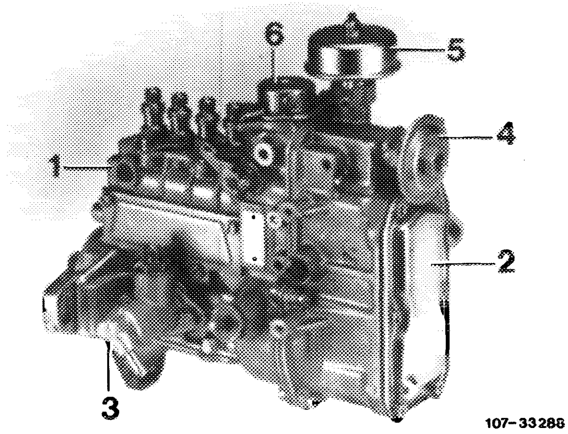
07.1-003 Explanation of injection pump type plate

For example **PES 5 M 55 C 320 RS 158/1**

P	Pump
E	Self-driven
S	Front flange attachment
5	Number of cylinders
M	Pump size
55	Element diameter in 1/10 mm
C	Character of revision
320	Assembly number
R	Direction of rotation
S158/1	Special version

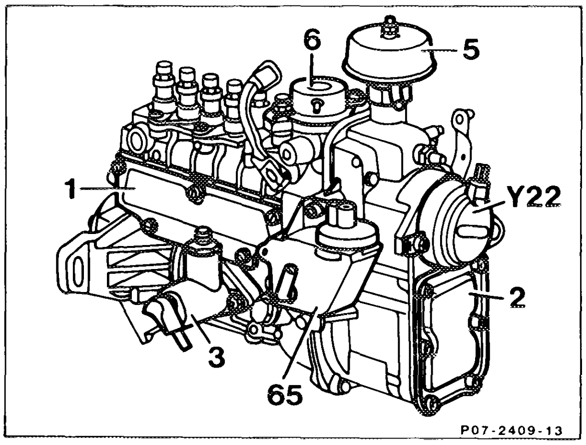


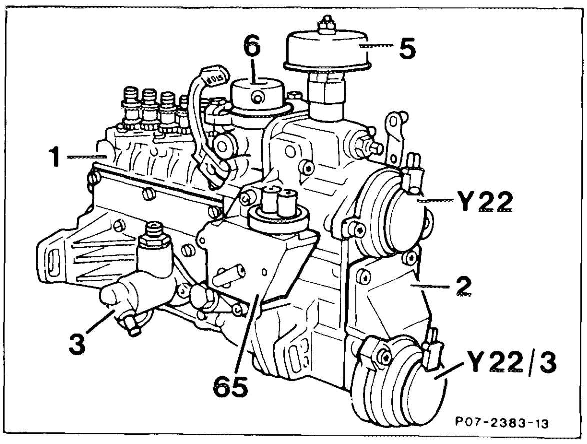
RSF- governor

R	Governor
S	Coil spring
F	Drive control

Arrangement of components

1	Injection pump
1b	Type plate
2	Governor
3	Fuel pump
4	Vacuum unit idle speed increase
5	ADA unit
6	Stop unit
65	Vacuum control valve
Y22	Electromagnetic actuator ELR





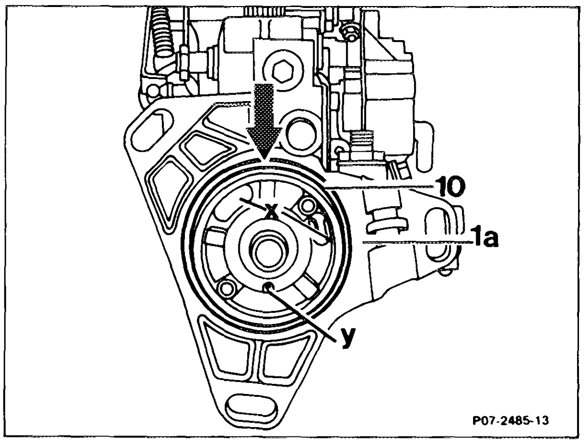
A. Lubrication of injection pump

The injection pump is connected to the engine oil circuit by way of an oil hole (arrow).

The oil returns to the crankcase by way of the circular groove (x) between bearing and housing.

