B - Power circuit
- C - Hydrostatic (master cylinder) circuit
- D - Combined hydrostatic/power circuit
- E - Component enclosure

Hydraulic components

Hydraulic booster unit (1)

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



NOTE: 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 reservoir seals to avoid ingress of debris.

Fluid reservoir (1.1)

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

Power valve (1.2)

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

Master cylinder (1.3)

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

Isolating valve (1.4)

Isolating valve consists of two solenoid valves controlling fluid inlet and outlet. Their function is to disconnect master cylinder from servo cylinder and to connect servo cylinder to 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 ECU, the valves decrease, hold or increase brake pressure according to 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)

Servo cylinders have four functions:

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

Hydraulic power unit (2)

Hydraulic power unit comprises an electrically driven pump and a pressure switch. Pressure switch incorporates three electro-mechanical switches: one for pump, another, at a different pressure setting, to illuminate pressure warning light. The latter switch plus third switch inform 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)

Diaphragm accumulator is precharged with nitrogen at up to 80 bar, its function is to store hydraulic energy.

Pressure conscious reducing valve (PCRIV) (4)

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

Brake calipers - front - (5) rear - (6)

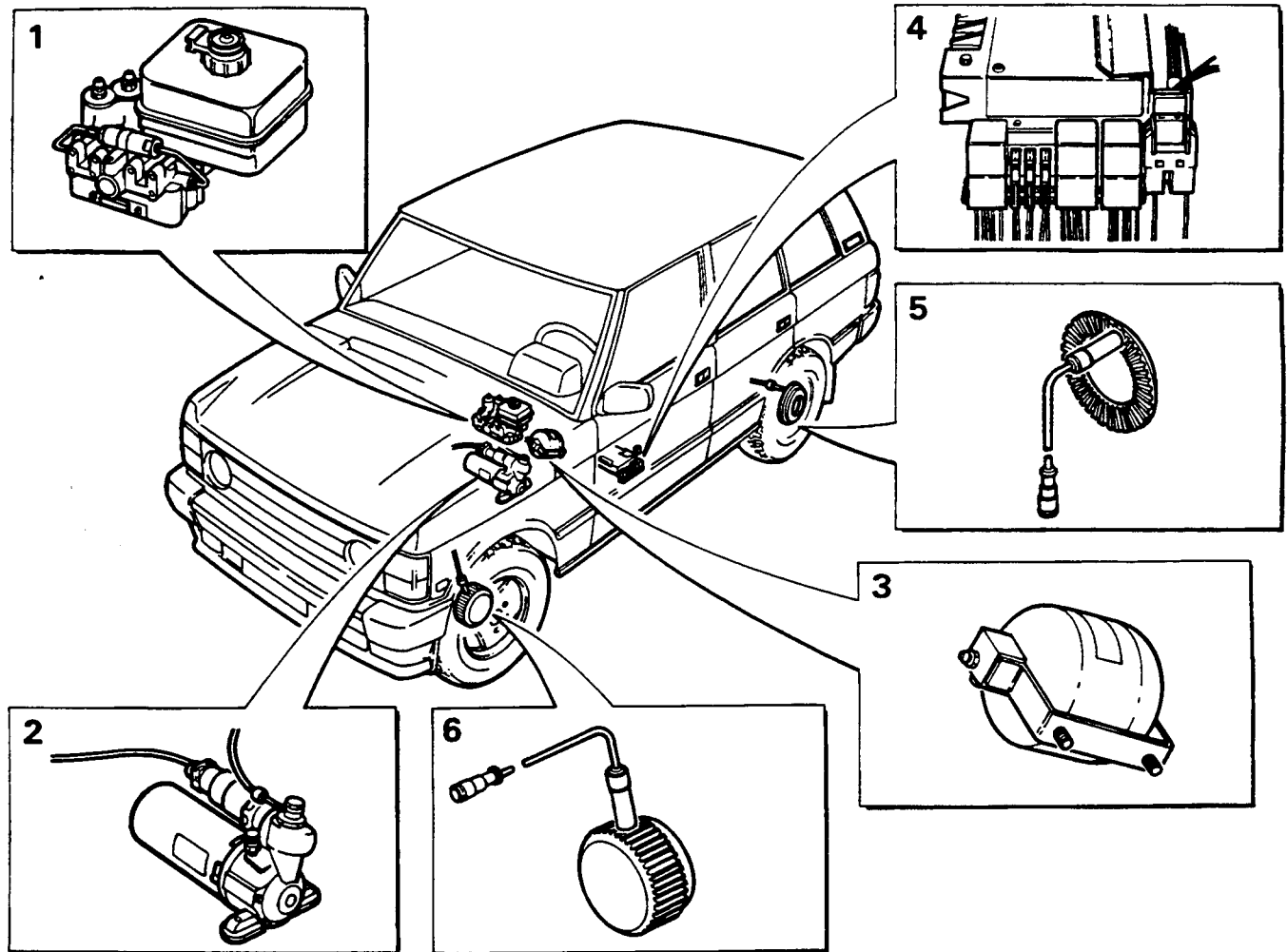
NOTE: To identify separate hydraulic circuits, they are referred to as **HYDROSTATIC** and **POWER** circuits.

Power circuit - Consists of rear calipers and upper pistons in the front calipers, supplied by direct hydraulic power from power valve.

Hydrostatic circuit - Lower pistons in the front calipers form this circuit, supplied with hydraulic energy from servo cylinders comprising a combination of master cylinder pressure and direct hydraulic power.



LOCATION OF COMPONENTS



RR2706M

Key to diagram (RR2706M)

- | | |
|--|--|
| <ul style="list-style-type: none"> 1. Hydraulic booster unit. 2. Power unit - hydraulic pump. 3. Accumulator. | <ul style="list-style-type: none"> 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 ECU located under left hand front seat, and earthed to centre tunnel.

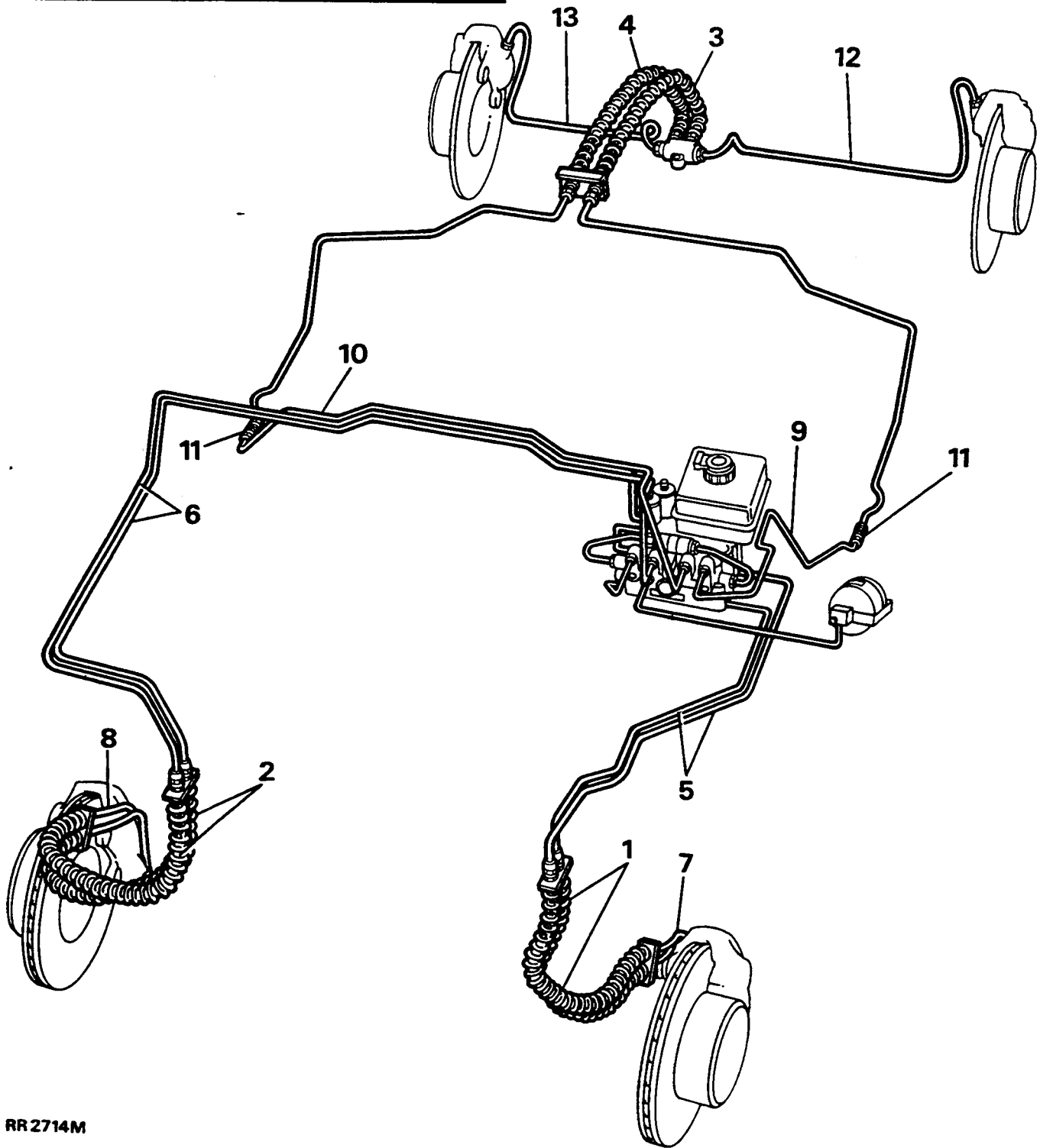
ECU is connected to ABS harness by a 35 way connector.

