A. General

The ABS anti-lock braking system (or electronic brake slip control) is one of the active safety elements of a vehicle which can decisively reduce the risk of becoming involved in an accident.

For this reason, the ABS is expected to meet the following demands:

1 The driving stability of the vehicle should be assured while braking, both when the braking force is slowly increased up to the locking limit and when suddenly increasing the braking force in the event of an emergency stop.

2 As long as the vehicle speed is adequately below the curve limit speed, braking on a bend should be possible without impairing driving stability while maintaining full steerability (the curve limit speed is the speed at which a vehicle can be driven around a bend without engine power and just fast enough that it will not leave the road under the influence of centrifugal force).

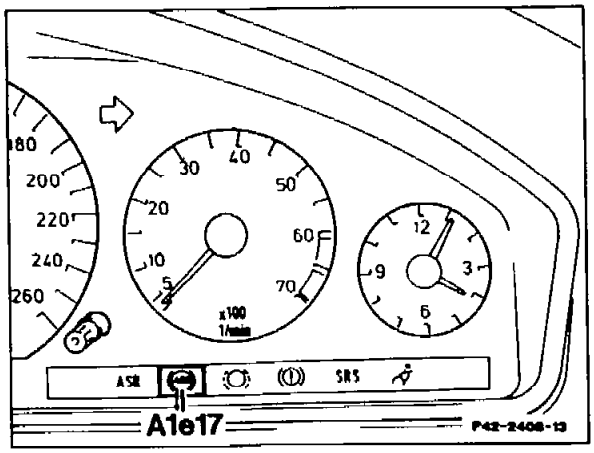
3 When the brake pedal is excessively operated to the extent that an uncontrolled braking system will result in the wheels locking, the ABS will modify the braking pressure in the wheel brakes to the extent that the wheels do not lock and that instead, the adhesion between the wheels and the road is optimally exploited.

Consequently, vehicles with ABS as compared with uncontrolled brake systems provide the following advantages when the brakes are fully applied:

- Higher driving stability
- Better steerability

B. Driving with ABS

The malfunction indicator lamp with the ABS symbol in the instrument cluster lights up when the ignition is switched on and goes out after the engine is started (same as charge-indicator lamp).
Should the lamp fail to go out, this could indicate low voltage in the vehicle electrical system or an open circuit in the current supply to the electronic control unit. Once the vehicle has attained a speed of approx. 5 km/h, the ABS performs a self-test (**BITE = Built In Test Equipment**). The ABS malfunction indicator lamp will light up if a fault is recognized.



If the problem assumes the form of a permanent fault, e.g., open wire, then the fault remains stored in the ABS control unit until the ignition is switched off. Short periods of undervoltage in the vehicle's electrical system are not recorded. Thus, if the battery voltage remains below 11 volts after the ignition has been switched on and the vehicle has exceeded the test speed, the ABS will remain inactive until such time as the alternator raises the system voltage to above 11 volts. Only then will the ABS malfunction indicator lamp go out.

Any braking in the locking range initiated above 8 km/h (above 12 km/h on the 1st version up to 02/84) can be governed down to a speed of 3 km/h (down to 5 km/h on the 1st version up to 02/84). This means that controlled braking will proceed only after the so-called control speed of 8 km/h (12 km/h on 1st version up to 02/84) has been exceeded.

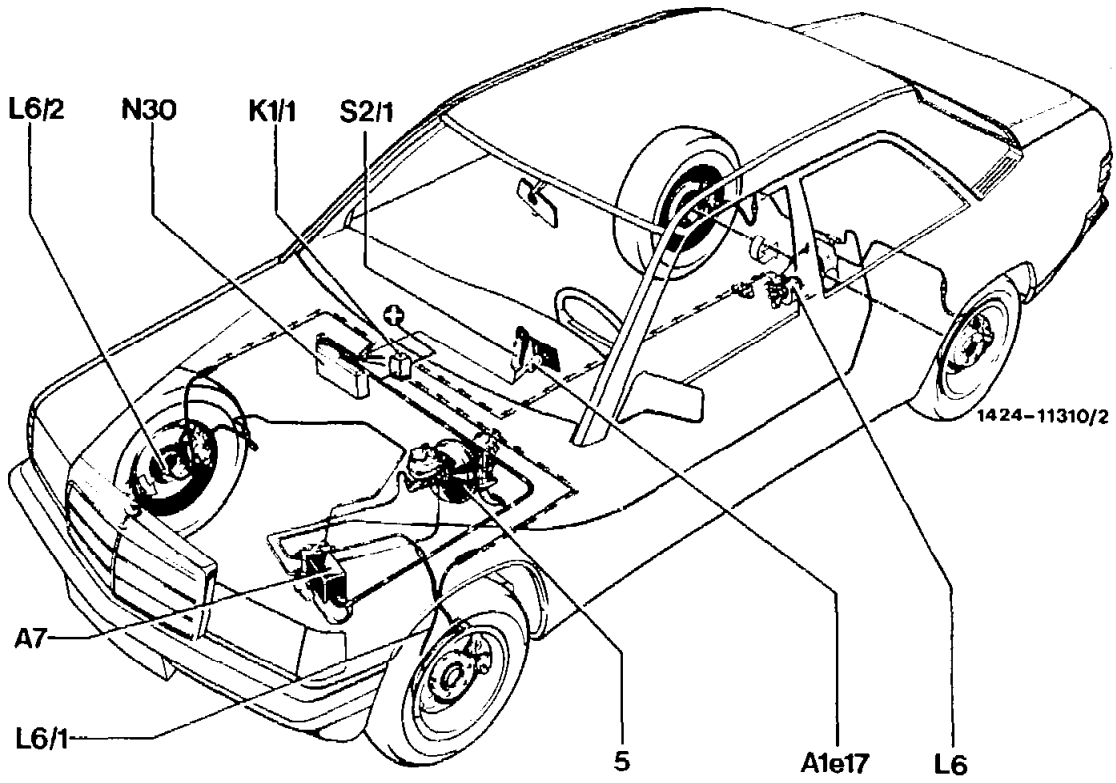
⚠

When the malfunction indicator lamp in the instrument cluster is on, this signals that the ABS is inactive; the antilock system will not operate when the vehicle's brakes are applied. The conventional brake system remains operational. The vehicle should be checked and repaired in a Mercedes-Benz service station as soon as possible.

Design

The anti-lock braking system comprises the conventional braking system known up to now and the following additional components:

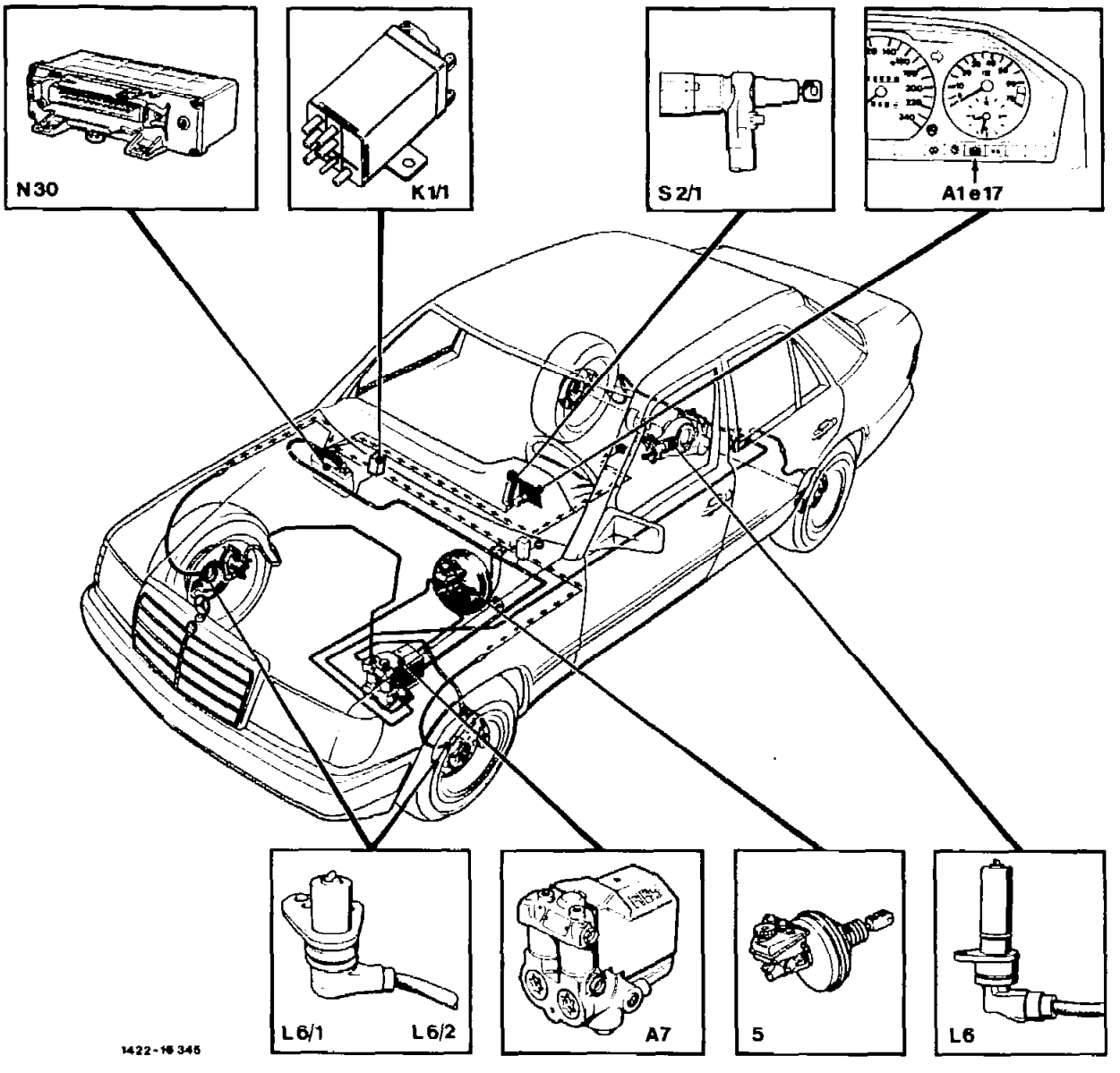
a) Hydraulic unit
b) Wheel speed sensors
c) ABS control unit
d) Harness with overvoltage protection relay