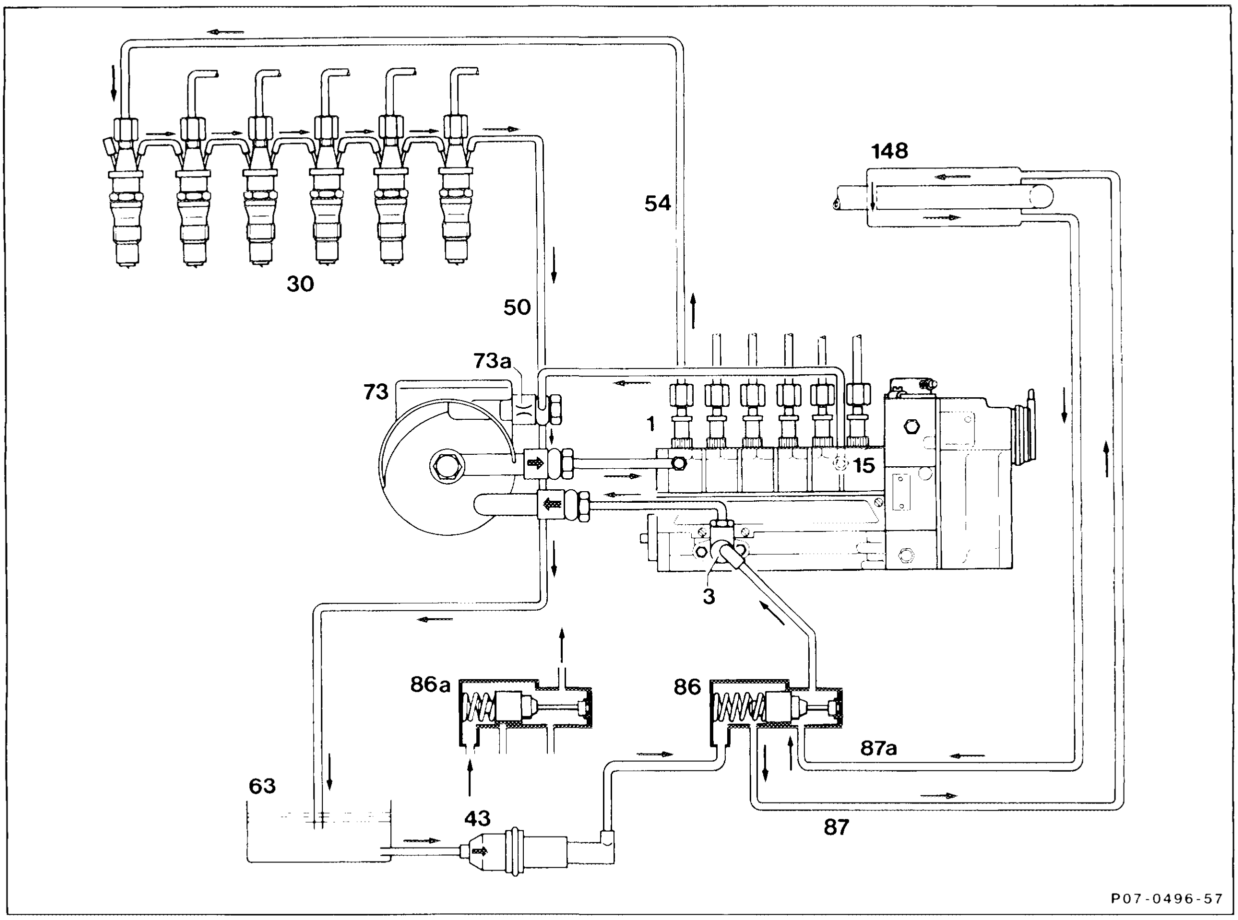
The O-ring (10) on the flange (1a) seals.

The hole (y) serves to reduce the load exerted by the oil on the radial sealing ring.