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 vehicle is in motion inductive sensors send signals to ECU. Front exciter ring is fitted to outside diameter of constant velocity joint in each front hub. Rear exciter ring is bolted to rear of each brake disc bell.

BRAKE PIPE LAYOUT - LEFT HAND DRIVE



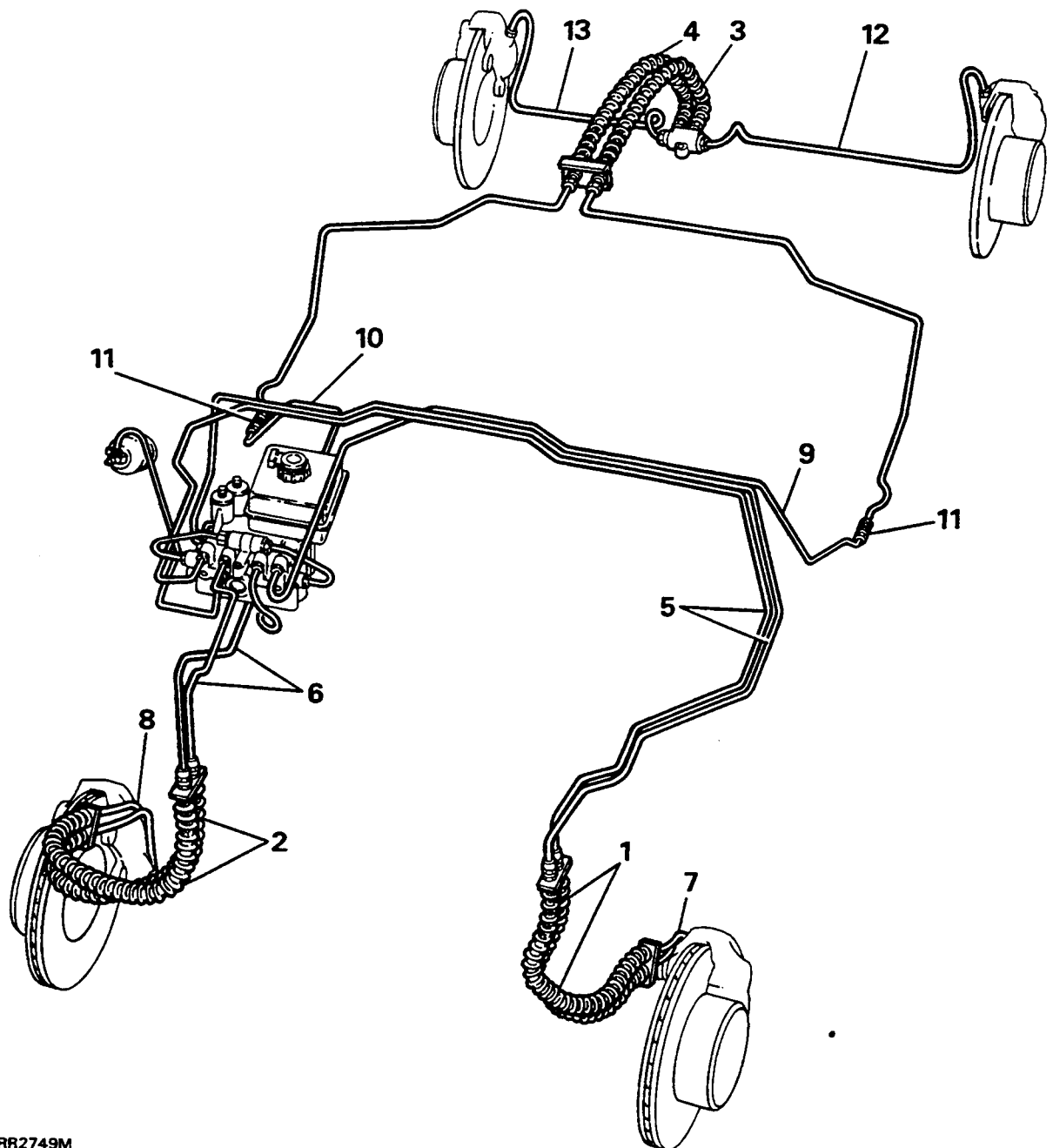
RR2714M

HOSES

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



BRAKE PIPE LAYOUT - RIGHT HAND DRIVE



RR2749M

PIPES

- | | |
|---|--|
| 1. Feed to front left hand hose connector. | 6. Feed to right hand intermediate hose. |
| 2. Feed to front right hand hose connector. | 7. Two way connector. |
| 3. Feed to front left hand caliper. | 8. Feed to rear left hand caliper. |
| 4. Feed to front right hand caliper. | 9. Feed to rear right hand caliper. |
| 5. Feed to left hand intermediate hose. | |

WARNING LIGHTS

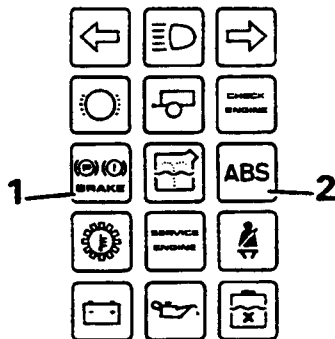
Brake fluid pressure/level and parking brake warning light - (red) - 1

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

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



WARNING: If light illuminates while vehicle is in motion, investigate fault immediately. Braking will be available after loss of pressure, but greater force will be required at pedal to slow vehicle.



RR2756E

ABS warning light - (amber) - 2 USA vehicles - (red) - 2



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

The ABS warning light situated in instrument binnacle indicates a failure in ABS system. Warning light will illuminate when ignition is switched ON, it will extinguish when vehicle speed exceeds 7 km/h (5 mph). This indicates that system self monitoring check was successful, and system performs correctly. If light remains on or subsequently illuminates with ignition ON a fault in ABS system is indicated. The self monitoring procedure is repeated frequently while ignition is ON. If a fault is detected during self monitoring, light will illuminate indicating that one or more wheels are not under ABS control.



WARNING: Reduced ABS control is possible with ABS warning light illuminated depending on 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 FAULT IS IMMEDIATELY INVESTIGATED.

ABS warning light - 1993 introduction

On 1993 model year vehicles a feature has been added to indicate whether or not the ABS ECU has recorded any faults which have not been repaired. If no faults are recorded the ABS warning light will switch off for half a second after ignition is switched on and the ECU has completed its self checks. This will occur during the time that the light is on between switching on and driving above 7 kph (5 mph). This enables a vehicle tester to check ABS without driving the vehicle.



NOTE: On a small number of early USA vehicles, the bulb check masks this feature.



DRIVING 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 wheels may be an aid to shorter stopping distance. However it is still an advantage to maintain the stability and manoeuvrability available with ABS control.