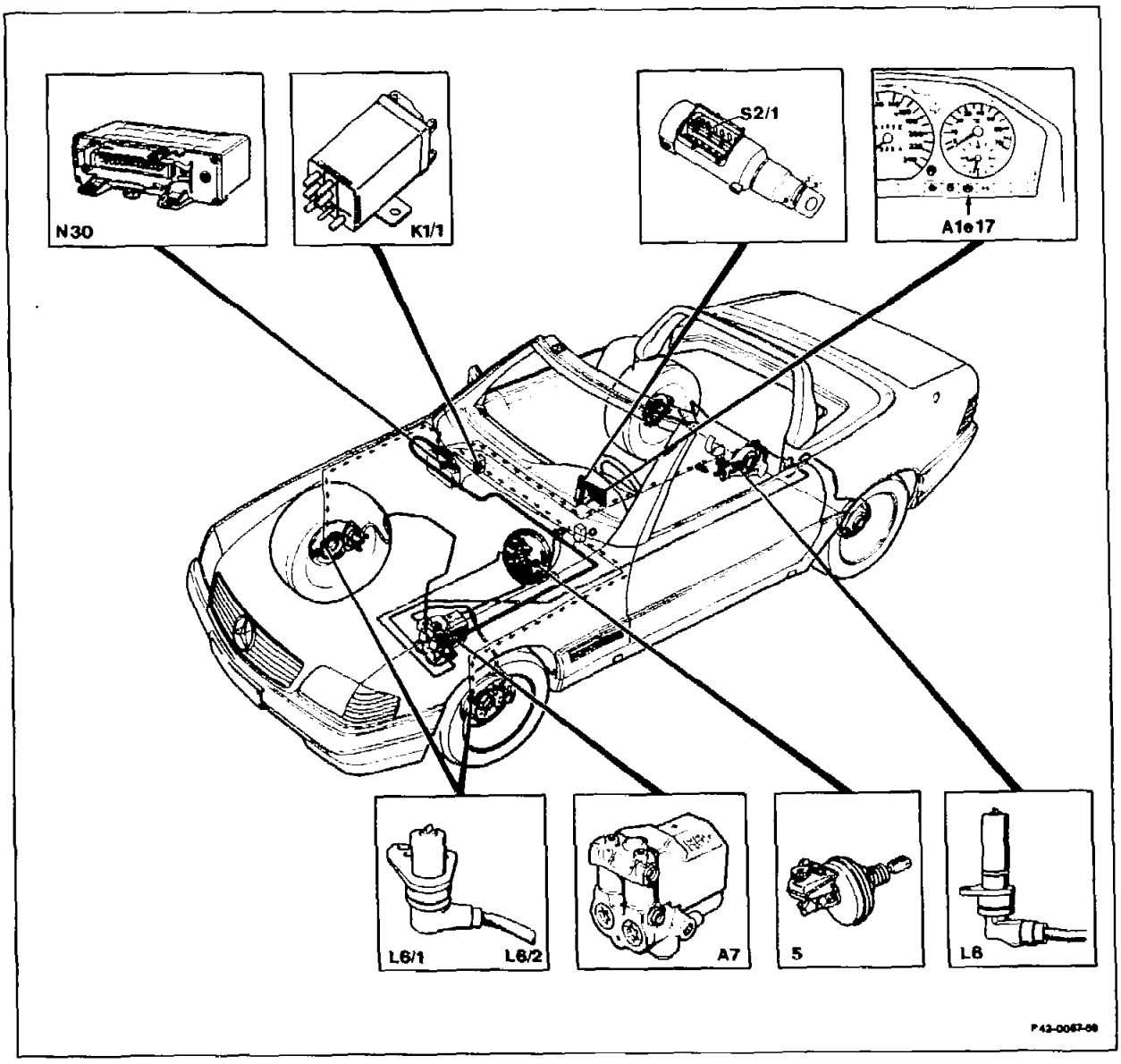
5	Brake booster with tandem brake master cylinder	L6/1	Left front wheel-speed sensor
A1e17	ABS malfunction indicator lamp	L6/2	Right front wheel-speed sensor
A7	ABS hydraulic unit	N30	ABS control unit
K1/1	Overvoltage protection relay 87E, 7-pole	S2/1	Ignition/starter switch
L6	Rear-axle wheel-speed sensor		

C. Location of components

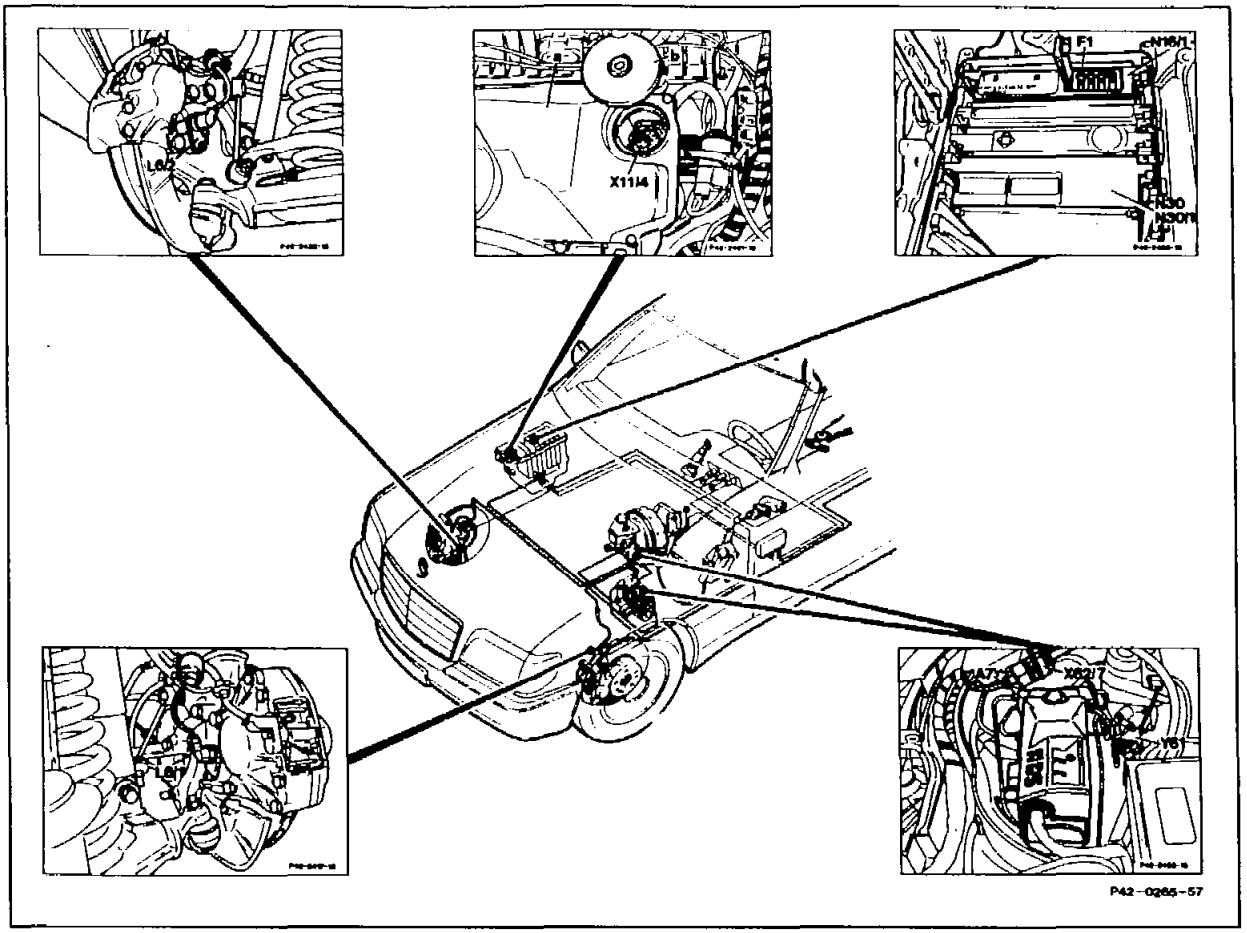
Model 124 (except 124.034)



5	Brake booster with tandem master cylinder	L6/1	Left front wheel-speed sensor
A1e17	ABS malfunction indicator lamp	L6/2	Right front wheel-speed sensor
A7	ABS hydraulic unit	N30	ABS control unit
K1/1	Overvoltage protection relay 87E, 7-pin	S2/1	Ignition/starter switch
L6	Rear-axle wheel-speed sensor		