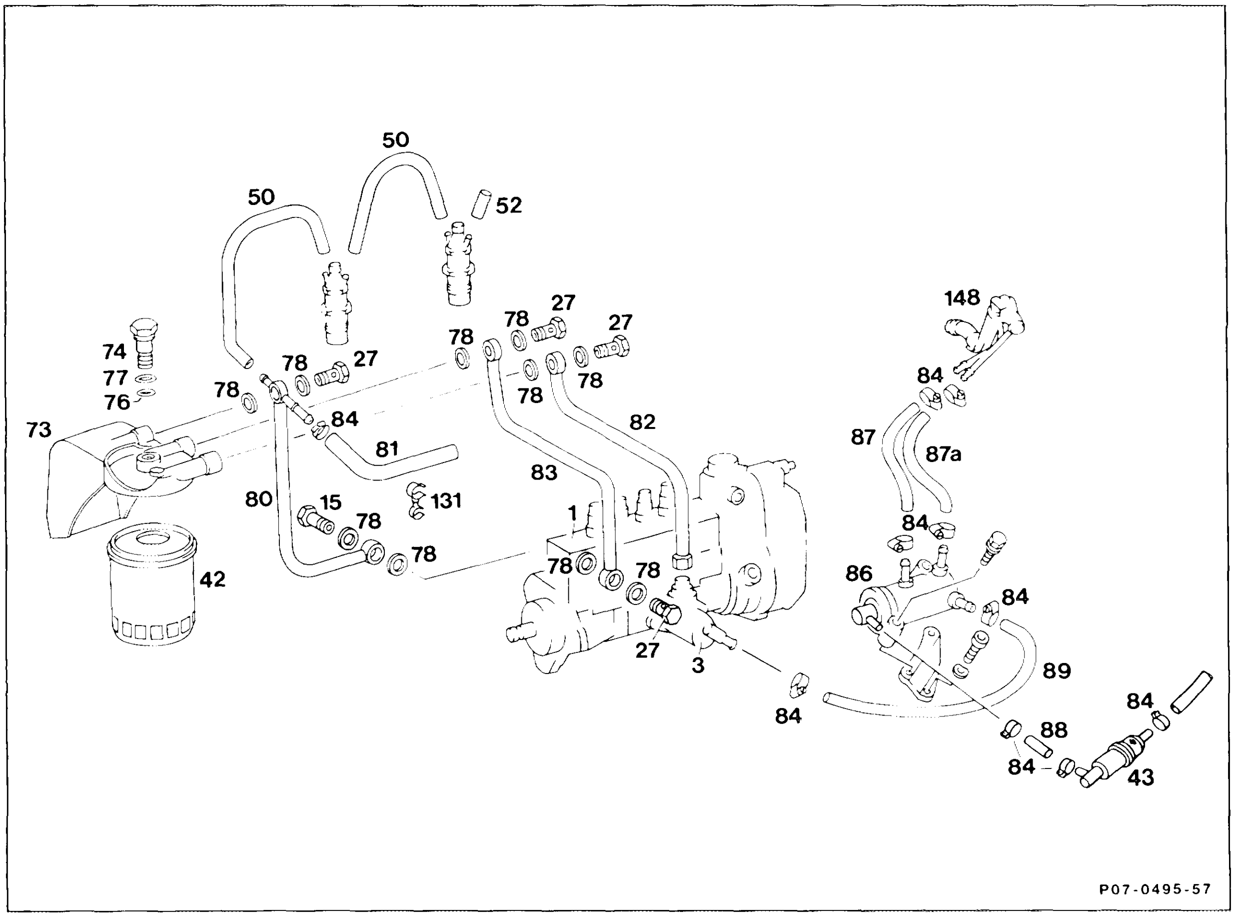
B. Fuel circuit

a) Fuel circuit diagram



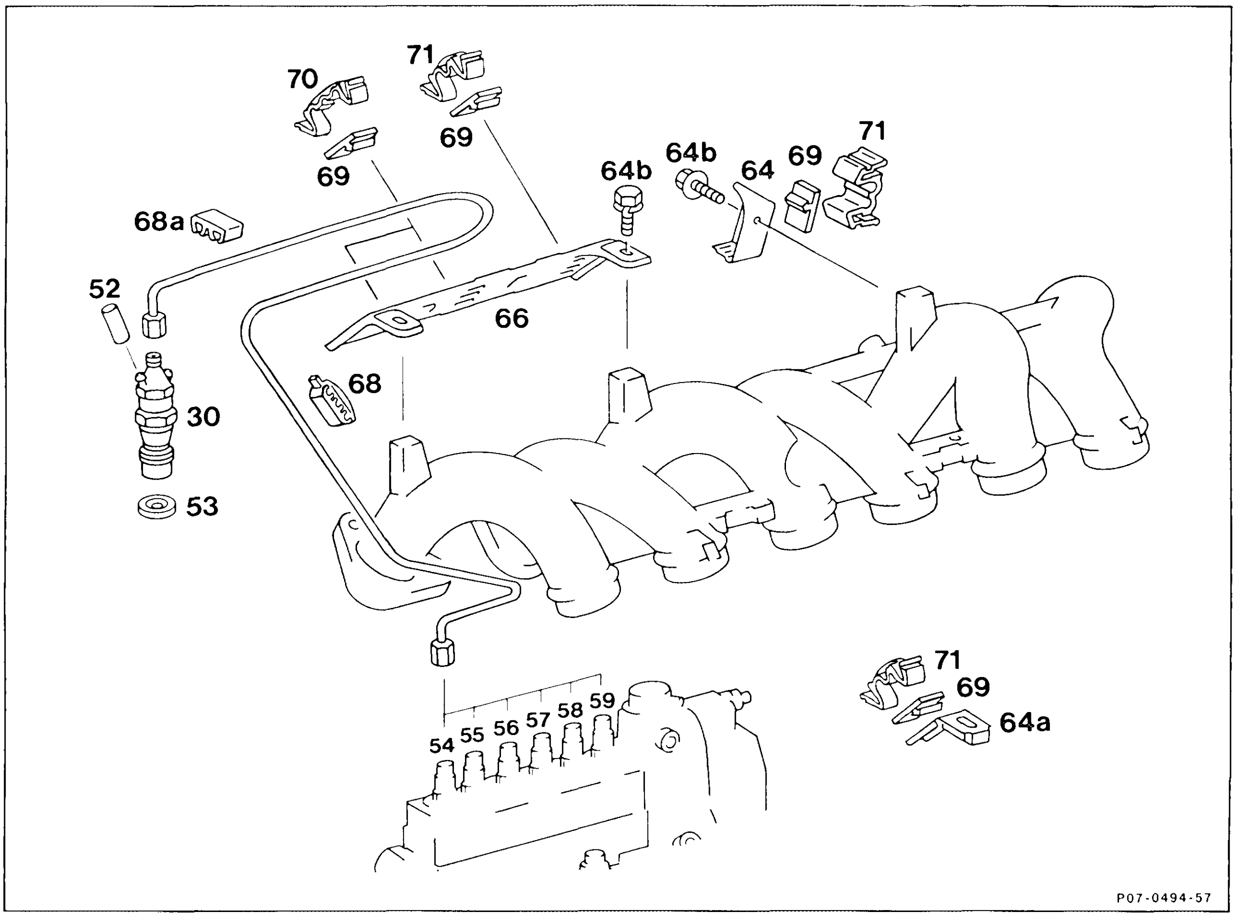
1	Injection pump	73a	Choke orifice in fuel filter upper part 0.8 mm diameter
3	Fuel pump	86	Fuel thermostat open, position up to +8 °C, fuel is preheated
15	Overflow valve with choke dia. 1.5 mm	86a	Fuel thermostat closed, as of +25 °C, fuel is no longer preheated
30	Injection nozzles	87	Supply line - cold fuel
43	Fuel prefilter	87a	Return line - preheated fuel
50	Leak-off fuel hose	148	Heater supply pipe with fuel heat exchanger
54	Injection line cylinder 1		
63	Fuel tank		
73	Fuel filter upper part		

