145

BRAKES

33

Summary

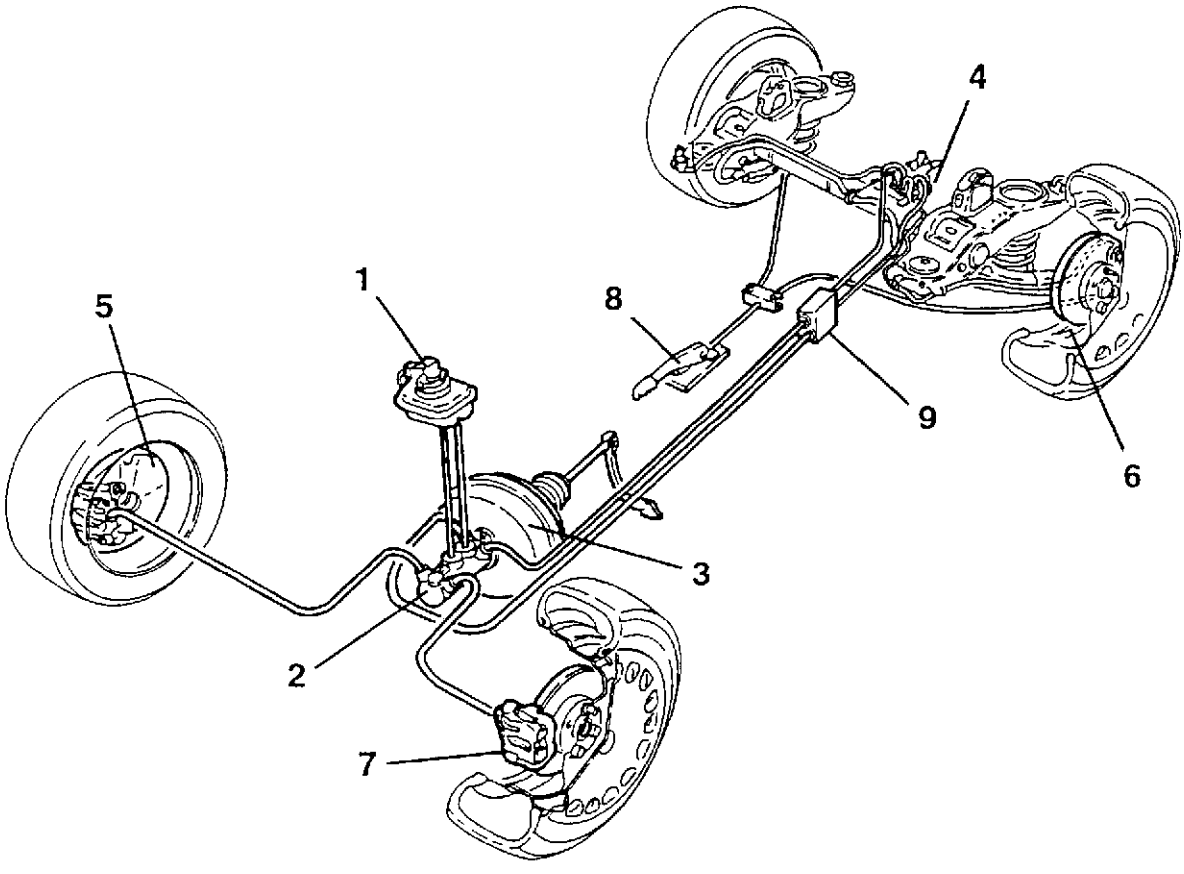
(*): See ABS BOSCH 5.3

DESCRIPTION

The braking system is hydraulically-operated with dual diagonally connected circuit with servobrake and braking load proportioning valve for the rear wheels; front disk brakes and rear drum brakes for the "lower" range without A.B.S. and disk brakes for the "higher" range fitted with A.B.S.
The system is of the conventional type and mainly comprises the following components:

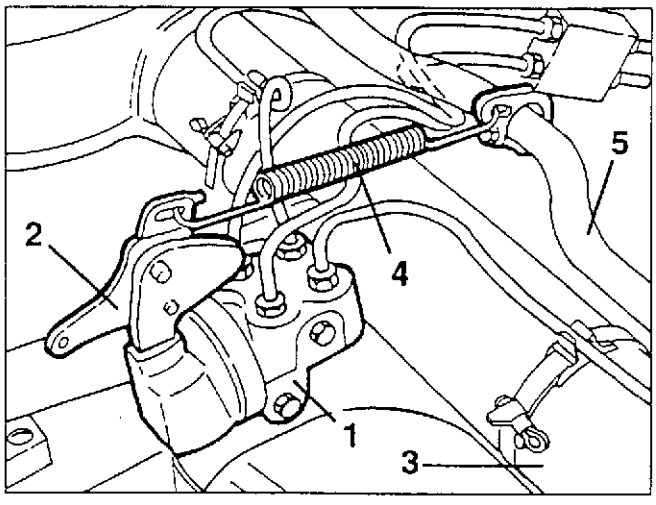
1. Brake fluid reservoir
(shared with the hydraulic clutch system)
2. Two-stage pump
3. Vacuum servo brake
4. Braking load proportioning valve
5. Front disk brakes
6. Rear drum brakes or disk
brakes depending on the versions
7. Floating type brake calipers
8. Mechanical handbrake
9. Four-way distributor

This solution is of the traditional type and obtained employing a series of devices aimed at:
a. meeting the current laws regarding the problems of environmental pollution.
The problem of environmental pollution has been faced by adopting brake linings of an ecological material (asbestos- free) in the same way as for the friction lining of the clutch.
b. reducing the temperature of the brake fluid to keep its chemical/physical characteristics unchanged.
The GIRLING floating type brake calipers with runner pins protected by boots only act on one side of the disk, thereby improving the dispersion of the heat produced during braking. Consequently the temperature of the brake fluid is also considerably reduced in comparison with traditional systems.
c. warranting a braking force suited to the characteristics of the vehicle under all circumstances.
The use of the two-stage pump and diagonal braking circuits makes it possible to still conserve 50% of the braking force in the event of a failure or seizing of a piston.

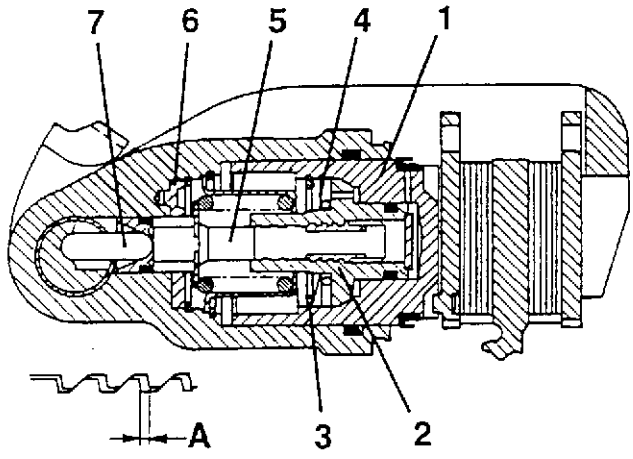


BRAKING LOAD PROPORTIONING VALVE (for versions without A.B.S.)

The braking system is fitted with a braking load proportioning valve (1), fastened to a bracket (2) integral with the rear axle (3) and connected by a spring (4) to the stabilizer bar (3), which regulates the pressure of the fluid acting on the rear wheels according to the load on the rear axle of the car.
This adjustment is carried out instant after instant by measuring the distance between the rear wheel axle and the body and its purpose is to prevent the rear wheels from locking if the load on the rear axle is lower causing the wheels to reduce their grip on the road surface.



The lead screw (2) backs off momentarily from its point of contact with the cylinder (1) but the action of the cup spring (4) turns the lead screw (2) on the shaft (5) until it returns into contact with the control cylinder (1). When the handbrake is operated, the mechanical force is transmitted from the control lever to the rod (7), then through the shaft-lead screw coupling it reaches the control cylinder (1) and from here to the brake linings without turning either the lead screw or the cylinder, because the cylinder has an obligatory engagement system which engages it on the brake lining plate during braking.



1. *Control cylinder*
2. *Lead screw*
3. *Safety ring*
4. *Cup spring*
5. *Shaft*
6. *Safety lock*
7. *Rod*

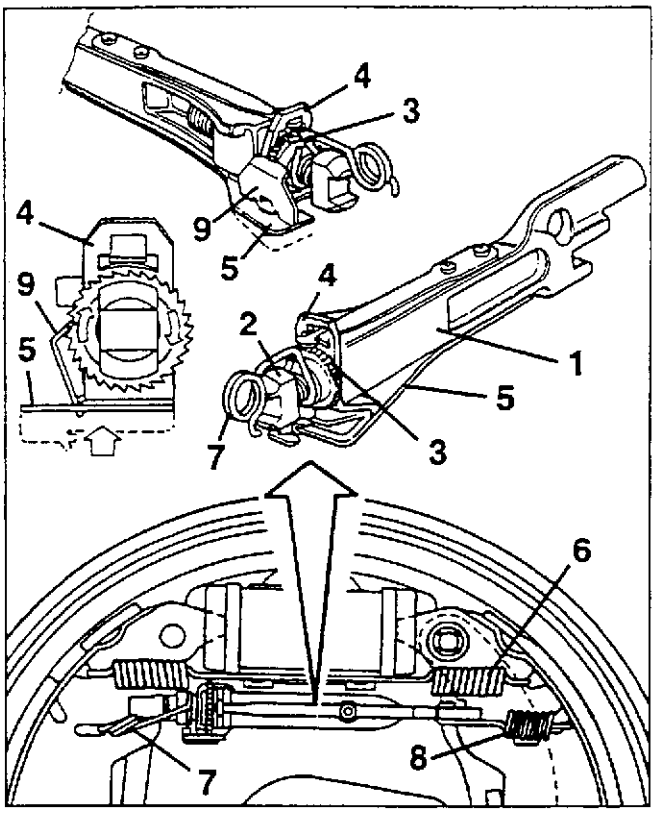
AUTOMATIC REAR BRAKE CALIPER ADJUSTMENT DEVICE (for versions with rear disk brakes)

This device, contained in the rear brake caliper cylinder automatically adjusts the distance between the brake disk and the friction lining.
It comprises a lead screw (2) which can rotate on the shaft (5) only in the direction of travel owing to the action of the cup spring (4).
The shaft (5) is unable to turn as it is constrained to the brake caliper body by the safety lock (6).
Between the shaft and the lead screw there is a threaded coupling (with four starts) with a preset clearance (A). During braking the control cylinder (1) pushed by the hydraulic pressure moves towards the braking lining with the lead screw (2), as the latter is constrained to the cylinder itself by the safety ring (3) and by the cup spring (4).
If the brake linings are excessively worn, even if the axial clearance (A) is taken up, it is not sufficient to absorb the whole stroke of the control cylinder (1) alone.

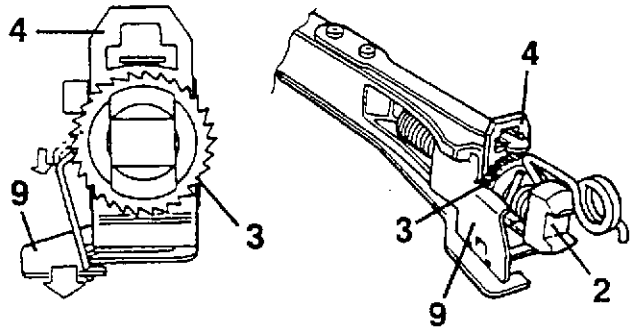
SELF-ADJUSTING DEVICE FOR PLAY TAKEUP BETWEEN SHOES AND DRUM (for versions with rear drum brakes)

This device automatically and continuously takes up the play between the shoes and drum each time the brakes are operated, if, in that moment, adjustment is necessary. The device comprises the tie-rod (1) inside which the adjustment screw (2) runs freely on which the toothed ring nut (3) is screwed.
In the rest position, the front shoe return spring (6) keeps the device compressed. Therefore, the ring nut (3) pushes the plate (4) into contact with the end of the tie-rod (1).
The plate (4) is also subjected to a thrust through the flexible blade (5). During the braking action, the two shoes move away from one another and come into contact with the drum; the two ends of the device are kept in contact with the shoes by springs (7) and (8).

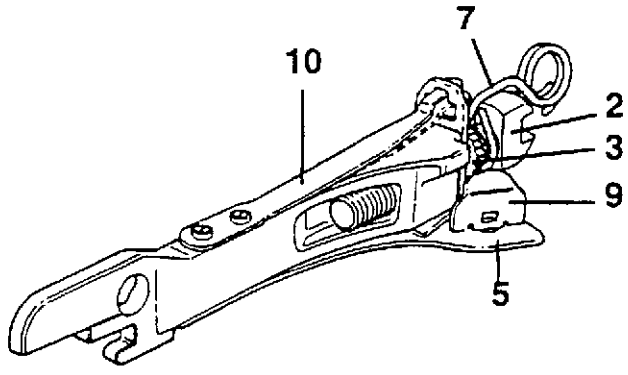
The plate (4) pushed by the flexible blade (5) reacts on the toothed ring nut (3) and the catch (9) permanently in contact with the ring nut, prevents it from turning.



When the brake is released, the self-adjusting device is again compressed by the action of the upper shoe return spring (6): the toothed ring nut (3) stops in the angular position taken during braking.
This stop during rotation is due to the friction between the plate (4) and the toothed ring nut (3). With the toothed ring nut (3) locked during rotation, if the condition of wear of the lining due to previous braking actions is sufficient, the catch (9) engages the next tooth.



The maximum stroke of the toothed ring nut (3) on the adjustment screw (2) is one tooth (0.020 ÷ 0.025 mm): an exception to this is settling of the brakes after dis-assembly, in which case the stroke is two teeth.
If after prolonged braking, the brakes overheat and the temperature reaches 100° ÷ 110°C, the flexible blade (10) comes into action, which flexes and blocks the plate (4) in the neutral position.

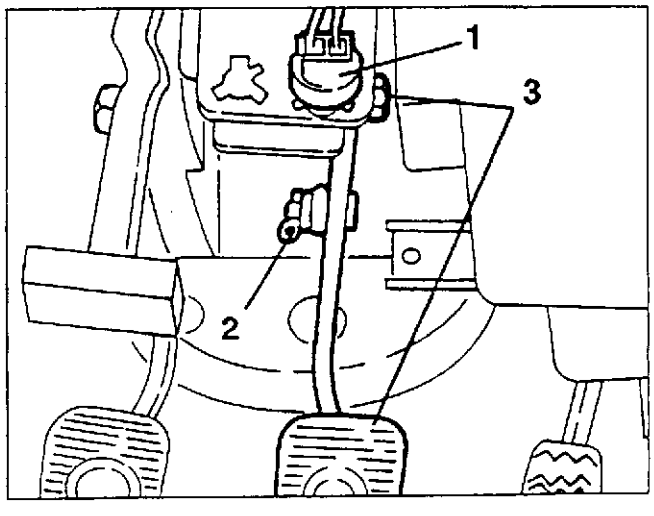


During braking the toothed ring nut (3) will no longer be subjected to the thrust of the flexible blade (5), therefore the catch (9) will take the same angle as the ring nut tooth, which will be free to run with the adjustment screw (2) on the catch (9) without taking up the play caused by the expansion of the drum.
When overhauling, before assembly of the brake linings, the toothed ring nut (3) must be moved to contact the spring (7) and slackened one half of a turn.

BRAKE PEDAL

REMOVAL/REFITTING

- Remove the fuse box and its support bracket (see GROUP 55).
1. Turn and remove the stop light from its housing.
2. Remove the pin fastening the brake pedal to the servobrake.
3. Slacken the fastening nut and remove the brake pedal.

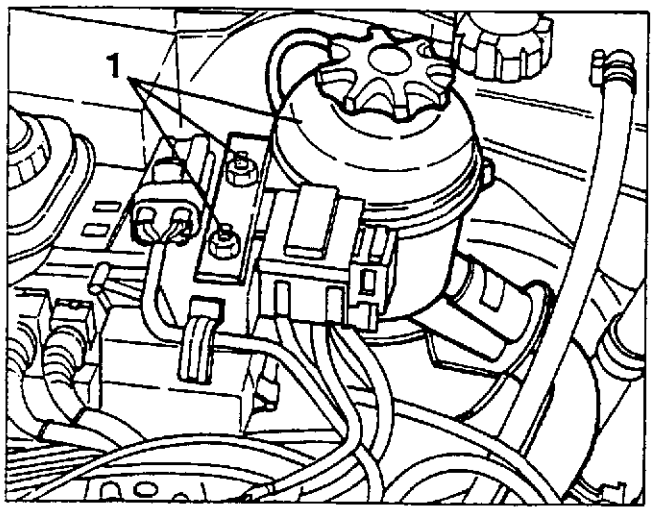


BRAKE/SERVOBRAKE PUMP

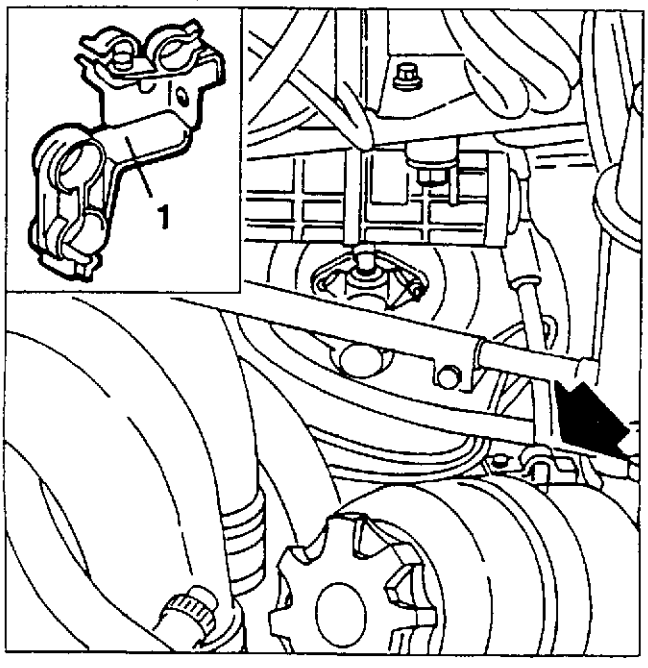
REMOVING/REFITTING
Specific for Boxer engines

- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Using a suitable syringe, empty the brake-clutch fluid reservoir.
- Remove the front left wheel.
- Using a suitable syringe, empty the power steering tank.

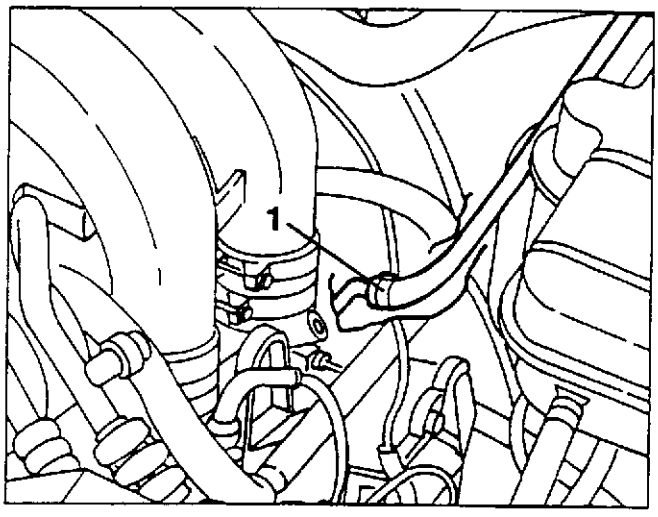
1. Slacken the two fastening nuts and move aside the power steering tank without disconnecting the pipes.



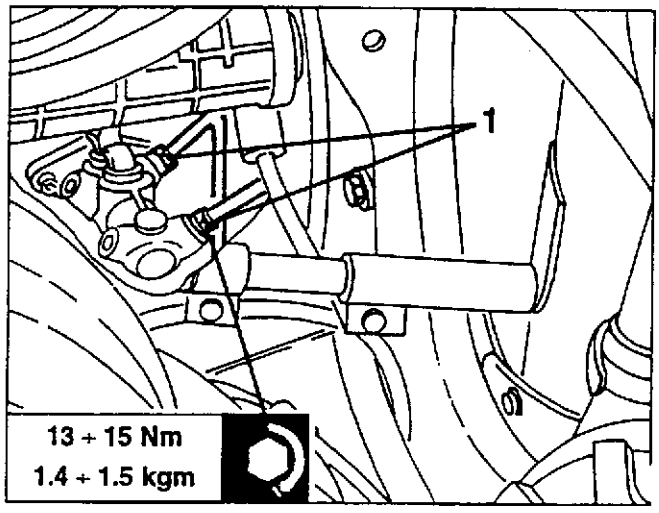
1.Release the power steering pipe, the clutch pipe and the air conditioner pipes from the fastening clamps, then slacken the two fastening screws and remove the bracket supporting the clamps.



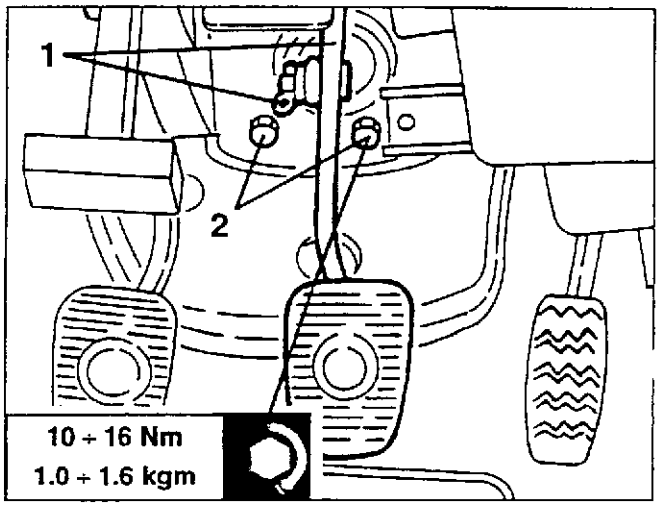
1. Disconnect the servobrake vacuum takeoff pipe.



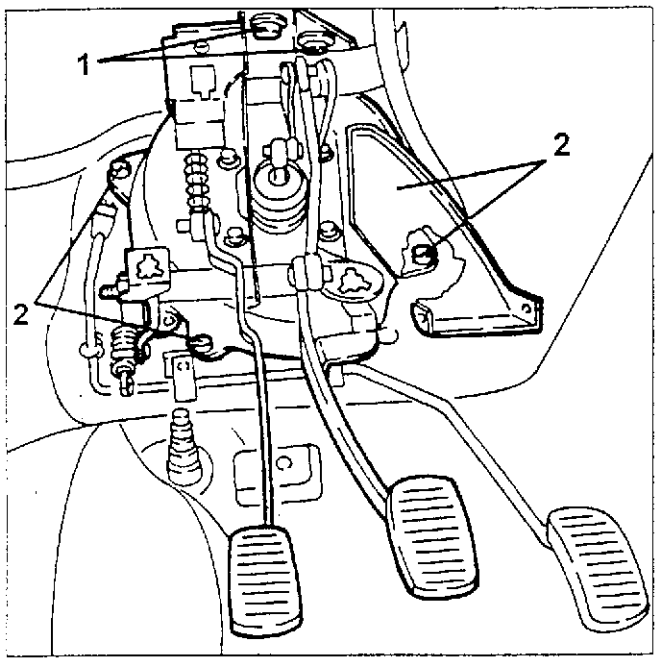
1. Disconnect the two fittings of the stiff delivery pipes from the brake pump.



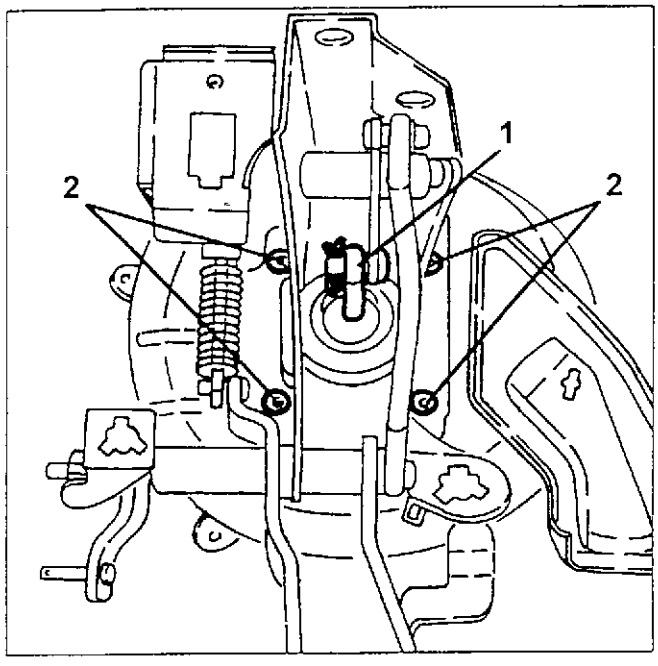
1. Working from the passenger compartment, remove the pin fastening the servobrake prod to the pedal, then disconnect them.
2. Slacken the four servobrake fastening screws.



1. Loosen the pedal board fastening screws.
2. Loosen the three brake booster fastening nuts and remove the brake booster, brake pump and pedal board assembly.



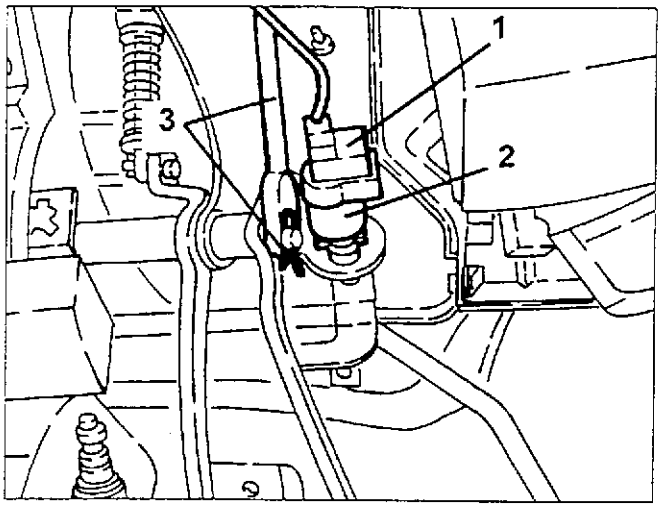
1. Remove the split pin and disconnect the brake pump from the linkage pin.
2. Loosen the four fastening screws and remove the brake pump/booster assembly from the pedal board.
- If required, separate the brake pump from the brake booster by removing the two fastening nuts. Please note that only the brake pump/booster assembly is abailable as a spare part.



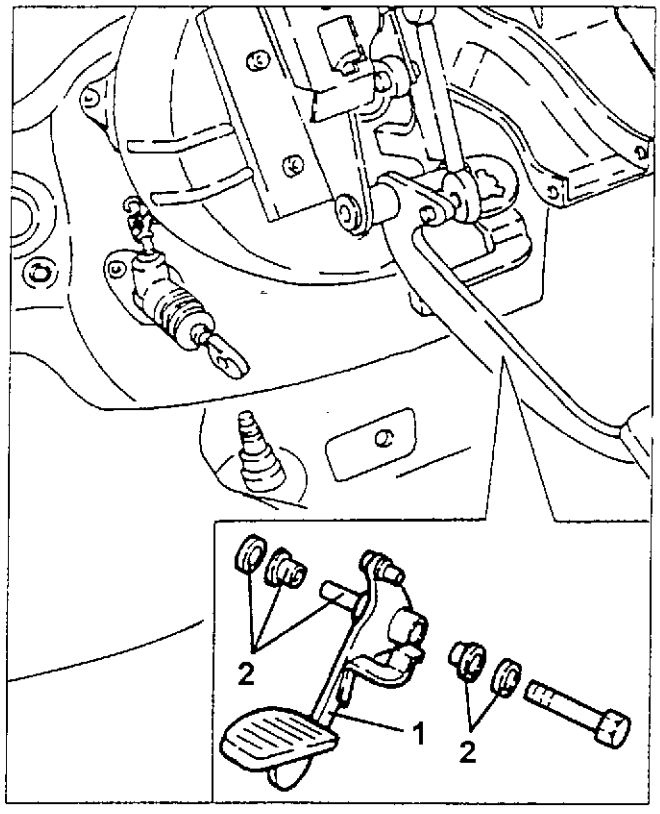
BRAKE PEDAL ('98 MODELS)

REMOVAL/REFITTING

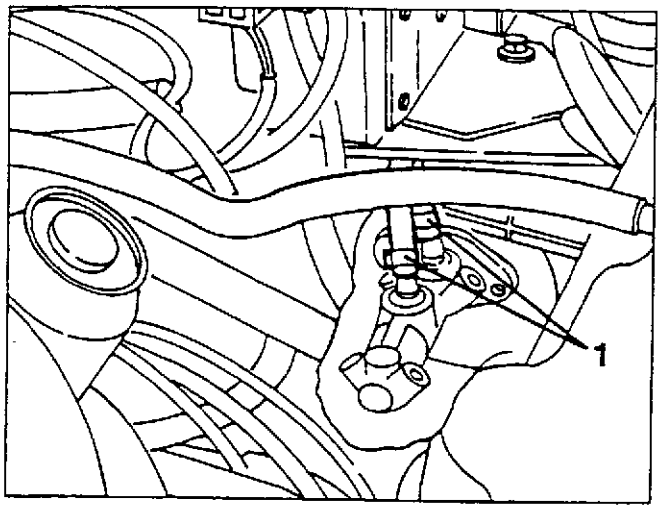
- Make sure the ignition key is at STOP and disconnect the (-) battery terminal.
- Remove the steering column (see ASSEMBLY 41).
1. From inside the passenger compartment, disconnect the brake light switch electrical connection.
2. Remove the brake light switch by turning it clockwise by 45°.
3. Remove the split pin and disconnect the brake pedal tie-rod.



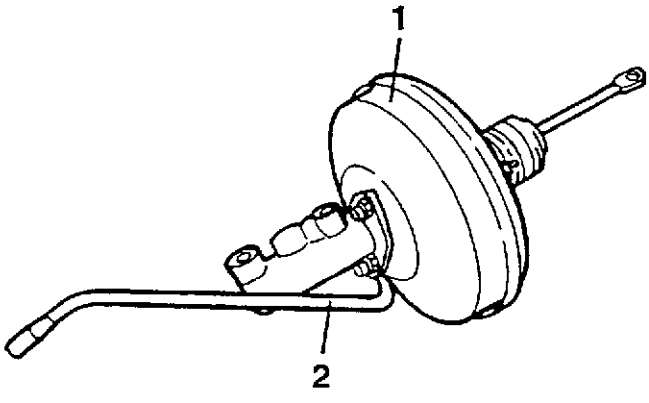
- Loosen the two valve bracket fastening screws.
- Remove the clutch pedal (see specific paragraph).
1. Remove the screw and remove the brake pedal.
2. At the bench, remove the plastic caps and the brake pedal bushing, if required.