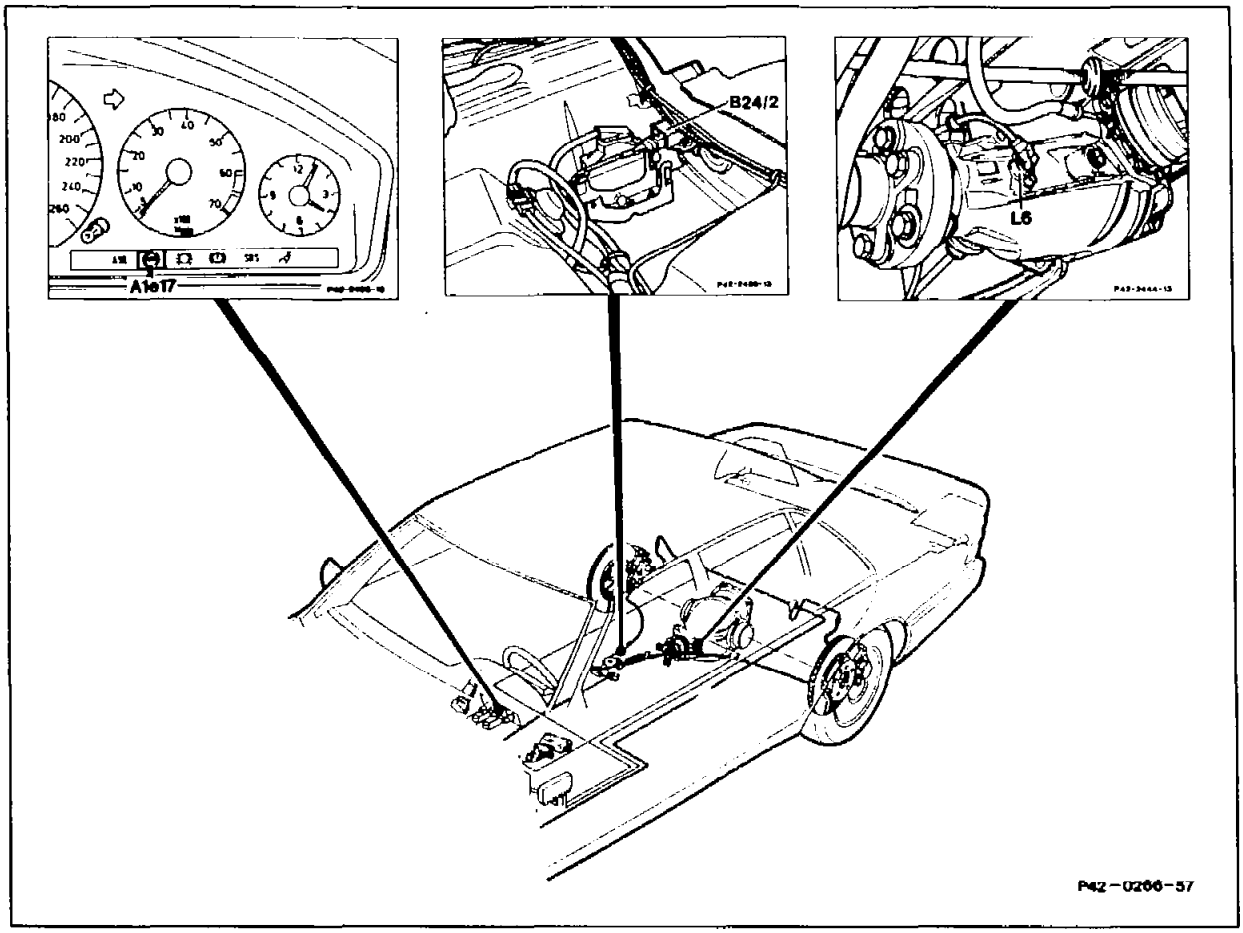


5	Brake booster with tandem master cylinder	L6/1	Left front wheel-speed sensor
A1e17	ABS malfunction indicator lamp	L6/2	Right front wheel-speed sensor
A7	ABS hydraulic unit	N30	ABS control unit
K1/1	Overvoltage protection relay 87E, 7-pin	S2/1	Ignition/starter switch
L6	Rear-axle wheel-speed sensor		



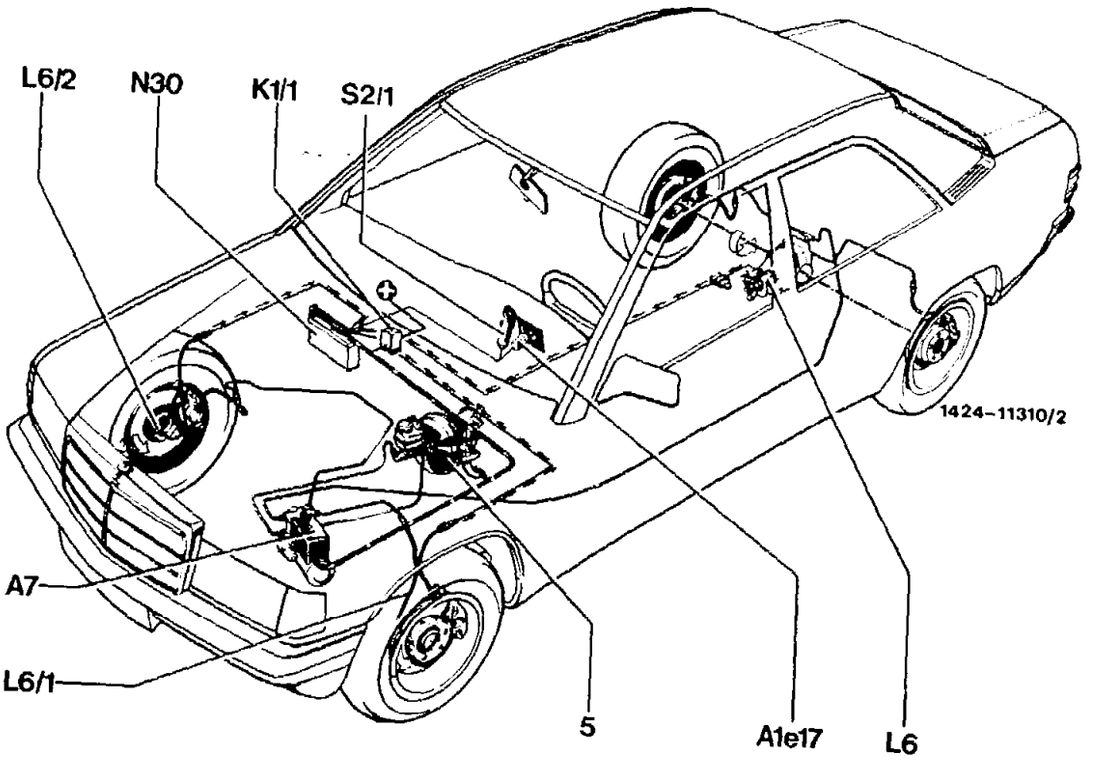
Electrical components at front axle and in engine compartment

A7	ABS hydraulic unit	N30	ABS control unit
L6/1	Left front wheel-speed sensor	X11/4	Diagnosis test socket, 38-pin (pulse signal)
L6/2	Right front wheel-speed sensor	Y61	Master cylinder switchover valve (Model 140.04/05 only)
N16/1	Basic module (GM)		

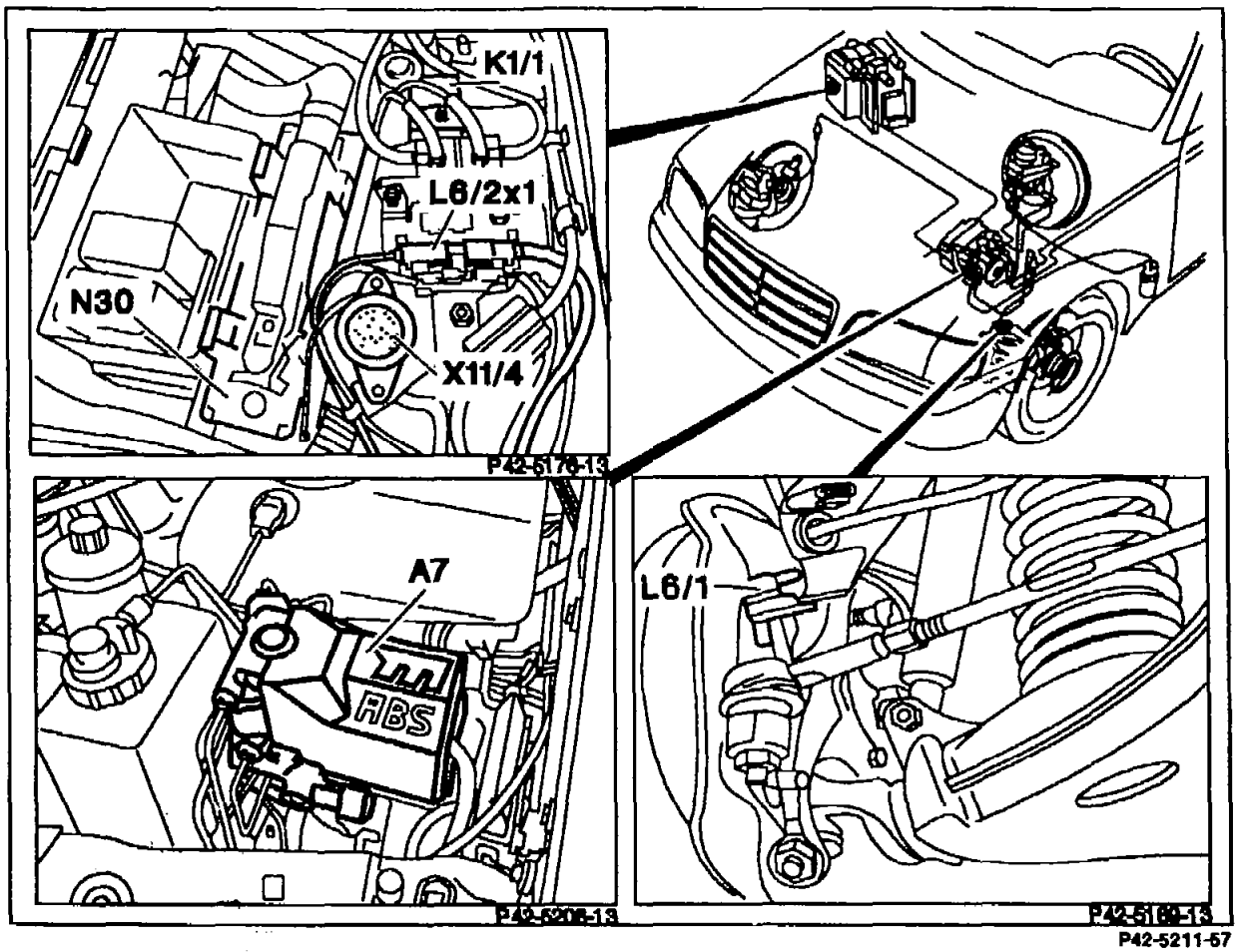


Electrical components at rear axle and in passenger compartment

A7e17	ABS malfunction indicator lamp
B24/2	ABS/ASR lateral-acceleration sensor (Model 140.04/05 only)
L6	Rear-axle wheel-speed sensor