1. Switch on ignition, system will automatically carry out self test function. This will be felt as a slight movement in brake pedal and a short, rapid series of clicks indicating that solenoid valves have been checked.
2. Observe warning lights, check parking brake/fluid pressure/level warning light extinguishes after initial bulb check or when parking brake is released, indicating that power assistance is available. Note time taken to pressurise system is approximately 20 seconds.
3. Start 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, 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 wheel locking tendency and will regulate brake pressure to maintain wheel rotation.
6. ABS operation will be felt as a vibration through pedal, at same time solenoid cycling will be heard.



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

7. Downward travel of pedal will also feel hard at 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 force while ABS retains control.

BRAKE APPLICATION WITH PARTIAL FAILURE



WARNING: If a fault develops in brake system it is essential that fault is investigated immediately.



NOTE: If, during braking, a drastically reduced resistance is detected at pedal and braking effectiveness is very much reduced, failure of the non-powered (master cylinder) portion of system is indicated. When this occurs **DO NOT PUMP BRAKE PEDAL**. Push the pedal through free movement to obtain braking effort. It is essential that brake pedal travel is not obstructed by 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 master cylinder only. This results in longer pedal travel and greater pedal effort required to decelerate vehicle.



WARNING: Foot pressure on pedal, using master cylinder only, will not achieve same degree of braking as is available from power assistance.

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



WARNING: Longer pedal travel is required, but power assisted braking is available at reduced efficiency.

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



WARNING: Brake pedal travel will be greater and extra pedal effort will be required, accompanied by the vehicle pulling to one side.



ABS FAULT DIAGNOSIS

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



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

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

Before commencing fault diagnosis procedure following items must be checked:

1. Inspect all exposed cables for damage or abrasion.
2. Check ground 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. Complete harness must be replaced if faults are found in wiring harness.
2. DO NOT use unspecified cables or connectors, as this could jeopardise safe function of ABS.
3. DO NOT attempt to open sealed 35 way connector to ECU.

Recommended equipment

Wabco diagnostic controller
- 446 300 300 0 - LRP No. STC2

English	STC3
French	STC4
German	STC5
Italian	STC6
Spanish	STC7

FAULT DIAGNOSIS PROCEDURE



NOTE: If ABS warning light illuminates due to large sensor air gap, fault will be retained by the ECU memory. Where wheel sensors have been pushed fully home prior to test, blink code will indicate a fault that has been rectified.



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.

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 contacts of 35 way connector, use of adaptor plug shown in illustrations is recommended.

When adaptor is fully engaged with 35 way connector, multimeter probes can be inserted into numbered contacts on face of adaptor. Adaptor plug is supplied as a spares item.

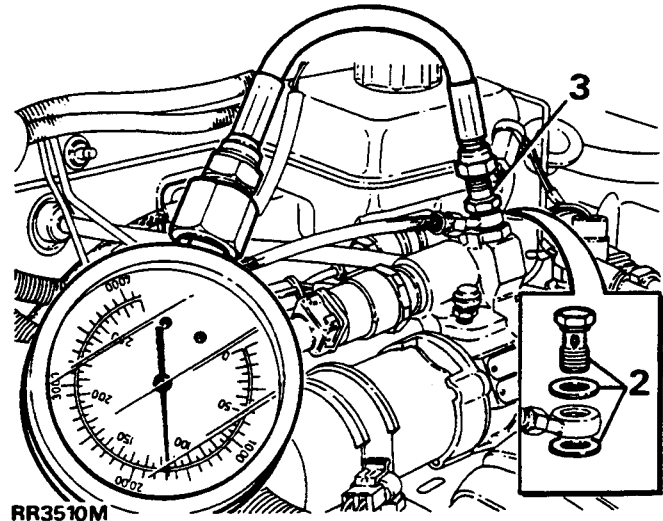
MULTI-METER CHECK PROCEDURE

See *ETM, D1*



CAUTION: Ensure multi-meter is correctly set to VOLTS or OHMS, dependant on test being carried out. Ensure ignition is switched ON or OFF as required.

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 fault by flexing harness and cables or moving contacts.



ACCUMULATOR PRECHARGE

Check

The diaphragm type accumulator is precharged with nitrogen at 80 bar, its function is to store hydraulic energy. Over a period of several years a normal loss of precharge will occur. This procedure will indicate extent to which precharge pressure has fallen.

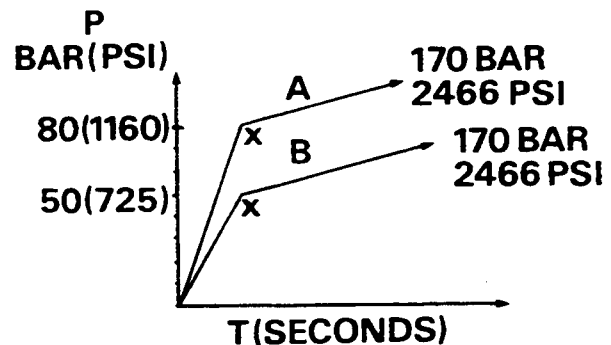


NOTE: A new accumulator at 68° F has a nominal pressure of 80 bar + 2. Minimum acceptable pressure is 50 bar.

Equipment - LRT.70.001 ABS pressure test equipment

1. Depressurise brake system. See *Repair, depressurise system*
2. Remove banjo bolt securing high pressure hose, use a second spanner on large hexagon to prevent it being loosened.

3. Fit pressure gauge adaptor, using sealing washers. Connect pressure gauge.
4. Switch ignition on and observe pressure gauge.
5. There should be a rapid rise in pressure to accumulator precharge, point X, of 80 bar, then a slowing down in rate of increase as pressure rises to system pressure, 170 bar - see graph A.

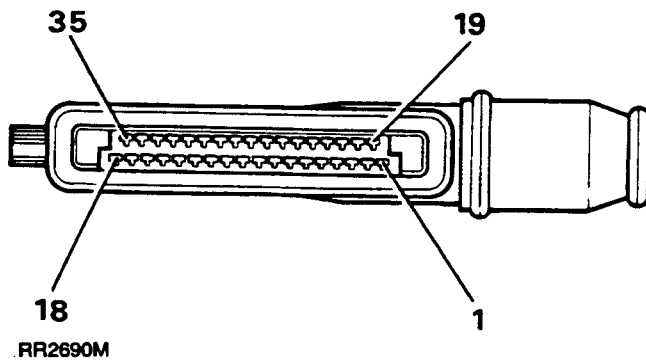


RR2743M

6. Accumulator has lost precharge if point x occurs below 80 bar, see graph B.
7. Fit new accumulator if point X occurs below 50 bar.
8. Depressurise system, remove pressure gauge and adaptor.
9. Fit banjo bolt securing high pressure hose, use NEW sealing washers. Tighten to 15 Nm.
10. Bleed pump.
11. Check/top up fluid level.



ECU HARNESS PLUG

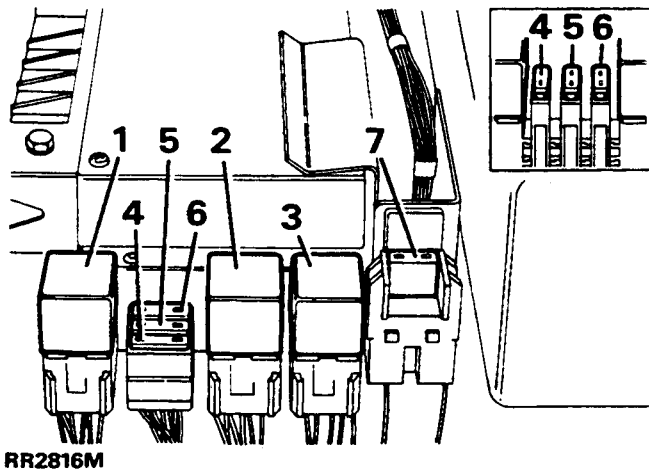


ECU harness plug wiring details - RR2690M

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

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)