1. Disconnect the two supply hoses from the brake pump.



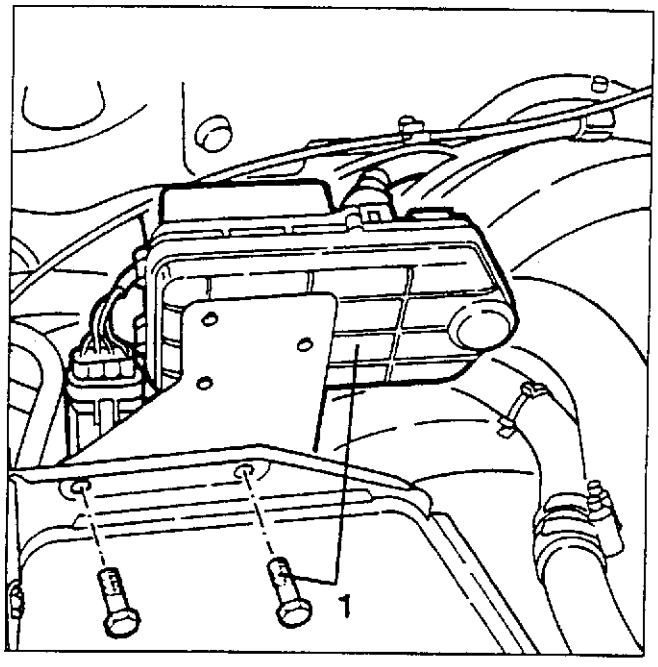
- Raise the car.
1. Remove the pump - servobrake unit retrieving it from the wheelhouse.
2. Remove the vacuum takeoff pipe from the servo-brake.
- If necessary, separate the pump from the servobrake slackening the two fastening nuts; Spares only supply the pump-servobrake unit complete.



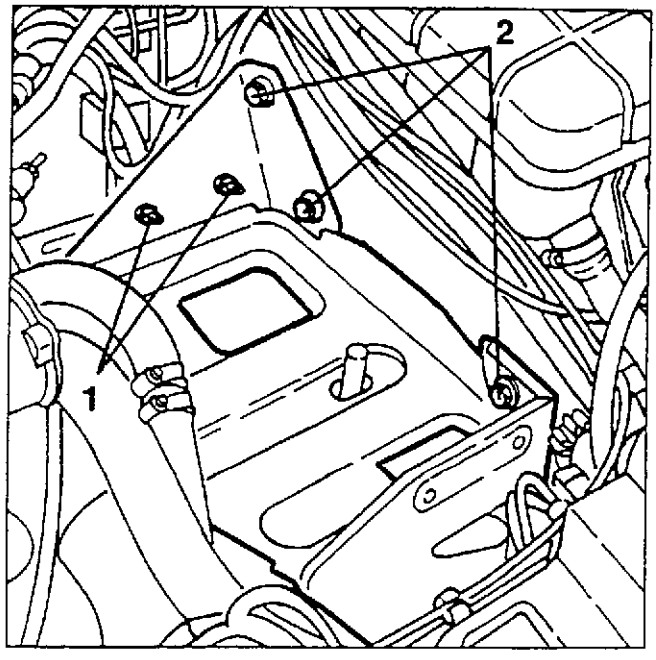
When refitting relieve the air from the braking system (see specific paragraph).

REMOVING/REFITTING
Specific for Turbodiesel engine

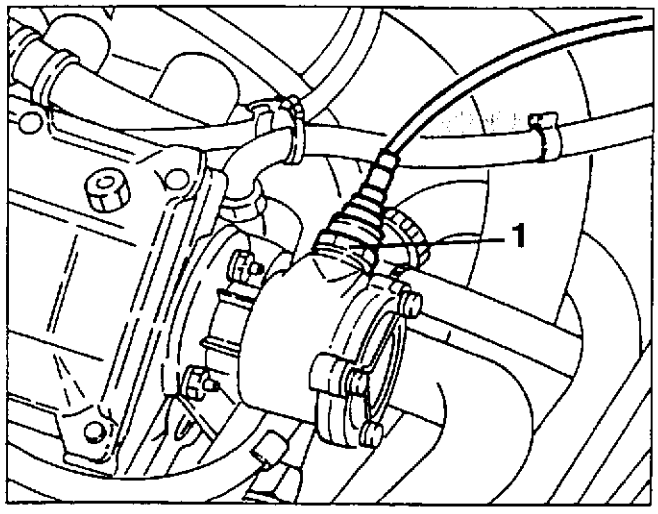
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Using a suitable syringe, empty the brake-clutch fluid reservoir.
- Remove the front left wheel.
- Remove the battery.
1. Slacken the two fastening screws and move aside the fan relays.



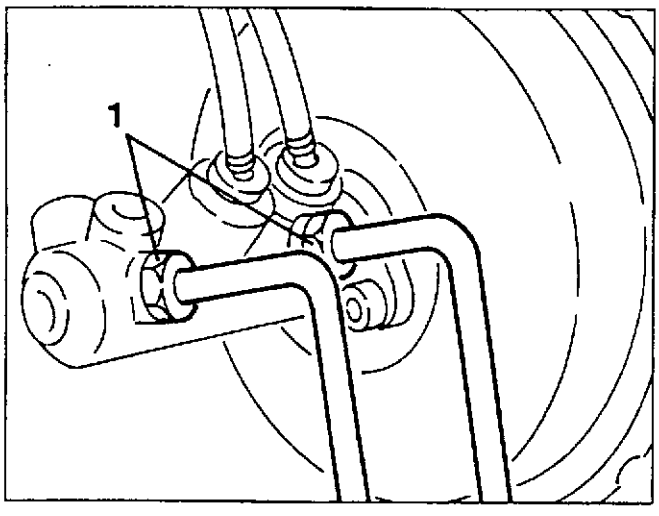
- Remove the duct for draining acid from the battery.
1. Slacken the two nuts fastening the glowplug warming control unit support bracket to the battery support.
2. Slacken the four fastening screws and remove the battery support.



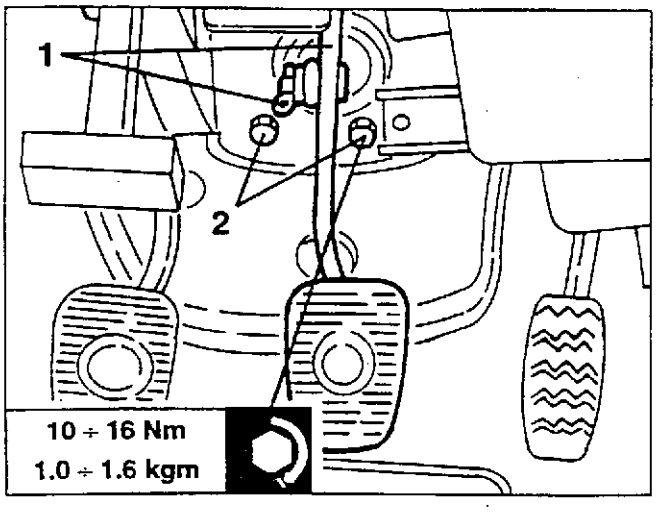
1. Disconnect the vacuum takeoff pipe from the servobrake air pump.



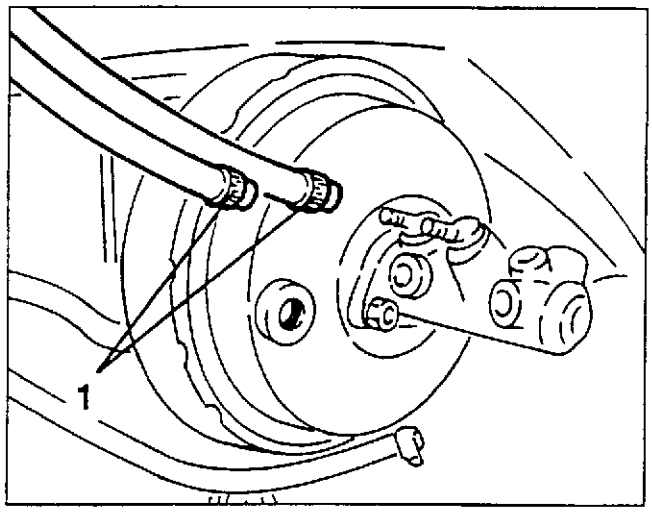
1. Disconnect the two unions of the stiff delivery pipes from the brake pump.



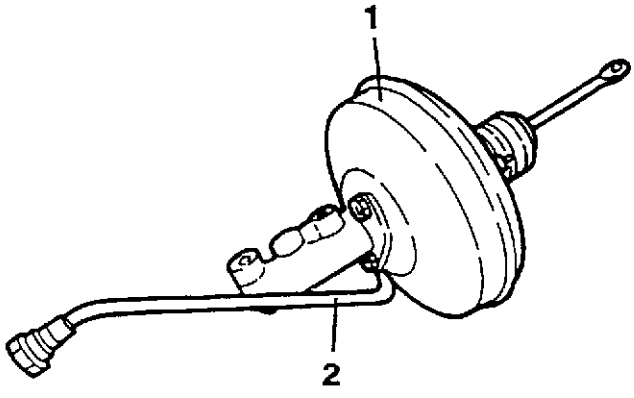
1. Working from the passenger compartment, remove the pin fastening the servobrake prod to the pedal, then disconnect them.
2. Slacken the four servobrake fastening nuts.



1. Disconnect the two supply hoses from the brake pump.



- Raise the car.
1. Remove the pump-servobrake unit retrieving it from the wheelhouse.
2. Remove the the vacuum takeoff pipe from the servobrake.
- If necessary, separate the pump from the servobrake slackening the two fastening nuts; Spares only supply the pump-servobrake unit complete.

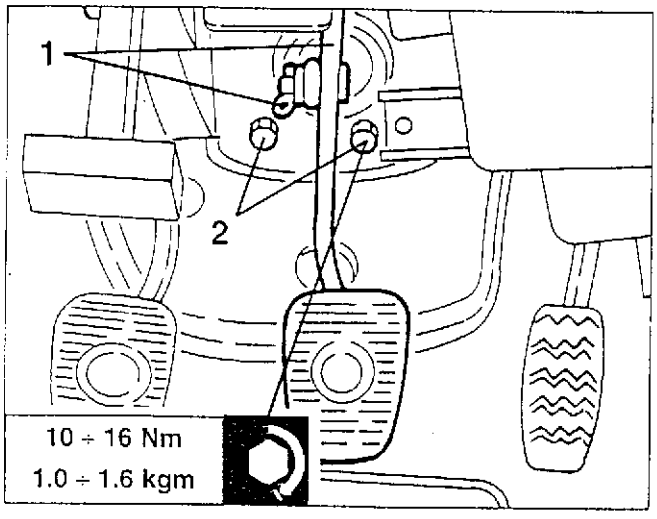


When refitting relieve the air from the braking system (see specific paragraph).

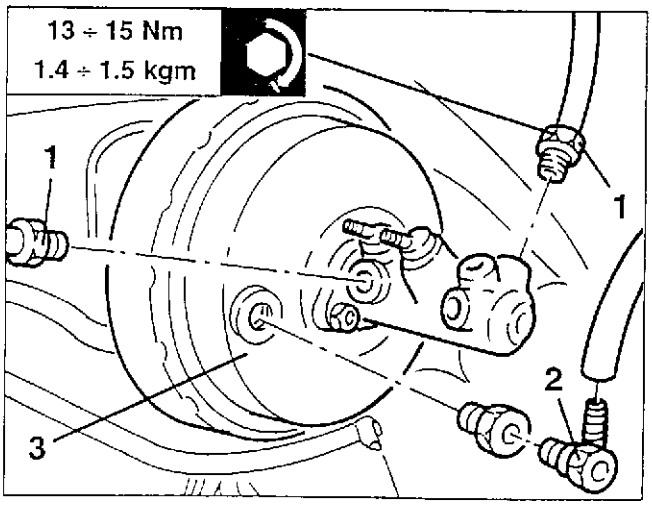
REMOVING/REFITTING
Specific for T. Spark 16V engine

- Disconnect the battery (-) terminal.
- Remove the hydraulic aggregate of the A.B.S. system complete with its support (see specific paragraph).

1. Perform the following operations inside the passenger compartment. Remove the brake booster shoe pin from the pedal and remove the pedal.
2. Remove the four brake booster fastening nuts.



1. Disconnect the two brake pump delivery pipes.
2. Disconnect the brake booster vacuum pipe.
3. Take the pump-brake booster unit.



- If required, split the pump from the brake booster by removing the two fastening nuts.
The pump-brake booster, however, is supplied as a single spare part.

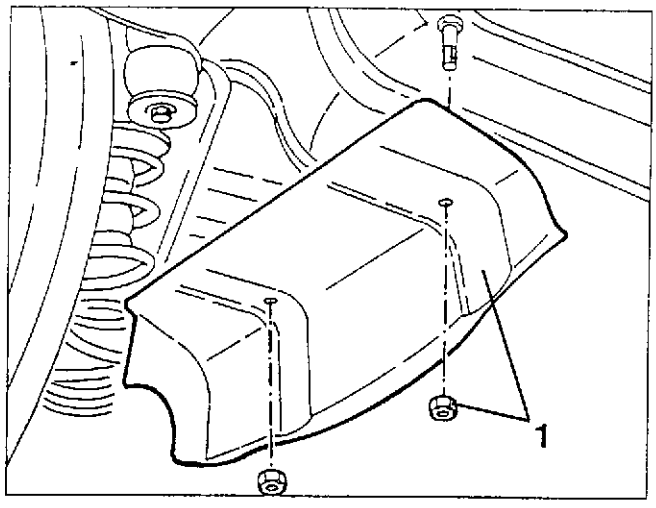
After refitting, bleed the air from the braking circuit (see specific chapter).

BRAKE FORCE DISTRIBUTOR

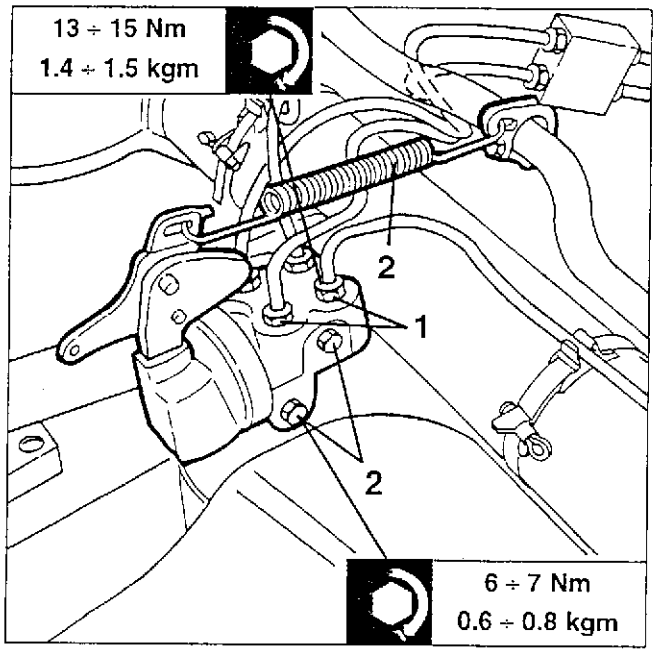
REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Empty the brake-clutch reservoir with a suitable syringe.
- Lift the vehicle.
- Remove the rear section of the exhaust pipe (see GROUP 10).

1. Remove the two fastening screws and remove the heat guard from the rear section of the exhaust pipe.



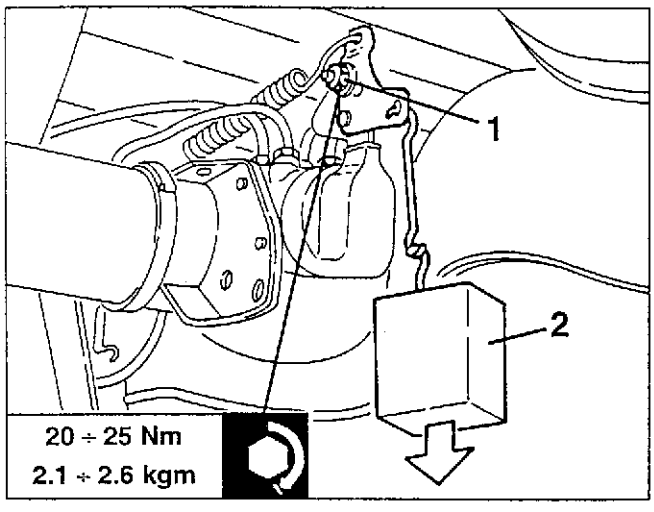
1. Remove the brake force distributor pipe fittings.
2. Remove the two fastening screws and remove the brake force distributor after having disconnected the respective spring.



After refitting, bleed the air from the braking circuit (see specific chapter).

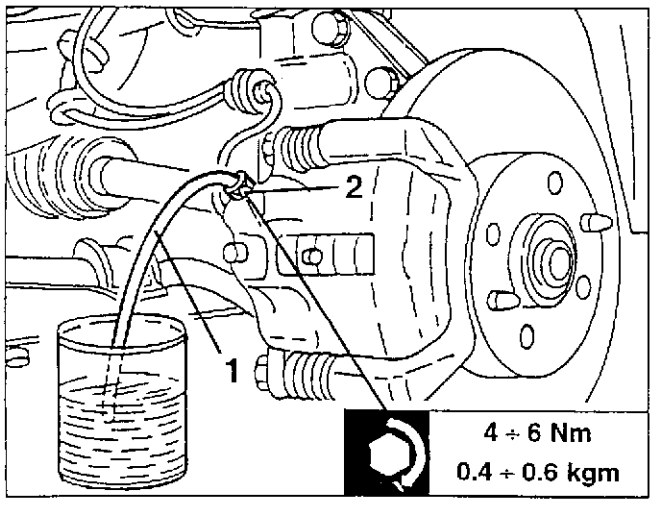
CALIBRATION

- Prepare the vehicle in running order and position it on a flat surface with the wheels on the ground to set the suspensions.
1. Loosen the brake force distributor rod fastening screw.
2. Apply a 3.5 kg weight **(2 kg from chassis no. 2039142 and 4030708)** for versions with rear drum brakes or a 8 kg weight **(7 kg from chassis no. 2039142 and 4030708)** for versions with rear disc brakes to the rod eye.
- Keep the rod in this position and tighten the fastening screw to the prescribed torque.



BRAKE SYSTEM AIR BLEEDING

- Fill the brake-clutch fluid reservoir to the max. level with the prescribed fluid.
- If required, remove the relevant wheel.
1. Fit a clear pipe to the bleeder valve. Place the other end of the pipe in a bowl containing the prescribed fluid.
2. Loosen the bleeder valve and press the brake pedal repeatedly (waiting a few seconds between presses). When fluid without air bubbles flows into the bowl, press the brake pedal fully and tighten the bleeder valve at the prescribed torque.



NOTE: Bleed each wheel separately.

IMPORTANT:
Check that during bleeding operations the fluid level does not drop under the minimum level.
Never re-use the fluid discharged during this operation.
Make sure the fluid does not drip on painted parts to avoid damaging them.

BRAKE SYSTEM PIPES

TESTS AND CHECKS

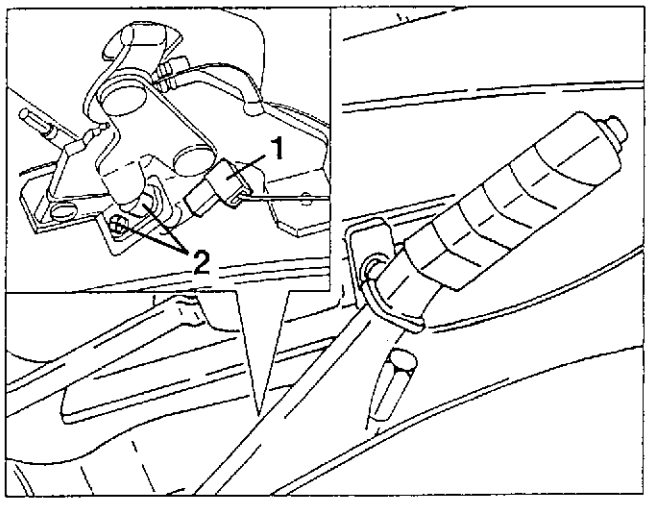
- Check the pipes and hoses are not enlarged, cracked or rusted. Check there are no leaks.
- To replace a pipe, drain the brake-clutch reservoir with a syringe and close the pipe ends to avoid dirt from getting inside the system.
- After refitting, bleed the air from the brake-clutch circuit (see specific chapter).

Never bend nor twist pipes.

HANDBRAKE WARNING LIGHT SWITCH

REMOVAL/REFITTING

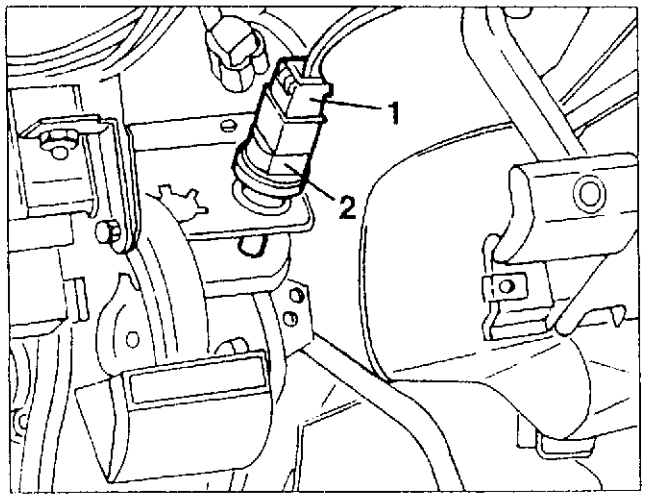
- Disconnect the (-) battery terminal.
- Remove the central oddment tray (see GROUP 70).
1. Disconnect the switch electric connection.
2. Remove the fastening screw and remove the switch.



STOP LIGHTS SWITCH

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the switch.
2. Turn the switch 45° clockwise and remove it.

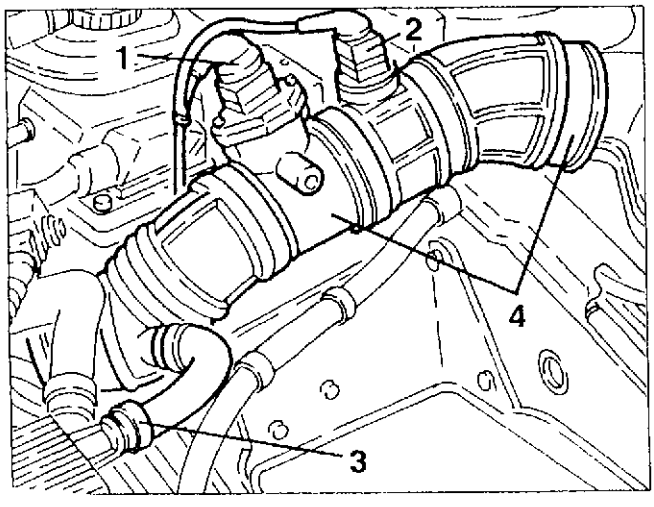


When refitting, adjust the stroke of the "mobile section" using the special ring nut.

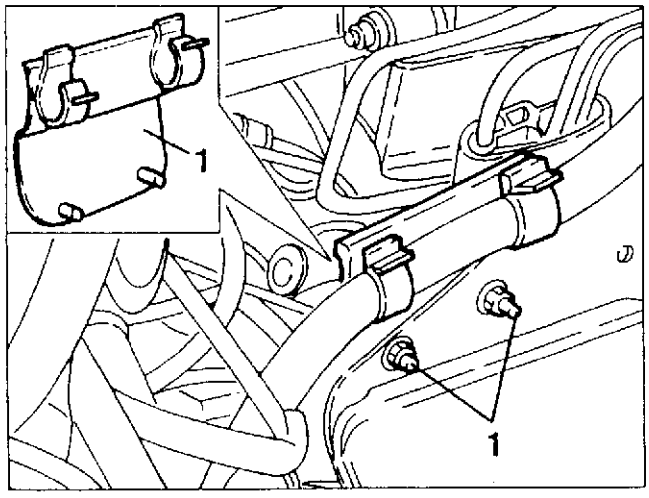
BRAKE-CLUTCH RESERVOIR (Specific for T. Spark 16V engines)

REMOVING/REFITTING

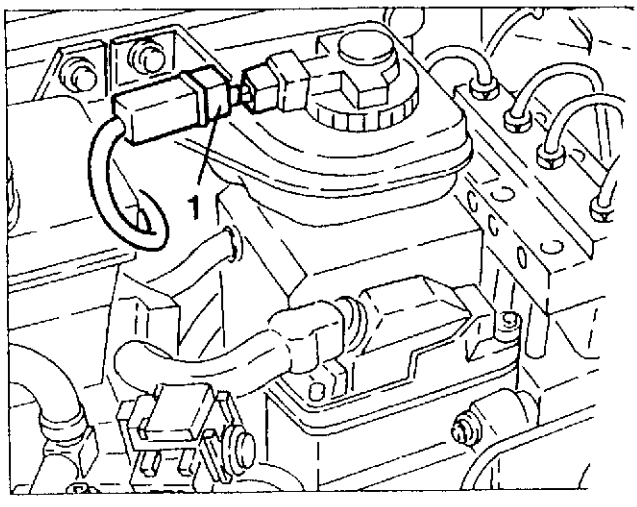
- Remove the battery.
1. Disconnect the electrical connection from the air-flow meter.
2. Disconnect the electrical connection from the intake air temperature sensor.
3. Slacken the fastening clamp and disconnect the oil vapour, recirculation pipe from the cylinder head cover.
4. Slacken the fastening clamps and remove the corrugated sleeve complete.



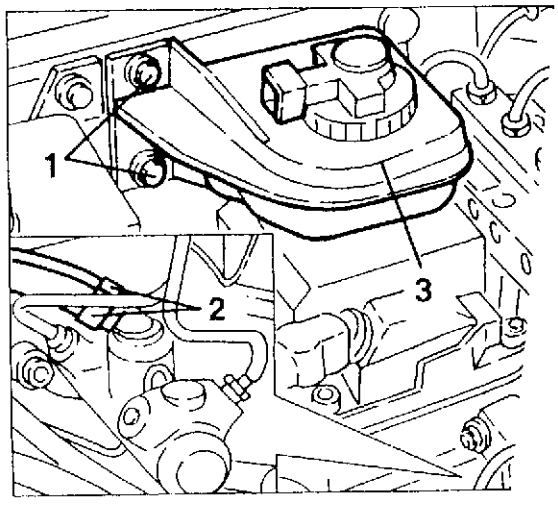
1. Slacken the two fastening nuts and remove the cable support bracket from the battery support.



1. Disconnect the electrical connection from the brake-clutch fluid minimum level sensor.



1. Slacken the two screws fastening the brake-c fluid reservoir.
2. From the brake pump disconnect the two s supply pipes leading from the reservoir.
3. Raise the brake-clutch fluid reservoir just e to disconnect the clutch system supply pipe remove it.

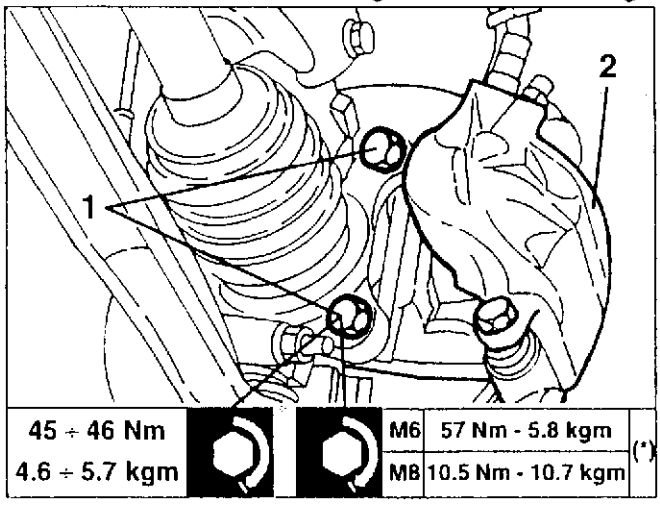


FRONT DISK BRAKES

REMOVAL/REFITTING

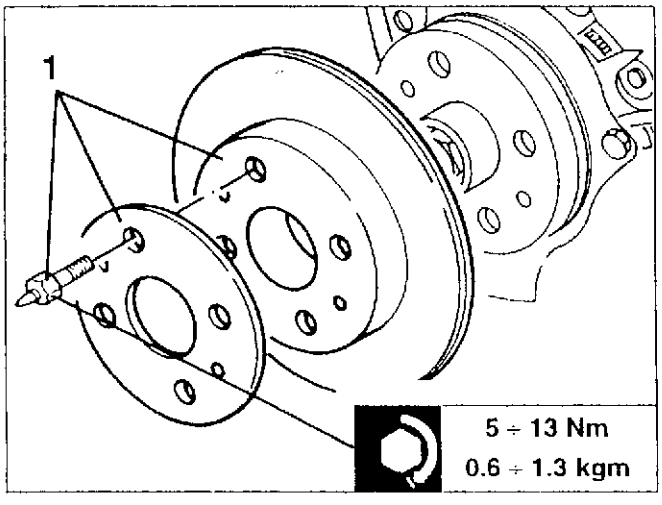
- Set the car on a lift.
- Remove the wheel on the side concerned.

1. Slacken the two screws fastening the brake caliper support plate.
2. Remove the complete brake caliper and move it to one side without disconnecting the hose and wiring.



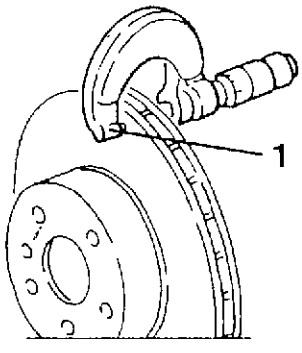
(*): For screws with "Driloc"; to be changed each time they are unscrewed or slackened.

1. Slacken the two fastening pins and remove the spacer and the brake disk.



CHECKS AND INSPECTIONS

1. Check the thickness of the disks and the working surfaces for signs of deep scoring and porosity. If necessary, grind them to within the specified tolerances.

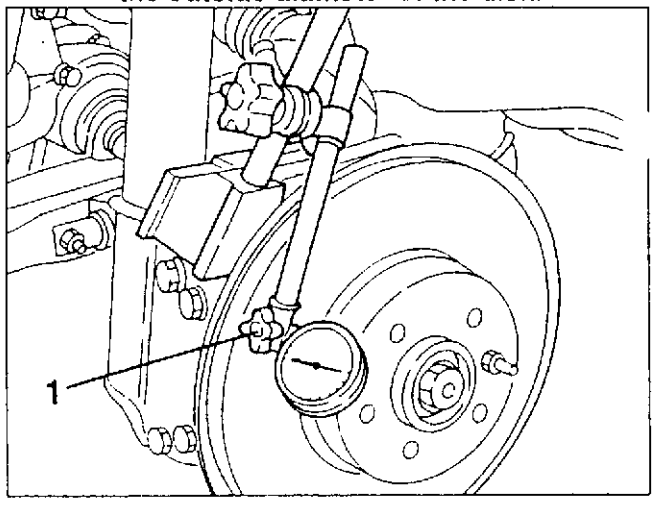


Thickness of disk	Wear limit	Grinding limit
Ventilated (*)	20.2 mm	21.1 mm
Ventilated	18.2 mm	19.1 mm
Not ventilated	10.2 mm	11.1 mm

(*): Specific for 1747 T. SPARK 16V and 1970 T. SPARK 16V

1. When changing the brake pads only, check that oscillation of the disk in relation to the axis of rotation is within the specified limits (0.15 mm max).

NOTE: The value must be measured 2 mm from the outside diameter of the disk.