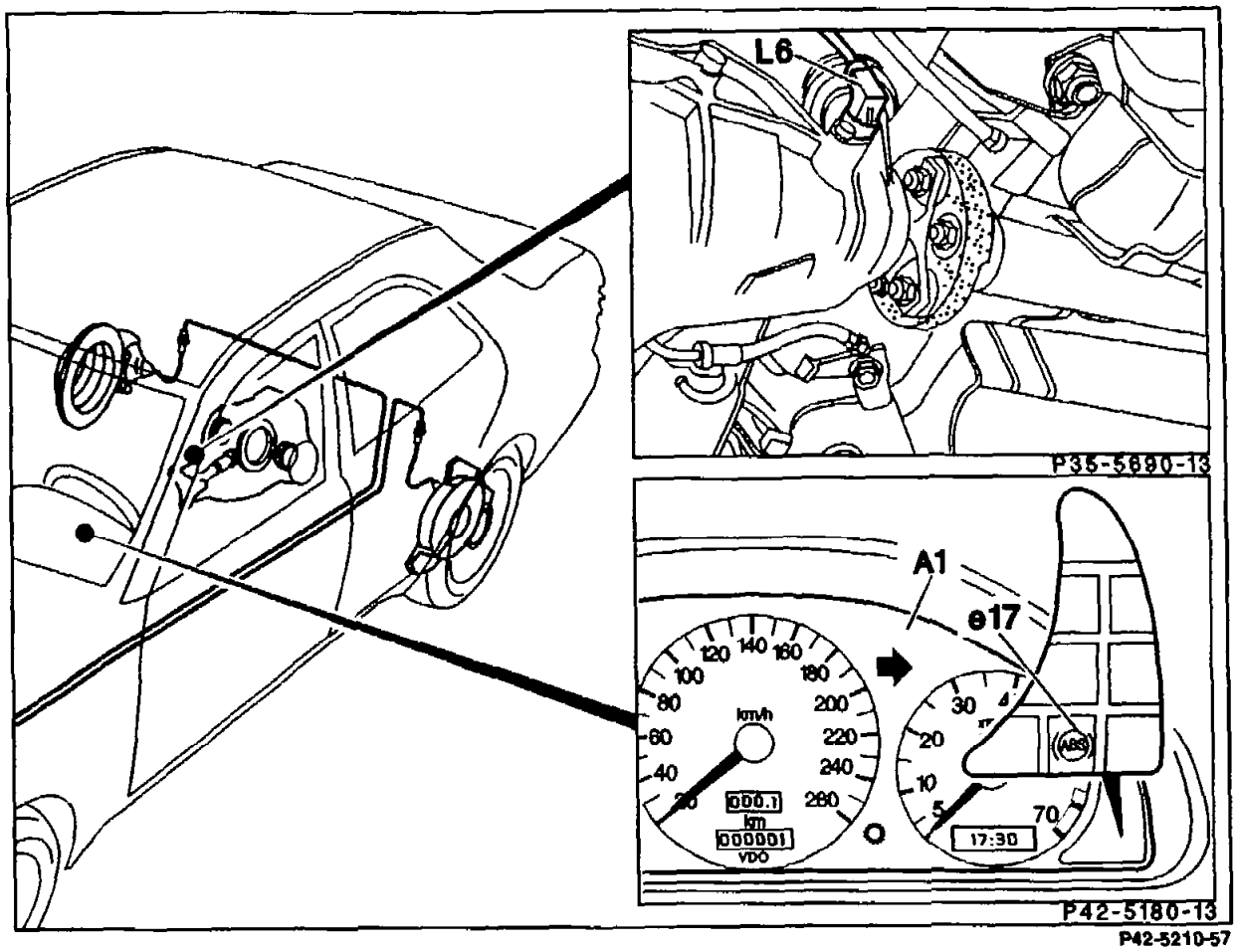


5	Brake booster with tandem master cylinder	L6/1	Left front wheel-speed sensor
A1e17	ABS malfunction indicator lamp	L6/2	Right front wheel-speed sensor
A7	ABS hydraulic unit	N30	ABS control unit
K1/1	Overvoltage protection relay 87E, 7-pin	S2/1	Ignition/starter switch
L6	Rear-axle wheel-speed sensor		



Electrical components at front axle and in engine compartment

A7	ABS hydraulic unit	L6/2	Right front wheel-speed sensor (not illustrated, mounted symmetrically on other side)
K1/1	Overvoltage protection relay 87E, 7-pin	N30	ABS control unit
L6/1	Left front wheel-speed sensor	X11/4	Diagnosis test socket, 38-pin (pulse signal)



Electrical components at rear axle and in passenger compartment

A1	Instrument cluster
A1e17	ABS malfunction indicator lamp
L6	Rear-axle wheel-speed sensor

D. Overall function

The ABS is operational when the ignition is switched on and a speed of 5-7 km/h has been attained. All braking operations in the locking range are controlled starting at the so-called control speed of 8 km/h (from 12 km/h on 1st version up to 02/84).

The following describes the control cycle on one wheel. The control sequence on the other wheels is the same. The wheel speed measured by the wheel speed sensor provides the wheel deceleration and the wheel acceleration signals for the electronic control unit. Linking of the individual wheel speeds provides the so-called reference speed, which is the approximate vehicle speed. A comparison of the wheel speed with the reference speed supplies the slip signals.

If, as a result of excessive brake fluid pressure in a brake caliper the wheel shows a tendency toward locking, a condition which is recognized by means of the wheel speed sequence (wheel slip), the fluid pressure will be held constant, that is an additional pressure increase is not possible.

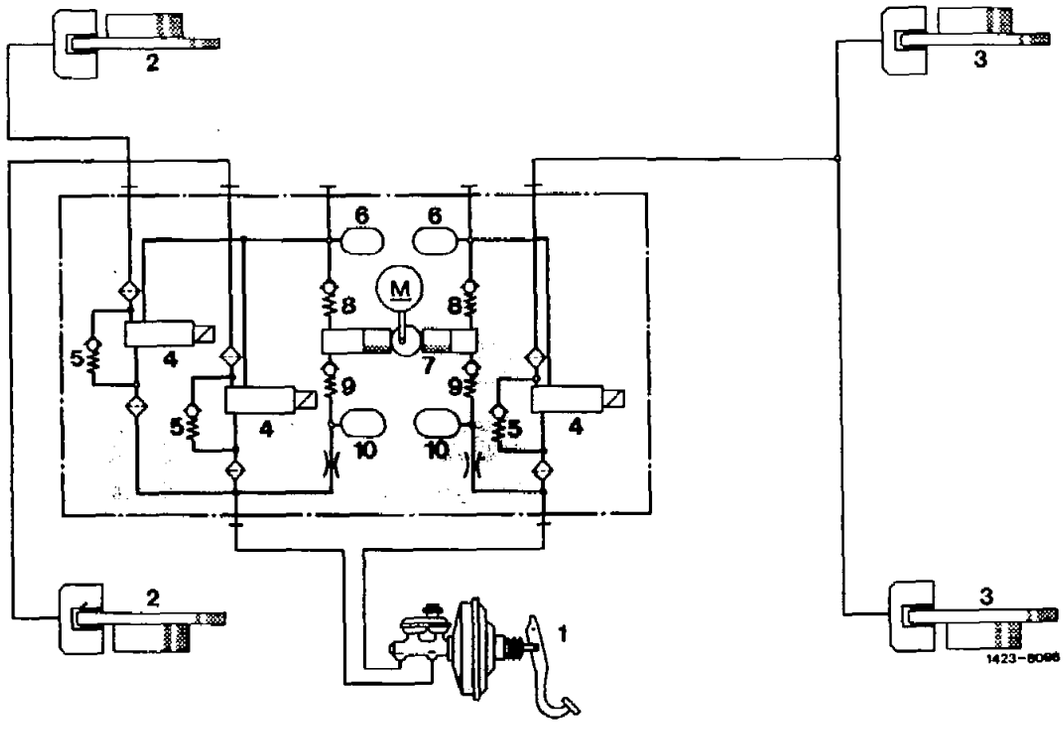
If there is still a tendency toward locking because the constant pressure is still too high, the outlet valve in the solenoid valve is opened to lower the fluid pressure. Simultaneously, the brake fluid still in storage is pumped back into the tandem brake master cylinder by the return pump. If the pressure is so low that the wheel wants to accelerate again, there will be no further pressure reduction and the fluid pressure will again be held constant.

When the acceleration of the wheel again passes a threshold value, the pressure is again increased by opening the input valve in the solenoid valve.

By means of pertinent signals from the ABS control unit, the hydraulic unit can actuate the three following control stages of
pressure build-up
pressure holding and
pressure reduction.

The control sequence is continually repeated under controlled braking, until the brake pedal is released or shortly before the vehicle stops.

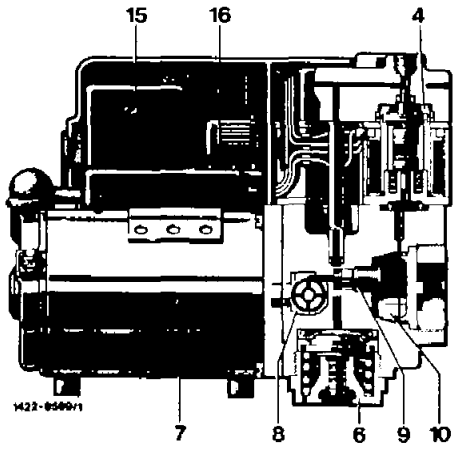
E. Hydraulics



1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Silencer

Irrespective of the pressure in the tandem brake master cylinder, the hydraulic unit can change the fluid pressure for the brake calipers during regulation.

However, a pressure increase as compared with pressure coming from the master cylinder is not possible.

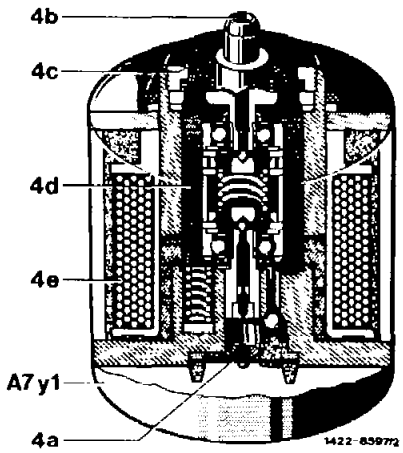


4 Solenoid valve
6 Pump slide
7 Return pump
8 Pump input valve
9 Pump output valve
10 Silencer
15 Return pump relay
16 Solenoid valve relay

The hydraulic unit comprises three fast-switching solenoid valves. Of these valves, one each is associated with the left-hand and right-hand front wheel brake and the third with the rear wheel brake.