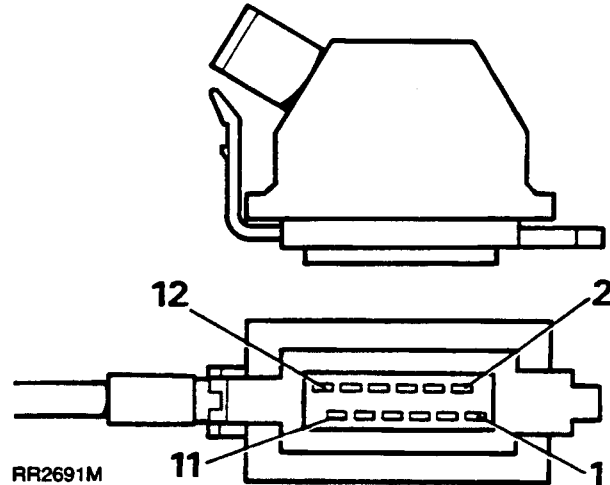
1. ABS warning light relay, green base - AB12
2. Valve relay, black base - AB14
3. Hydraulic pump relay, black base - AB2
4. Hydraulic pump relay fuse, 5amp tan - AB10
5. Stop light switch, diagnostic plug, ECU pin 9 fuse, 5 amp tan - AB11
6. Valve relay fuse, 25 amp white - AB13
7. Hydraulic pump relay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

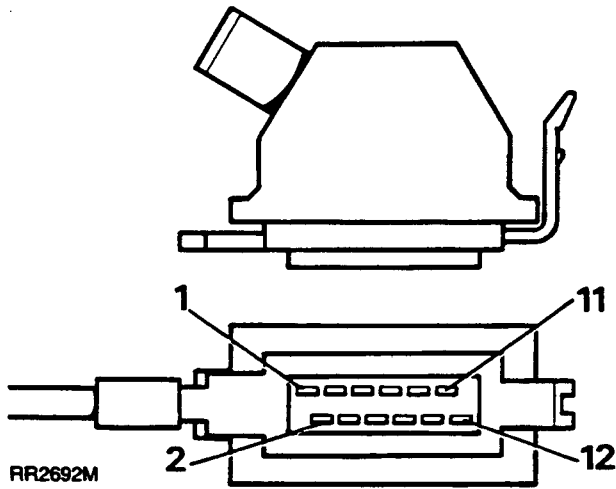
BOOSTER HARNESS PLUG WIRING DETAILS



CAUTION: ABS harness plugs are sealed units and must not be dismantled. The ABS harness is a non-serviceable item, in the event of failure a new harness **MUST** be fitted.

Right hand drive - RR2691M



**Left hand drive - RR2692M**

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

CIRCUIT DIAGRAM ABS 1990/91 MY**Illustration 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

Cable colour code

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

The last letter of a colour denotes the tracer colour.

Booster unit components AB21-25**IV Inlet valve****OV Outlet valve**

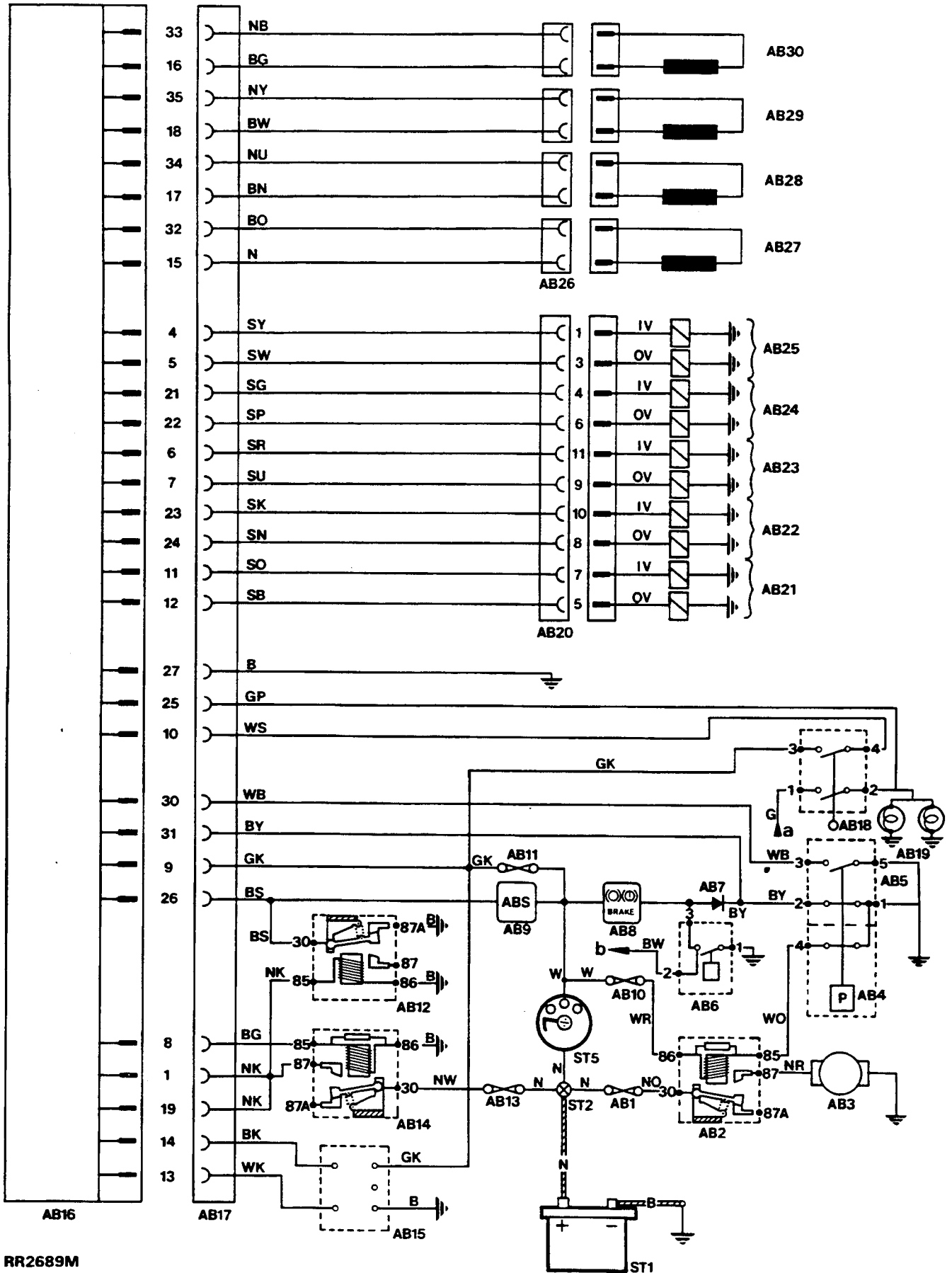
AB21.	Isolating valve
AB22.	Front left solenoid valves
AB23.	Front right solenoid valves
AB24.	Rear left solenoid valves
AB25.	Rear right solenoid valves
AB26.	Sensor connectors (4)
AB27.	Front left sensor
AB28.	Front right sensor
AB29.	Rear left sensor
AB30.	Rear right sensor

a. 12 volts from fuse A5

b. To bulb check



ABS - Circuit diagram



RR2689M

ABS FAULT AND REMEDY CHART

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



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



GENERAL SERVICE INFORMATION



NOTE: ABS components ARE NOT serviceable. Replace components 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 correct brake fluid. If an assembly fluid is required use **ONLY** brake fluid. Do **NOT** use mineral oil, i.e. engine oil etc.

FLUID LEVEL CHECK / TOP UP

1. Park vehicle on level ground.
2. Turn ignition ON, to activate hydraulic pump. If pump does not activate depress brake pedal several times until pump operates.
3. When pump stops, check level is between 'MIN' and 'MAX' marks.
4. If level is below 'MIN' mark top up fluid level to 'MAX' mark on reservoir, using correct fluid - **See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and Fluids**



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

DO NOT OVER FILL RESERVOIR

DEPRESSURISE SYSTEM



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.