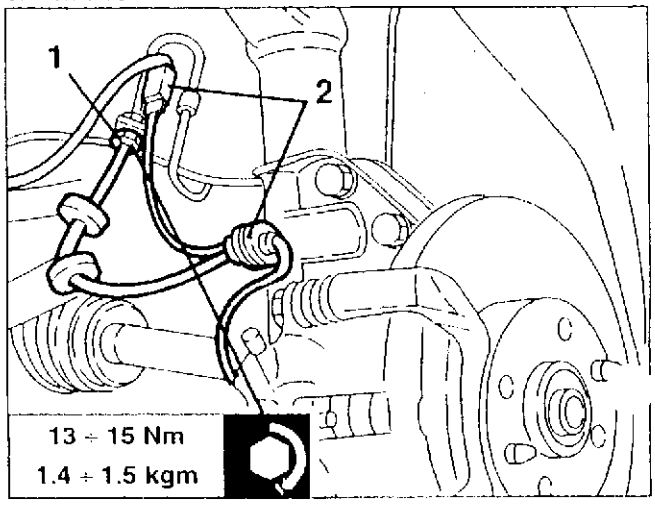


FRONT BRAKE CALIPER (Specific for versions before change)

REMOVAL/REFITTING

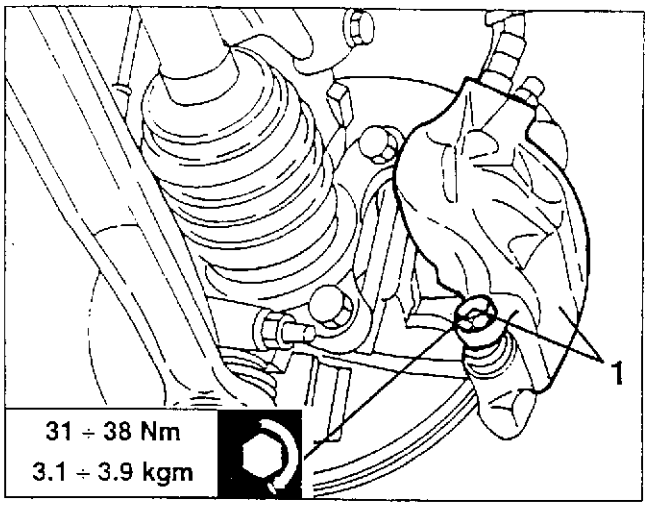
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Remove the wheel on the side concerned.

1. Disconnect the intermediate coupling between the stiff pipe and the brake caliper fluid delivery hose.
2. Disconnect the electrical connection of the brake pad wear sensor, then free it from the fastening on the shock absorber.



1. Slacken the two fastening screws and remove the brake caliper with its pads.

NOTE: **When refitting change the caliper fastening screws and tighten them to the specified torque.**

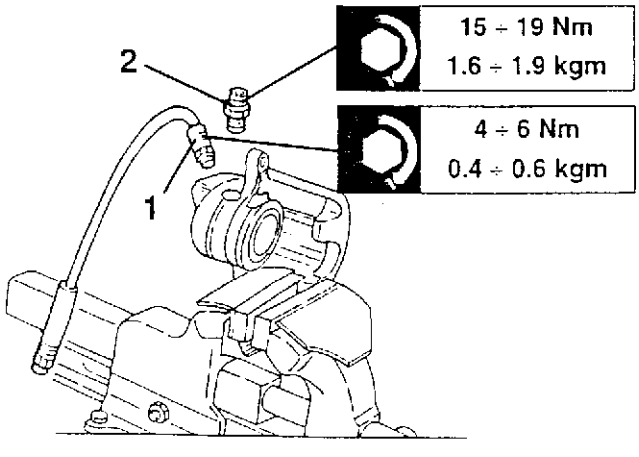


WARNING:
When refitting check that the rubber boots protecting the fastening pin threads are intact, if not, change them.
When refitting the brake pad with the wear sensor, it must be fitted on the inner side of the disk (brake caliper piston side): also check that the relief on the outer part of the same pad is positioned to the rear of the direction of travel.

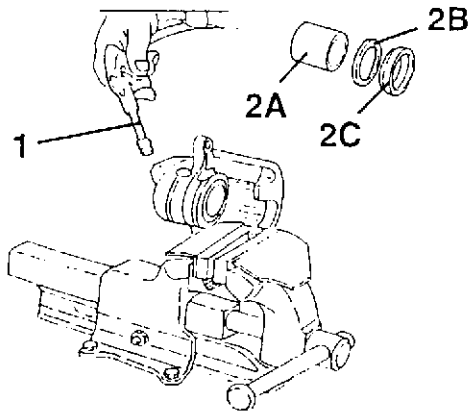
When refitting bleed the air from the brake system (see specific paragraph).

DIS-ASSEMBLY/REASSEMBLY

1. Disconnect the hose connection from the caliper.
2. Remove the relief screw.



1. Blow a jet of compressed air into the brake fluid inlet hole to bring the piston out.
2. Remove the piston (2A), seal (2B) and the protective boot (2C).

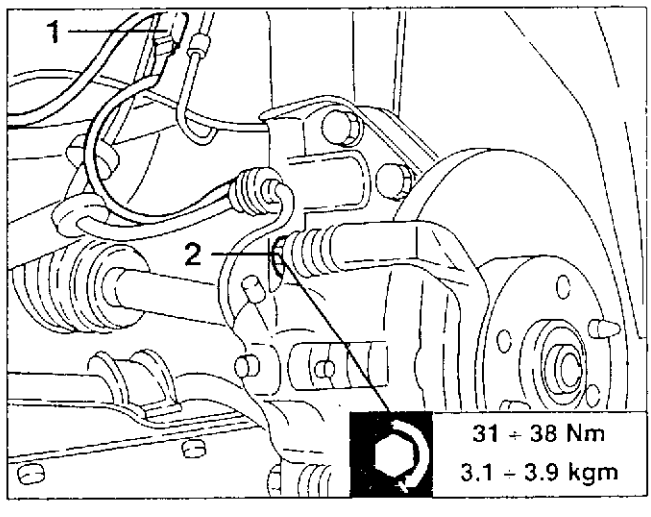


CHECKS AND INSPECTIONS

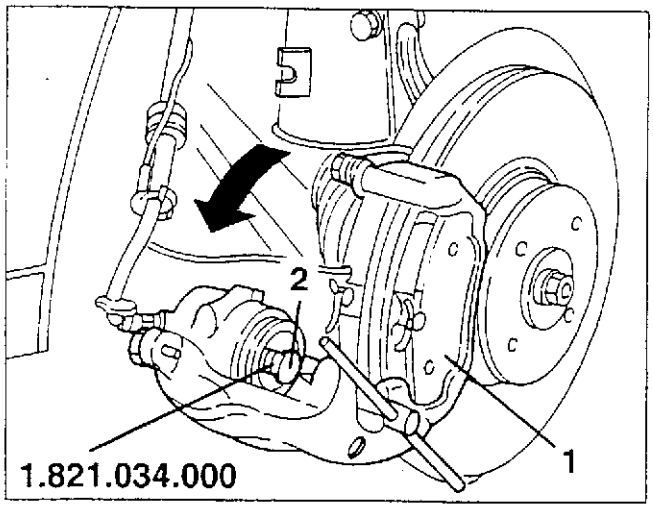
- The piston and caliper body must not reveal signs of abrasion or seizing; if they do, change the caliper complete with piston.
- Always change the protective boot and seal.
- Make sure that the relief screw is not clogged.
- Check the hose for swellings and cracks.
- Change the brake pads if the thickness of the friction material is below 1.5 mm.
- Check the brake caliper support bracket for cracks and distorsion.

CHANGING THE FRONT BRAKE PADS

- Remove the front wheel.
1. Disconnect the electrical connection of the brake pad wear sensor.
2. Slacken the upper screw fastening the caliper body.



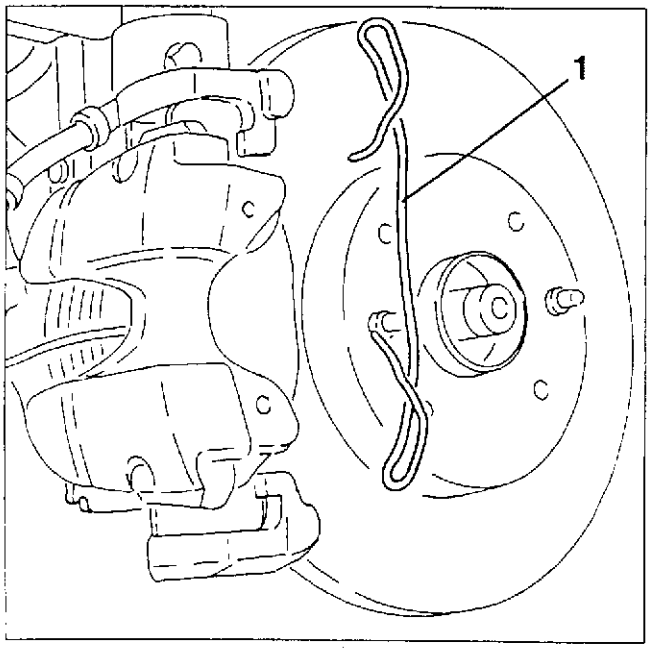
When refitting replace the caliper body fastening screws and tighten them to the specified torque.
1. Turn the caliper as illustrated and replace the brake pads.
NOTE: The brake pad with wear sensor, must be fitted on the inner side of the disk (brake caliper piston side); at the same time check that the relief, on the outer part of the pad is positioned at the rear with respect to the direction of travel.
2. When refitting the caliper adjust the position of the piston using tool no. 1.821.034.000.



FRONT BRAKE CALIPER
(Specific for versions after change)

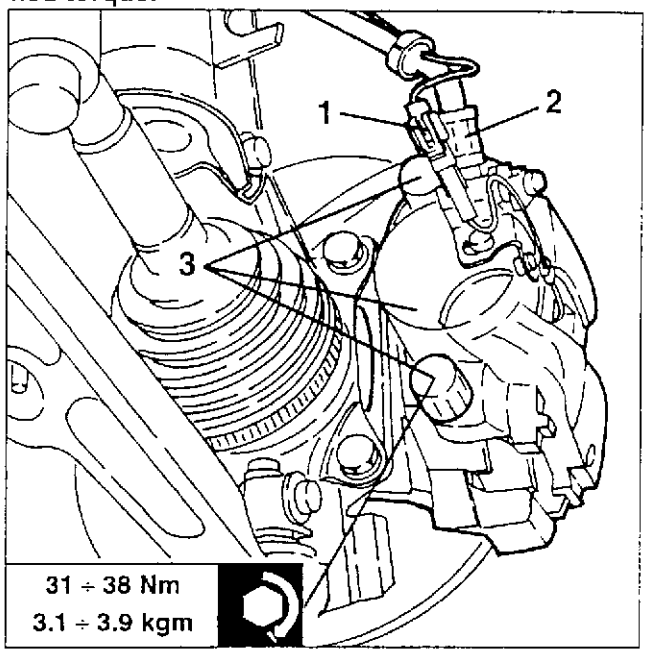
REMOVING/REFITTING

- Set the car on a lift.
- Disconnect the the battery (-) terminal.
- Remove the wheel on the side concerned.
1. Remove the spring from the brake caliper.

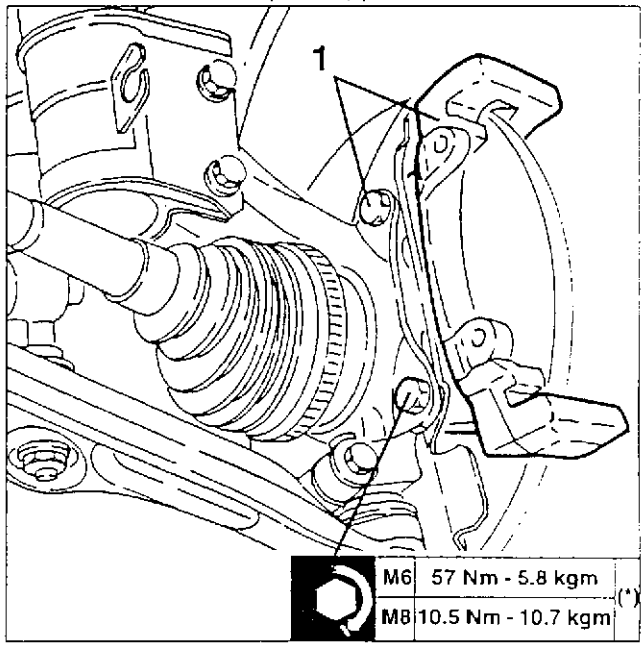


1. Disconnect the connection of the brake pad wear sensor.
2. Disconnect the brake fluid delivery pipe from the caliper.
3. Remove the protective caps, slacken the two fastening screws and remove the brake caliper and pads.

NOTE: When refitting sostituire caliper body fastening screws and tighten them to the specified torque.



1. If necessary, slacken the two fastening screws and remove the brake caliper support.



(*): For screws with "Driloc"; to be changed every time they are tightened or loosened.

When refitting relieve the air from the braking system (see specific paragraph).

DISASSEMBLY/REASSEMBLY

See the instructions for the version before the change

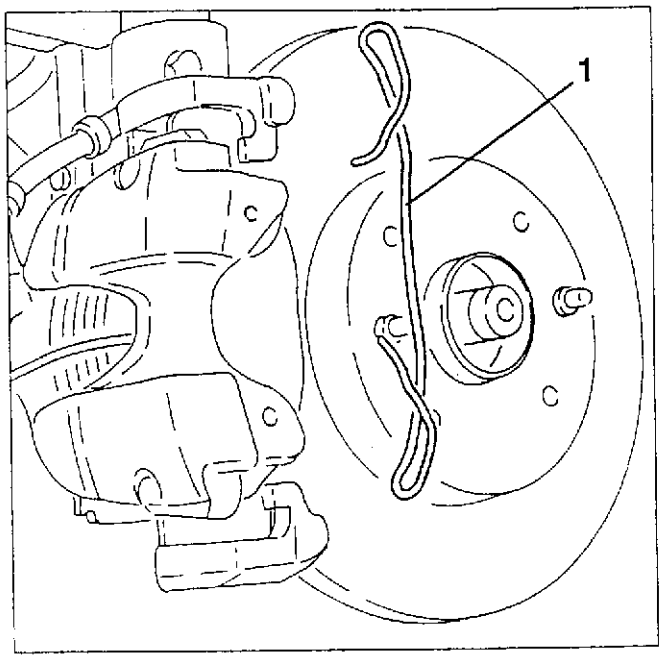
CHECKS AND INSPECTIONS

See the instructions for the version before the change

CHANGING THE FRONT BRAKE PADS

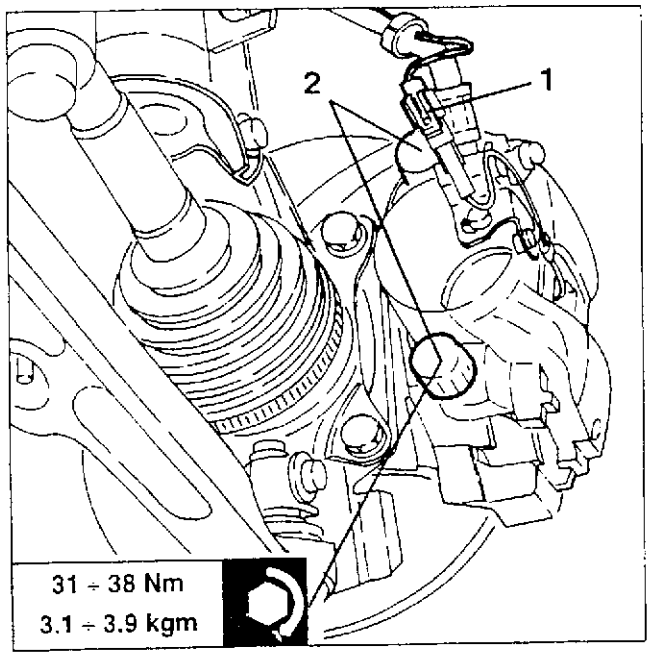
- Set the car on a lift.
- Remove the wheel on the side concerned.

1. Remove the spring from the brake caliper.

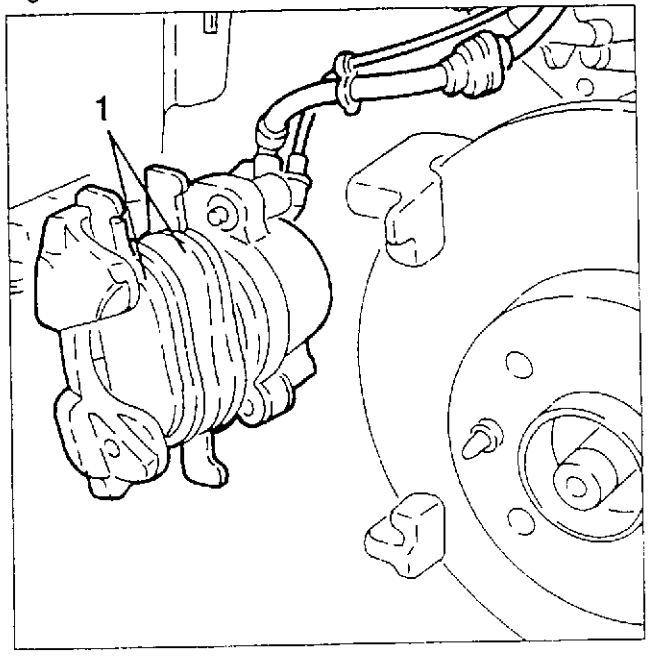


1. Disconnect the brake pad wear sensor electrical connection.
2. Remove the protective caps and slacken the two screws fastening the brake caliper to its support.

NOTE: When refitting change the caliper body fastening screws and tighten them to the specified torque.



1. Back the caliper off the support, without disconnecting the control piping, then remove the brake pads.

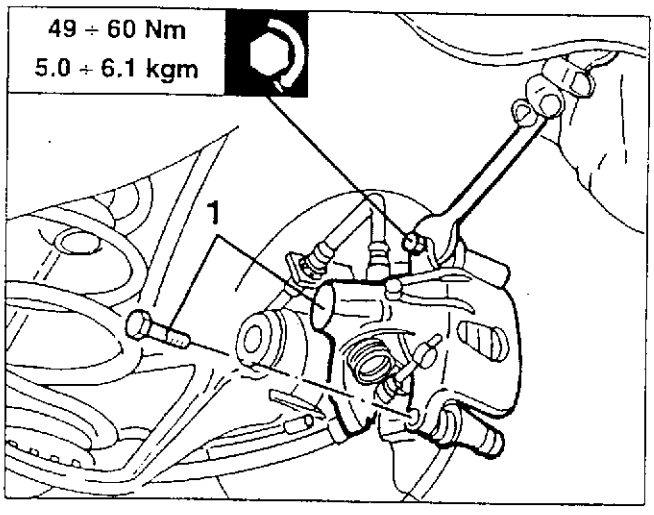


REAR DISK BRAKE

REMOVING/REFITTING

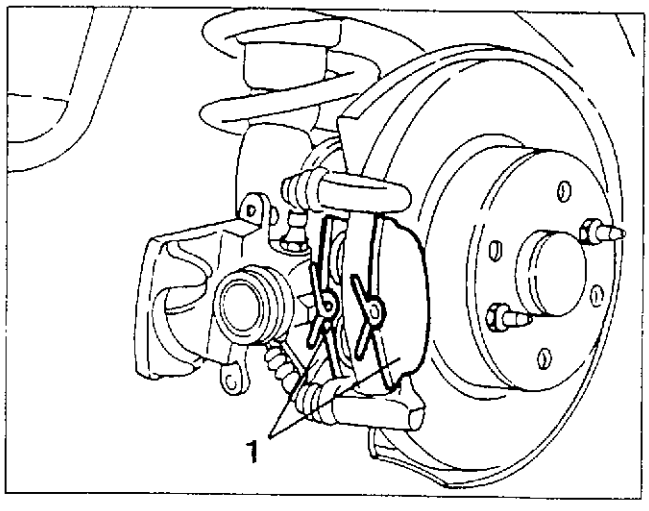
- Set the car on a lift.
- Remove the wheel on the side concerned.

1. Slacken the two screws fastening the brake caliper to its support and move it aside without disconnecting the pipe and the handbrake cable.

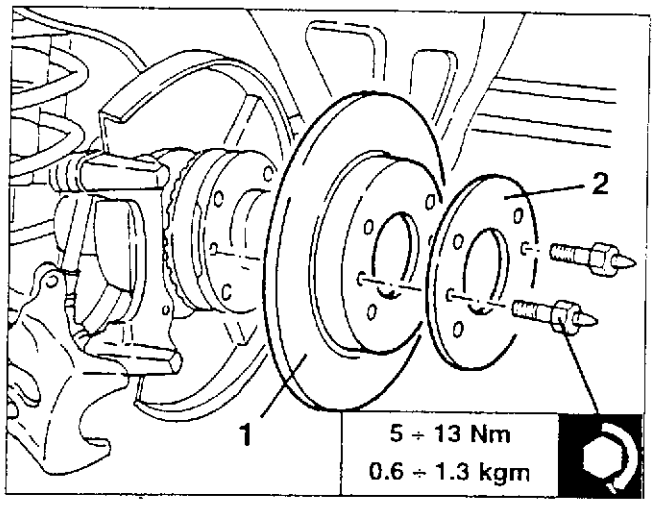


When refitting change the caliper body fastenins screws, tightening them to the specified torque.

1. Remove the brake pads.



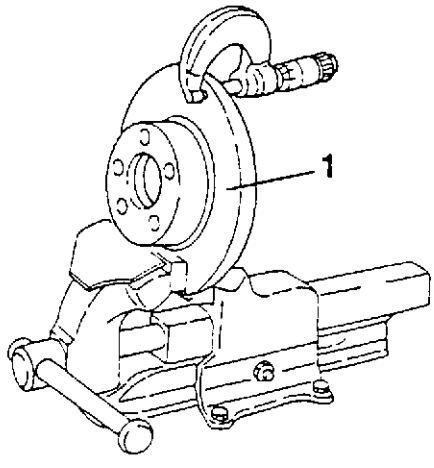
1. Slacken the two fastening pins and remove the brake disk.
2. Retrieve the spacer (where applicable).



CHECKS AND INSPECTIONS

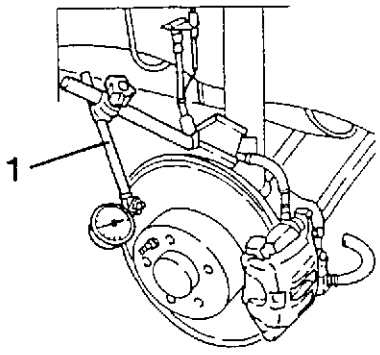
1. Check the thickness of the disks and check that the working surfaces have no deep scores or porosity. If necessary, grind observing the specified tolerances.

At wear limit	At grinding limit
9.2 mm	10.1 mm



1. When changing the brake pads only, check that oscillation of the disk in relation to the axis of rotation is within the specified limits (0.15 mm max).

NOTE: The value must be measured 2 mm from the outside diameter of the disk.

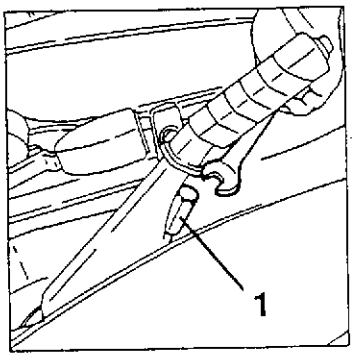


REAR BRAKE CALIPER

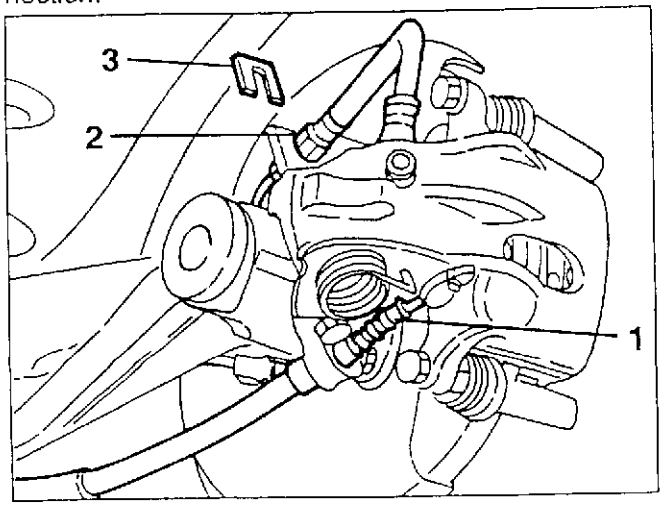
REMOVAL/REFITTING

- Set the car on a lift.
- Using a suitable syringe, empty the brake-clutch fluid reservoir.
- Remove the wheel on the side concerned.
- Remove the handbrake lever leather trim.

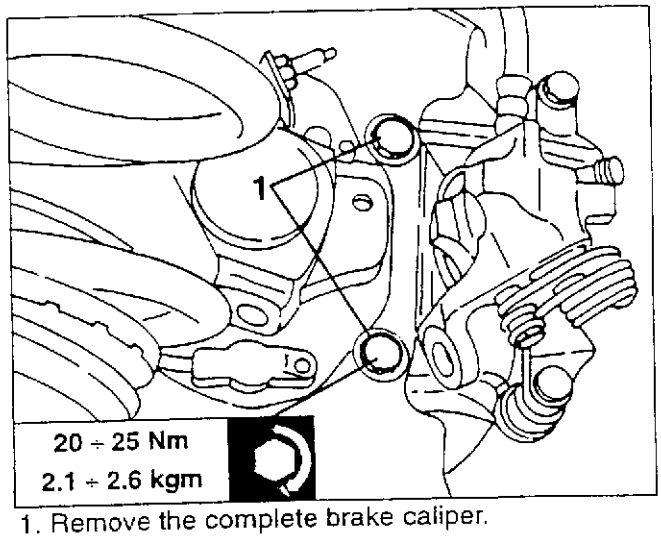
1. Using the handbrake lever adjustment nut, slacken the tension of the cables.



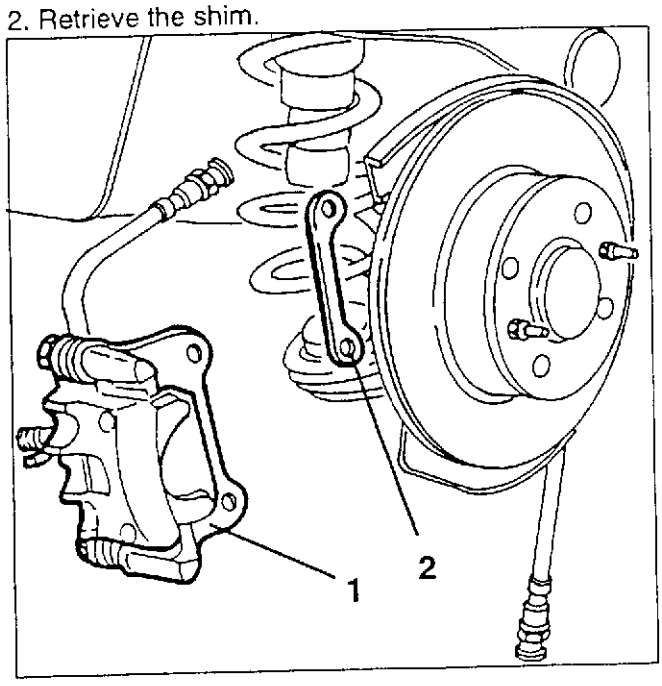
1. Disconnect the handbrake cable from the brake caliper.
2. Slacken the hose connection.
3. Remove the stopper and withdraw the hose connection.



1. Slacken the two screws fastening the complete brake caliper.

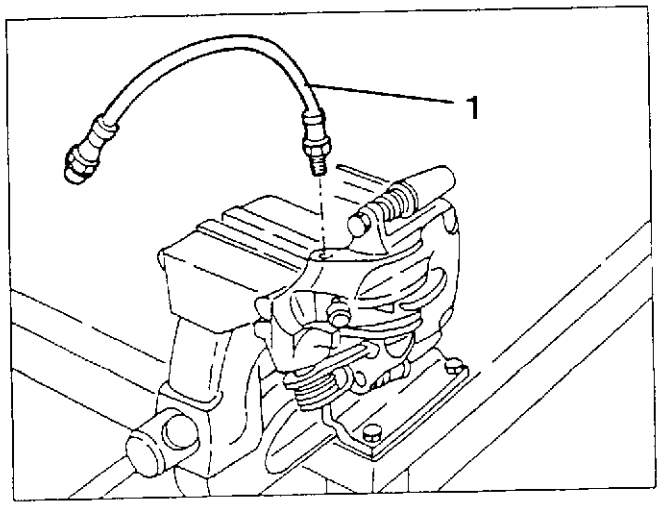


1. Remove the complete brake caliper.
2. Retrieve the shim.

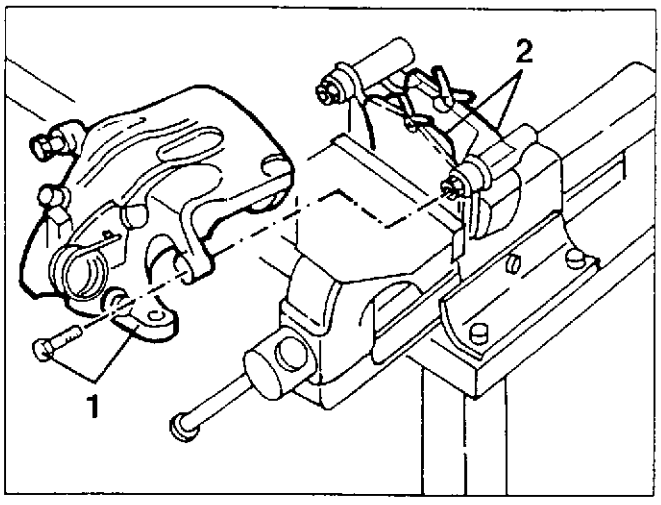


DIS-ASSEMBLY

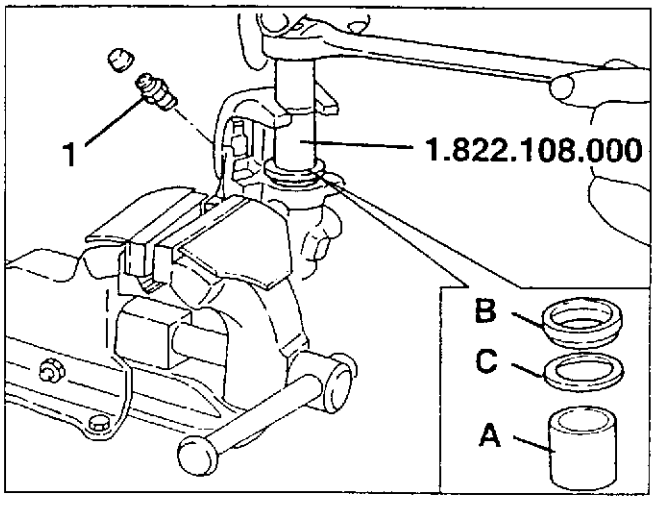
1. Disconnect the hose connection from the brake caliper.



1. Slacken the two screws fastening the brake caliper to its support bracket and remove it.
2. Retrieve the brake pads.



1. Remove the relief screw.
– Using tool N° 1.822.108.000 (A),dis-assemble the piston(A), the protective boot (B) and the seal (C).