By activating the valves with varying voltages, the brake fluid pressure of the individual brake calipers can be

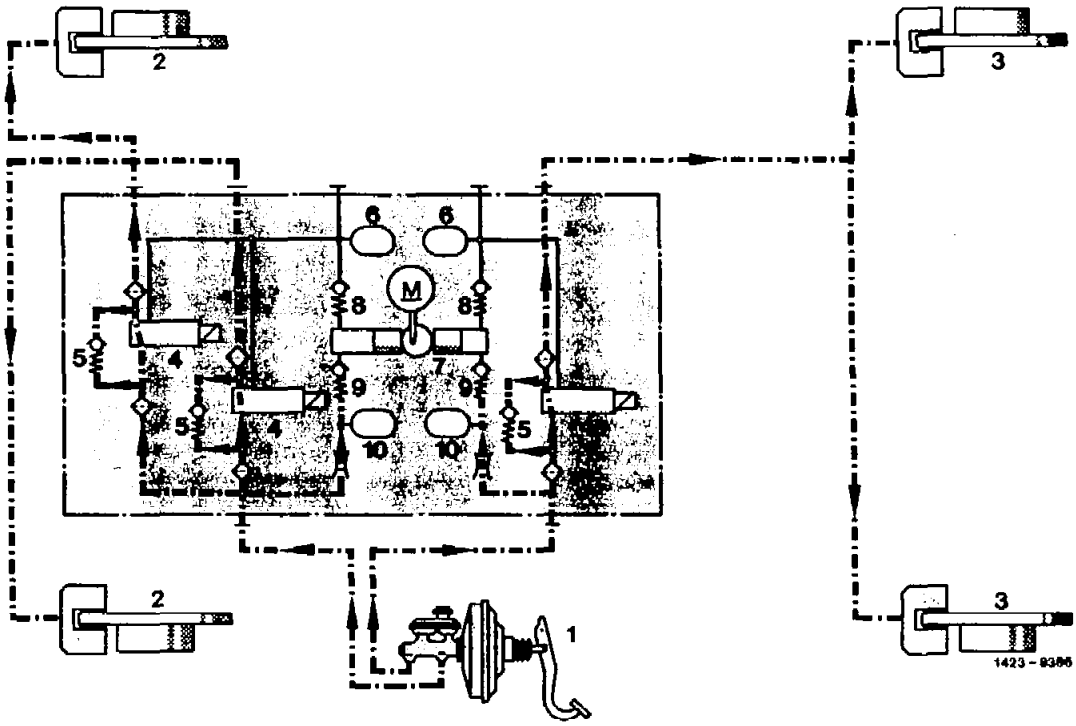
increased	=	pressure build-up stage (no current)
held	=	pressure holding stage (half max. current)
or reduced	=	pressure reduction stage (max. current).



A7y1 Front-axle solenoid valve
4a Connection - brake line from brake master cylinder
4b Output - return pump
4c Connection - brake line to wheel brake
4d Armature
4e Coil

Pressure build-up stage

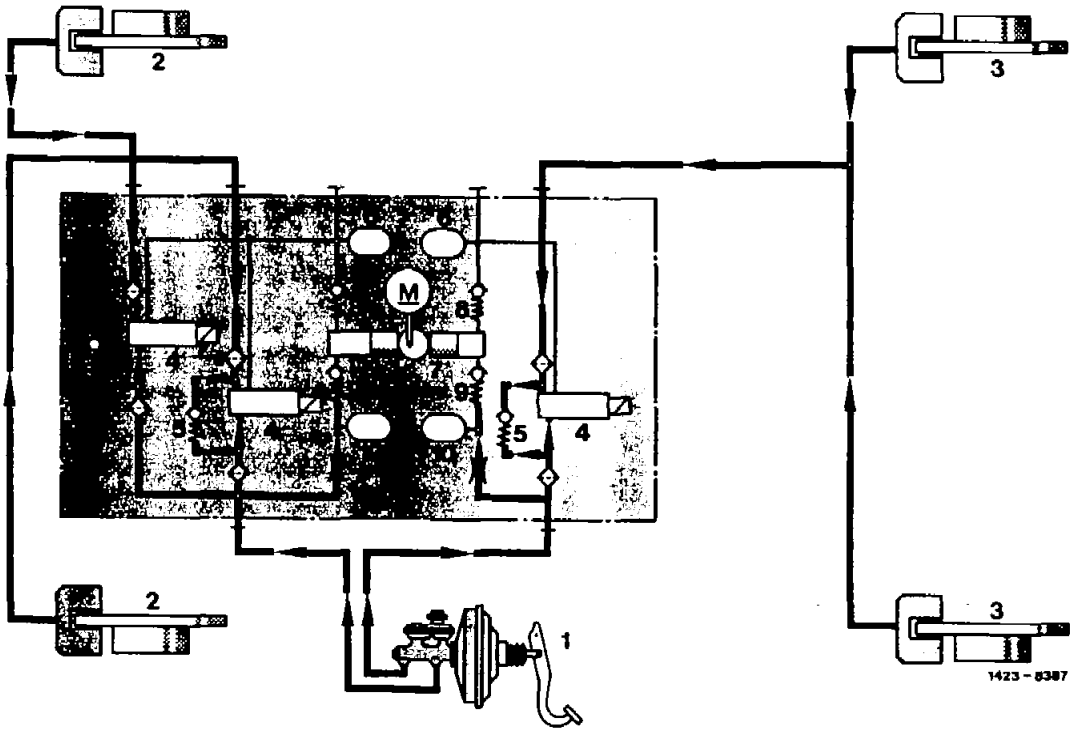
In the pressure build-up stage the pressure can be increased via the open input valve in the solenoid valve up to the pressure activated by the tandem brake master cylinder.



1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Silencer

Pressure holding stage

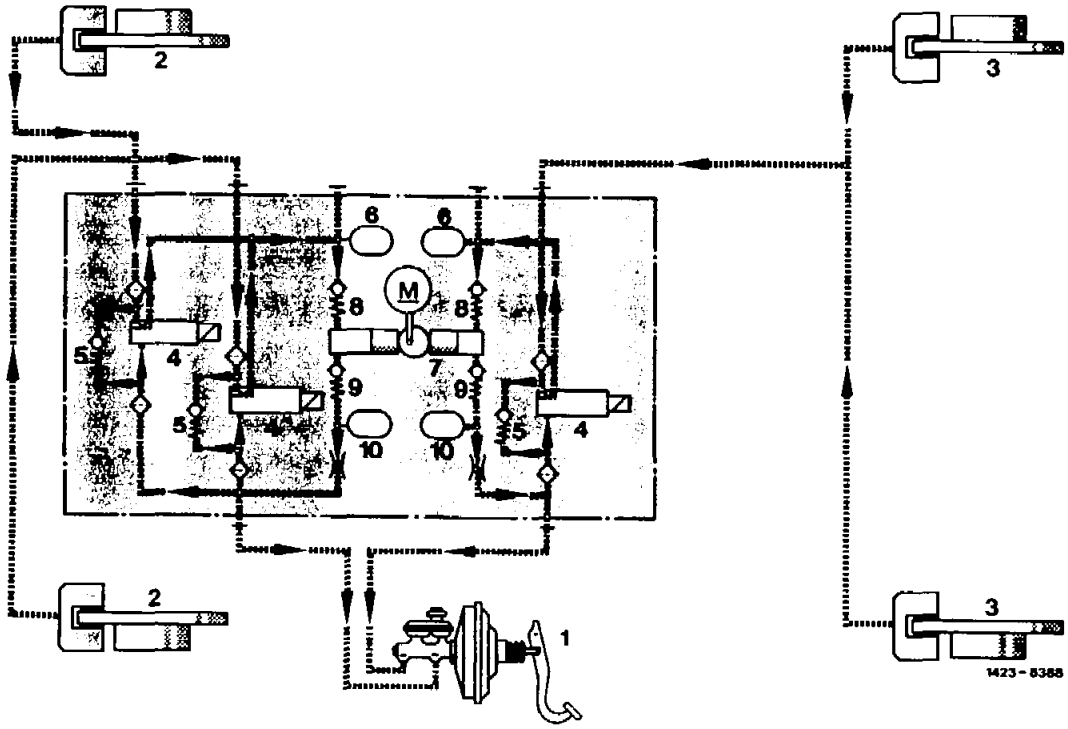
In the pressure holding stage which precedes each pressure reduction stage, the fluid pressure from the hydraulic unit to the wheel brakes is held constant because the output and input in the solenoid valve is closed.



1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Silencer

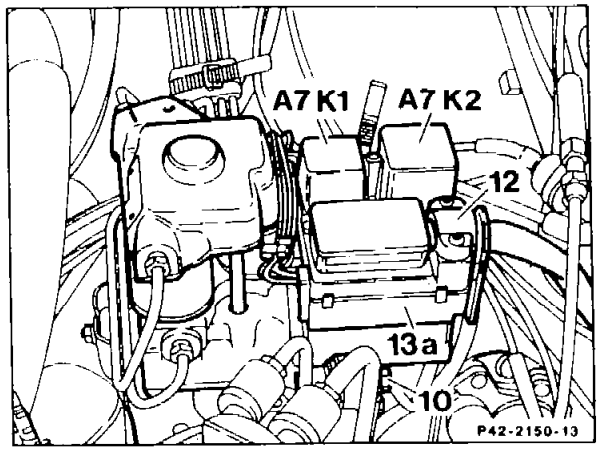
Pressure reduction stage

During the pressure reduction stage the brake fluid flows via a reservoir (6) into return pump (7). To maintain the fluid volume of the master cylinder, the return pump returns the brake fluid into the master cylinder against the prevailing pressure. To dampen the delivery noise, each circuit is provided with a silencer (10).



1	Brake booster with tandem brake master cylinder	6	Pump reservoir
2	Front wheel brake	7	Return pump
3	Rear wheel brake	8	Pump input valve
4	Solenoid valve	9	Pump output valve
5	Check valve	10	Silencer

On plug socket (13a) of the hydraulic unit there is a relay (A7K1) for solenoid valves and relay (A7K2) for the return pump. The hydraulic unit is connected to the vehicle ground at the hexagon nut (10) via a grounding cable.