BRAKE SYSTEM BLEED (ABS)

Service repair no - 70.25.02

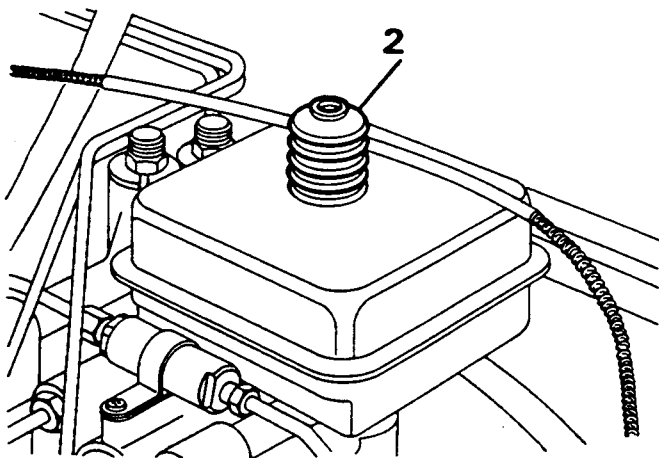
Equipment: Bleed tube and a clean bottle containing a small amount of clean liquid.

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: Do not allow reservoir fluid level to fall below 'MIN' level during bleeding. Regularly check level and keep topped up to 'MAX' level.

WARNING: Do not use previously used brake fluid. Ensure only new fluid is used, 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 system. Ensure ignition remains OFF until instruction 7.
2. Fill fluid reservoir with specified fluid to 'MAX' level.

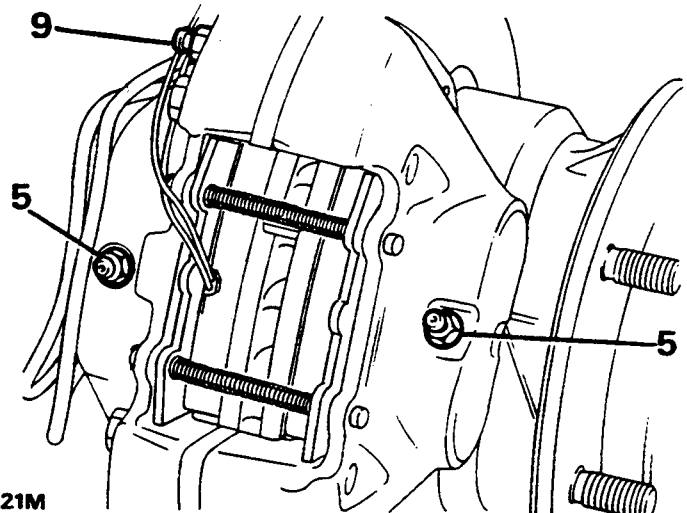


RR2721M



NOTE: Time consumed in filling booster may be reduced by fitting a rubber bellows unit to filler neck, using hand pressure to pressurise the reservoir. A spare bellows unit from booster push rod is suitable for this purpose. Ensure bellows unit is perfectly clean to avoid foreign matter entering system. Raising rear of vehicle will assist fill procedure.

3. Depress brake pedal slowly and progressively five times, using full pedal stroke. Release pedal for five to ten seconds, air bubbles will rise into reservoir.
4. Repeat instruction 3. until some resistance is felt. If no resistance is felt check clevis pin is connected to correct (UPPER) hole in brake pedal
5. Bleed four front caliper lower (hydrostatic) bleed screws in the conventional manner. In the order: outer bleed screw driver's side, opposite caliper outer bleed screw, inner bleed screw, inner bleed screw driver's side. Depress brake pedal slowly and progressively, locking bleed screw at bottom of each stroke.

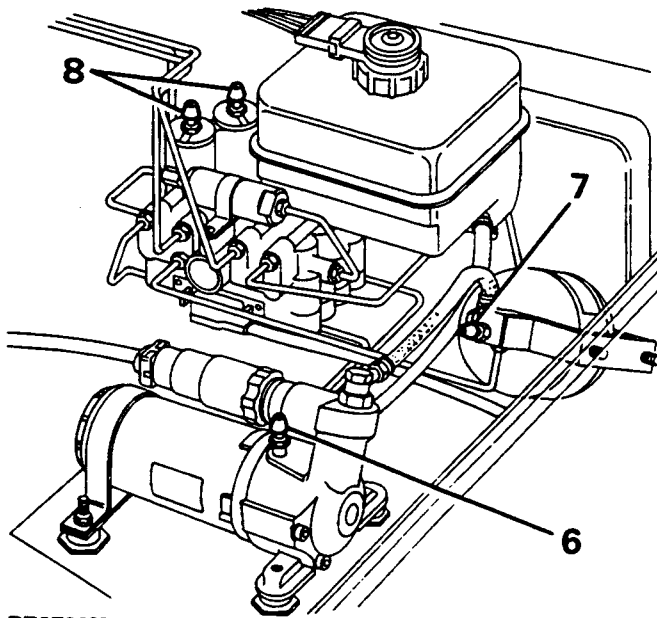


RR2821M

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



7. Bleed accumulator - open bleed screw. If vehicle has ETC, accumulator bleed screw is on top of ETC valve block. Switch on ignition, run pump for 3-4 secs, switch off and repeat procedure until fluid is clear of air bubbles. Switch off ignition. Close bleed screw.
8. Bleed two hydraulic booster bleed screws. Open one bleed screw, depress brake pedal, switch on ignition, run pump until fluid is clear of air bubbles. Close booster bleed screw, switch off ignition, release pedal. Repeat for other bleed screw.



RR2722M

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 fluid is clear of air bubbles. 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 lower two thirds of pedal travel, until fluid is clear of air bubbles. 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 Fluid level check/top up*
14. Dry all connections, fully pressurise system, check for leaks. If two full brake applications switch on pump, from fully charged, rebleed system.

HYDRAULIC BOOSTER UNIT

Service repair no - 70.65.20

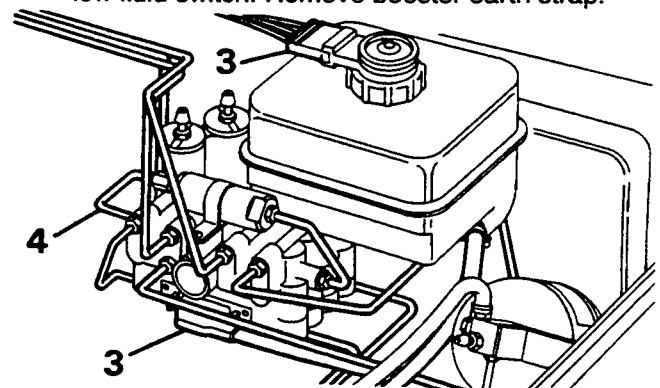
Remove and refit

Remove



CAUTION: Do not allow booster unit to be dropped or rested on its front face. Damage to plastic tangs of multiplug could occur, requiring fitting a new booster unit

1. Disconnect the battery negative lead. depressurise system.
2. Thoroughly clean area around booster unit outlet ports and electrical connector.
3. Disconnect electrical multiplug and connector low fluid switch. Remove booster earth strap.



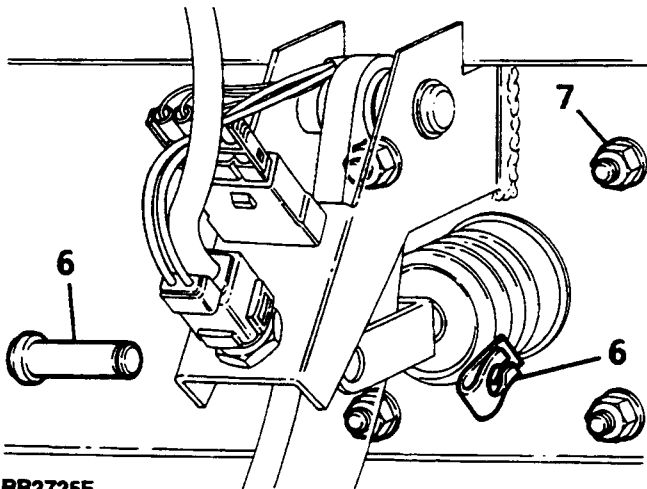
RR2723M

4. Remove brake pipes and hydraulic pipes to accumulator and hydraulic power unit.



NOTE: Each outlet port is numbered, each brake pipe is marked with corresponding number for reassembly. Immediately seal each pipe and outlet port to prevent ingress of foreign matter.

5. Inside vehicle remove lower dash panel. *See CHASSIS AND BODY, Repair, lower dash panel*



RR2725E

6. Release spring clip and clevis pin.
7. Remove four nuts and plain washers securing booster unit.
8. Remove booster unit.