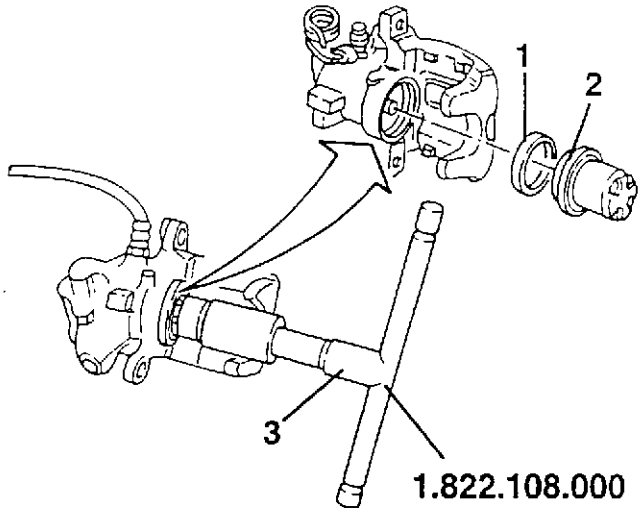


CHECKS AND INSPECTIONS

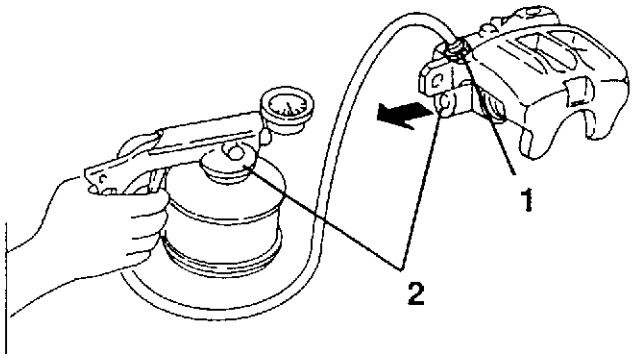
- The piston and caliper body must not reveal signs of abrasion or seizing; if they do, change the caliper complete with piston.
- Always change the protective boot and seal.
- Make sure that the relief screw is not clogged.
- Check the hose for swellings and cracks.
- Change the brake pads if the thickness of the friction material is below 1.5 mm.
- Check the brake caliper support bracket for cracks and distorsion.
- If the automatic handbrake cable stroke adjustment device is not working properly, change the complete caliper.

REASSEMBLY

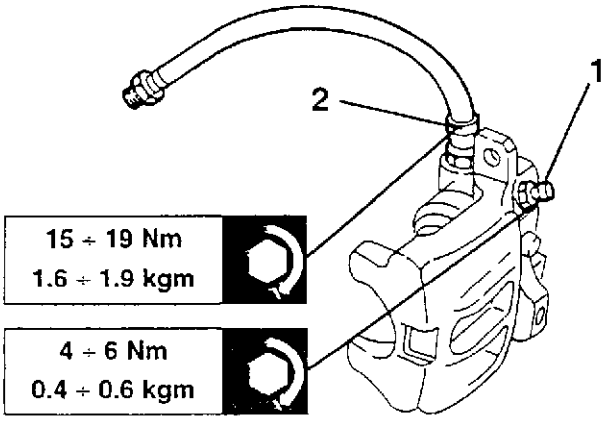
1. Fit the seal ring in the caliper body.
2. Position the protective boot on the rear section of the piston.
3. Fit the piston and adjust the position using tool N° 1.822.108.000.



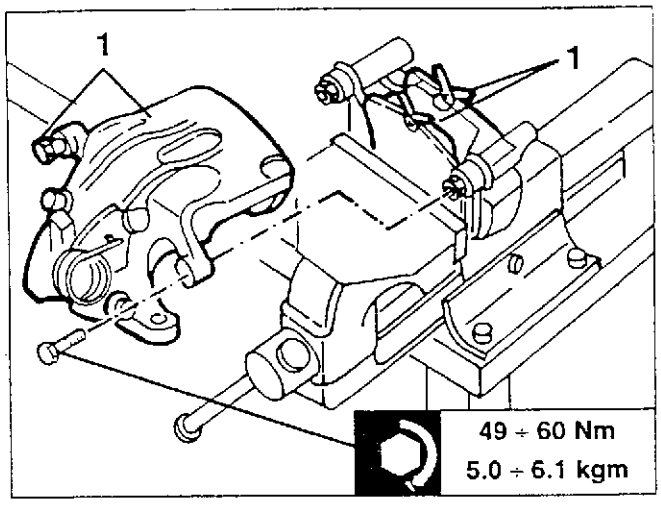
1. Partially tighten the relief screw.
2. Fill the caliper with the specified brake fluid until the fluid comes out of the hose connection hole free of air bubbles.



1. Lock the relief screw to the specified torque.
2. Assemble the hose and lock the connection to the specified torque.



1. Position the brake pads, then assemble the brake caliper on its support bracket tightening the new fastening screws to the specified torque.

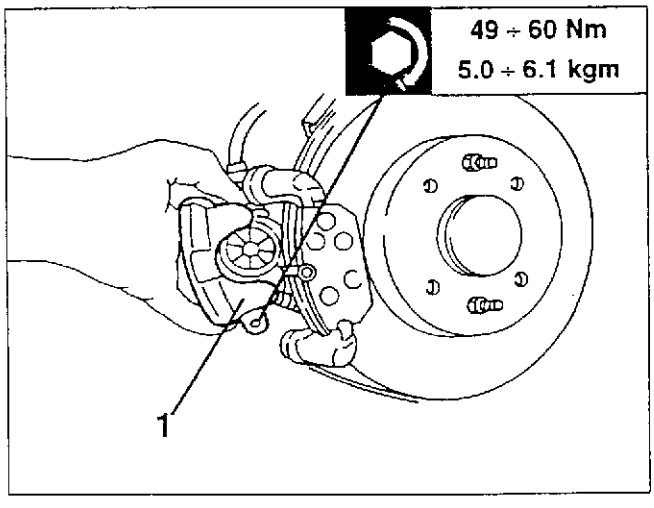


CHANGING THE REAR BRAKE PADS

- Remove the rear wheel.

1. Slacken the two screws fastening the caliper body and move it aside to simplify changing the pads.

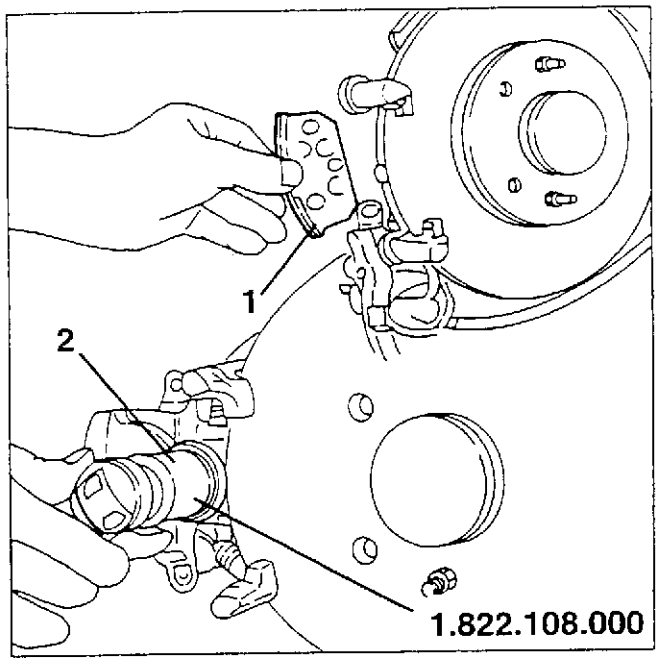
When refitting change the caliper body fastening screws, tightening them to the specified torque.



1. Change the brake pads.

NOTE: **There is no specific direction for assembling the rear brake pads.**

2. Using tool N° 1.822.108.000 move the piston backwards to simplify refitting the caliper, then refit the caliper itself.

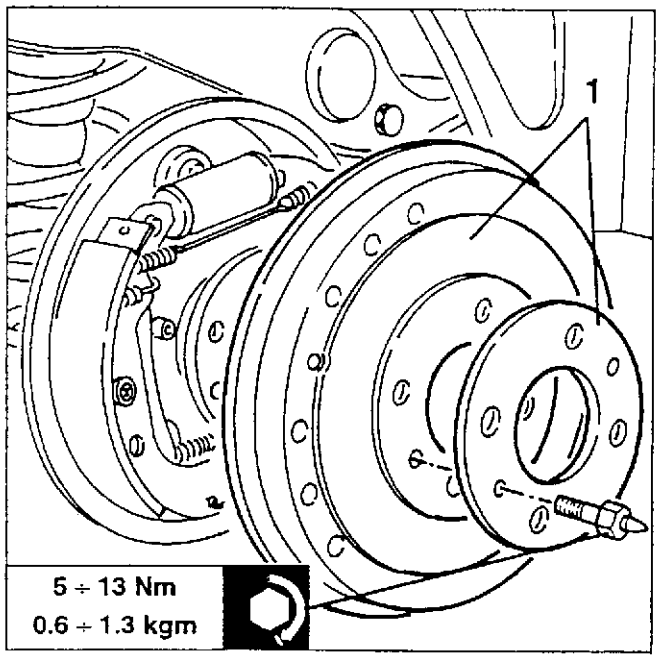


BRAKE DRUM

REMOVAL/REFITTING

- Set the car on a lift.
- Remove the wheel on the side concerned.

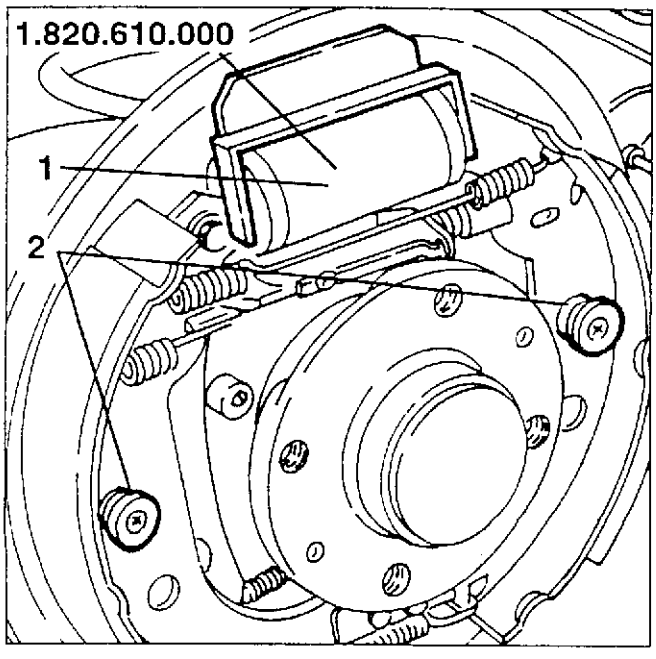
1. Slacken the two fastening pins and remove the spacer and drum.



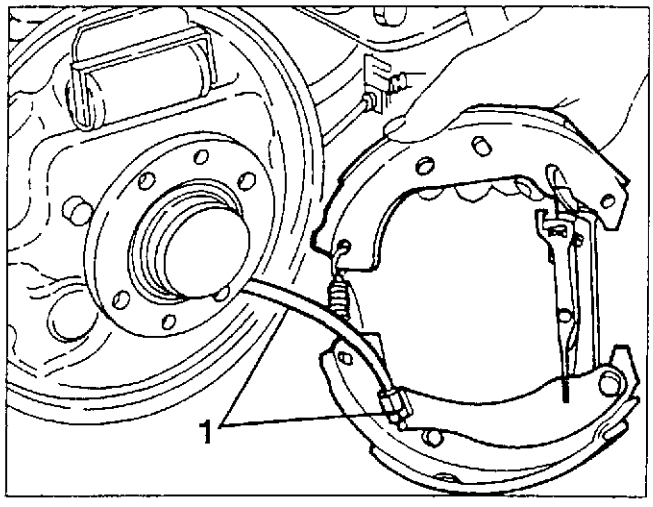
CHANGING THE BRAKE SHOES

- Remove the drum (see specific paragraph).

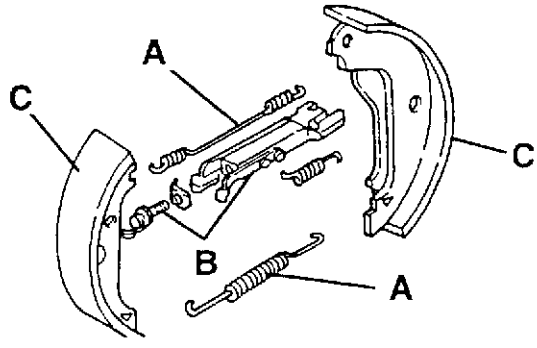
1. Install tool n° 1.820.610.000 for retaining the brake cylinder piston.
2. Slacken the two shoe fastening pins.



1. Move the shoe unit away just enough to disconnect the handbrake cable.



- On the bench remove the two shoe return springs (A) and the self-adjusting play takeup device (B) from the shoes (C).

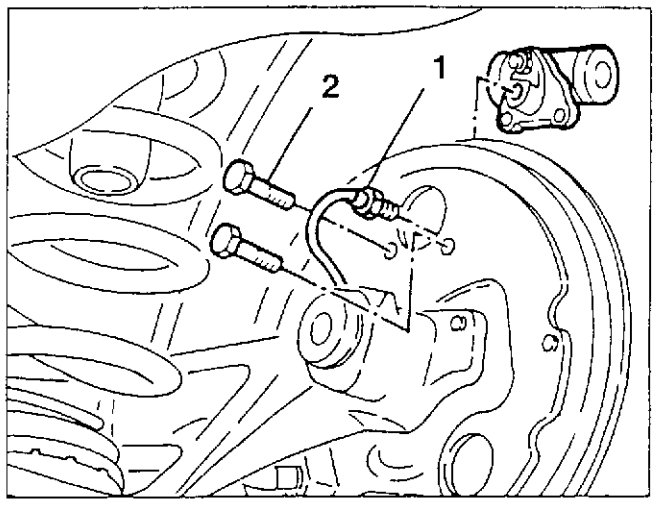


SHOE CONTROL CYLINDER

REMOVAL/REFITTING

- Remove the rear drum brake shoes.

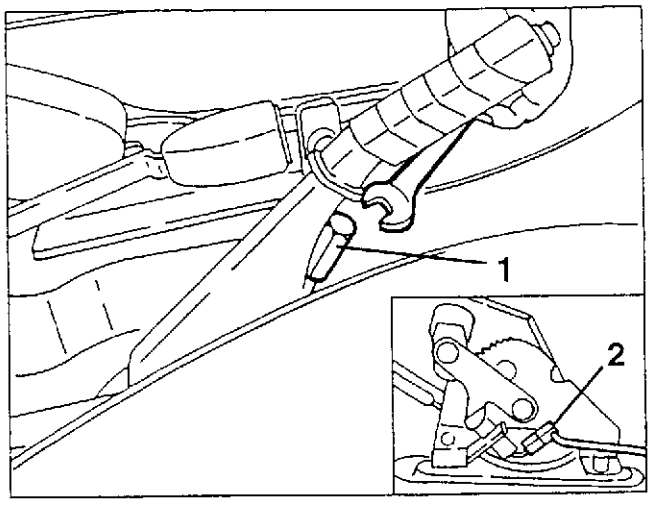
1. Disconnect the hose connection from the shoe control cylinder.
2. Slacken the two screws fastening the shoe control cylinder and remove it.



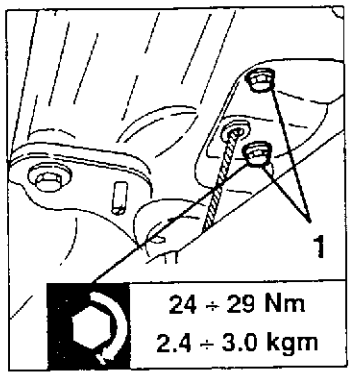
CONTROL LEVER

REMOVAL/REFITTING

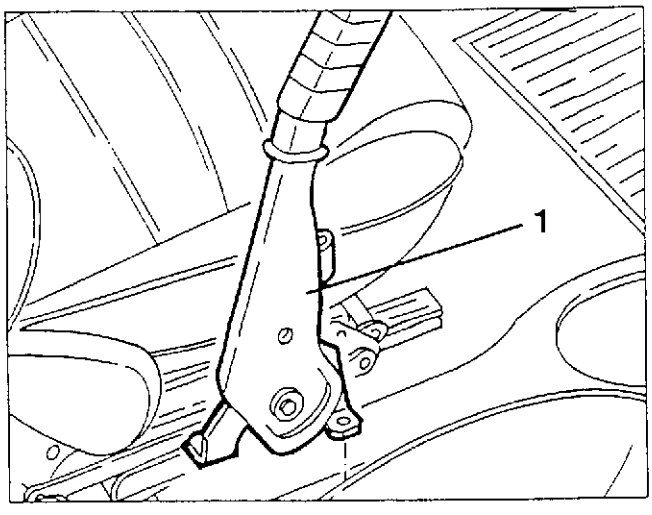
- Set the car on a lift.
- Remove the centre brake console (see GROUP 70).
1. Completely unscrew the handbrake lever adjustment nut and free the control cable.
2. Disconnect the electrical connection from the handbrake switch.



- Raise the car.
1. Slacken the fastenings of the exhaust pipe heat guard and slacken the two screws fastening the handbrake lever.



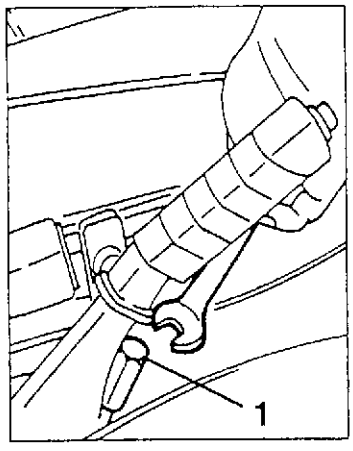
- Lower the car.
1. Remove the handbrake lever.



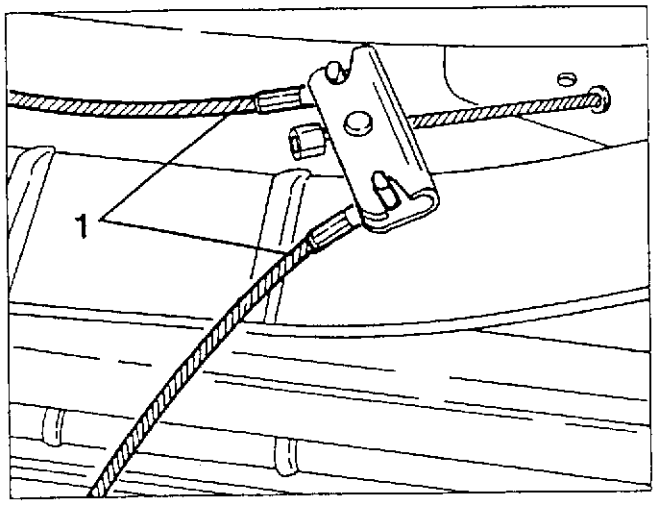
FRONT CONTROL CABLE

REMOVAL/REFITTING

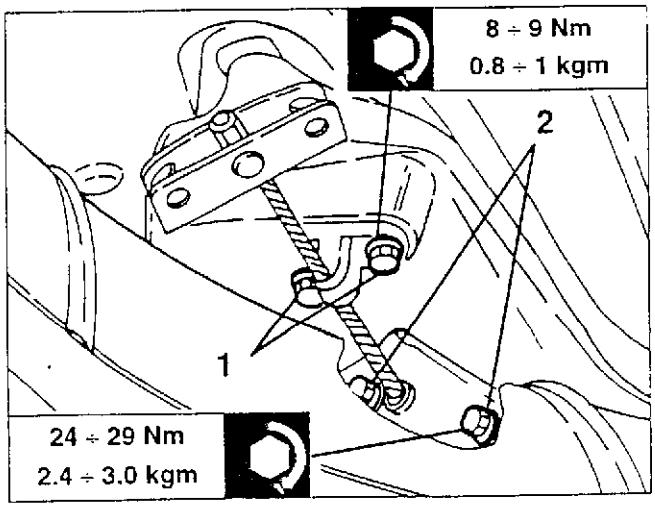
- Set the car on a lift.
- Remove the handbrake lever leather trim.
1. Completely unscrew the handbrake lever adjustment nut and free the control cable.



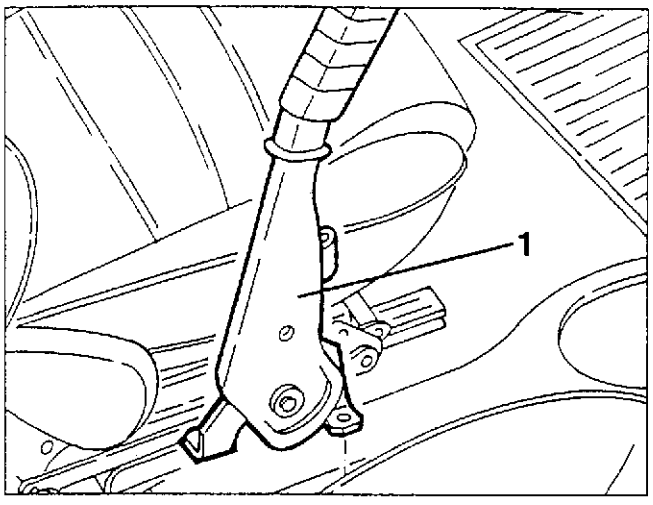
- Raise the car.
1. Disconnect the handbrake cables from the hooking bracket.



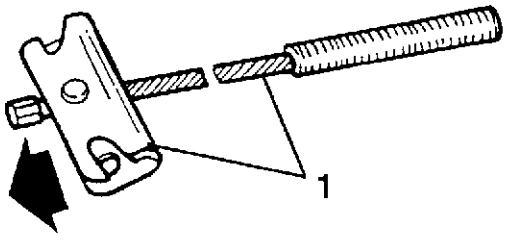
1. Slacken the fastenings of the exhaust pipe heat guard and slacken the two screws fastening the handbrake front cable support.
2. Slacken the two screws fastening the handbrake lever.



- Lower the car.
1. Remove the handbrake control lever.



1. Raise the car and retrieve the handbrake front cable withdrawing it from the grommet.

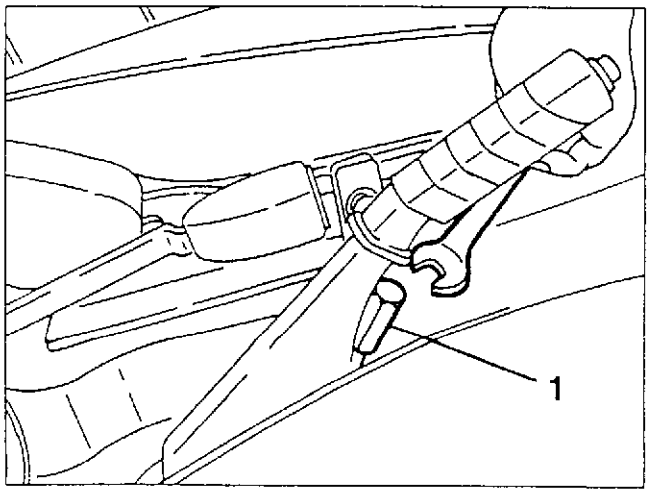


When refitting, make sure that the cable grommet is correctly positioned.

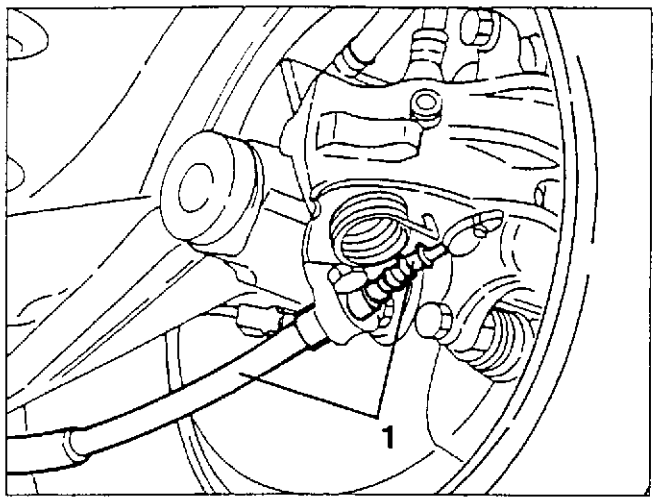
REAR CONTROL CABLES

REMOVAL/REFITTING

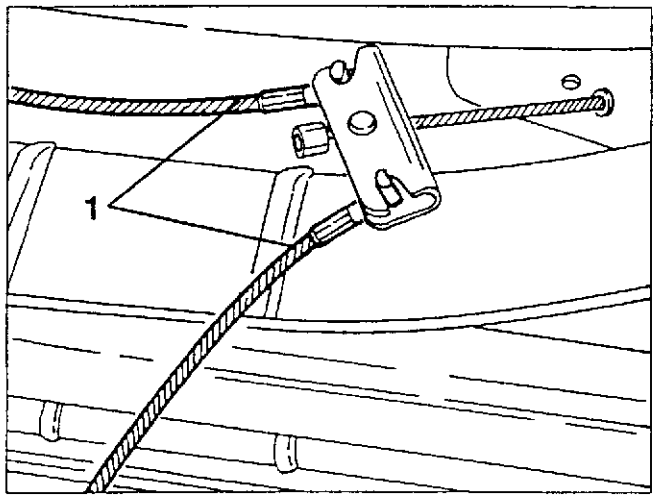
1. Remove the boot and slacken the tension of the handbrake cables using the special adjustment nut.



1. Disconnect the handbrake rear cables from the brake calipers.



- Free the handbrake rear cables from the support clamps.
1. Disconnect the handbrake rear cables from the hooking brackets and remove them.



ADJUSTING THE CONTROL CABLES

The handbrake should be adjusted only after changing the brake pads, or the control cables, or the brake caliper, as wear takeup is automatic.

- Disconnect the handbrake cables from the brake calipers and pump the brake pedal forcefully at least ten times.
- Reconnect the handbrake cables to the calipers.
- Move the handbrake lever to the third position on the toothed sector and tighten the adjustment nut until the rear wheels are braked.

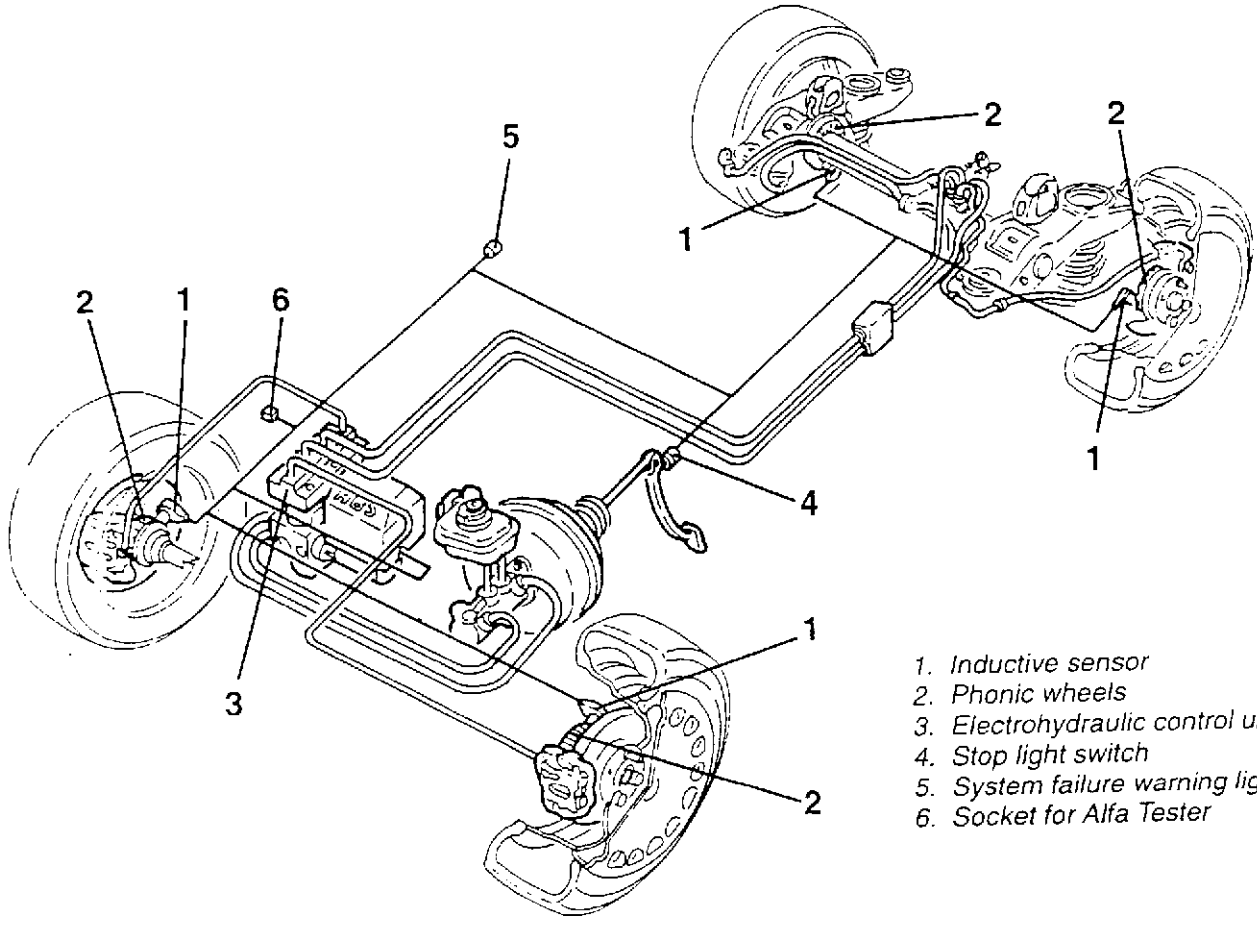
With the lever in the rest position, check that the wheels turn freely.

BOSCH 2E ABS

(up to chassis no. .....)

DESCRIPTION

The BOSCH 2E A.B.S. wheel anti-lock system, integrated with the conventional hydraulically-operated system can be split into the following parts:
- a control unit (3) which, compared with other types of anti-lock systms, integrates the electronic one with the electrohydraulic one controlling both electronic and system management;
- a diagnosis socket (6) for the Alfa Tester;
- four sensors (1), integral with the fixed part suspension facing the same number of phonic wheels (2);
- a switch (4), in correspondence with the brake pedal, for controlling the stop lights;
- a warning light (5), in the instrument cluster, to alert the driver of faults in the A.B.S. system.