b) Low-pressure side



1	Injection pump	79	Banjo fitting
3	Fuel pump	80	Return line
15	Overflow valve with choke dia. 1.5 mm	81	Hose return
27	Hollow screw	82	Supply fuel filter
42	Fuel filter	83	Supply injection pump
43	Fuel prefilter	84	Hose clamp
50	Leak-off fuel hose	86	Fuel thermostat
51	Hose clamp	87	Supply line fuel heat exchanger
52	Screw plug	87a	Return line fuel heat exchanger
73	Fuel filter upper part	88	Supply fuel thermostat
74	Hollow screw fuel filter	89	Suction line fuel pump
76	O-ring	131	Fuel holder
77	Seal fuel filter	148	Heater supply pipe with fuel heat exchanger
78	Sealing ring		

c) High-pressure side



1	Injection pump	64	Holder, cylinder 4, nozzle side
30	Injection nozzle complete	64a	Holder, cylinder 4, pump side
52	Screw plug	64b	Screw
53	Nozzle plate	66	Holder, lines
54	Injection line 1	68	Plastic clip
55	Injection line 2	68a	Plastic clip
56	Injection line 3	69	Rubber backing
57	Injection line 4	70	Plastic holder for 3 lines
58	Injection line 5	71	Plastic holder for 2 lines
59	Injection line 6		

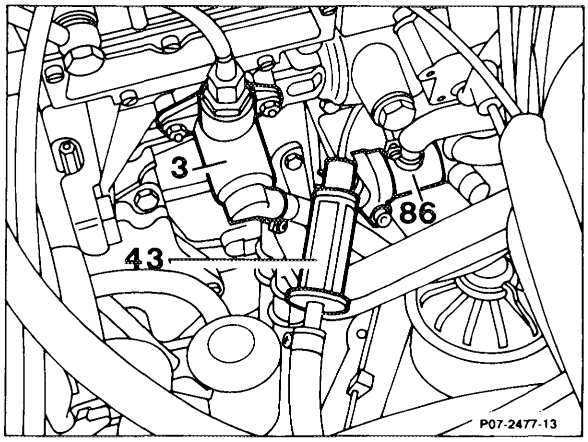
Note

Injection line cylinders 2 - 6 not shown in the figure.

Injection line cylinders 5 - 6 holders as of cylinder 4.

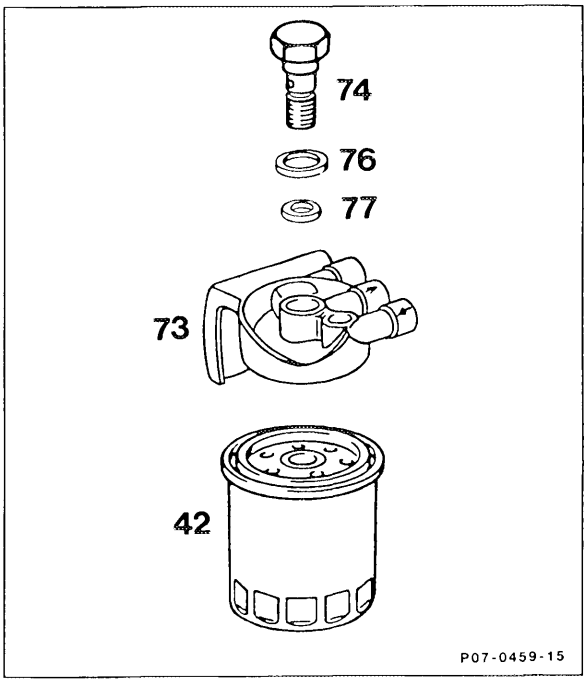
C. Fuel prefilter (43)

Installed in the suction line ahead of the fuel pump (3). The filter housing is made of transparent plastic material.
The mesh size is 0.6 mm (600 µm).