Refit

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

9. Reverse removal procedure. Ensuring correct fitment of pipes. Tighten booster fixings to **25 Nm** and pipes to **15 Nm**.
10. Fit clevis pin into UPPER of two holes in brake pedal.
11. Adjust brake light switch: pull red (later vehicles, white) sleeve and black plunger fully forward. Pull brake pedal back fully to reset switch.
12. Bleed brake system. *See Brake system bleed (ABS)*

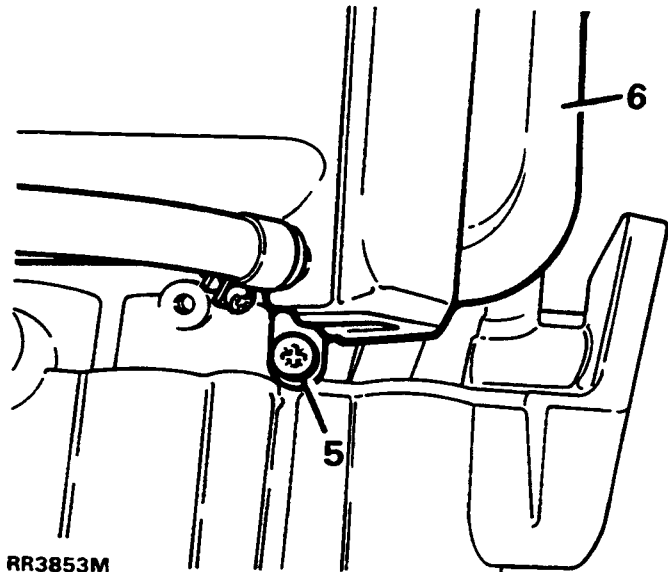
RESERVOIR (INCLUDES SEALS)

Service repair no - 70.65.22

Remove and refit

Remove

1. Disconnect the battery negative lead.
2. Depressurise system. *See Depressurise system*
3. Disconnect low fluid warning plug.
4. Remove reservoir cap. Remove hose from pump, plugging exposed apertures.
5. Remove securing bolt, adjacent to low pressure hose.
6. Ease reservoir from booster unit.



RR3853M

7. Remove two seals from top of booster unit. Avoid damage to seals which could result in rubber particles entering system. Plug booster unit apertures

Refit

8. Lubricate and fit new seals. Refit reservoir. Tighten securing bolt to **10 Nm**.
9. Bleed pump. Check/top up fluid level.



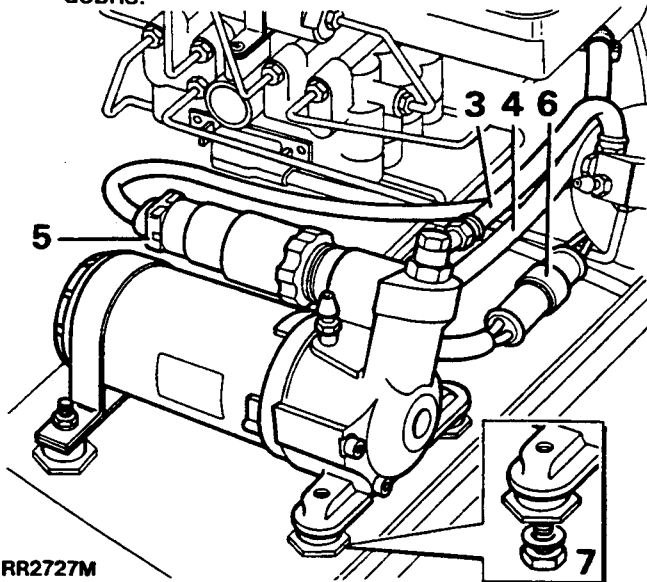
HYDRAULIC POWER UNIT

Service repair no - 70.65.20

Remove and refit

Remove

1. Disconnect the battery negative lead.
2. Depressurise system. *See Depressurise system*
3. Disconnect braided hose to accumulator.
4. Disconnect low pressure hose to reservoir, clamp hose to prevent fluid loss and ingress of debris.



RR2727M

5. Disconnect pressure switch plug.
6. Disconnect power unit connector.
7. Working below unit remove four nuts and plain washers.
8. Remove hydraulic power unit complete with mountings. Note position of earth strap, if fitted, when removing mountings.

Refit

9. Reverse removal procedure. Fit new sealing washers on high pressure hose.
10. Bleed system. *See Brake system bleed (ABS)*

ACCUMULATOR

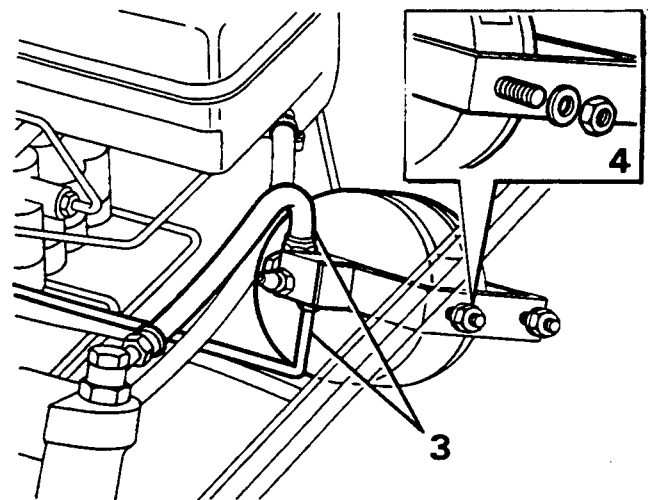
Service repair no - 70.65.21



WARNING: The accumulator is precharged with nitrogen at up to 80 bar. Handle with extreme caution. DO NOT puncture or burn if disposal is necessary.

Remove, refit and disposal

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



RR2728M

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

Refit

6. Reverse removal procedure. Fit new sealing washers on high pressure hose.
7. Bleed brakes. *See Brake system bleed (ABS)*

Disposal



WARNING: It is essential that safety goggles and gloves are worn when carrying out this procedure.

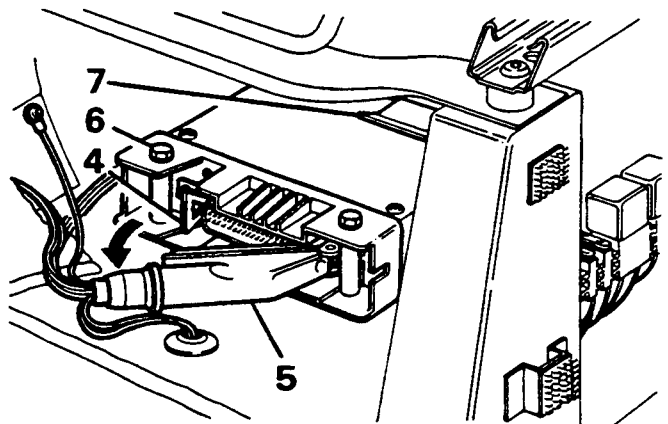
8. Secure accumulator firmly using a suitable vice.
9. Drill 5 mm diameter hole in accumulator, opposite hole fluid ports, to depressurise nitrogen chamber.
10. Dispose of accumulator in normal way.

ELECTRONIC CONTROL UNIT - ECU

Service repair no - 70.65.01

Remove and refit
Remove

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



RR2726M

Refit

8. Refit ECU securely in retaining bracket, fit and tighten two screws.
9. Reconnect ECU harness plug. Ensure plug is firmly located and that retaining clip secures plug.
10. Reverse removal procedure.