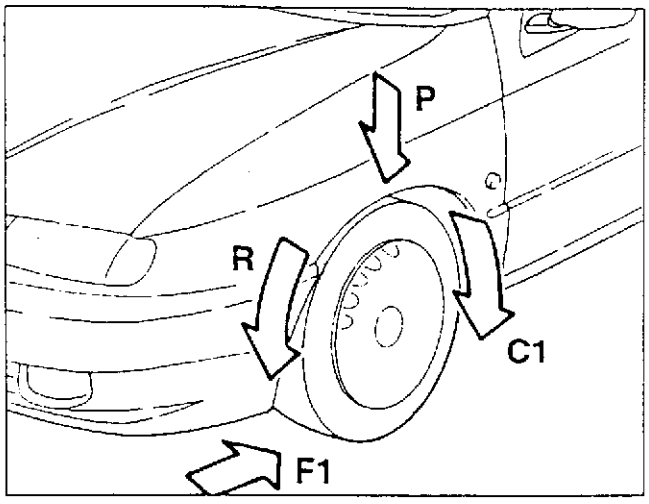
1. *Inductive sensor*
2. *Phonic wheels*
3. *Electrohydraulic control unit*
4. *Stop light switch*
5. *System failure warning light*
6. *Socket for Alfa Tester*

OPERATING PRINCIPLE

During daily use of the vehicle we are used to pressing the brake pedal according to the slowing down required of the vehicle. When the road surface is dry and clean, no particular inconveniences generally occur, as it is possible to reach heavy pressures before the tyre begins to skid.
Conversely, if the asphalt and tyre conditions is not perfect, it would be instinctive to keep higher safety distances as lengthening of the braking distance is foreseeable, owing to both physical problems of grip and in considerable difficulty in dosing the braking force in the best way possible.

If one finds oneself in an unexpected situation (such as uneven road surface, braking on road surfaces at the limit of grip, or panic braking) it would be extremely fiddicult to control the vehicle, resulting in longer stopping distances and the possible loss of control. All this takes place because the wheels skid during braking and it is therefore impossible for the tyre to absorbe the lateral forces acting on it.
During braking, the peripheral speed of the wheel tends to lower more than that of the vehicle; if the wheel locks and the car is still moving, the difference between these two speeds is at its highest level.

This difference in speed is known as "slipping coefficient" which represents the percentage of difference between the two speeds, therefore:
- slipping coefficient 0% if the wheel is free to roll;
- slipping coefficient 100% if the wheel is locked and the car is moving.



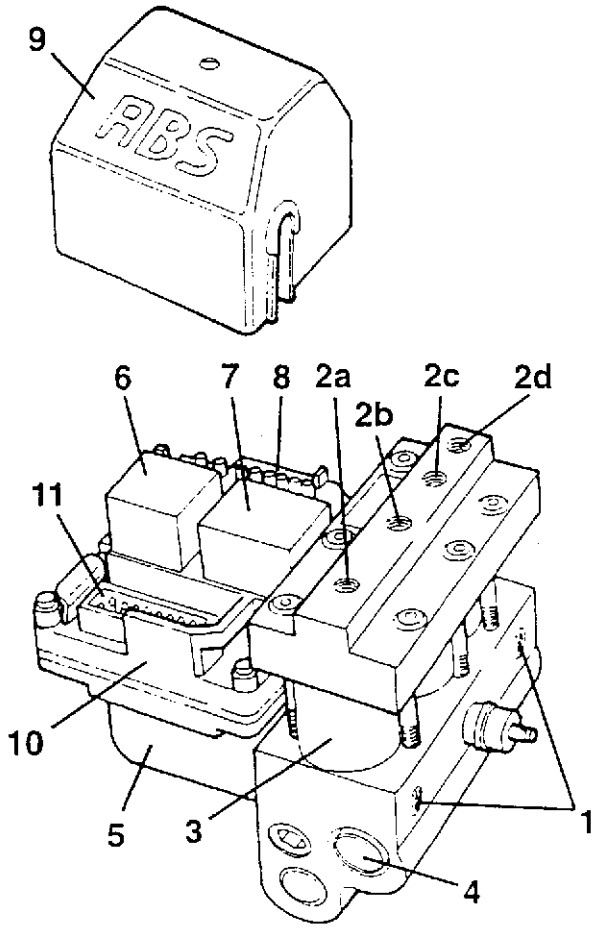
C1 Braking torque
F1 Braking force
P Weight bearing on the tyre
R Tyre rolling radius

During braking, braking friction increases decidedly, for low values of the slipping coefficient, then lowering, gradually as the wheel slows down with respect to the speed of the car. Maximum braking efficiency is therefore obtained with slipping coefficient between 5% and 15% with a maximum of 20% depending on the tyre and road surface.
The purpose of the wheel anti-lock system (A.B.S.) is that of modulating the braking pressure so that the slipping coefficient is always kept between optimum values: this will make it possible to brake with the maximum braking friction and stop the vehicle in the smallest space possible allowed by the condition of the road surface and the wear of the tyres.

ELECTROHYDRAULIC CONTROL UNIT

The control unit in the engine compartment is connected through unions (1) to the brake pump and through unions (2) to the braking system pipes.
The unit cannot be overhauled with the exception of relays (6) and (7), and muste be changed entirely if a fault is found. To replace the above-mentioned relays and the multiple socket (8), it is necessary to remove the cover (9) after slackening the fastening screw.

From the sensors in correspondence with the phonic wheels, the control unit receives information about the turning speed of the wheels, and processes it electronically. It then generates command signals which make it possible to hydraulically change the pressure of the brake fluid in the caliper cylinders.
Depending on the behaviour of the wheels, the electrohydraulic unit changes the pressure of the brake fluid at the calipers in three separate steps, as described in the previous paragraph.

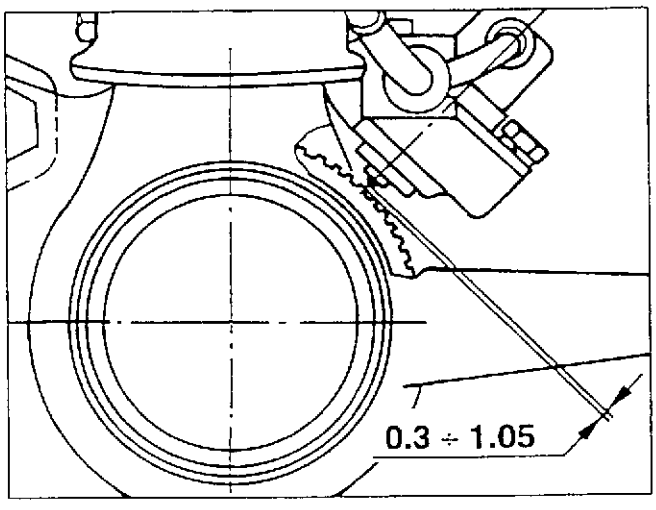


1. *Unions for connecting hydraulic unit - brake pump*
2. *Unions for connecting hydraulic unit - pipes:*
   a) left front caliper (VL)
   b) right rear caliper (HR)
   c) left rear caliper (HL)
   d) right front caliper (VR)
3. *Solenoid valves*
4. *Sequential hydraulic valve*
5. *Electric recovery pump*
6. *Electric pump control relay*
7. *Solenoid valve safety and supply relay*
8. *Multiple connector*
9. *Cover*
10. *Electronic control unit*
11. *15-pole connector for hydraulic control unit*

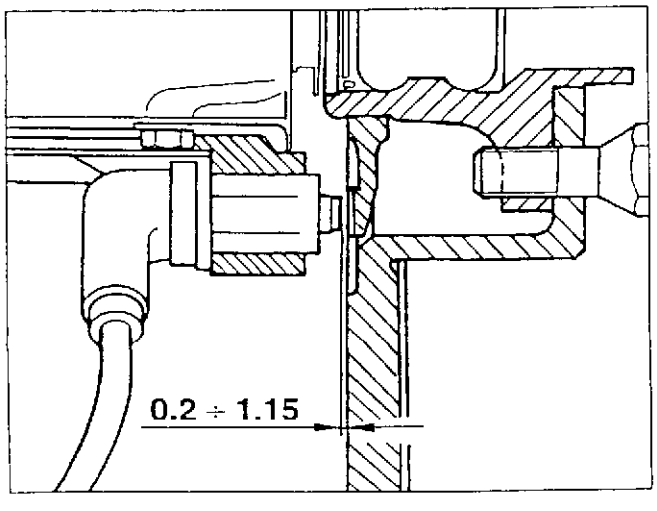
INDUCTIVE SENSORS

The sensors designed to detect the number of revolutions of the wheels of the car supply the control unit with the necessary continuity the information necessary for the control unit to correctly govern the operation of the hydraulic system.
The sensors measure the speed of travel, acceleration, deceleration and wheel slip. They are of the inductance type fitted in special housings on the front wheel uprights and on the rear brake caliper holder plates and it is not possible to adjust them.
As their position cannot be adjusted by shims, if the gap differs from the specified values, they must be changed.

Front wheels



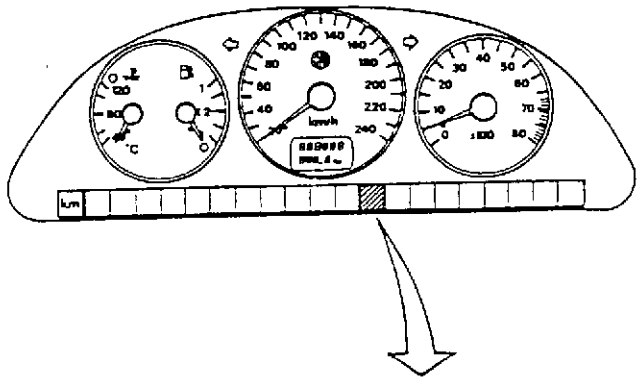
Rear wheels

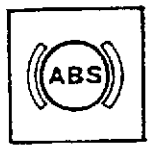


The lines of magnetic flux are closed by the teeth of the phonic wheel facing the sensor and turned by the wheel.The passage from solid to hollow, due to the presence or lack of a tooth causes a change in the magnetic flux sufficient to create an induced electromotive force at the terminals of the sensor and an alternating electric signal at the control unit.

FAILURE WARNING LIGHT

When the ignition switch is turned to MARCIA, the failure warning light turns on; as soon as the engine is started it will turn off. The control unit receives the engine running signal from the alternator. The A.B.S. device cuts in at appr. 3 kph and at about 6 kph the device performs the test cycle which excludes the wheel revolution sensors.
If the response from the components is positive, the warning light stays off; if the response is negative the warning light turns on and the system will cut out automatically leaving the conventional braking system to slow down the vehicle. In this case the warning light will flash.





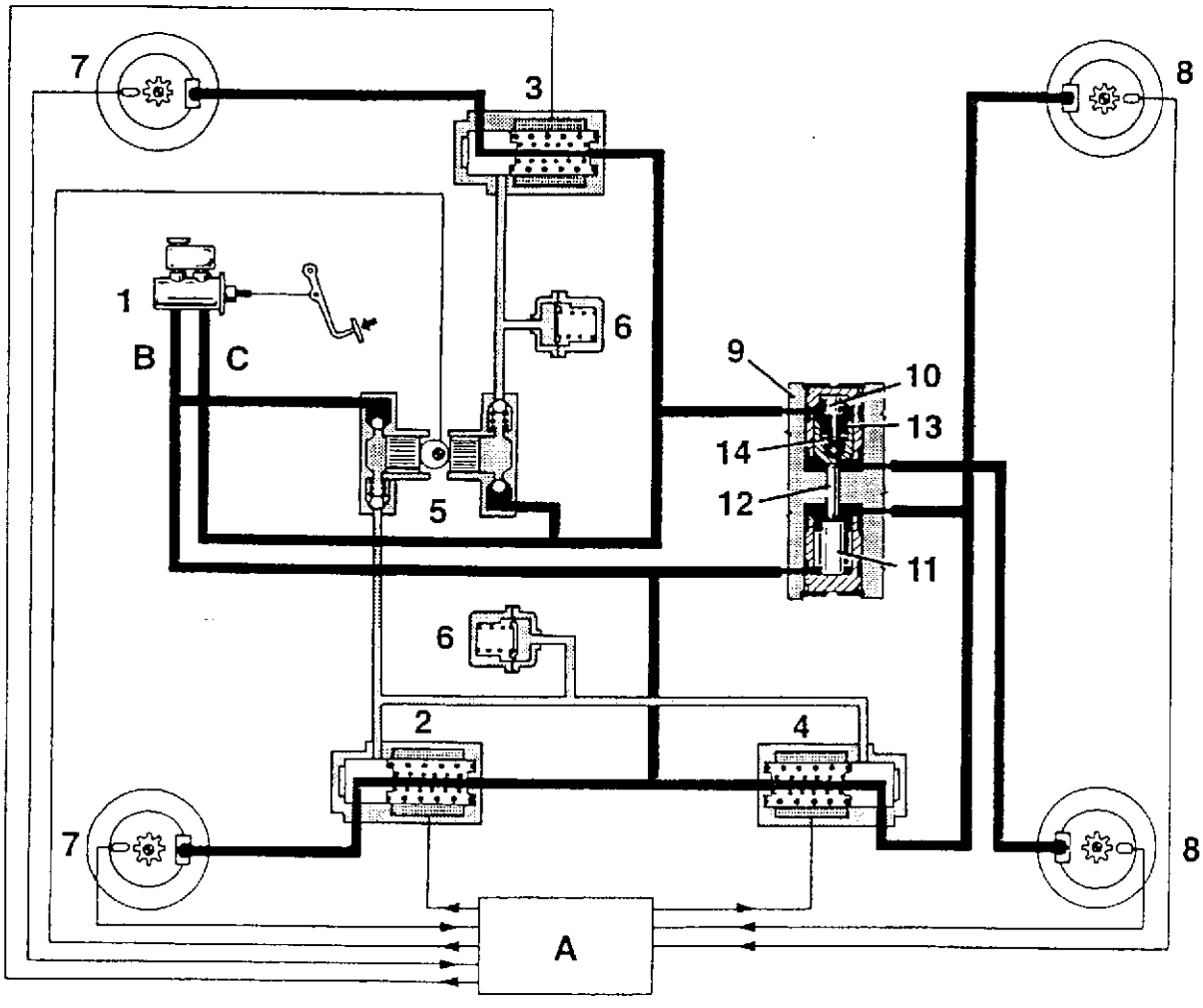
DESCRIPTION OF HOW THE WHEEL ANTI-LOCK DEVICE WORKS

Depending on the pulses received from the electronic control unit, the electrohydraulic unit changes the pressure of the brake fluid on the calipers in three phases:
1. Pressure increase phase
2. Pressure decrease phase
3. Pressure maintaining phase

Pressure increase phase

In this phase the solenoid valves of the electrohydraulic control unit are not energised and the pressure in the calipers originates from the pressure exerted on the brake pedal by the driver.
The pressure of the brake fluid at the outlet of the brake pump hose (B) reaches the left front wheel and the right rear wheel through solenoid valves (2) and (4), while from hose (C) it reaches the right front wheel and the left rear wheel through the solenoid valve (3) and the sequential valve (9).

The pressure of the brake fluid crosses the sequential valve (9) because the piston (10), pushed by the spring (13), keeps the valve (14) in the open position; piston (11) does not intervene as both its surfaces are affected by the same pressure.
The braking force increases and as a result the wheels reduce their speed in relation to that of the car (slipping increases), if a rear wheel tends to lock the sensor detects what is happening and the electronic control unit reduces the pressure.

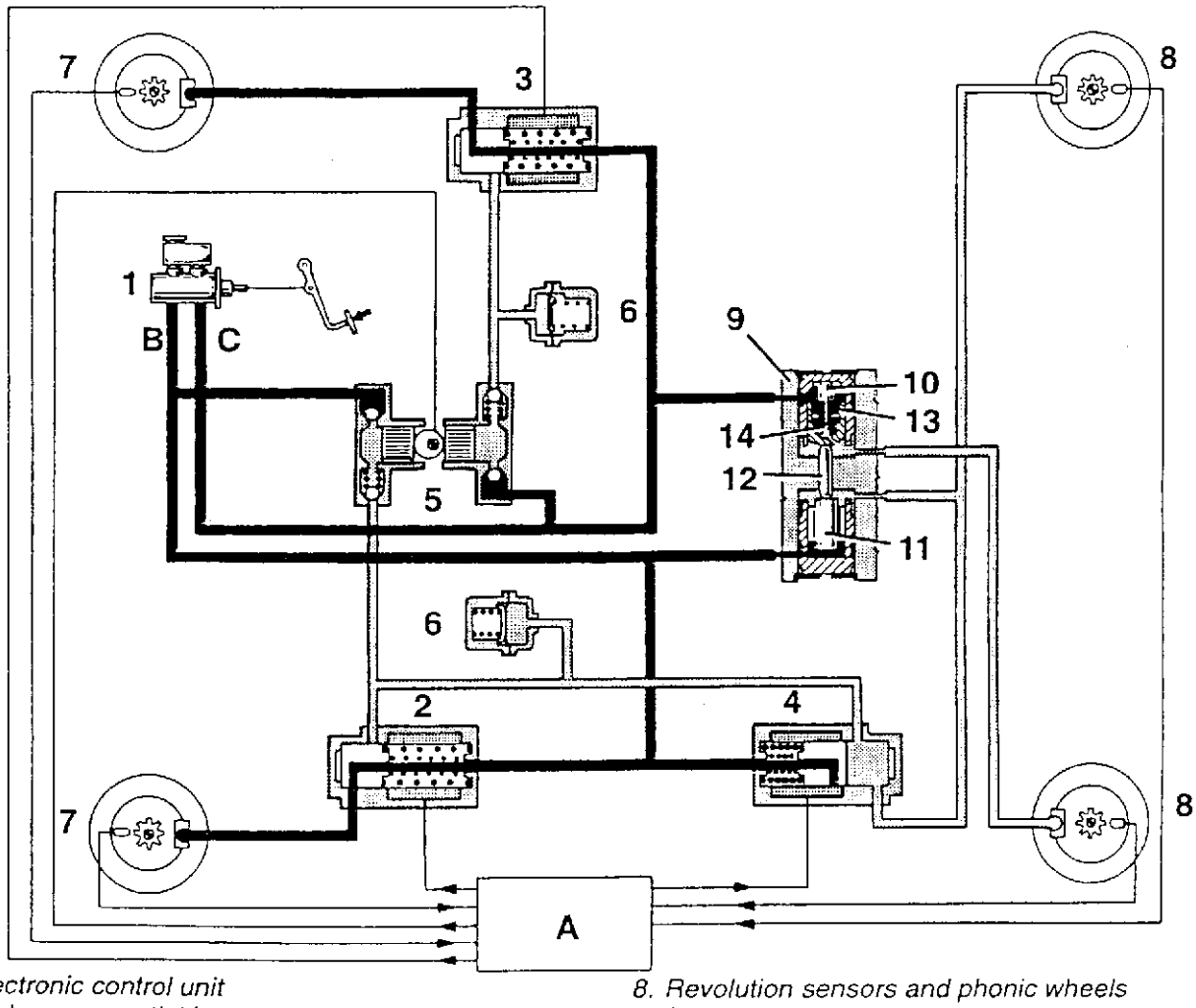


A. *Electronic control unit*
B. *Brake pump outlet hose*
C. *Brake pump outlet hose*
1. *Brake pump*
2. *Solenoid valve for front wheel brake circuit*
3. *Solenoid valve for front wheel brake circuit*
4. *Solenoid valve for rear wheel brake circuit*
5. *Electric recovery pump*
6. *Accumulators*
7. *Revolution sensors and phonic wheels for front wheels*
8. *Revolution sensors and phonic wheels for rear wheels*
9. *Hydraulic sequential valve*
10. *Piston*
11. *Piston*
12. *Stiff rod connecting pistons*
13. *Spring*
14. *Valve*

Pressure decreasing phase

The electronic control unit measures the tendency of the wheel to lock and the ABS device comes into operation.
The solenoid valve (4) is energised by a 5 Amp current and the connection between the brake pump and the right rear brake caliper is cut off, while the connection between the brake caliper and the recovery pump (5) is opened, being activated at the same time as the solenoid valve (4).
In this way the pressure of the brake fluid in the right rear brake caliper and in the piston chamber (11) connected to it, decreases. The subtracted brake fluid is recirculated into the main circuit through the recovery pump (5). This is the origin of the intermittent hydraulic pulsations which can be perceived by the driver through the brake pedal.

The accumulator (6) in the circuit stores the part of the brake fluid subtracted from the brake caliper and at the same time acts as a damping chamber for the pressure peaks during the recovery phase.
The lack of balance between the forces acting on the piston (11), causes it and the rod (12) to move. Through piston (10) the rod moves piston (11) causing valve (14) to close.
The result is the gradual decrease of the pressure in the left rear brake caliper caused by the increased volume in the piston chamber (10).
The balance of the forces acting on pistons (10) and (11) will be reached when the braking pressures in the rear brake calipers reach the same value.

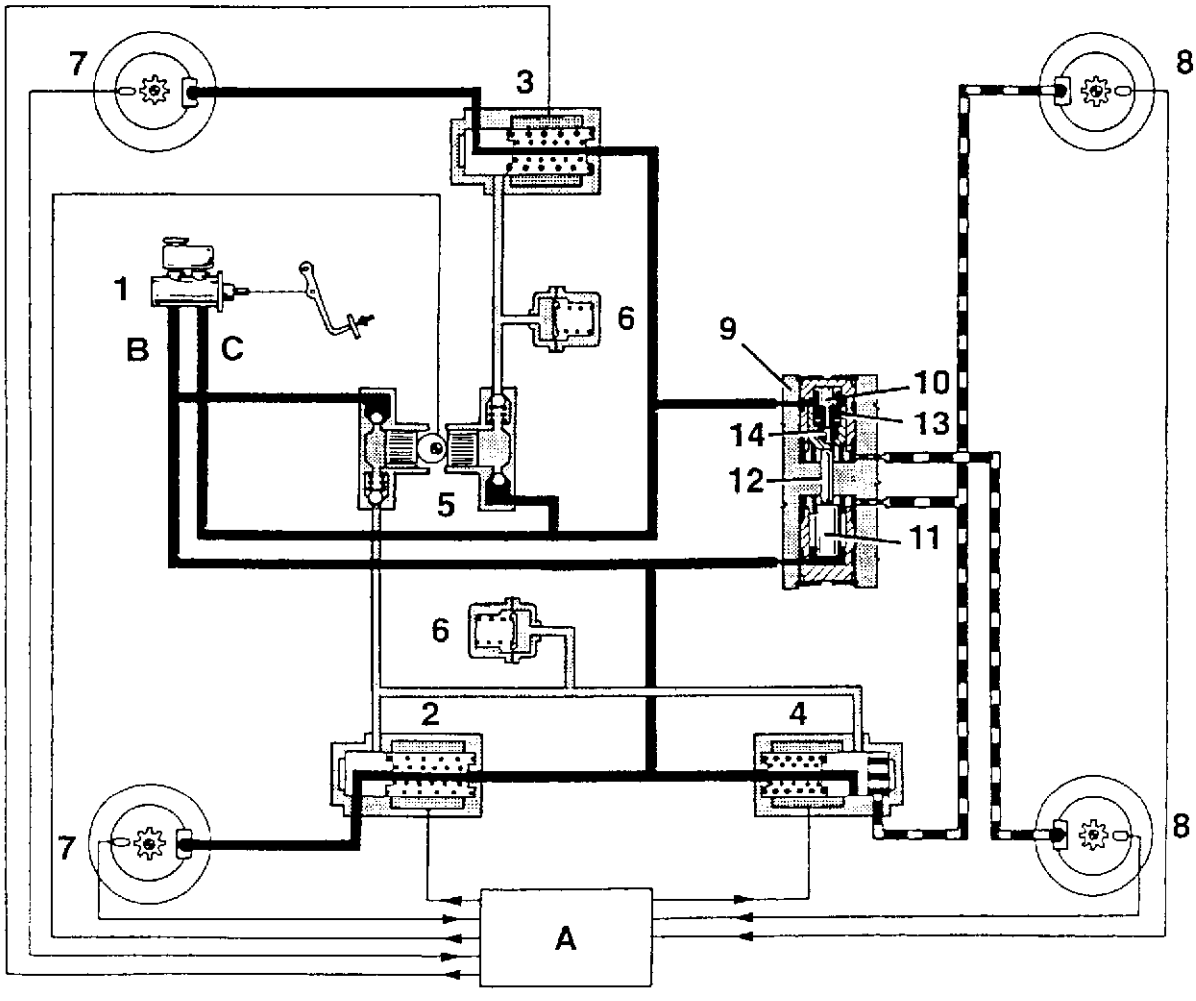


A. Electronic control unit
B. Brake pump outlet hose
C. Brake pump outlet hose
1. Brake pump
2. Solenoid valve for front wheel brake circuit
3. Solenoid valve for front wheel brake circuit
4. Solenoid valve for rear wheel brake circuit
5. Electric recovery pump
6. Accumulator
7. Revolution sensors and phonic wheels for front wheels
8. Revolution sensors and phonic wheels for rear wheels
9. Sequential hydraulic valve
10. Piston
11. Piston
12. Stiff rod connecting pistons
13. Spring
14. Valve

Pressure maintaining phase

In this phase there is an increase in both the speed and acceleration of the wheel.
The solenoid valve (4) is energised with a 2 Amp current; the connection between the brake pump and the rear brake calipers is still cut off (standby position).
The pressure on the rear brake calipers increases slightly as a result of the movement of the solenoid valve and it is then kept at a constant rate.

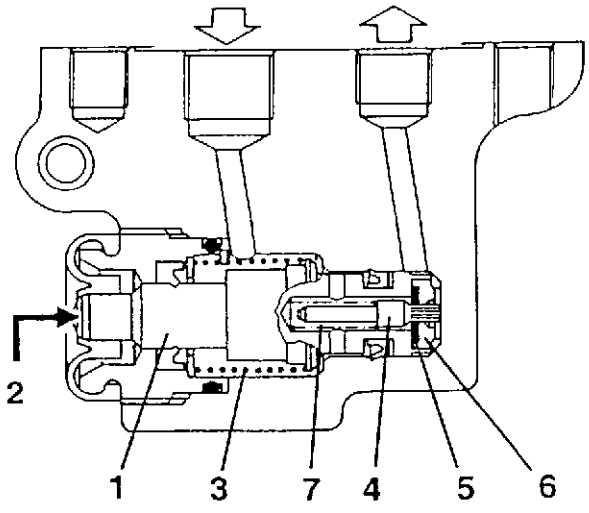
The braking force continues its slowing action even if the speed of the wheels nears that of the vehicle; once the permitted threshold has been reached it is necessary to increase the braking force again.
This cycle is repeated down to a speed of approximately 6 kph when the ABS system cuts itself off to allow the vehicle to come to a halt.



A. Electronic control unit
B. Brake pump outlet hose
C. Brake pump outlet hose
1. Brake pump
2. Solenoid valve for front wheel brake circuit
3. Solenoid valve for front wheel brake circuit
4. Solenoid valve for rear wheel brake circuit
5. Electric recovery pump
6. Accumulators
7. Revolution sensors and phonic wheels front wheels
8. Revolution sensors and phonic wheels for rear wheels
9. Hydraulic sequential valve
10. Piston
11. Piston
12. Stiff rod connecting pistons
13. Spring
14. Valve

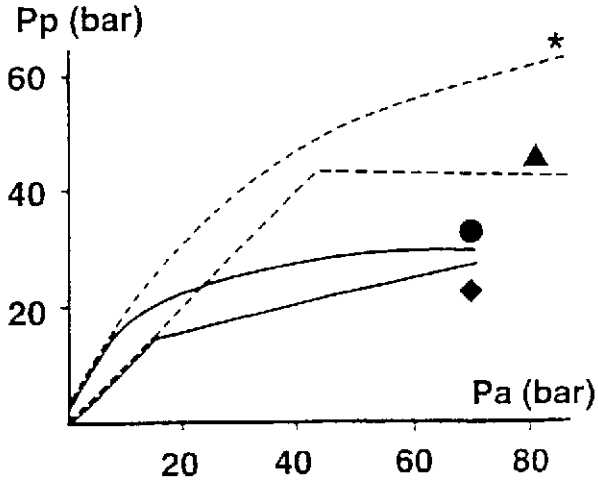
BRAKING LOAD PROPORTIONING VALVE

This is fastened on the half shells of the rear axle and differs from the conventional type in its operating system.
The load acting on the suspension arms is measured by the spring (2) which trabnsforms the variation in force applied on the device.
During braking the oil coming from the brake pump enters the proportioning valve, crosses it and moves on to the rear brakes with a pressure which, acting on the grooved plate (6) causes a thrust in the opposite direction to the one acting on the operating piston (1).
The operating piston (1) is held in the stop limit position by the combined action of the outer and inner springs (2) When the thrust acting on the grooved plate (6) exceeds that of the opposing force, the operating piston (1) moves to the left thus cutting off the connection between the brake pump and the rear calipers, causing a jump in pressure at a preset ratio of 0.30.
During operation of the ABS device, when the braking action decreases, the pressure in the rear section of the proportioning valve, acting through the grooving of the inner piston (4) overcomes the reaction of the spring (7) and moves the piston (4) to the left in order to balance the pressure inside the proportioning valve and keep the pressure jump constant at the preset ratio of 0.30.
The braking load proportioning valve which is integrated with the two branches of the braking circuit continues to operate even if the pressure on one of the two branches is lowered (breakage of a hose, connection, etc.).



1. *Operating piston*
2. *Force of the outer spring acting on the operating piston*
3. *Inner spring*
4. *Inner spring*
5. *Seal ring*
6. *Grooved plate*
7. *Spring for inner piston*

Characteristic curves of the pressure distribution between front and rear brakes actuated by the braking load proportioning valve.



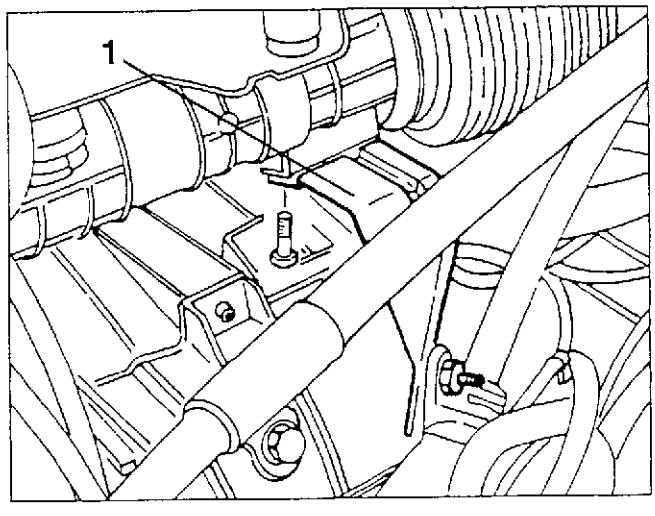
P_a Braking pressure on the front axle
P_p Braking pressure on the rear axle
* Ideal curve with fully loaded car
▲ Reale curve with fully loaded car
● Ideal curve with driver only
◆ Real curve with driver only

HYDRAULIC UNIT
Boxer engines

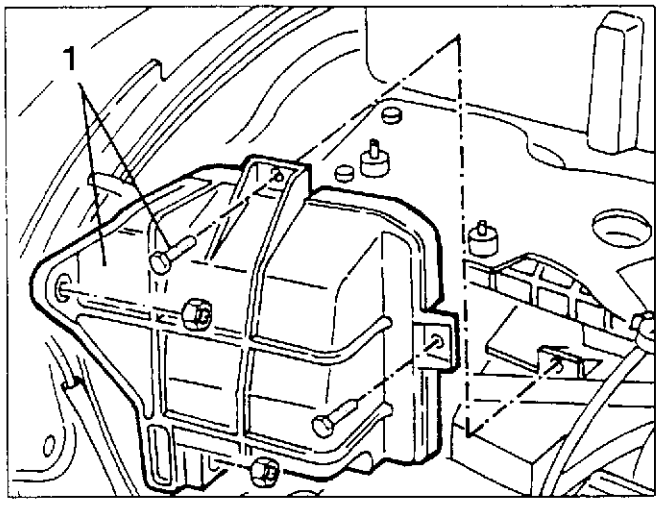
REMOVAL/REFITTING

- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Using a suitable syringe, empty the brake-clutch fluid reservoir.
- Remove the right front wheel.
- Remove the air cleaner complete (see GROUP 10).