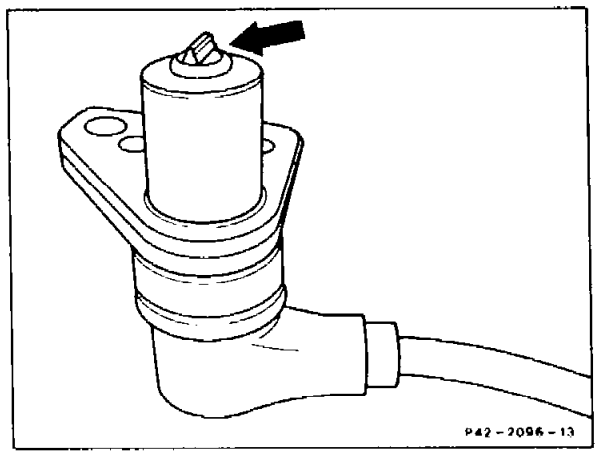


10	Hexagon nut
12	Harness stress relief
13a	Plug socket
A7K1	Solenoid valve relay
A7K2	Return pump relay

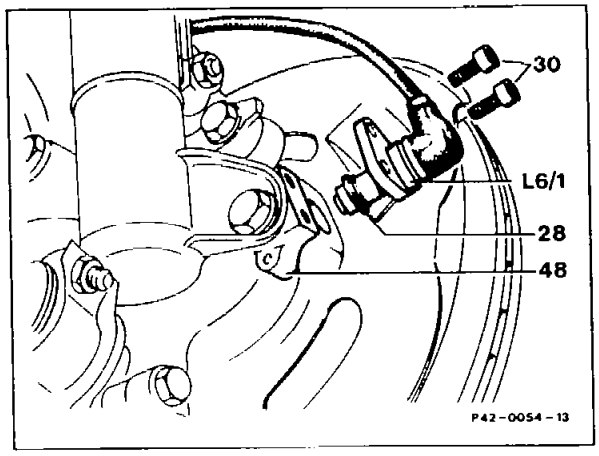
F. Electronics

Wheel speed sensors

Rod-shaped wheel speed sensors or impulse sensors are used for measuring wheel speeds. In the three-channel system with three wheel speed sensors installed in our vehicles (excluding vehicles with ASR), the wheel speed of each wheel is measured separately on the front axle.

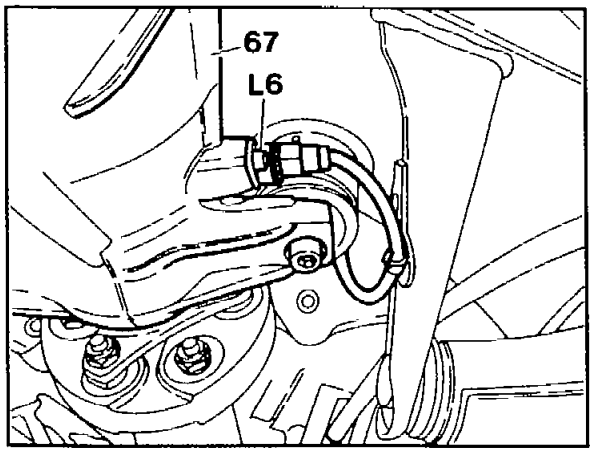


The left/right front wheel-speed sensors (L6/1 and L6/2) are installed in the steering knuckles.



L6/1 Left front wheel-speed sensor

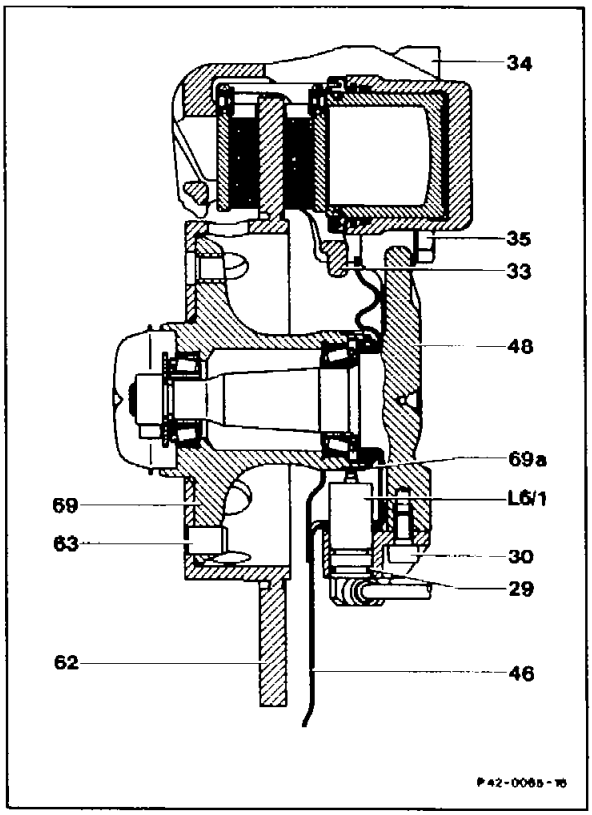
The wheel speed sensor (L6) is located on the rear axle casing (67). The drive pinion serves to measure the mean speed of both rear wheels.



P42-2149-13

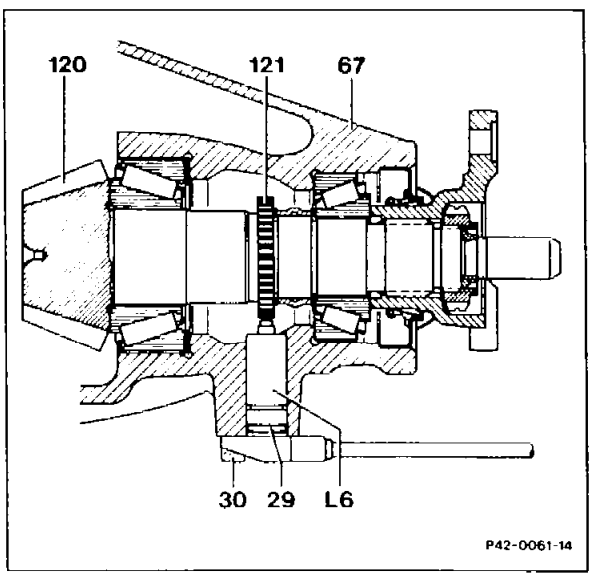
The wheel speed sensors sense wheel speeds by way of the rotor teeth. On the front axle, the rotor teeth (69a) are machined into the front wheel hub (69).

The wheel speed sensors (L6/1, L6/2) on the front axle have a diameter of 18 mm.



29 O-ring, speed sensor
30 Hexagon socket screw
33 Brake caliper, brake anchor
34 Brake caliper, cylinder housing
35 Hexagon bolt
46 Heat shield
62 Brake disc
63 Tensioning sleeve
69 Front wheel hub
69a Teeth (rotor)
L6/1 Left front wheel-speed sensor

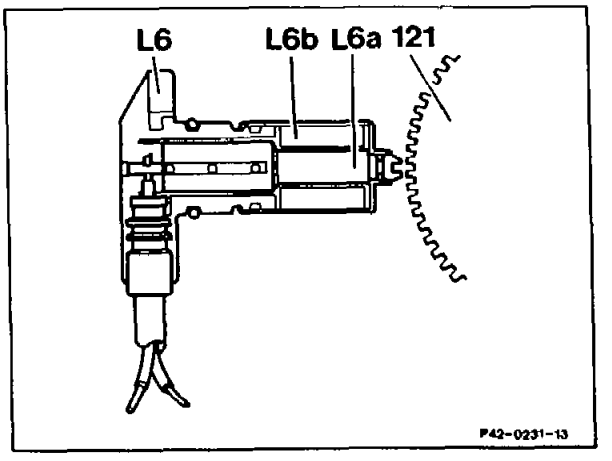
On the rear axle, the rotor is a toothed wheel (121) and pressed onto the drive pinion gear (120). For each rear axle ratio there is a corresponding gear wheel with a different number of teeth. Refer to "RA 42–0714 Removal and installation of wheel speed sensor on rear axle" for assignment of rotor to rear axle.



P42-0061-14

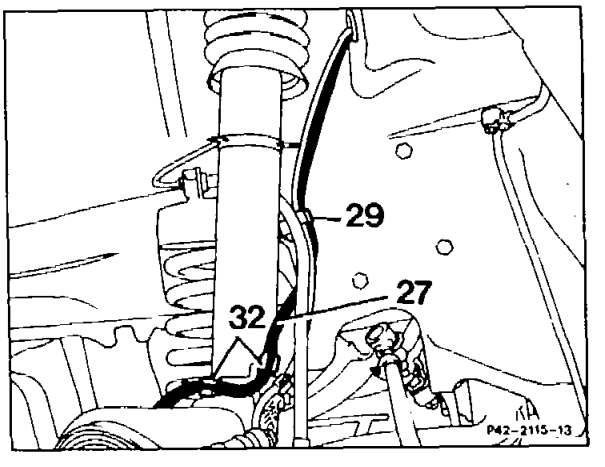
L6 Rear-axle wheel-speed sensor
29 O-ring, wheel speed sensor
30 Hexagon socket screw
67 Rear axle casing
120 Drive pinion gear
121 Toothed wheel (rotor)

Wheel speed sensors consist of a magnetic core and a coil. Rotation of the toothed wheel or rotor, which is located at a given distance in relation to the wheel speed sensor, will change the magnetic field, so that an alternating voltage is induced in the coil. This alternating voltage changes its frequency in accordance with the wheel speed and the number of teeth, i.e. the frequency is proportional to the wheel speed.