D. Fuel filter (42)

Installed in the delivery line between fuel pump and injection pump.
The paper filter element is integrated in a metal housing. The paper element has a mean pore size of 0.006-0.01 mm (6-10 µm).

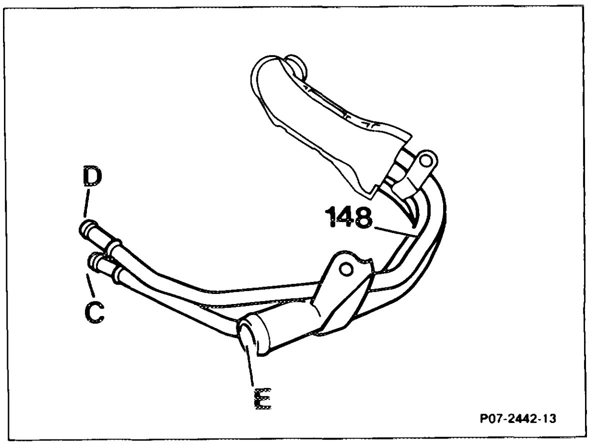


42	Filter
73	Fuel filter upper part
74	Screw
76	O-ring
77	Sealing ring (aluminum)

Note
Owing to the greater delivery capacity of the fuel pump and the chokes in the filter upper part and on the injection pump the fuel system is bled automatically during starting.

E. Fuel preheating (148)

A heat exchanger (148) for preheating the fuel is installed in the supply line of the heating system.



Heat exchanger

C Supply
D Return
E Heater supply
148 Heat exchanger

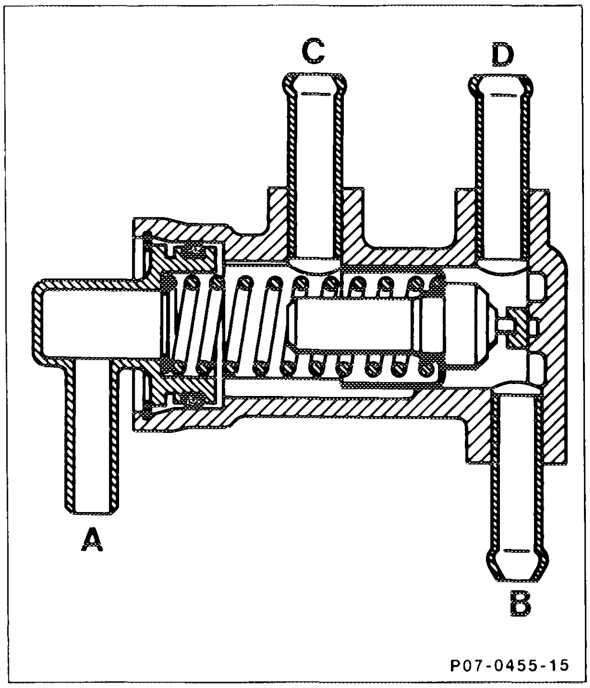
Function

Full preheating up to +8 °C fuel temperature; the required fuel is drawn via the heat exchanger by the fuel pump.

From +8 °C to +25 °C mixed operation; the required fuel flows partially via the heat exchanger.

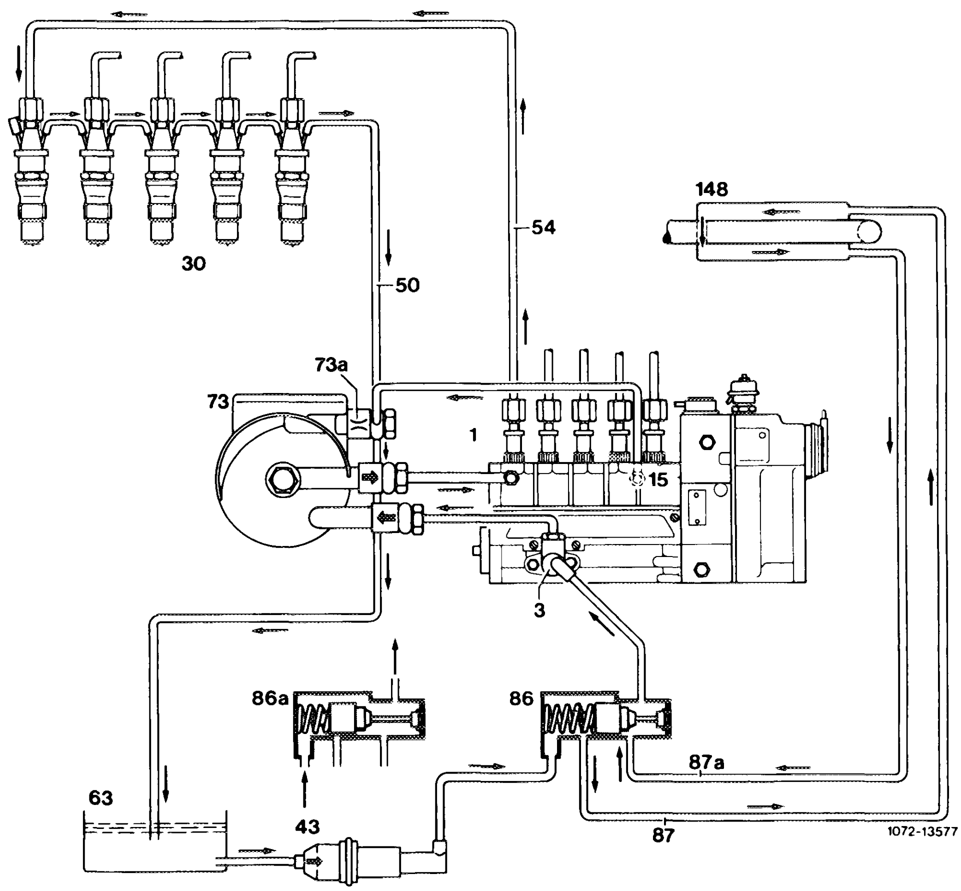
Above +25 °C the heat exchanger is by-passed by the thermostat action; the fuel pump draws the fuel directly.