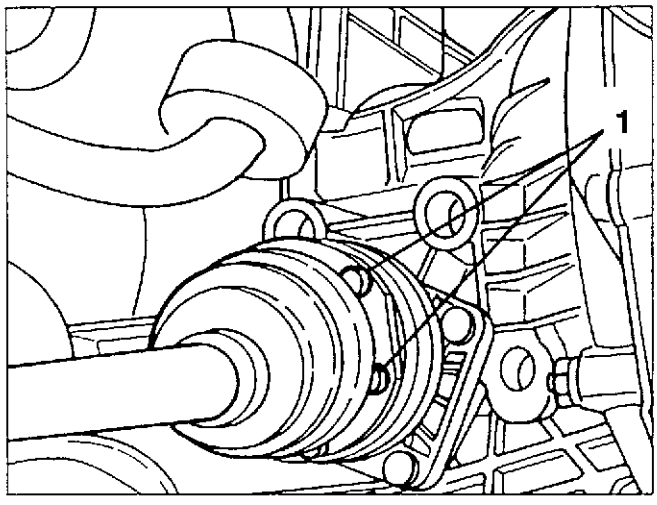
1. Remove the power steering hose support bracket.



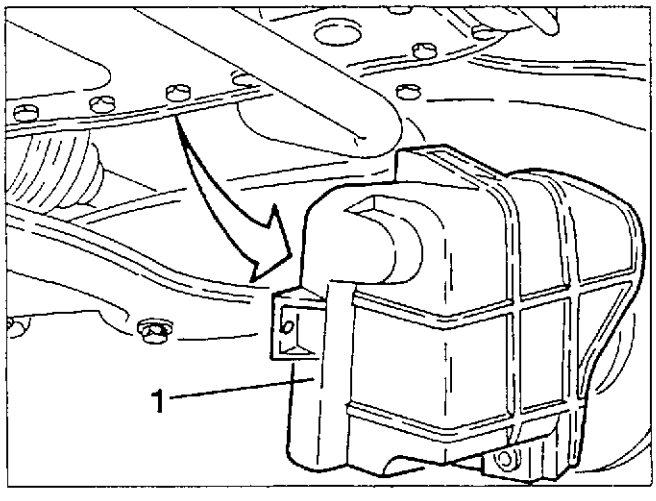
1. Slacken the fastening screws and nuts and remove the front half box of the hydraulic unit.



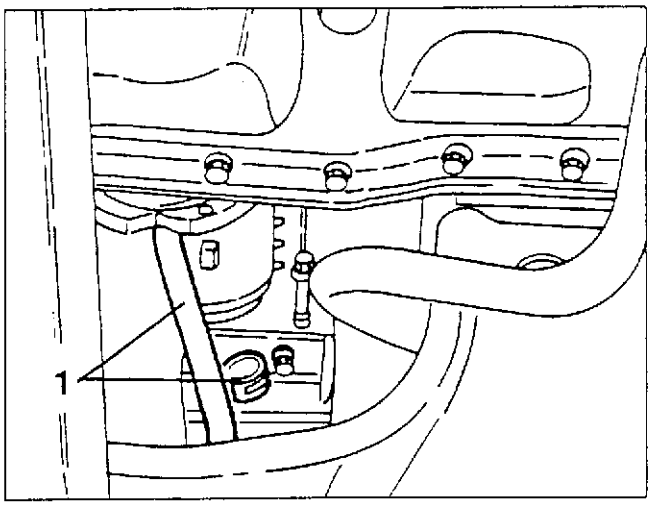
- Raise the car.
1. Slacken the fastening screws and disconnect the right axle shaft from the differential and move it to one side.



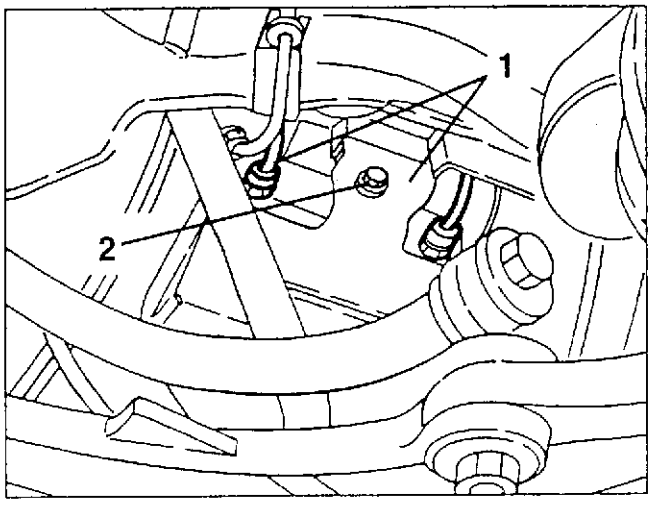
1. Slacken the remaining fastening nut and remove the rear half box from the hydraulic unit.



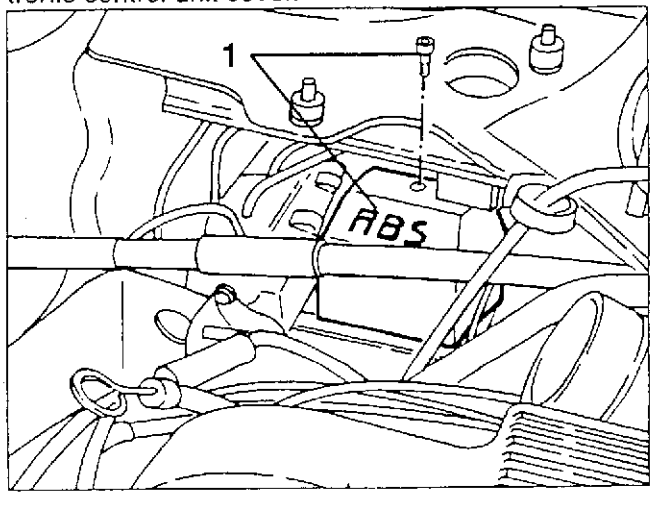
1. Free the cabling from the clamp located under the hydraulic unit.
- Slacken the fastening nut and disconnect the earth cable from the hydraulic unit.



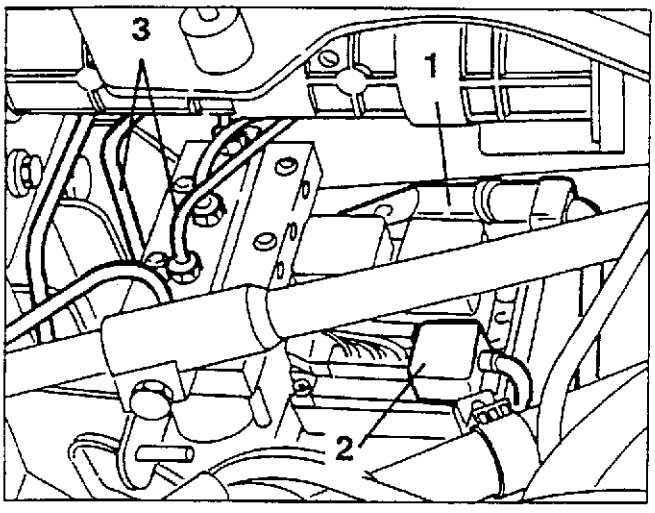
1. Disconnect the two stiff pipe connections to the brake pump from the hydraulic unit.
2. Slacken the three nuts fastening the hydraulic unit.



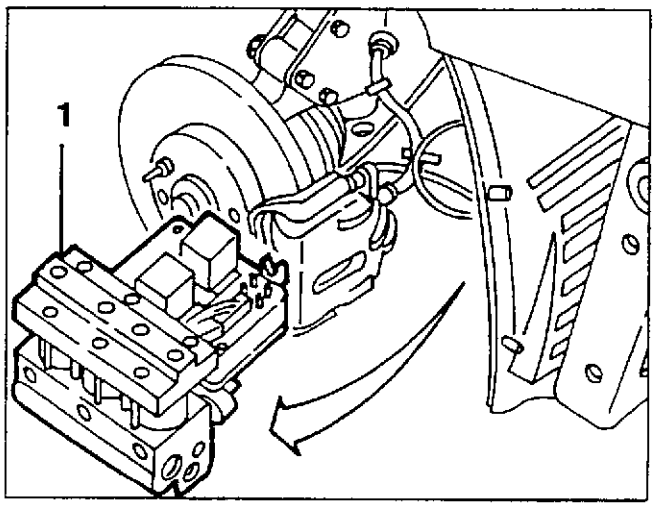
- Lower the car.
1. Slacken the fastening screw and remove the electronic control unit cover.



1. Disconnect the comb from the control unit wiring.
2. Disconnect the four-pin connector from the control unit.
3. Disconnect from the hydraulic unit the four connections of the brake hoses.



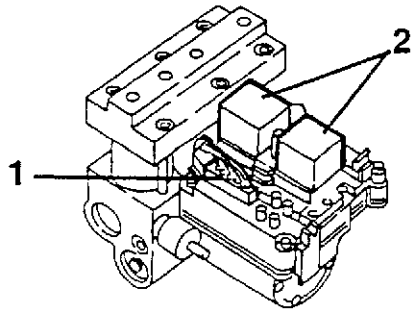
1. Remove the hydraulic unit raising it just enough to free it from its support, then withdraw it through the wheel house.



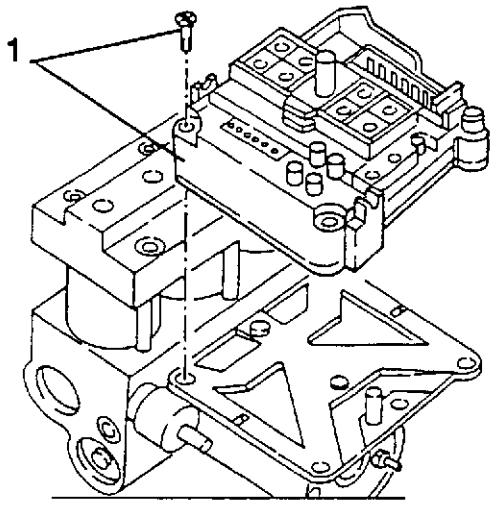
When refitting, bleed the air from the brake system (see specific paragraph).

DIS-ASSEMBLY/REASSEMBLY

1. Disconnect the electrical connection illustrated from the control unit.
2. Remove the two relays from the control unit.



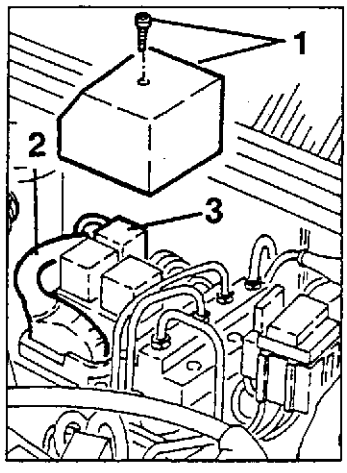
1. Slacken the fastening screws and remove the control unit.



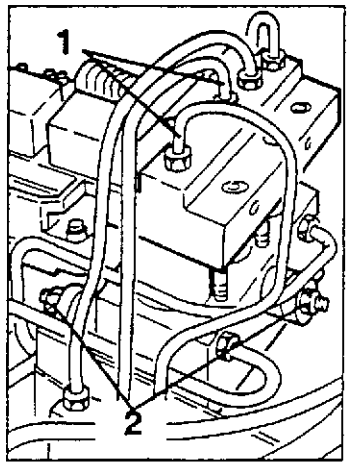
HYDRAULIC UNIT
Turbodiesel engine

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- Using a suitable syringe, empty the brake-clutch fluid reservoir and then remove it.
1. Slacken the fastening screw and remove the control unit cover.
2. Disconnect the control unit connection.
3. Disconnect the four-pin electrical connection from the control unit.



1. Disconnect the connections of the unit.
2. Slacken the nuts fastening the flexible mounts of the hydraulic unit, then remove it.



When refitting, bleed the air from the brake system.

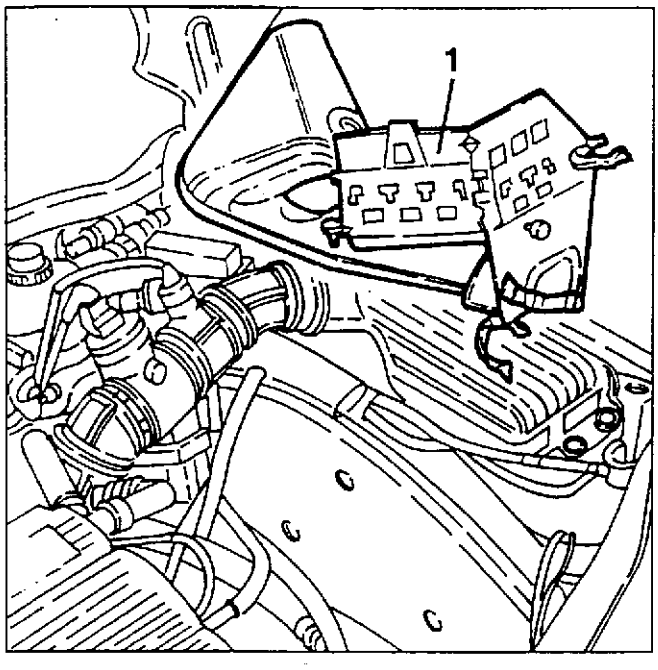
DIS-ASSEMBLY/REASSEMBLY

Proceed as described for the Boxer engines.

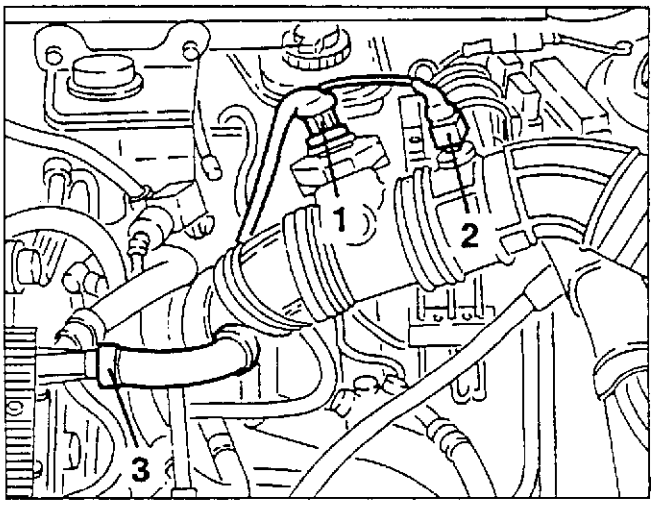
HYDRAULIC AGGREGATE
T. Spark 16V Engine

REMOVING/REFITTING

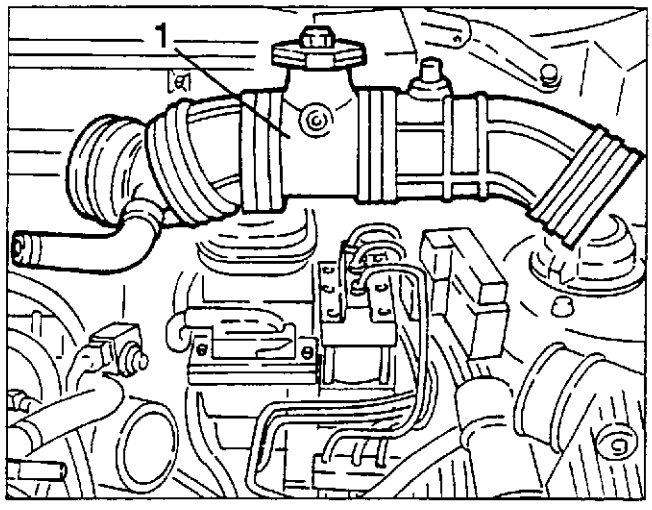
- Remove the battery.
- Remove the relays from the battery support and set them to one side with their wirings to prevent them from hindering the subsequent operations.
1. Slacken the fastening screws, then remove the battery support after removing the rear cable support from it.



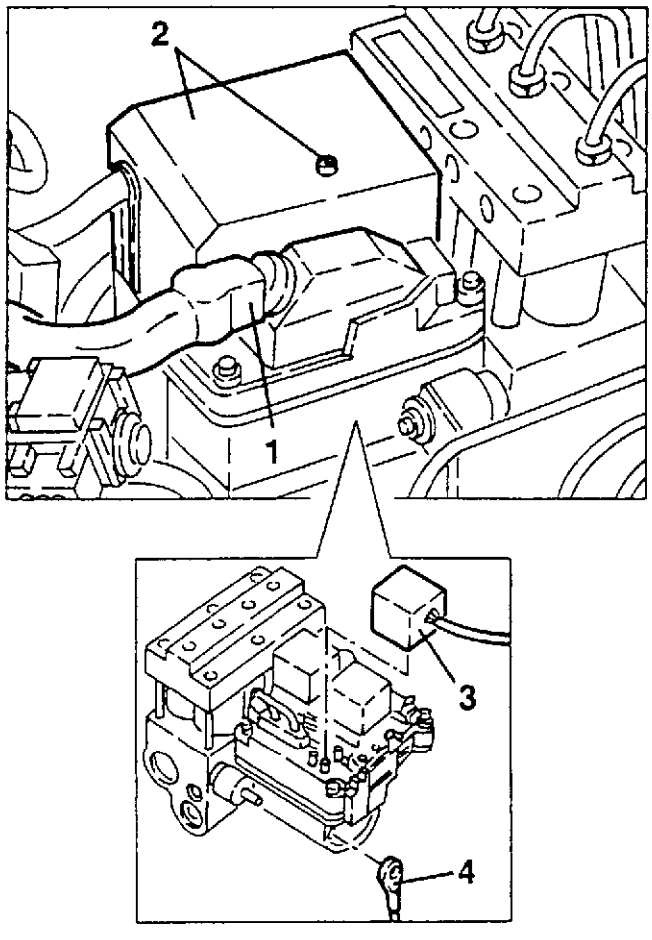
1. Disconnect the electrical connection from the air-flow meter.
2. Disconnect the electrical connection from the intake air temperature sensor (NTC).
3. Slacken the fastening clamp and disconnect the oil vapour recirculation pipe from the cylinder head.



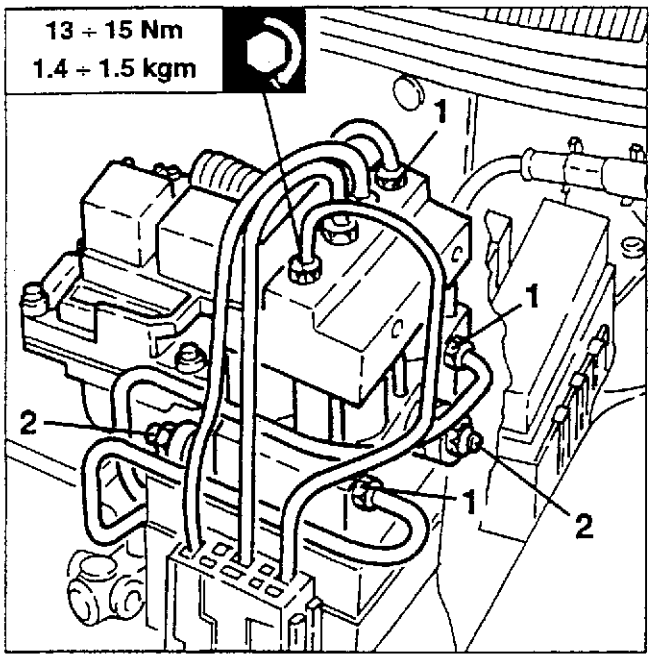
1. Slacken the fastening clamps and remove the corrugated sleeve complete.



- Move aside the fusebox at the side of the brake-clutch fluid reservoir to prevent it from hindering subsequent operations.
- Remove the brake-clutch fluid reservoir (see specific paragraph).
1. Disconnect the electrical connection of the A.B.S. control unit.
2. Slacken the fastening screw and remove the control unit cover.
3. Disconnect the four pin electrical connection from the control unit.
4. Disconnect the earth cable.



1. Disconnect the fittings of the pipes of the hydraulic aggregate.
2. Slacken the three nuts fastening the flexible supports of the hydraulic aggregate, then remove it.



When refitting relieve the air from the braking system (see specific paragraph).

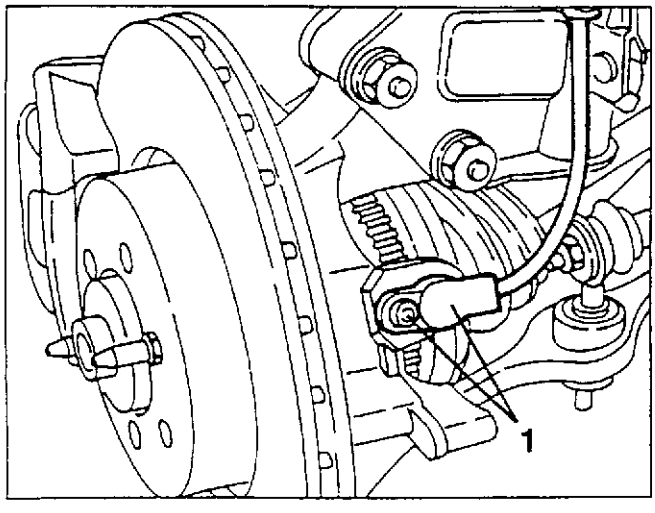
DISASSEMBLY/RE-ASSEMBLY

Proceed as described for Boxer engines.

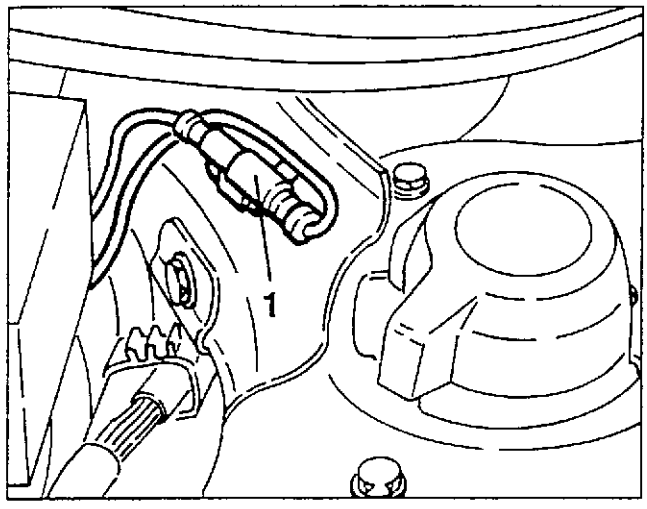
FRONT INDUCTIVE SENSORS

REMOVING/REFITTING

1. Slacken the screw fastening the A.B.S. inductive sensor from the wheel upright.



1. Disconnect the electrical connection near the shock absorber dome and remove the inductive sensor together with the wiring, after releasing it from the fasteners.

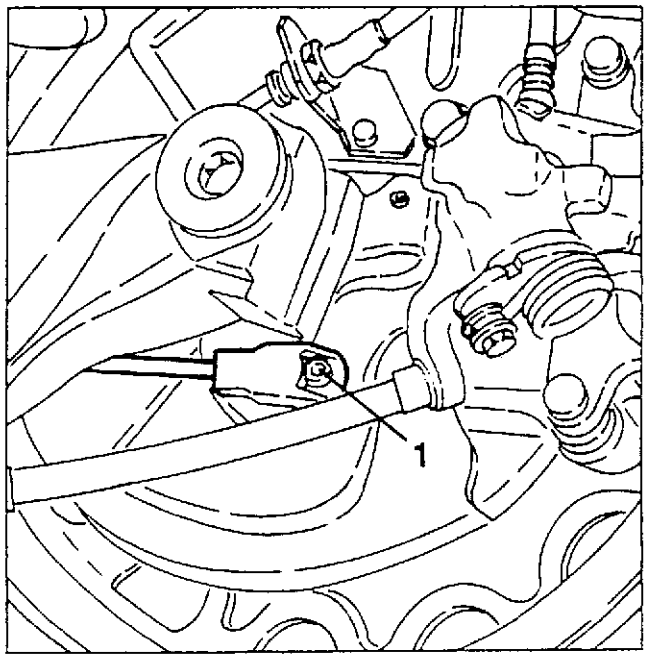


When refitting grease the seat of the inductive sensor with the specified grease.

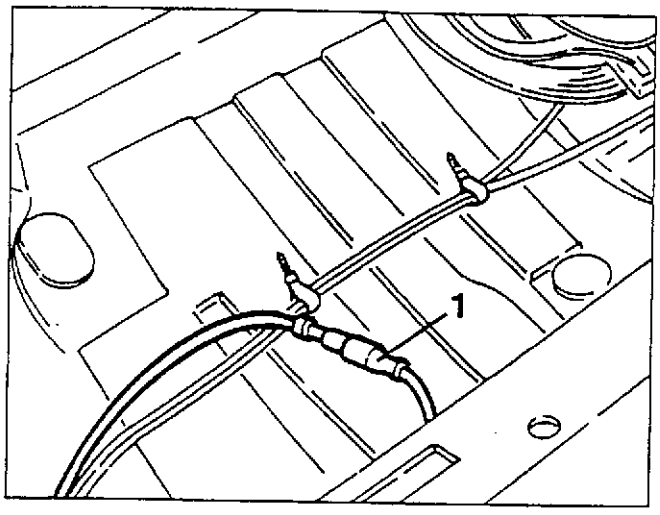
REAR INDUCTIVE SENSORS

REMOVING/REFITTING

1. Slacken the screw fastening the inductive sensor to the brake disk connection.



1. Tilt forward the rear seat cushion, disconnect the electrical connection of the inductive sensor and remove it.



When refitting grease the seat of the inductive sensor with the specified grease.

CHECKING THE GAP

- Using a thickness gauge, check the gap between the inductive sensor and the corresponding phonic wheel.

Front inductive sensors gap	0.3 ÷ 1.05 mm
Rear inductivei sensors gap	0.2 ÷ 1.15 mm

CAUTION:
The gap is not adjustable as shims for this purpose are not supplied.
Check that the sensor and the teeth of the phonic wheel are intactore if the gap is not within the specified tolerance.

BOSCH 5.3 ABS

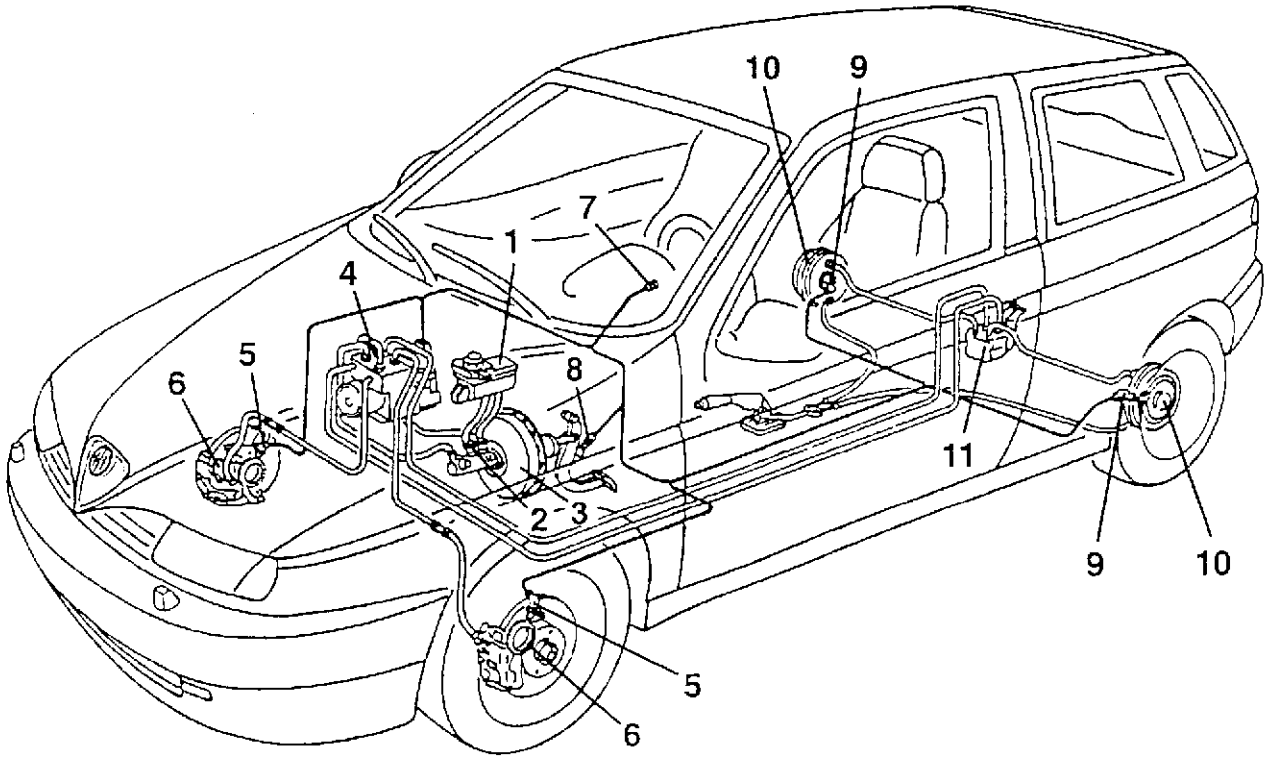
(from chassis no. .....)

DESCRIPTION

The Bosch 5.3 A.B.S. further optimises compactness (ease of assembly), lightness and reliability.
The use of new microhybrid electronic components, optimisation of the flows as a result of the study of the new, more compact shapes of the valve bodies and the reduction of the number of hydraulic components since they are pressed directly onto the valve seat of the nozzles which are previously assembled separately have made it possible to improve the characteristics of the solenoid valves.
The main components of the system are:
- new electronic control unit, more powerful and versatile than the previous ones;
- electrohydraulic control unit (4) which modulates the braking pressure at the brake calipers through eight solenoid valves, two for each wheel;
- four sensors (5) and (9), one for each wheel, which detect the angular rotation speed of the wheels.