SENSORS - FRONT

Service repair no - 70.65.32

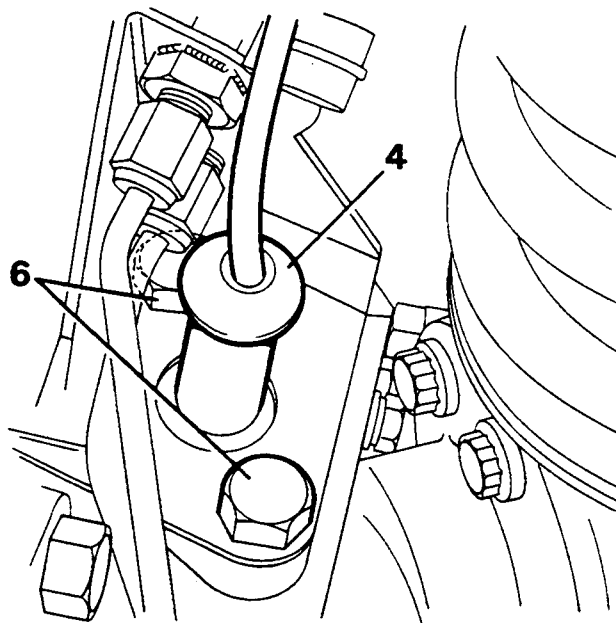
Remove and refit



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

Remove

1. Disconnect the battery negative lead.
2. Disconnect required sensor electrical connection, located on inner wing panel adjacent to decker panel.
3. Remove sensor lead and pad wear harness plug from clips.
4. Clean area surrounding sensor to prevent ingress of dirt. Using a suitable lever pry sensor from mounting bush.



RR2752M

5. Release harness cable ties, remove sensor lead from vehicle.
6. Remove top swivel retaining bolts complete with brake jump hose and sensor seal. Remove sensor bush.

Refit

7. Insert new sensor bush and seal.
8. Refit brake jump hose bracket, coat bolts with Loctite 270.
9. Lightly coat new sensor using EP 90 oil. Push sensor through bush until it contacts exciter ring. Rotate wheel, turning steering from lock to lock to set sensor air gap.
10. Secure sensor lead in original position.
11. Reconnect sensor electrical connection.
12. Clear error code *See Fault diagnosis, fault diagnosis procedure*
13. Drive vehicle to ensure ABS warning light is extinguished.

SENSORS - REAR

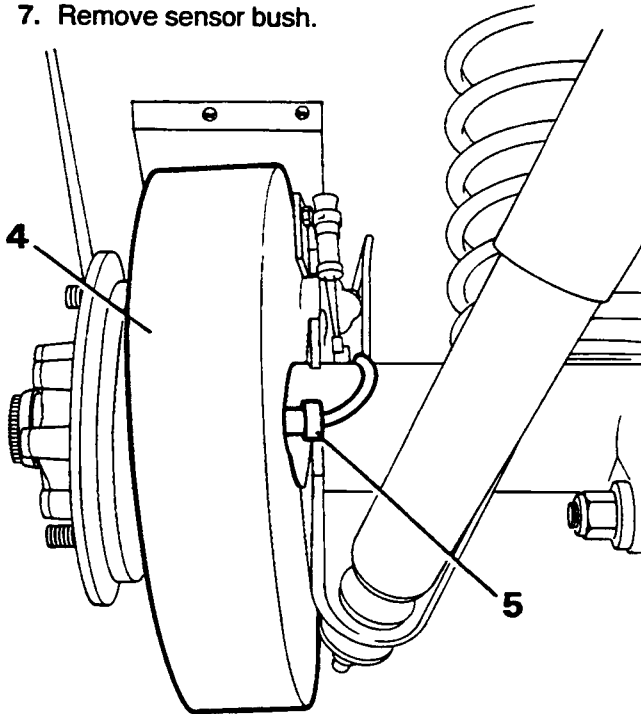
Service repair no - 70.65.31

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

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

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

7. Remove sensor bush.



RR2753M

Refit

8. Fit new sensor bush.
9. Lightly grease new sensor using silicone grease. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information, Recommended lubricants and fluids**
10. Push sensor through bush until it touches exciter ring. Sensor will be 'knocked back' to correct position when vehicle is driven.
11. Secure harness in position.
12. Reconnect sensor electrical connection.
13. Clear error code - **See Fault diagnosis, Fault diagnosis procedure**
Drive vehicle to ensure ABS warning light is extinguished.



STOP LIGHT SWITCH

Service repair no - 76.65.10

Remove and refit

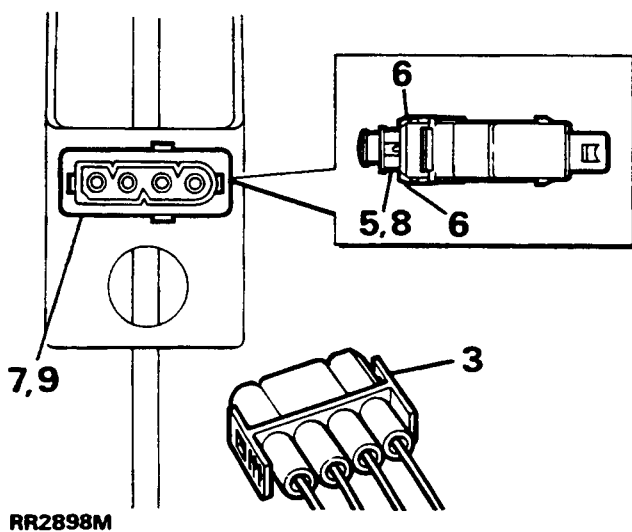
Remove

1. Turn ignition off. Disconnect the battery negative lead.
2. Remove lower fascia panel. *See CHASSIS AND BODY, Repair, Lower dash panel*
3. Disconnect multi-plug to switch.
4. Depressurise system. *See Depressurise system*
5. Depress brake pedal, pull red sleeve (later vehicles, white) and black plunger of switch FULLY forward.
6. Release switch retaining clips.



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

7. Remove switch.



Refit

8. Pull red sleeve (later vehicles, white) and black plunger of switch fully forward.
9. Depress brake pedal, fit switch. Ensure retaining clips are FULLY located.
10. Hold switch firmly in place, pull brake pedal back fully to set switch.
11. Turn ignition on. Wait for ABS pump to shut off.
12. Check switch adjustment by slowly depressing brake pedal and checking that the switch clicks at least once before booster hisses.
13. If incorrect, adjust switch by depressing brake pedal and pushing black plug in one detent at a time.
14. Check that stop lamps go off when pedal is released. If not, depress pedal and pull black plunger out one detent at a time.

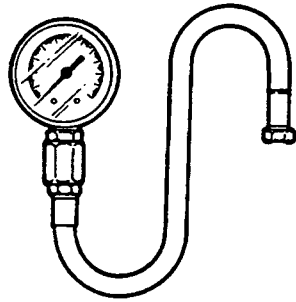
EXCITER RINGS

See REAR AXLE AND FINAL DRIVE, Repair, rear hub assembly (ABS) or See FRONT AXLE AND FINAL DRIVE, Overhaul, Front Stub Axle, Constant Velocity Joint and Swivel with ABS



ABS BRAKES SERVICE TOOLS

LRT-70-001 ABS pressure test adaptor
LST 140



LST140



ELECTRONIC TRACTION CONTROL - ETC

- WABCO DIFFERENTIAL BRAKING

WABCO, manufacturers of Range Rover ABS brake system have developed a differential braking system, ETC, available as an extension to ABS. The system operates on the rear axle only, to prevent loss of traction where one wheel has more grip than the other.

The system works by applying the brake to a spinning rear wheel. This transfers torque to the wheel with the grip. The brake supplies the torque resistance which the wheel cannot.

An example of when the system would operate is where one side of the vehicle is on ice and the other side on tarmac. ETC will control the spinning rear wheel.

If both wheels spin the system does not operate, as braking one wheel will not aid traction.

The system switches itself out at 50 kph (30 mph) since a vehicle travelling above this speed will not need ETC.

System operation is smooth and continuous and will not affect the comfort of the vehicle.

ETC is inhibited when the brakes are applied.