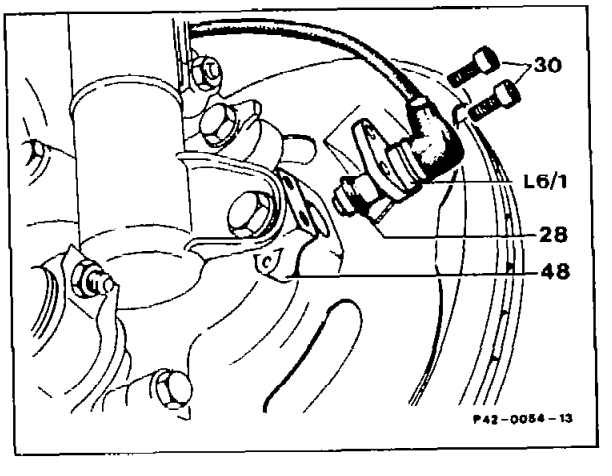


L6 Wheel speed sensor
L6a Magnetic core
L6b Coil
121 Toothed wheel (rotor)

The cable (27) of the wheel speed sensor (L6/1 or L6/2) from the steering knuckle to the coaxial plug in the engine compartment is routed via the bracket (29, 32) in the wheelhouse.



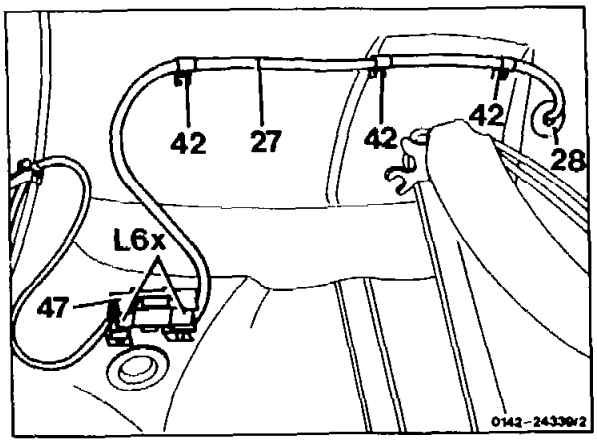
Example models 124, 201



Location - front axle models 124, 201

L6/1 Left front wheel-speed sensor
28 O-ring
30 Fixing bolts
48 Steering knuckle

The wheel speed sensor on the rear axle is connected to the cable harness under the rear seat via the plug connection (L6x).

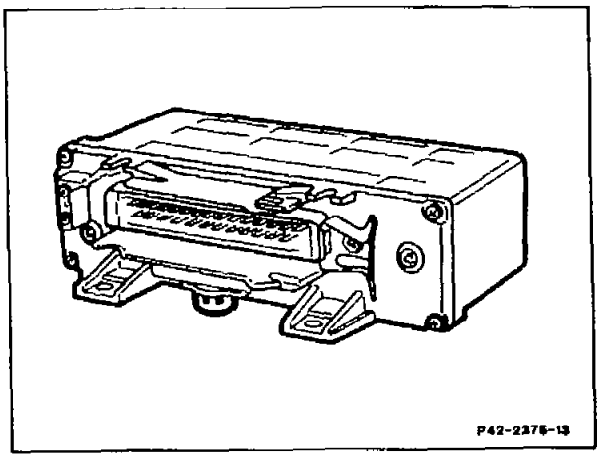


Location - rear axle models 124, 201

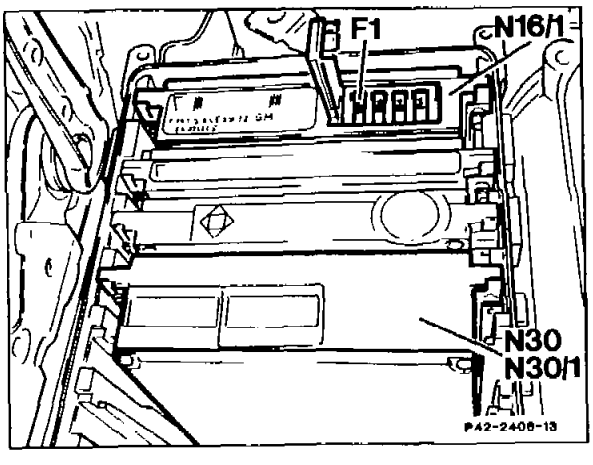
L6x Plug connection
27 Cable - wheel speed sensor
42 Clip

ABS control unit

Model 124 (except 124.034), 129 (except 129.058/063), 201, 202, located on the right side of the engine compartment.



The control unit installed in Models 124.034, 129.058/063, 140 and 202 includes a fault memory. On Models 124, 129 and 140 this is located in the module box. For information on diagnosis and test program, see Chassis Diagnosis Manual, Volume 2, Section 6.



N30 ABS control unit

The control unit processes the signals from the wheel speed sensors and controls the valves in the hydraulic unit.

The entire signal conditioning and signal processing is digital.

The control unit is connected to the ABS main cable harness via a 35-pole plug connection. The electronic control unit is functionally divided into:

- the signal conditioning section
- the logic section and
- the safety circuit.
- fault memory (Model 124.034, 129.058/063, 140, 202)

Signal conditioning section
In the signal conditioning section the signals supplied by the wheel speed sensors are converted into a form suitable for use by the logic section.

To prevent problems while measuring the wheel speed, which may be caused by production tolerances and by movements in the steering knuckle, the input signals are filtered prior to use. Deceleration and acceleration signals obtained from the wheel speed signals are processed in the logic section.

Logic section
The logic section of the ABS control unit employs the following input signals for each controlled wheel or the controlled rear wheels:
wheel slip
wheel speed acceleration
wheel deceleration

Output signals from the logic section control the solenoid valves of the hydraulic unit. As a result, the following hydraulic functions can be generated in the brake calipers of the wheel brakes:

pressure build-up
pressure holding
pressure reduction

Safety circuit
The safety circuit has the job of recognizing faulty signals in the ABS control unit and faults outside the ABS control unit in the electrical installation. In addition, the safety circuit intervenes in the control sequence during extreme driving conditions such as aquaplaning. When a fault is recognized, the system should be switched off, a condition which is indicated to the driver by the ABS malfunction indicator lamp coming on.

The safety circuit continuously monitors the battery voltage. If the voltage is below specific requirements (11 V), the system is also switched off until the voltage returns to the specified range.

In addition to monitoring operation, the safety circuit also incorporates an active component, a test cycle with the designation **BITE** (Built In Test Equipment).

The test cycle begins as soon as the wheel speed in all three speed channels is higher than 5-7 km/h. The cycle is activated by the wheel speed sensor voltage, which is monitored automatically at the same time. The test cycle itself checks parts of the monitoring circuit as well as the logic section. For this purpose, the electronic control unit is fed with the specific test sample signals to check whether the correct output signals are available.

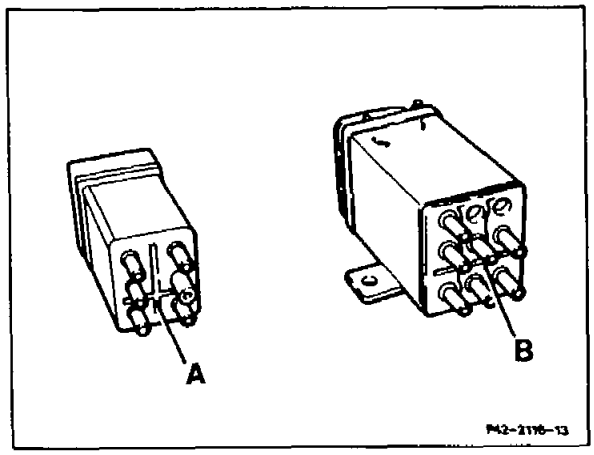
Fault memory

The control unit installed on Models 124.034, 129.058/063, 140 and 202 incorporates a fault memory and is thus suitable for fault diagnosis. Recorded errors remain stored even when the battery cable is disconnected.

Relay with overvoltage protection

To guarantee the function of the ABS system under all operating conditions, the power supply is switched via a relay, which is activated by terminal 15 (ignition lock).

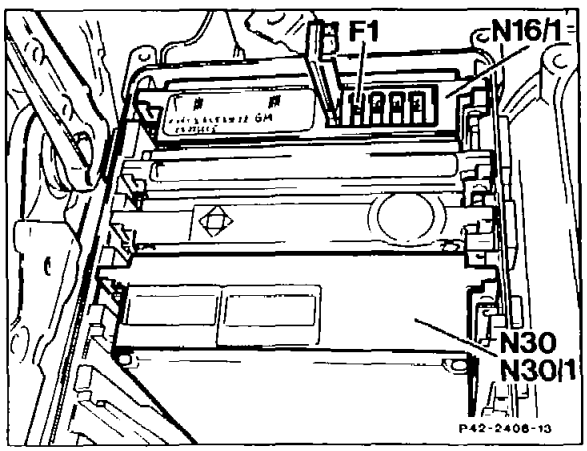
The overvoltage protection, which protects the electronic control units against overvoltages is connected in series between the battery and relay (ABS, CIS-E, ASD or ASR).



A 5-pole
B 7-pole

The relay and the overvoltage protection form one unit. The overvoltage protection has a replaceable fuse. A 4-pole overvoltage protection was fitted on models 124, 201 up to December 1984. On vehicles as of January 1985, depending on the vehicle model and special equipment, a 5-, 7- or 9-pole overvoltage protection relay has been fitted.

On Models 124.034, 129.058/063 and 140 the electrical current is supplied by the basic module (N16/1). This is located along with the control unit (N30) in the module box.