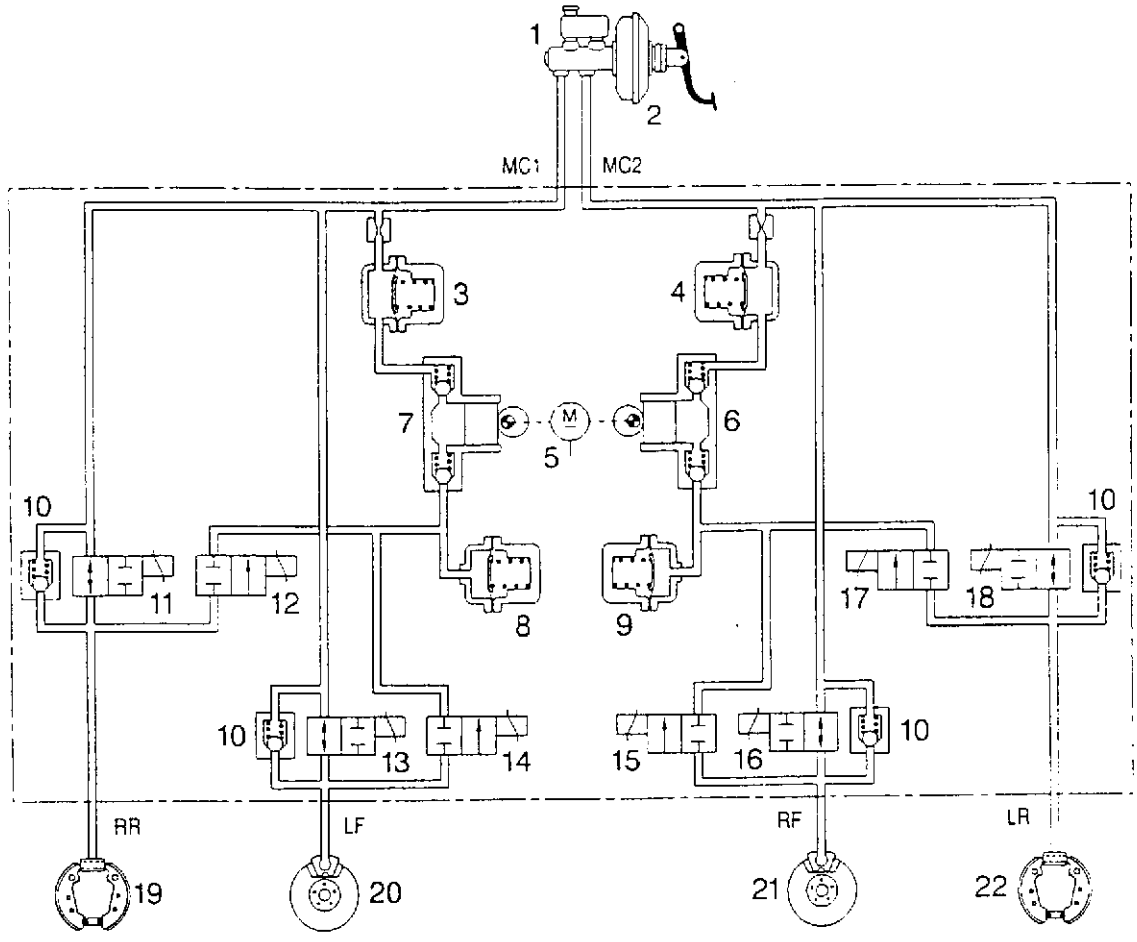
The system is completed by:
- the hydraulic system piping;
- a specific wiring loom;
- a switch on the brake pedal (8) for detecting the braking condition;
- a warning light (7), on the check panel.

In addition, under particular diagnosis conditions, the warning light (7), supplies information about the faults memorised by the control unit through a series of coded flashes (see Electric System Diagnosis").



1. *Brake fluid reservoir*
2. *Brake pump*
3. *Vacuum servobrake*
4. *Electrohydraulic control unit with electronic control unit incorporated*
5. *Front wheel rpm sensor*
6. *Front brakes*
7. *Failure warning light*
8. *Stop lights control switch*
9. *Rear wheel rpm sensor*
10. *Rear brakes*
11. *Braking load proportioning valve*

Hydraulic system layout



Braking system with double crossed circuit

1. *Brake control pump*
2. *Servobrake*
3. *High pressure accumulator (damping chamber)*
4. *High pressure accumulator (damping chamber)*
5. *Recovery pump drive motor*
6. *Recovery pump*
7. *Recovery pump*
8. *Low pressure accumulator (reservoir)*
9. *Low pressure accumulator (reservoir)*
10. *Fast pressure reduction valve*
11. *Right rear charge solenoid valve*
12. *Right rear discharge solenoid valve*
13. *Left front charge solenoid valve*
14. *Left front discharge solenoid valve*
15. *Right front charge solenoid valve*
16. *Right front discharge solenoid valve*
17. *Left rear charge solenoid valve*
18. *Left rear discharge solenoid valve*
19. *Right rear drum brake*
20. *Left front disk brake*
21. *Right front disk brake*
22. *Left rear drum brake*

MC1. Supply union for brake pump 1st stage
MC2. Supply union for brake pump 2nd stage
RR. Delivery union to right rear cylinder
FL. Delivery union to left front caliper
FR. Delivery union to right front caliper
RL. Delivery union to left rear cylinder

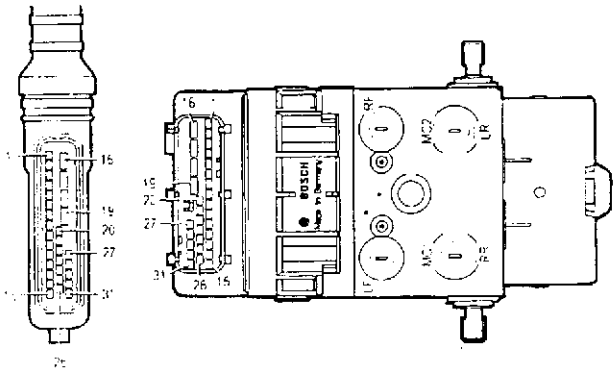
COMPONENTS

Electrohydraulic control unit

The electrohydraulic control unit comprises two sections fastened to one another: an electronic control unit and an electrohydrauiic control unit.
On the basis of the signals received from the sensors and with the help of characteristic programmes mapped in its memories, the electronic control unit commands the electrohydraulic control unit.
The electrohydraulic control unit is connected to the brake pump and to the A.B.S. system components through the pipes of the braking system.
The main change with respect to the previous versions is the replacement of the three-way valves with two 2-way solenoid valves for each wheel.

Electronic control unit

The electronic control unit is formed of hybrid circuits with resistances, diodes, transistors and integrated logic circuits. The heart of the system are two CMOS microprocessors with 12K ROM which autonomously carry out the same programme and monitor one another mutually. Both receive the same input signals which each processes individually and only when the results obtained are identical, thedoes the control unit send the operative command to the electrohydraulic control unit.
Conversely, if for example there is a fault in the wheel anti-lock system, the device cuts itself out and braking takes place conventionally: simultaneously, the fault warning light on the check panel comes on.



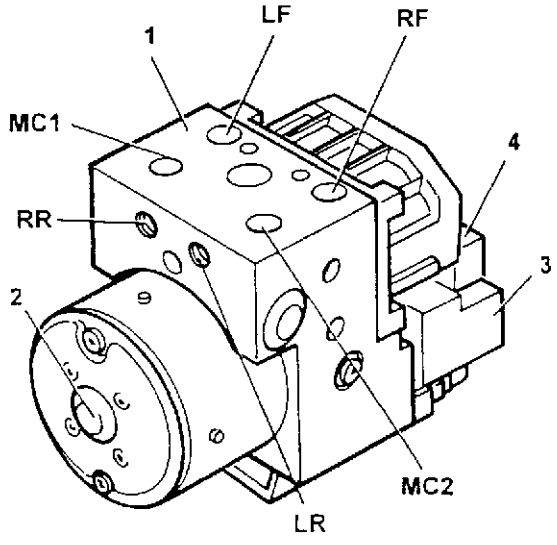
Operating logic

The signals (alternate or analogue) sent by the rpm sensors to the electronic control unit are transformed by the input amplifier into square wave signals.
The frequency of these signals gives the control unit the corresponding values of speed, acceleration or deceleration of the single wheels.
From the combination of the single wheel peripheral speeds, a reference speed is processed which is continuously updated and indicates the speed of the car at all times.
When the driver presses the brake pedal the wheels can each decelerate to a different extent: comparison of the peripheral speed of each wheel with the reference speed keeps the skidding of each wheel constantly under control.
If the braking force causes a wheel to skid with respect to the others, the electronic control unit sends the command to the solenoid valves of the electrohydraulic control unit to reduce the braking force on the wheel that has lost grip. This way the wheel concerned regains speed.
The memory of the electronic control unit also contains threshold acceleration and deceleration values that none of the wheels may ever exceed.
Therefore, through systematic, very rapid comparison of the wheel skidding, deceleration and acceleration values, rolling of the tyre during braking is kept under control.
As soon as the foreseen combined acceleration/deceleration and skid values are exceeded, the electronic control unit intervenes with commands to the solenoid valves of the electrohydraulic control unit, in the three adjustment phases to lower, maintain or return the pressure generated by the driver on the brake pedal to the brake calipers, bringing the braking condition to the optimum values set by the system.
These phases determine an intermittent but extremely fast adjustment cycle which is repeated until the car stops. The electronic control unit commands the different phases supplying the solenoid valves pulses with different current intensities. It also makes sure that both rear wheels are given the same braking force applicable to the rear wheel that is more subjected to locking, i.e. the one with lower grip (to ensure stability).
If a fault is detected, the wheel anti-lock device cuts out and alerts the driver by turning on the warning light on the check panel, while however ensuring operation of the conventional braking system.

The electronic control unit is informed that the driver is braking by the signal from the switch on the brake pedal. Besides controlling braking, this information is also helpful under certain particular conditions, such as for example if a sharp acceleration that makes the wheels skid is followed by heavy braking, or in the case of irregular road surfaces (humps, steps) that can involve changes in speed of the wheel due to causes not linked with the braking in progress.
In these conditions the microprocessors process a strategy connected with the changes of speed of the wheels of these particular moments, bringing braking back to the correct parameters. Since these are particular conditions of braking control, the lack of connection of the switch on the brake pedal to the control unit does not compromise the efficiency of the system. For this reason it is not signalled by the warning light, nor is the A.B.S. system disabled.

Further details about the operating principle of the ABS are given below.

Electrohydraulic control unit



1. Electrohydraulic control unit
2. Electric recovery pump
3. Electronic control unit
4. Control unit connector

The electrohydraulic control unit is connected to the brake pump and to the brake caliper cylinders through the brake system lines and together with the electronic control unit it forms the electrohydraulic control unit.
Its task is to change the pressure of the brake fluid in the brake caliper cylinders according to the command signals leading from the electronic control unit.
It comprises eight two-way solenoid valves (two for each hydraulic circuit) and an electric recovery pump (2) with double circuit.
The eight solenoid valves and the electric recovery pump are driven by the electronic control unit depending on the signals of the four rpm sensors. The pump makes it possible to recover the brake fluid during the pressure reduction phase making it available again upstream of the solenoid valves for the next pressure increase phase.
The unit is connected to the braking system through unions identified by the codes stamped on them as illustrated.

Pipe outlets

MC1	Supply union from brake pump - circuit 1
MC2	Supply union from brake pump - circuit 2
LF	Delivery union to left front brake caliper
LR	Delivery union to left rear brake caliper
RF	Delivery union to right front brake caliper
RR	Delivery union to right rear brake caliper

Inductive sensors

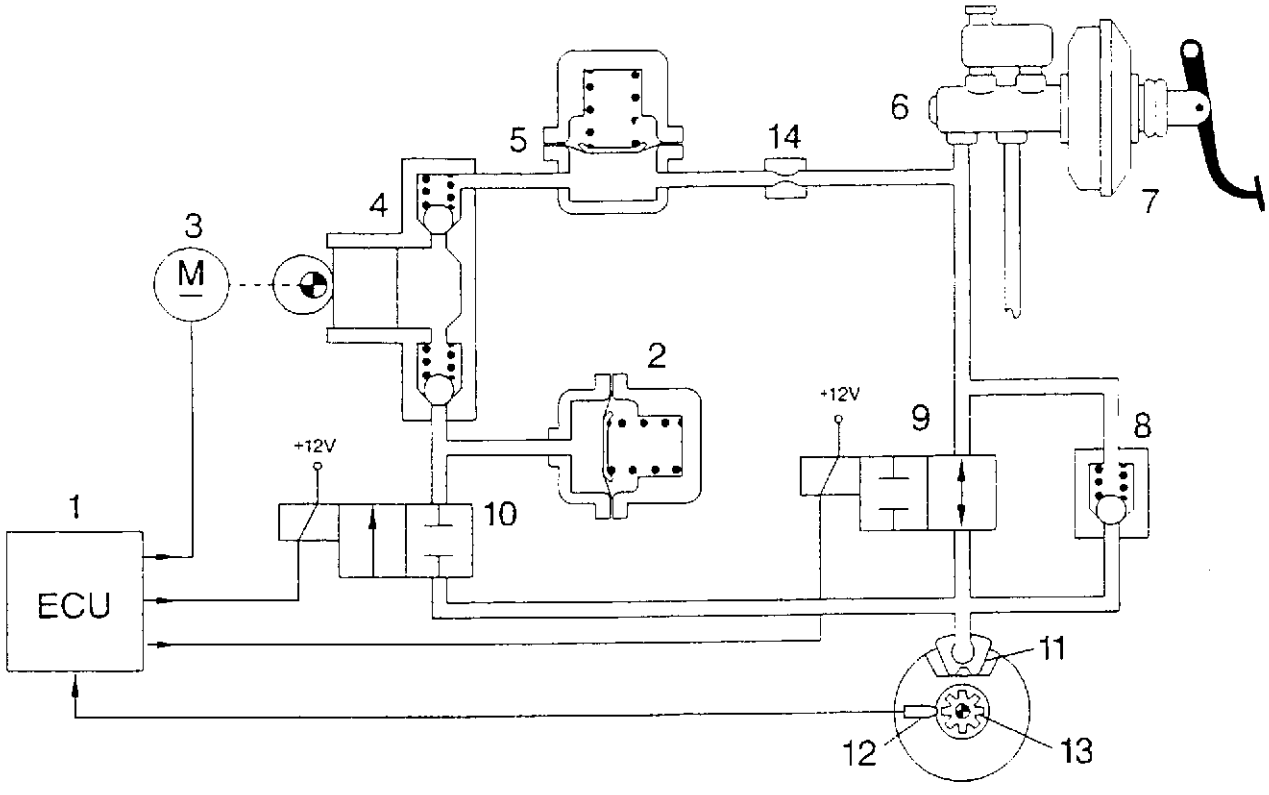
These are quite the same as those used for the previous versions.

DESCRIPTION OF HOW THE WHEEL ANTI-LOCK SYSTEM WORKS

Rest position

Each branch of the Bosch 5.3 ABS system is fitted with two 2-way solenoid valves; all the solenoid valves are managed by the control unit (1).

When the charge solenoid valve (9) is deactivated (not connected to earth by the control unit) it is in the opening position, thereby allowing the flow of brake fluid to the brake caliper.
The pressure is maintained by closing this valve, i.e. supplying it electrically.

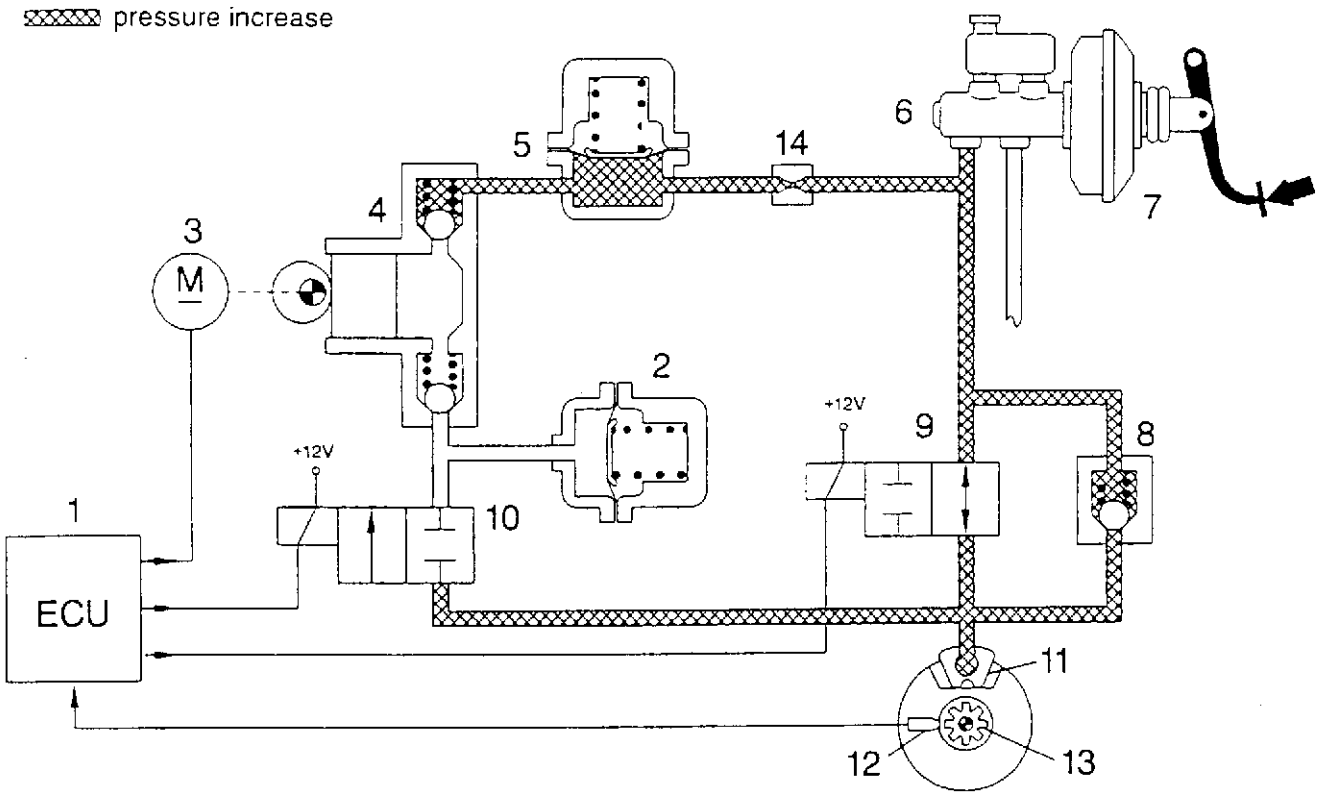


1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Recovery pump drive motor
4. Recovery pump
5. High pressure accumulator (damping chamber)
6. Brake control pump
7. Servobrake
8. Fast pressure reduction valve
9. Charge solenoid valve
10. Discharge solenoid valve
11. Brake caliper
12. Revolution sensor
13. Phonic wheel
14. Restrictor

When the discharge solenoid valve (10) is deactivated (not connected to earth by the control unit) it is in the closed position and does not allow the fluid to be discharged on the low pressure accumulator (2).
The accumulators (2) and (5) have the task of temporarily storing the brake fluid made available during the pressure reduction phase.

The recovery pump (4) sends the brake fluid that flows back from the brake calipers during pressure reduction to the brake pump via the corresponding accumulator.
On the basis of the signals received from the rpm sensors on the front and rear wheels, the electronic control unit drives the electrohydraulic control unit, which in turn changes the pressure of the brake fluid sent to the calipers according to three phases: increase, maintenance or reduction of the pressure.

Pressure increase phase

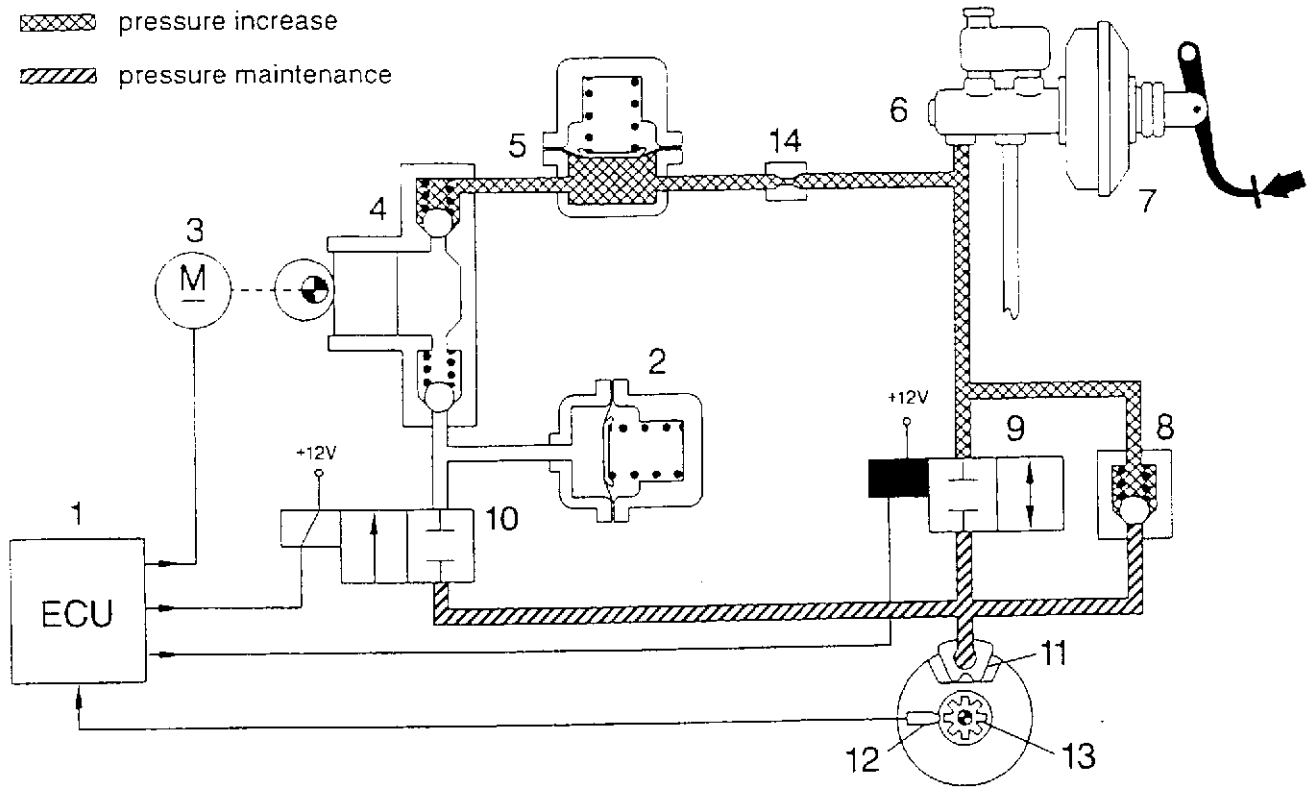


1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Recovery pump drive motor
4. Recovery pump
5. High pressure accumulator (damping chamber)
6. Brake control pump
7. Servobrake
8. Fast pressure reduction valve
9. Charge solenoid valve
10. Discharge solenoid valve
11. Brake caliper
12. Revolution sensor.
13. Phonic wheel
14. Restrictor

When the driver presses the brake pedal, the pressure generated by the brake pump (6) reaches the brake caliper without undergoing changes, as the solenoid valves (9) and (10) of the hydraulic unit are not connected to earth by the electronic control unit.
When the braking force increases, deceleration of the wheel increases accordingly; this causes faster deceleration of the car (i.e. wheel slip increases).
The slip rate must not exceed a determinate value beyond which the wheel loses its grip on the ground and starts to slide, losing direction and lengthening braking distances.

The revolution sensor (12) signals that deceleration values have been reached that would compromise the grip of the wheel with the ground: at this point the electronic control unit (1) commands the solenoid valves of the electrohydraulic unit, reducing the braking force and allowing the wheel to increase speed and recover grip.

Pressure maintenance phase

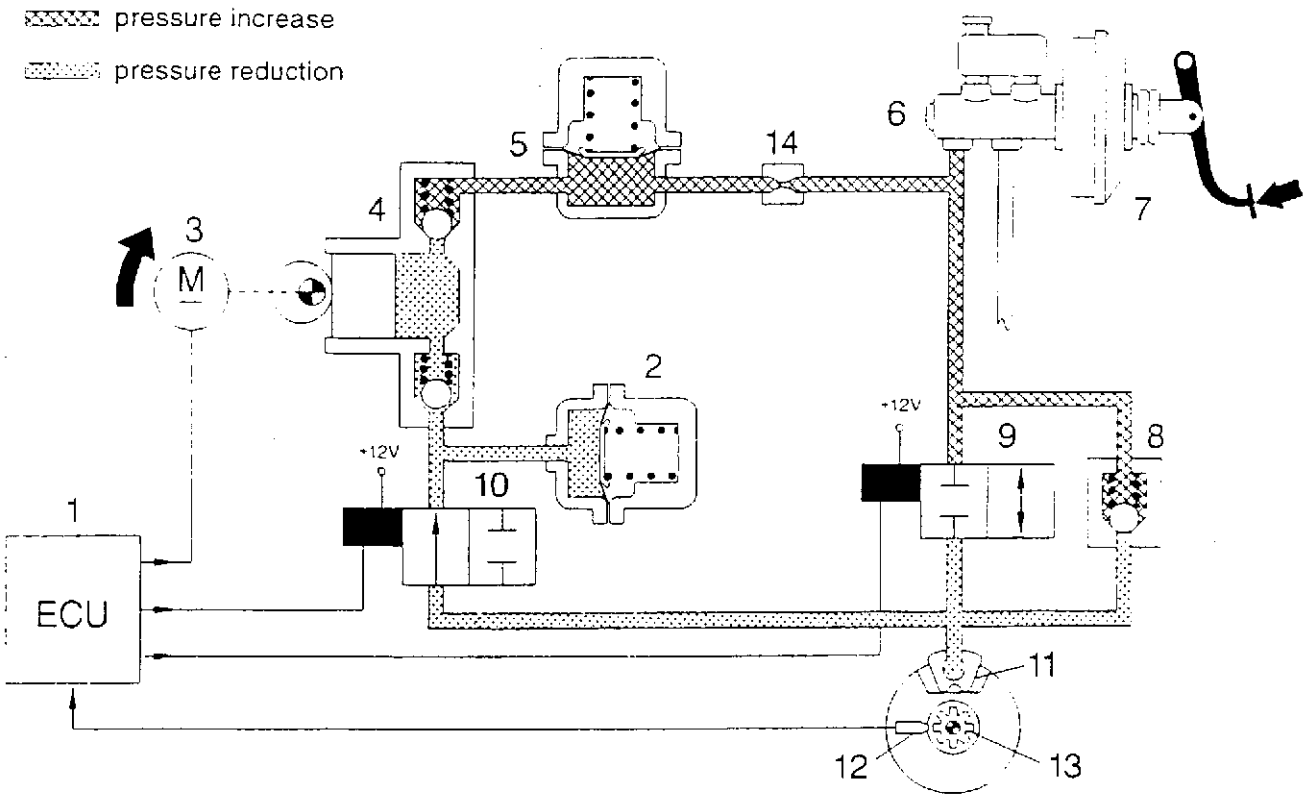


1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Recovery pump drive motor
4. Recovery pump
5. High pressure accumulator (damping chamber)
6. Brake control pump
7. Servobrake
8. Fast pressure reduction valve
9. Charge solenoid valve
10. Discharge solenoid valve
11. Brake caliper
12. Revolution sensor
13. Phonic wheel
14. Restrictor

During this phase, the electronic control unit (1) connects the charge solenoid valve (9) to earth, so it closes, while the discharge solenoid valve (10) that is not connected to earth, is already closed.
The hydraulic connection between the brake pump (6) and the brake caliper (11) is cut off (standby position).
The pressure in the brake caliper (11) is kept constant at the rating reached previously, regardless of the pressure on the brake pedal.

Although the braking effort maintains a continuous slowing action, the wheel changes its speed, in relation to the grip on the ground, until the signal of the rpm sensor (12) gives a value similar to the reference speed calculated by the electronic control unit (1).
At this point, the control unit passes from the maintenance phase to the pressure increase phase (if the wheel accelerates) or reduction (if the wheel tends to lock).

Pressure reduction phase



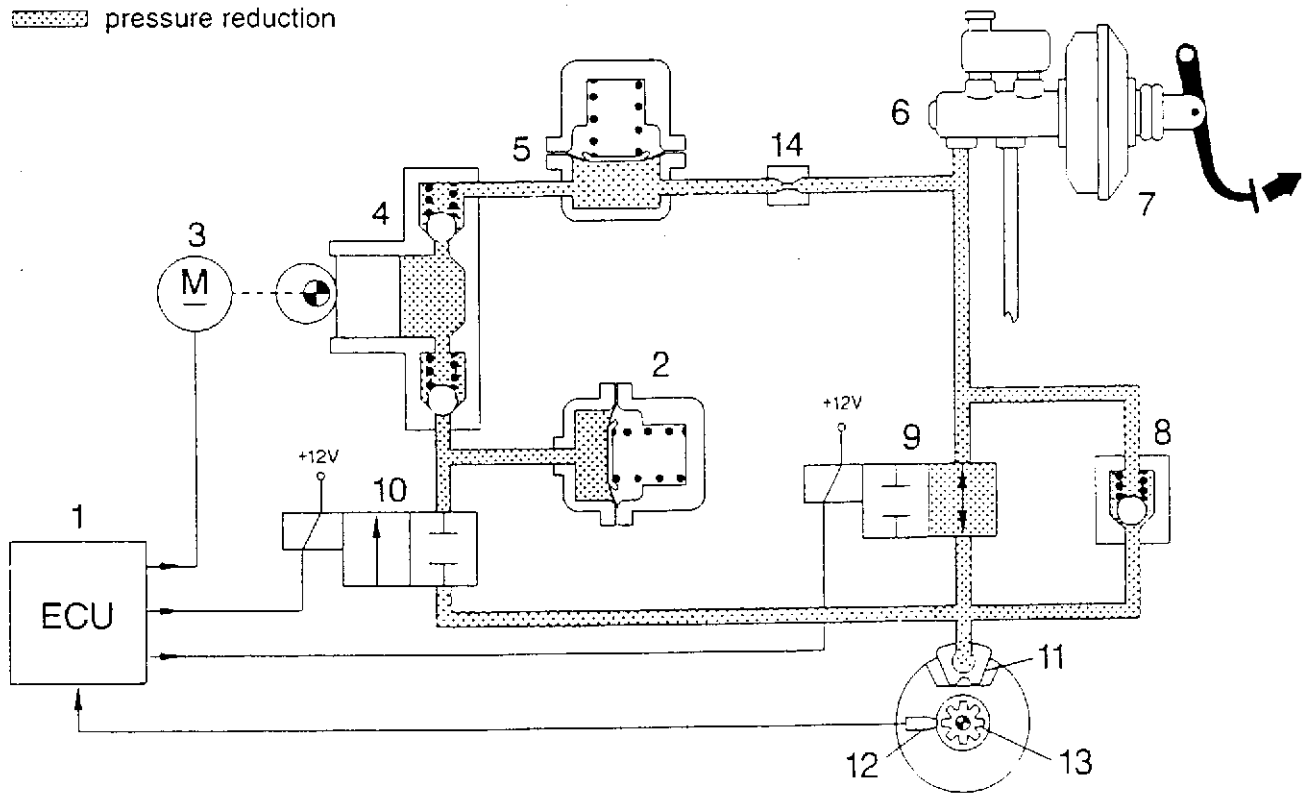
1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Recovery pump drive motor
4. Recovery pump
5. High pressure accumulator (damping chamber)
6. Brake control pump
7. Servobrake
8. Fast pressure reduction valve
9. Charge solenoid valve
10. Discharge solenoid valve
11. Brake caliper
12. Rpm sensor
13. Phonic wheel
14. Restrictor

The electronic control unit (1) detects the tendency of the wheel to lock and activates the electrohydraulic unit to keep deceleration of the wheel within the thresholds allowed.
The electronic control unit (1) connects to earth the charge (9) and discharge (10) solenoid valves.
The charge solenoid valve (9) remains closed keeping the connection between the brake pump (6) and brake caliper (11) shut; The discharge solenoid valve (10) opens putting the brake caliper (11) into hydraulic connection with the low pressure accumulator (2) and the recovery pump (4), in order to withdraw part of the fluid at the brake caliper (11) and reduce the pressure on the caliper itself.
Simultaneously, the electronic control unit (1) supplies the drive motor (3) of the recovery pump (4) which makes it possible to re-admit the fluid taken from the brake caliper (11) to the main circuit. The accumulator (2) or low pressure reservoir in the circuit has the task of storing part of the brake fluid taken from the calipers. Through the circuit of the recovery pump (4), the fluid is withdrawn and sent, via the damping chamber (5) and the restrictor (14), into the main circuit of the brake pump (6). In this phase a series of pressure waves (or hydraulic thrusts) are generated which are dampened by the presence of the damping chamber (5) and the restrictor (14).
During braking, light pushes on the brake pedal are to be considered normal when the ABS system is operational. During this phase, due to the effect of the lowering of the braking force, the wheel tends to resume the reference speed calculated by the electronic control unit (1).
The type of braking is intermittent or by steps with a succession of the phases depending on the wheel rolling conditions and according to a repetitive cycle that is not perceived by the driver, in the form of jerks, owing to the quickness and frequency with which it occurs and because it is evened out by the inertia of the wheel which is prevented from reaching extreme skidding conditions because of the rapidity of the device.