The fuel preheating allows trouble-free operation with winter diesel fuel usually up to approx. -25 °C outside temperature.



Fuel thermostat

A Supply from fuel tank
B Suction line to fuel pump
C Supply to heat exchanger
D Return from heat exchanger



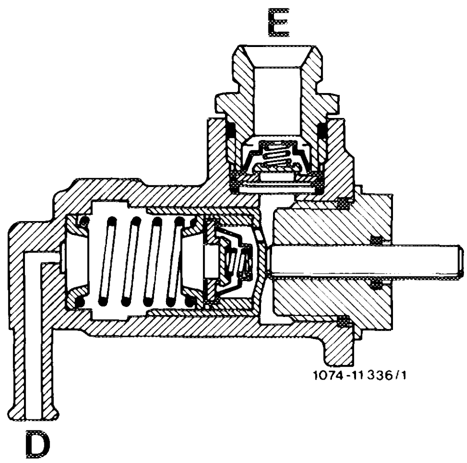
Function diagram fuel preheating

1	Injection pump	54	Injection line cylinder 1
3	Fuel pump	63	Fuel tank
15	Overflow valve with choke 1.5 mm dia.	73	Fuel filter upper part
30	Nozzle holder combination	73a	Choke orifice in fuel filter upper part
42	Fuel filter	86	Fuel thermostat up to +8 °C
42a	Choke orifice in fuel filter upper part 0.8 mm diameter	86a	Fuel thermostat above +25 °C
		87	Supply line (cold fuel)
43	Fuel prefilter	87a	Return line (preheated fuel)
50	Fuel bleed hose	148	Fuel heat exchanger

F. Fuel pump

The increased delivery capacity of the fuel pump ensures that the fuel system is bled automatically. The manual priming pump is no longer required.

Rate of delivery > 150 cm^3/30 s, with starter speed > 150/min, in fuel return.

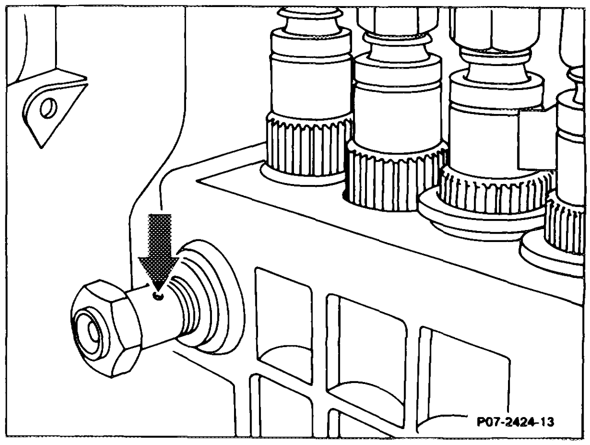


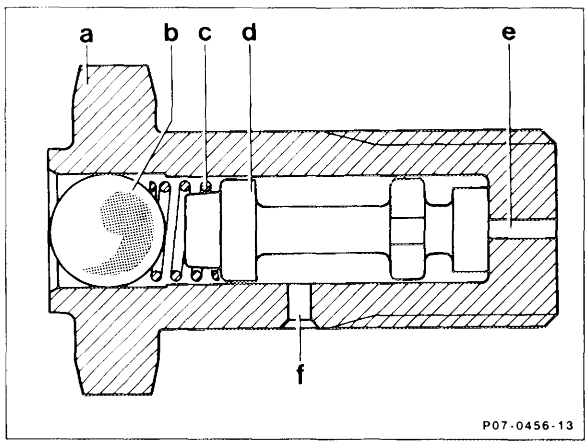
E Suction side
D Delivery side

A choke in the overflow valve on the injection pump is required for bleeding the injection pump.

Overflow valve with choke dia. 1.5 mm (arrow).

The overflow valve prevents unfiltered fuel from reaching the injection pump via the return line if the supply is clogged (e.g. filter).