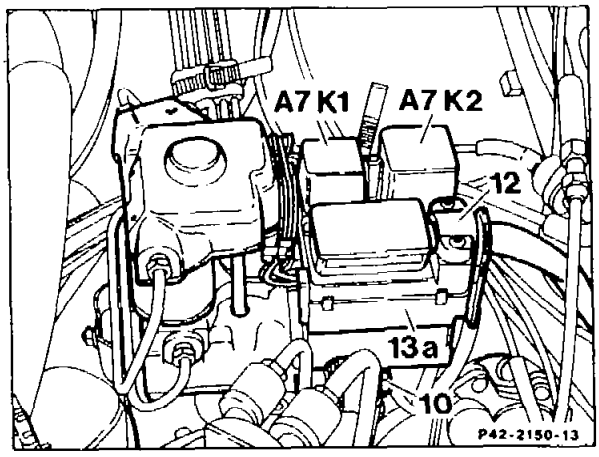
N16/1 Basic module

ABS hydraulic unit (A7)

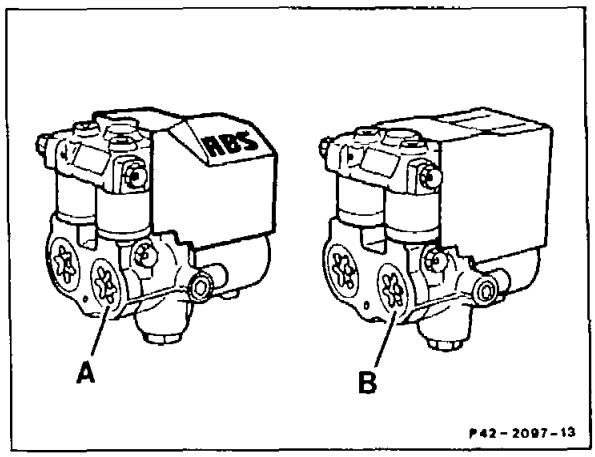
Two relays are located under the cover of the hydraulic unit. Relay (A7K2) activates the return pump and current flows to the solenoid valves via relay (A7K1).

A diode soldered into the plug socket (13a) controls the ABS malfunction indicator lamp in the instrument cluster when the multipin plug is disconnected from the electronic control unit.

Phased in at the beginning of 1986, the diode is no longer located in the plug socket but in the solenoid valve relays. The new relay has 6 contact pins (previously 5).



In connection with the appropriate relay and fixing clamps the revised design of hydraulic unit can also be installed in vehicles produced earlier. It can be recognized on the outside by the inclined cover with the letters ABS (item A).



Electric wiring diagrams

For electric wiring diagrams and information on the layout of wires and plug connectors as well as relay and control unit locations, consult the manuals: "Electric wiring diagrams"

G. Revised brake-force distribution between front and rear axles Model 124.036 from 02/93, 129.076 and 140.04/05/07

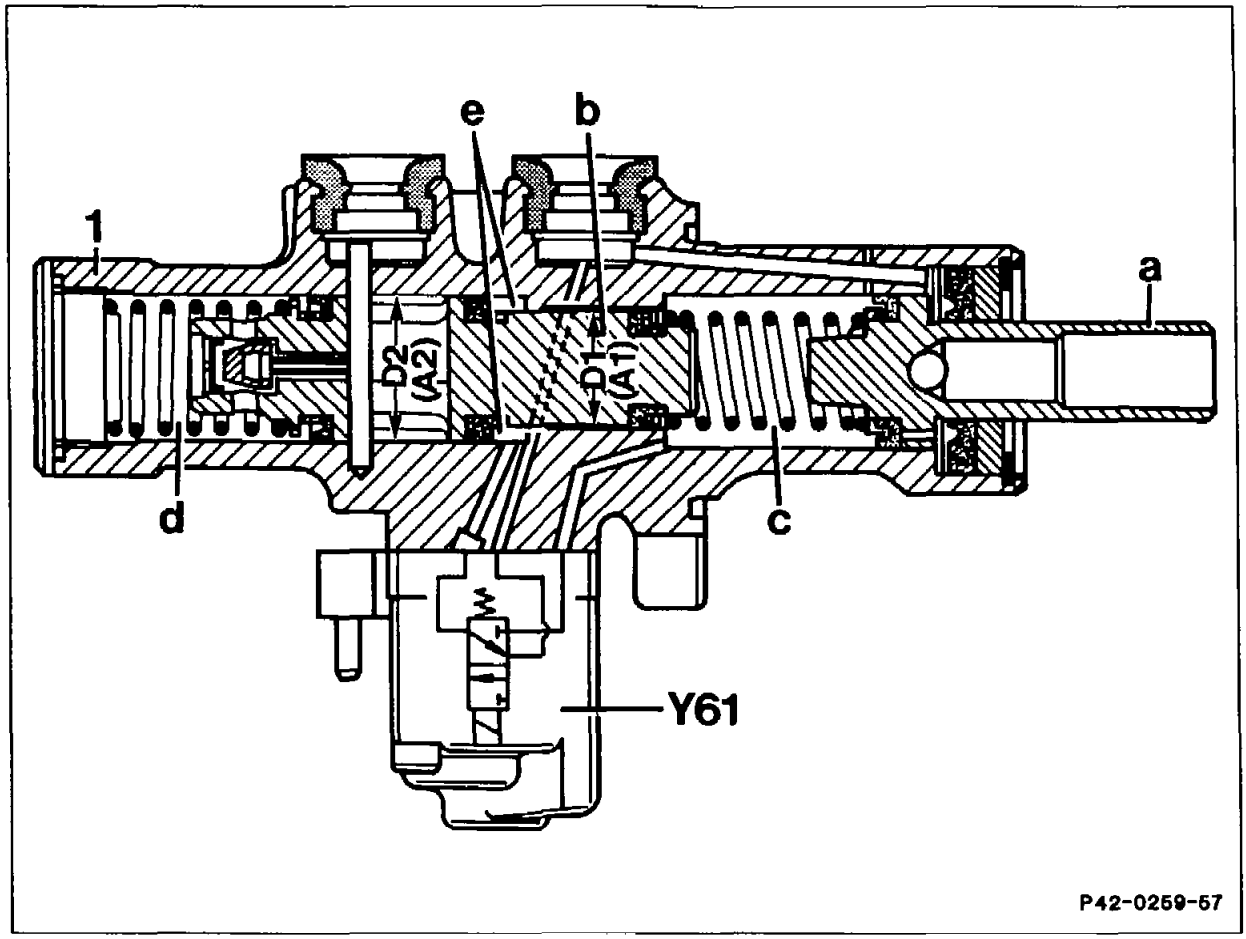
The propertion of total braking force applied at the rear axle has been substantially increased in order to reduce both thermal loads and brake wear at the front.

To enhance stability under braking, active ABS control begins earlier at the rear axle. The revised brake-force distribution is provided by a newly-developed, tandem master cylinder with variable duistribution.

To prevent the application of excessive braking force at the rear axle under special circumstances, the unit incorporates a switchover valve to return to standard brake-force distribution at high cornering speeds or when an ABS fault has been recognized.

Revised brake-force distribution
Ratio, front to rear axle:
Model 124.036 from 02/93 and 129.076 = 65.6:34.4
Model 140.04/05/07 = 63:37

Standard brake-force distribution
Ratio, front to rear axle:
Model 124.036 from 02/93 and 129.076 = 74.3:25.7
Model 140.04/05/07 = 72:28



1	Tandem master cylinder	A1	Smaller effective area
a	Pushrod piston	A2	Larger effective area
b	Floating piston	D1	Small diameter
c	Pressure chamber for front circuit	D2	Large diameter
d	Pressure chamber for rear circuit	Y61	Master cylinder switchover valve
e	Supplementary pressure chamber (ring chamber)		

Tandem master cylinder with variable distribution

Diameter of pressure piston: 1 1/16"
Floating diameter: 1"
Diameter of floating piston: 13/16"

The basic design corresponds to that of a conventional master cylinder with pressure (a) and floating piston (b). The master cylinder switchover valve (Y61) enlarges the effective area (A1) of the floating piston (b) to the larger area (A2) to achieve a hydraulic pressure ratio of 1:1 between front and rear axles.

Operation with ABS in ready state (normal operation)

The master cylinder switchover valve (Y61) is triggered **only** when the brakes are applied; the control circuit runs from the brake-light switch and through the ABS control unit (N30).
When the valve is activated, it establishes a connection between the pressure chamber (c) for the front brake circuit and the supplementary pressure chamber (ring chamber, e) while simultaneously blocking the return line to the brake fluid reservoir. The pressure on the floating piston (b) for the rear circuit is exerted against the smaller effective area (A1) + supplementary pressure chamber (ring chamber, e) = larger effective surface A2.

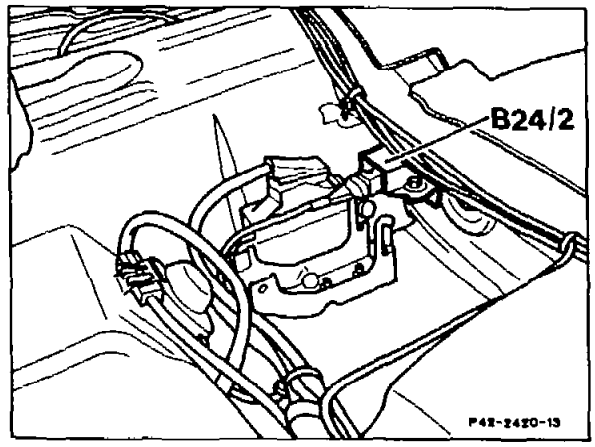
Operation with ABS in ready state and high lateral acceleration or after recognition of ABS fault

In order to prevent excessive brake force at the rear axle at immoderate cornering speeds or when an ABS fault has been recognized, the switchover valve responds to these conditions by switching the master cylinder to standard brake-force distribution.
When the lateral acceleration rises to in excess of 0.4 g, or an ABS error is recognized, no signal is transmitted to the master cylinder's switchover valve (Y61) and the master cylinder remains in its basic position.
When the ABS is operational, the brake-force distribution on the Model 140 is regulated to 72:28, with 74,3:25.7 on the Models 124.036 and 129.076.

When an ABS error is present, the brake-force distribution remains the same for unregulated braking.
Pressure is bled from the supplementary pressure chamber (ring chamber, e) via the passage to the fluid reservoir.
Pressure is exerted only against the smaller effective area (A1) of the floating piston (b), that is, the brake pressure applied at the rear is reduced in proportion to the reduction in effective pressurized area; the proportion of total braking force applied at the rear sinks into a range correspondingg to standard distribution.

ABS lateral-acceleration sensor

The ABS lateral-acceleration sensor (BN24/2) installed under the rear seat provides the ABS (or ASR) control unit with information on the lateral forces that occur during cornering. At high rates of lateral acceleration it triggers the change in brake-force distribution.



The ABS control unit (N30) processes the signals from the lateral-acceleration sensor (B24/2) and transmits control signals to the switchover valve in the master cylinder (Y61). Operating voltage is supplied by the basic module (N16/1). The control units are installed in the module box.