COMPONENTS

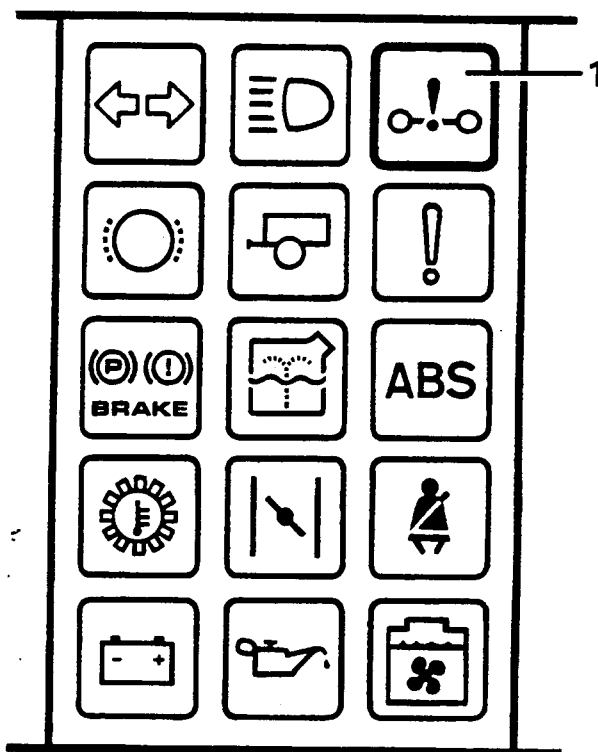
As ETC is an extension of the ABS unit it is only available on ABS equipped vehicles.

ECU - the system uses an extended ABS ECU. The same ECU is used on both ETC and non ETC vehicles. If ETC valve block is not connected electrically the ECU assumes the vehicle does not have ETC.

Two solenoid valves - similar to ABS control valves, incorporated in a valve block fitted to the ABS booster. In case of failure the valve block may be removed from the booster unit and a new unit fitted.

Brake pipes - three additional brake pipes to the ETC valve block are required.

ETC Warning light (1) - situated in the instrument binnacle, the warning light works in three different ways:



RR3901M

ETC active - The light will illuminate for a minimum of two seconds or as long as the system is active. In practice this time will rarely exceed ten seconds. This warns the driver that traction is becoming limited.

Protection mode - In the unlikely event that the system remains active continuously for more than sixty seconds, the system shuts down to protect brakes and solenoid valves from overheating. The warning light will flash at half second intervals for a minimum of ten seconds while ETC is shut down. If ETC is shut down, but NOT required by conditions, the light will not flash.

ETC fault - If a fault occurs which disables ETC, the warning light is constantly illuminated, (even when there is no wheel spin,) until ignition is switched off.

Bulb check - The light will illuminate for three seconds when ignition is switched on and ABS/ETC self checks completed.

USA - early vehicles - the warning light will be illuminated as part of warning light bulb check.

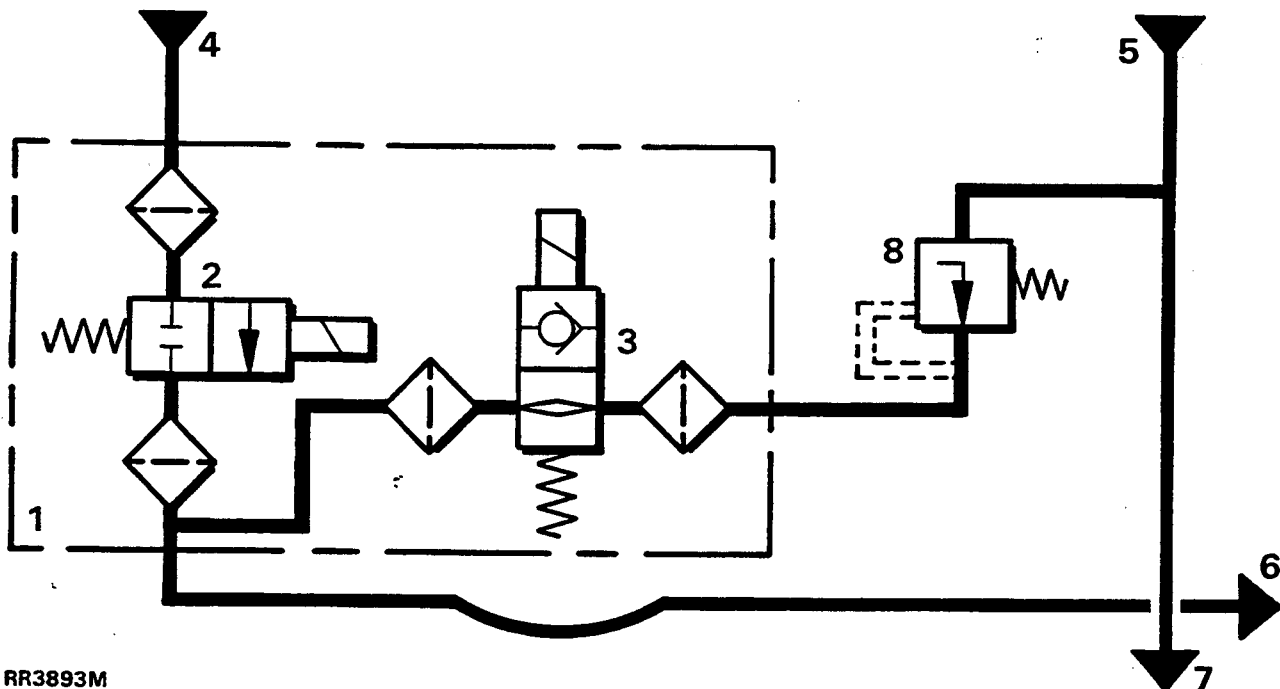
USA - later vehicles - the warning light will NOT be illuminated as part of warning light bulb check.

CHANGES TO ACCOMODATE ETC

PCRIV valve - moved to below booster unit, mounted on inner wing panel.

Accumulator - has direct feed to ETC valve block. Accumulator bleed valve is relocated to ETC valve block.

ETC HYDRAULIC COMPONENTS - RR3893M



RR3893M

For full details of ABS components, *See ABS brakes, HYDRAULIC COMPONENTS*

1. ETC valve block
2. Power circuit solenoid valve - normally closed
3. Master cylinder isolating solenoid valve - normally open
4. From accumulator
5. From master cylinder power valve
6. Power circuit to rear brakes
7. Power circuit to front brakes
8. PCRIV valve

ETC OPERATION - see RR3893M

When the wheelspeed sensors detect a rear wheel is spinning at above vehicle speed, solenoid valve 3. closes, isolating the master cylinder from the rear brakes. Solenoid valve 2. is pulsed open, allowing accumulator pressure to the rear brakes. The rear brake ABS valves operate to apply or release the brake at the spinning wheel as required.

FAULT DIAGNOSIS

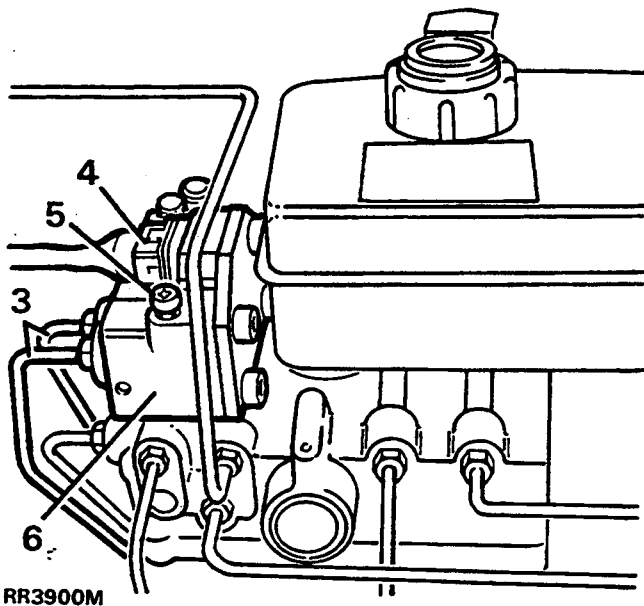
Diagnosis is by Wabco Diagnostic Controller - STC 2 with new software card, for both ETC and non ETC vehicles. See also Range Rover Electrical Trouble Shooting Manual.



ETC VALVE BLOCK

Remove and refit**Remove**

1. Disconnect the battery negative lead.
2. Depressurise brake system, *See ABS Brakes, depressurise system*
3. Remove three hydraulic pipes from ETC valve block.



4. Disconnect ETC multi-plug.
5. Remove two valve block securing bolts.
6. Remove ETC valve block.

Refit

7. Reverse removal procedure.
8. Bleed brakes, *See ABS brakes, brake system bleed (ABS)*



NOTE: Bleed screw on ETC valve block is used when bleeding accumulator.