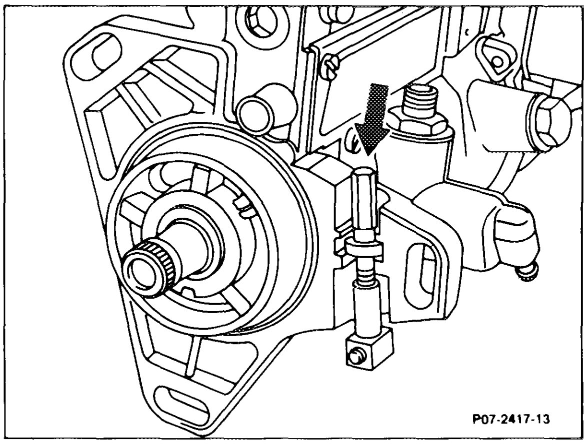


Choke with overflow valve

a Housing
b Ball
c Spring
d Plunger
e Supply
f Choke orifice dia. 1.5 mm

G. Start of delivery adjusting device

An adjusting device (arrow) is provided on the injection pump flange in order to allow adjustment of start of delivery with the engine running.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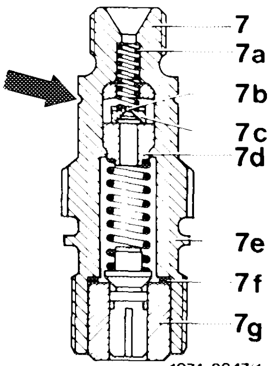
H. Relief chokes in delivery valve holder

In order to reduce the hydrocarbon content in the exhaust gas, relief chokes (7b) are installed in the delivery valve holders (7) of the injection pump. The delivery valve holders with relief choke are identified externally by one or two circular grooves (arrows). The relief choke (7b) is a plate valve (7c) with a choke orifice opening in the direction of the injector. The choke orifice for all engines is 0.45 mm diameter.
The valve seat (7d) is riveted into the delivery valve holder.



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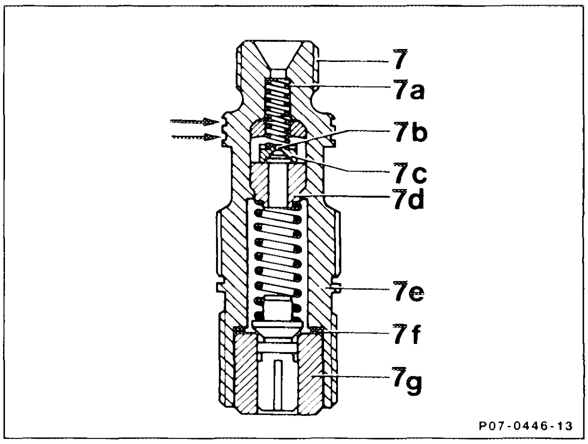
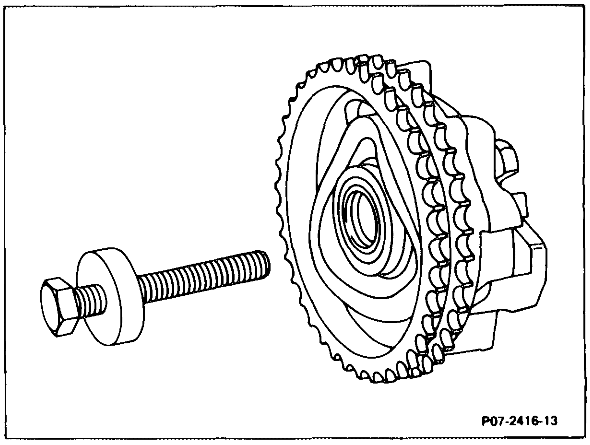
7 Delivery valve holder connection
7a Spring
7b Relief choke
7c Plate valve
7d Valve seat
7e Delivery valve holder
7f Seal
7g Delivery valve



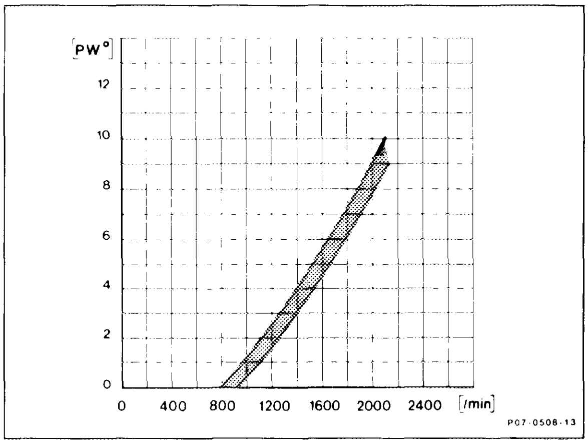
I. Injection timing device

The timing device is mounted on the injection pump shaft and secured with a left-hand threaded center bolt.