With the car without A.B.S. the driver is able to act intermittently on the brake pedal with a frequency of 2 cycles per second (2 presses and 2 releases).
With the A.B.S. system, the cycles increase to 4, 10 per second (depending on grip).
Normally operation of the A.B.S. ceases at speeds below 2.75 km/h to allow the wheels lock completely when the car reaches a halt.

NOTA: The recovery pump is of the free piston type with double circuit, driven by an electric motor that turns constantly during the recovery phase.
The pistons are not coupled with the electric motor but they are moved by the cam, only upon arrival of the brake fluid.
Therefore, the pump can perform only one impelling stroke while suction is not possible owing to the lack of mechanical connection between motor and pump.

Brake pedal release



1. Electronic control unit
2. Low pressure accumulator (reservoir)
3. Recovery pump drive motor
4. Recovery pump
5. High pressure accumulator (damping chamber)
6. Brake control pump
7. Servobrake
8. Fast pressure reduction valve
9. Charge solenoid valve
10. Discharge solenoid valve
11. Brake caliper
12. Revolution sensor
13. Phonic wheel
14. Restrictor

To enable rapid reduction of the pressure on the brake caliper (11) when the brake pedal is released, the system is fitted with a non return valve (8) in parallel with the inlet solenoid valve (9).

INSTRUCTIONS FOR REMOVING/REFITTING

The electrohydraulic control unit cannot be overhauled and it is fault-proof until it is tampered with. It must be replaced if found to be faulty.

After each replacement of a hydraulic unit, revolution sensor, electronic control unit or wiring (especially if after an accident) the entire A.B.S. system must be checked with the Tester.

After all operations on the hydraulic system of the A.B.S. or brake system, it is necessary to fill with DOT 4 brake fluid, relieve the air, and check the tightness of all the connection points.

The electrohydraulic control unit is supplied filled with DOT 4 brake fluid and with the solenoid valves not supplied. The operation for filling with fluid and relieving the air is the same as for a conventional system, but requires more time.

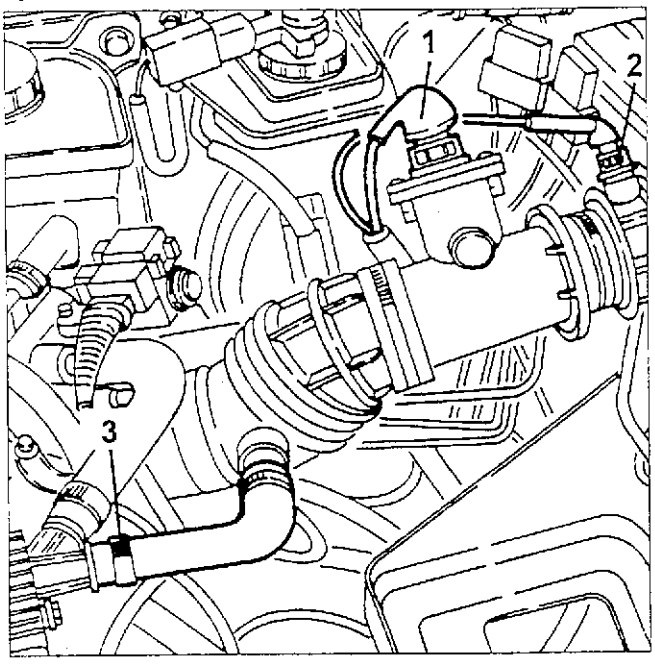
During removal of the electrohydraulic unit avoid overturning it to prevent spilling the oil contained in the hydraulic part.

When refitting pay attention to the unions: to prevent mistakes in connecting the various parts of the braking circuit during repair operations, the connections of the hydraulic modulator unit are of different sizes (M10x1 and M12x1), the unions are also identified by the codes stamped on them.

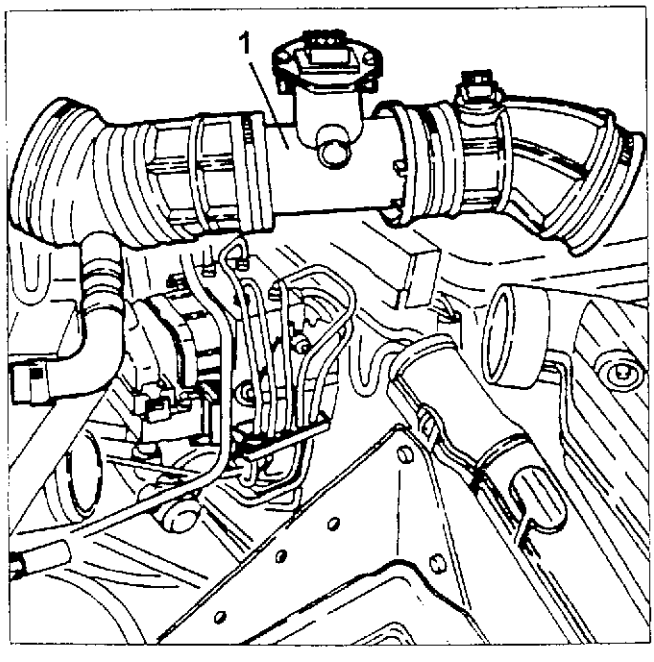
HYDRAULIC UNIT
T. Spark 16V Engines

DISCONNECTION/RE-CONNECTION

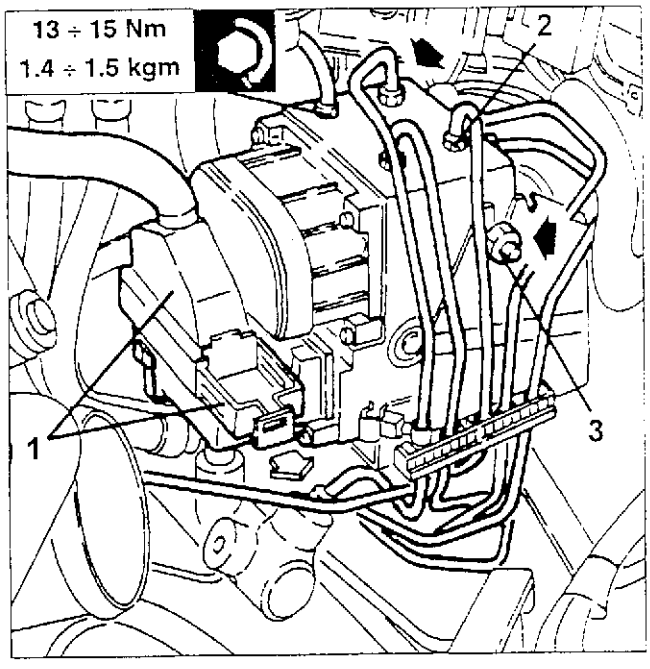
- Disconnect the battery terminals and remove it.
1. Disconnect the electrical connection from the air inflow tester.
2. Disconnect the electrical connection from the temperature sensor of sucked air.
3. Loosen the hose clamp and disconnect the pipe for oil vapours recirculation from the cover of the cylinder head.



1. Loosen the two hose clamps, hence remove the complete corrugated manifold.



- Let the brakes-clutch fluid drain out completely (see specific paragraph).
1. Pull forwards the blocking device of the gearcase comb, hence extract it from its seat.
2. Disconnect the pipe joints from the hydraulic unit.
3. Unscrew the two clamping nuts and remove the hydraulic unit.



ATTENTION: The hydraulic unit is not repairable. In case of defects or failure, it must be replaced.

While reconnecting, perform the air exhaustion operation from the braking system.(see specific paragraph).

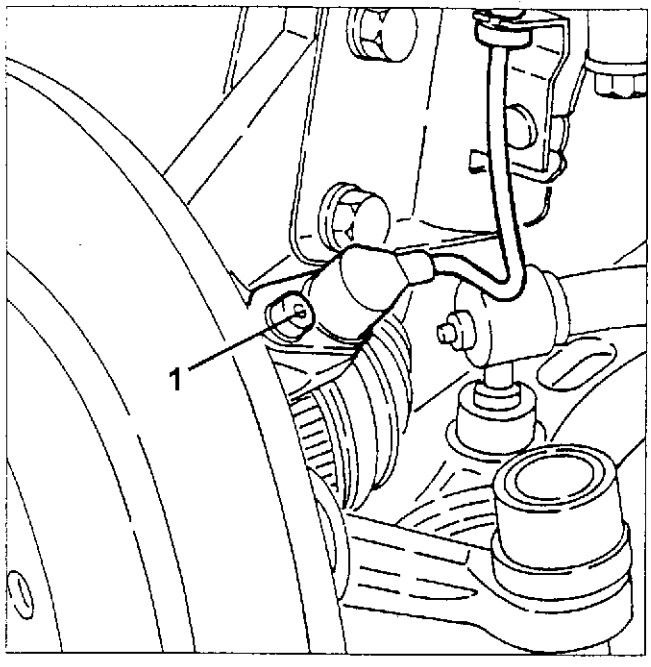
HYDRAULIC UNIT
Turbodiesel Engine

Refer to the corresponding procedure regarding the T. SPARK 16V motorization, considering that the accessibility of the hydraulic unit is differnt.

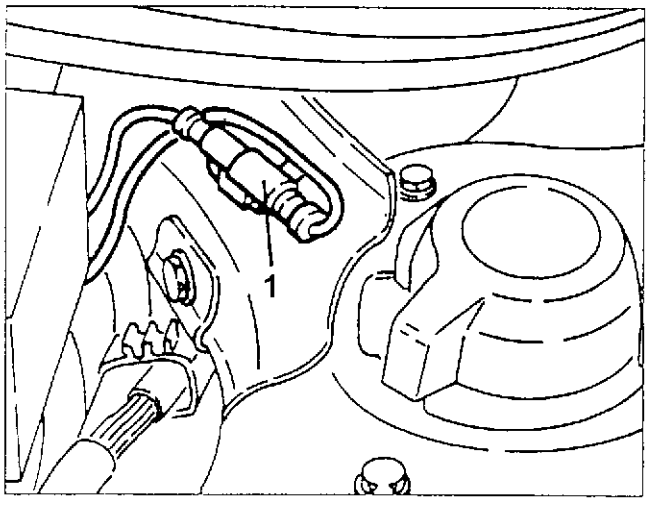
FRONT INDUCTIVE SENSORS

DISJOINING/ RE-JOINING

1. Unscrew the clamping screw of the ABS inductive sensor to the wheel post.



1. Disconnect the electrical connection located in proximity of the shock absorber dome and remove the sensor and the wiring after loosening the clamps.

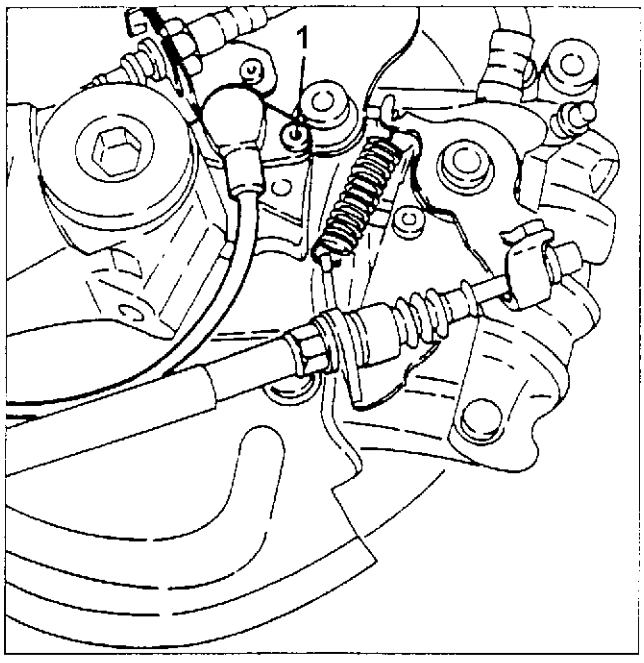


When re-joining, grease the sensor seat with the prescribed grease.

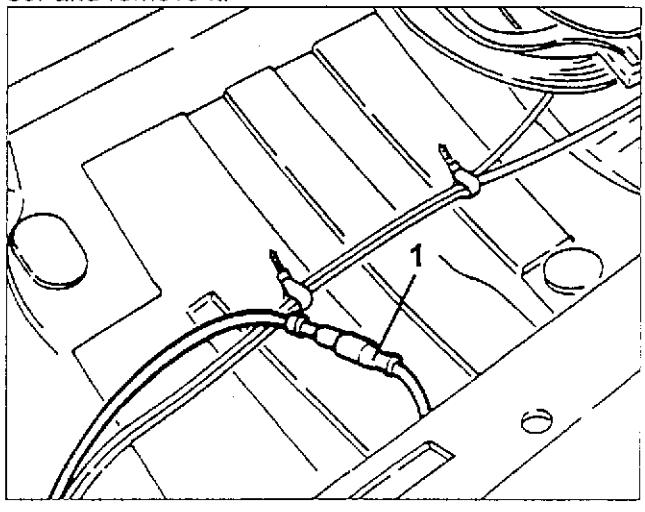
REAR INDUCTIVE SENSORS

DISJOINING/RE-JOINING

1. Unscrew the clamping screw of the inductive sensor to the wheel hub.



1. Turn the cushion of the back seat over, disconnect the electrical connection of the inductive sensor and remove it.



When re-joining, grease the sensor seat with the prescribed grease.

ENTREFER CHECKING

- Using a thickness gauge, estimate the entrefer value between the inductive sensor and the corresponding phonic wheel.

Front inductive entrefer sensors	0.3 ÷ 1.05 mm
Rear inductive entrefer sensors	0.2 ÷ 1.15 mm

WARNING: The entrefer is not adjustable as compatible thickness is not provided. Check the integrity of the sensor and of the teeth of the phonic wheel in case of a value besides the prescribed tolerance.

ABS BOSCH 5.3 WITH EBD (99s Models)

DESCRIPTION

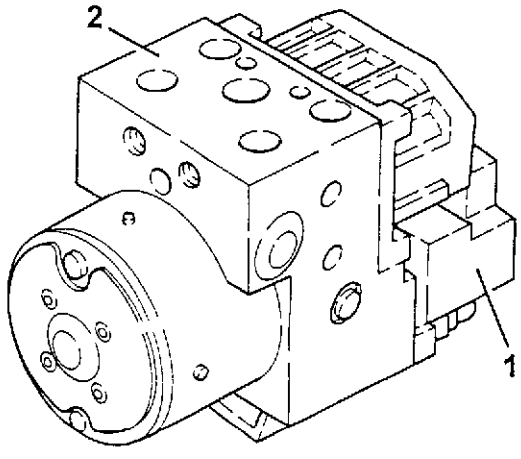
This A.B.S. system differs from the "A.B.S. BOSCH 5.3" system because it adopts:
- an electonic braking distribution frame (which replaces the traditional mechanical braking control system)
- active sensors in place of inductive ones.

The A.B.S. system is composed by:
- an integrated electronic gearcase
- an electrohydraulic gearcase which modulates the braking pressure through eight electrovalves, two for each wheel.
- four active sensors detecting the angular speed of the wheels rotation.

COMPONENTS

Electrohydraulic group

It is made by an electronic gearcase (1) and by an electrohydraulic one (2).



Electronic gearcase

The electronic gearcase has the following functions:
- to acquire the data coming from the active sensors of the wheel revolutions.
- to store the checking parameters defined during the vehicle's truing.
- to store the checking software
- to process the acquired data
- to control the braking process
- to detect failures and defects of the braking system components
- to strore the failure codes and activate the pilot lights ABS and EDB
- to transmit and to receive data through the diagnostics connectors.

Electrohydraulic gearcase

The electrohydraulic gearcase is made by:
- eight two-way electrovalves
- a double-circuit recovery pump
- two low pressure batteries
- two high pressure batteries.

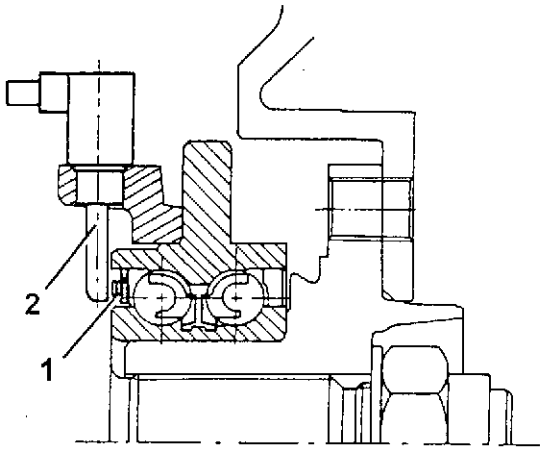
It modulates the fluid's pressure to the calipers through electrovalves and by:
- increasing the brakes fluid pressure
- maintaining the brakes fluid pressure
- discharging the brakes fluid pressure.

Active sensors

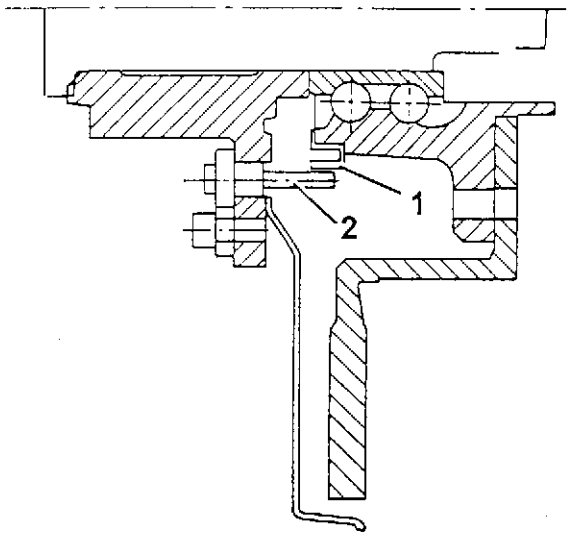
They are composed by two main elements:
- a magnetic multi-polar coder (1) integrated in the bearing of the wheel hub
- a picker up (2).

The advantages offered by the active sensors are:
- reduction in the electromagnetic sensitivity
- less weight and smaller dimensions
- simplification of transmission joints to eliminate phonic wheels.

Front active sensors



Rear active sensors



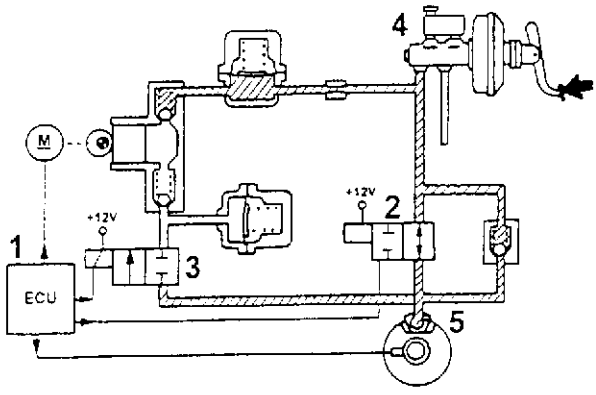
FUNCTIONING DESCRIPTION OF ABS SYSTEM

The electronic gearcase elaborates the signals coming from the active sensors and from the control switch of stoplights and modulates the brakes luid pressure under the conditions of:
- phase of pressure increase
- phase of pressure holding
- phase of pressure reduction.

Phase of pressure increase

By pressing of the brake pedal, the electronic gearcase (1):
- does not feed the charging electrovalve (N.A.) (2)
- does not feed the discharging electrovalve (N.C.) (3).

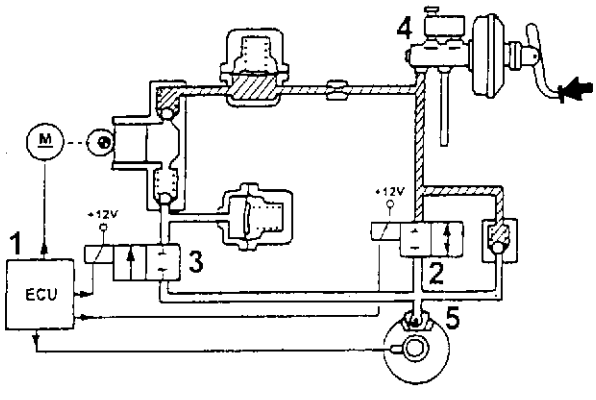
Therefore the pressure produced by the brake (4) reaches the calipers (5) without variations.



Phase of pressure holding

The electronic gearbox (1):
- feeds the charging electrovalve (N.A.) (2)
- does not feed the discharging electrovalve (N.C.) (3).

Therefore the hydraulic connection between the brakes pump (4) and the calipers (5) is interrupted. The calipers' pressure (5) stays constant even while increasing the pressure onto the brake pedal.

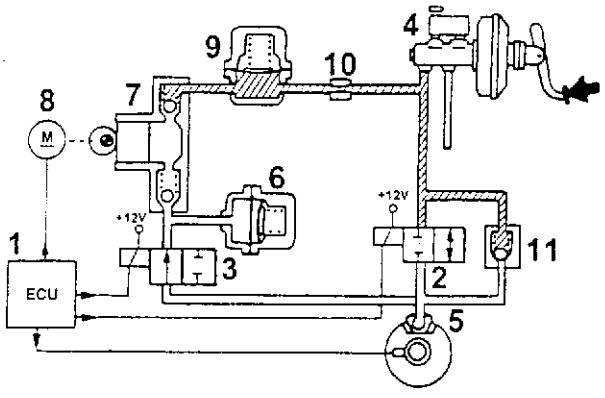


Phase of pressure reduction

The electronic gearcase (1):
- feeds the charging electrovalve (N.A.) (2)
- feeds the discharging electrovalve (N.C.) (3).

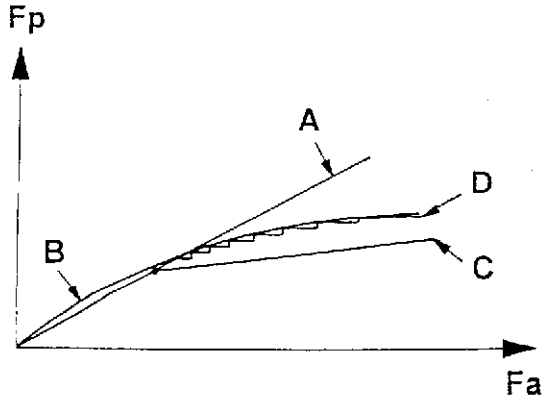
The hydraulic connection between the brakes pump (4) and the calipers (5) is interrupted and the discharging electrovalve (3) opens and puts into connection the caliper (5) with the low pressure battery (6)and the recovery pump (7).

The electronic gearcase (1) feeds,besides, the control motor (8) of the recovery pump (7) so to let the fluid taken away from the caliper (5) flow again.
The fluid goes through the high pressure battery (9)and the squeeze (10) which have a damping function.
The system is equipped with a one-way valve (11) which is parallel to the charging electrovalve(2) so enabling a fast reduction of the pressure onto the caliper (5) while releasing the brake pedal.



EBD (Electronic Brake force Distribution)

The EBD controls the distribution of the braking power and therefore replaces the traditional mechanical braking device so enabling to :
- intervene onto the rear calipers.
- improve distribution of the braking power
- intervene under any load condition (both statical and dynamical), of running and of car degradation (worn tyres, brakes and suspensions)
- implement a strategy following the ideal distribution curve.



Fa. Braking power of the front axle
Fp. Braking power of the rear axle
A. Distribution curve performed by the braking system
B. Ideal distribution curve
C. Traditional distribution curve
D. Distribution curve performed by EDB functioning

The EDB failing functioning is signalled by the simultaneous lighting of the pilot lights of:
- the A.B.S.
- the insufficient brake fluid and /or insertrd hand brake
It is therefore necessary to drive the car carefully to the closest authorized service center to have the system checked, should it fail.

Recovery

The electronic gearcase is equipped with a safety circuit which controls the ABS system's efficiency.
With the key inserted for four seconds, the safety circuit controls:
- the functioning of the electronic gearcase
- it starts the electrovalves to check the functioning
- it starts the recovery pump to check the functioning
- it checks the signals from the active sensors.

The safety circuit checks the presence of signal in the active sensors.

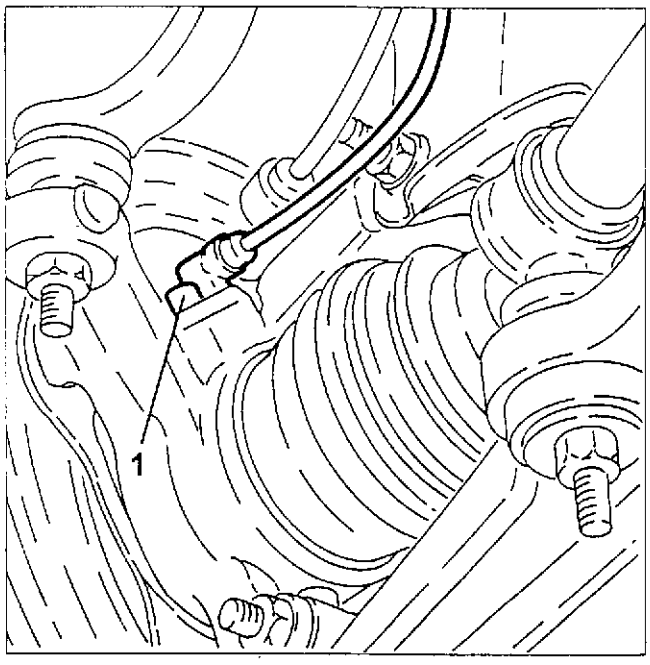
The safety circuit, with the car running, acts as follows:
- continously compares the angular speed of the wheels to the calculated reference speed.
- checks the memory's conditions
-checks the functioning of the two remote control switches and of the lectrovalves.
- constantly checks the battery voltage
- checks the efficiency of the brake pedal switch.

If, during the checking phase, the safety circuit has detected defects or failures, it acts as follows:
- disconnects the ABS guaranteeing the functioning of the traditional braking system.
- signals the failure condition to the driver through the lighting of the corresponding pilot light abord.

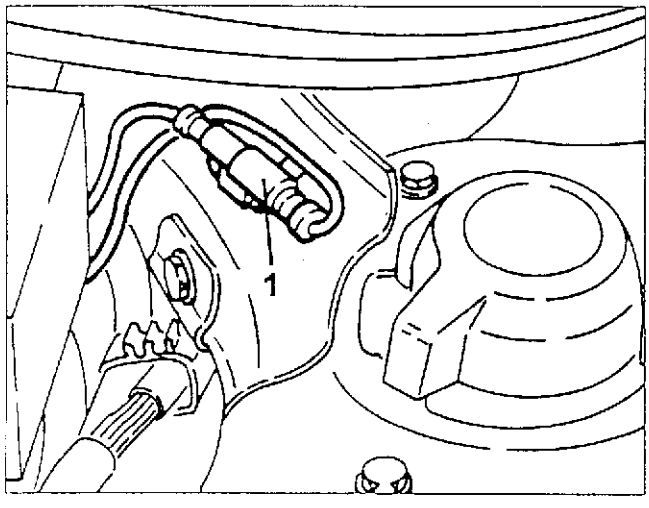
FRONT ACTIVE SENSORS

DISCONNECTION/RE-CONNECTION

1. Unscrew the clamping screw of the active ABS sensor to the wheel riser.



1. Diconnect the electrical connection close to the shock absorber dome and remove the sensor together with the wiring after having loosened the clamps.

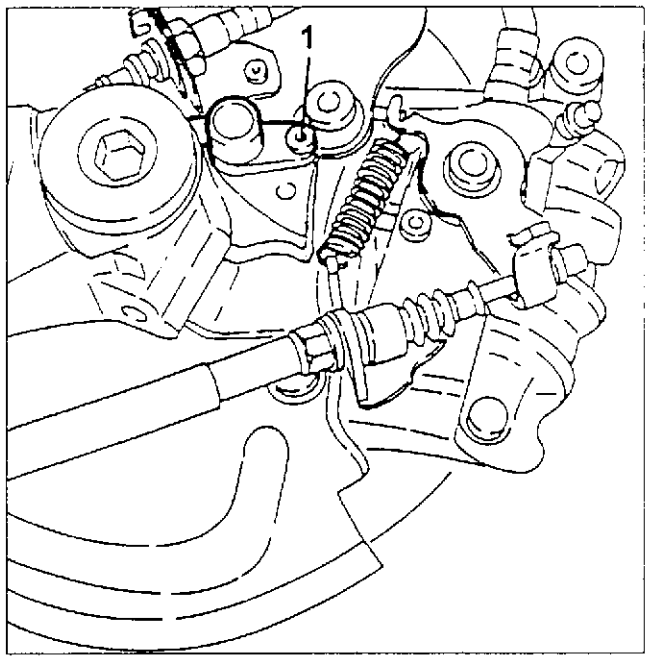


When re-connecting, grease the seat of the active sensor with the prescribed grease.

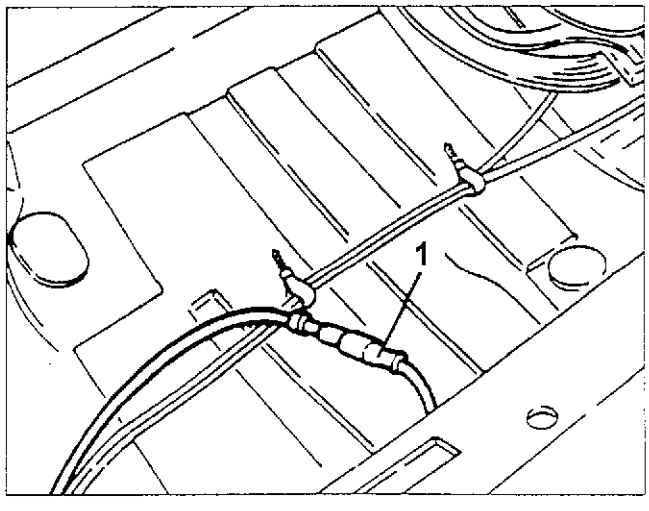
REAR ACTIVE SENSORS

DISCONNECTION/RE-CONNECTION

1. Unscrew the clamping screw of the active sensor to the wheel's hub.



1. Turn the back seat cushion forwards over, disconnect the electrical connection of the active sensor and remove it.



When re-connecting, grease the seat of the active sensor with the prescribed grease.