Timing device advance curve

n = 1/min injection pump
PW° = Advance angle injection pump

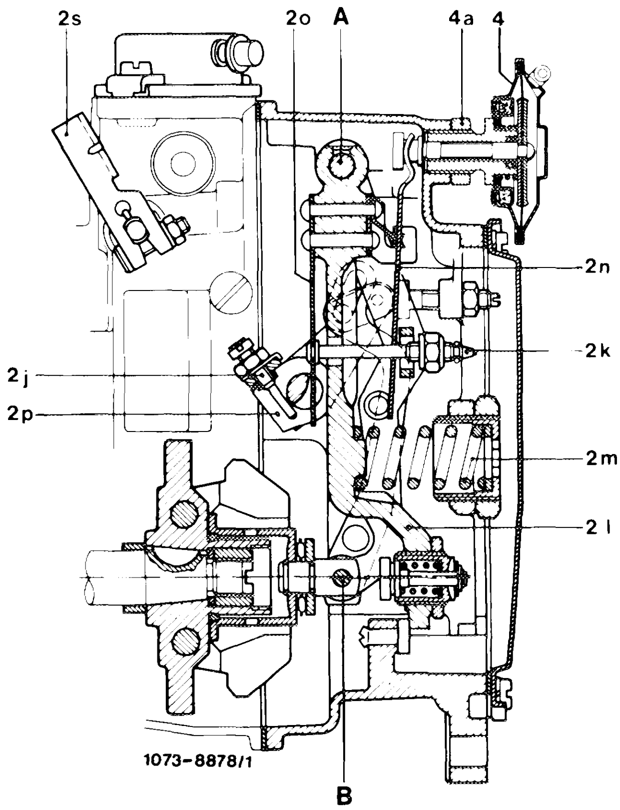


J. RSF governor, construction and mode of operation

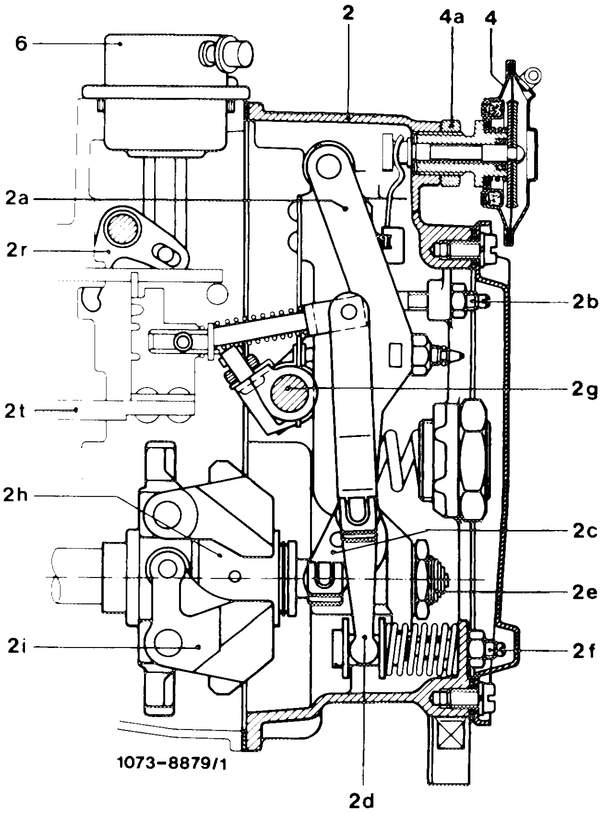
The governor is an idle speed/maximum speed governor whose control spring (2m) is dimensioned and adjusted such that, with the exception of torque control (see "Speed regulation during starting and full-load operation"), it does not regulate in the part load range.

In the part load and full-load ranges the control rod (2t) of the injection pump is only actuated by the accelerator pedal which is connected with the adjusting lever (2g) of the governor by way of the control linkage.

The vacuum unit (4) serves to preload the idle speed spring (2n) and adjust the idle speed.

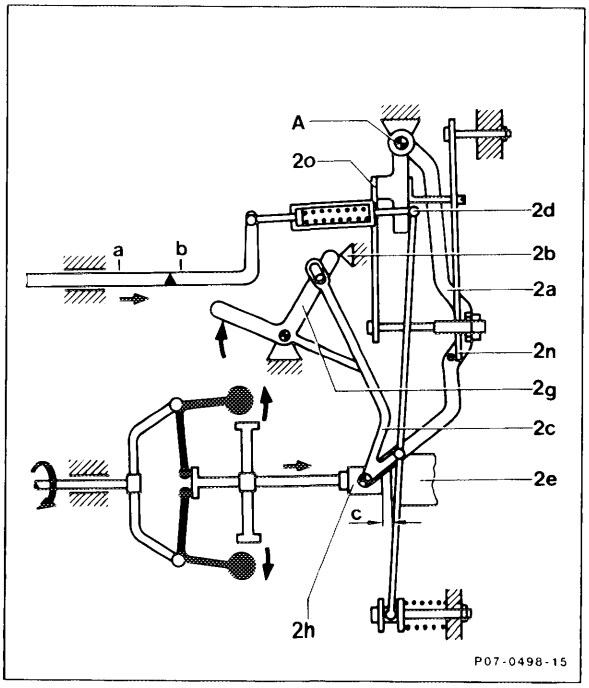


2 Governor
2a Guide lever
2b Stop screw for idle speed volume
2c Reverse-transfer lever
2d Fulcrum lever
2e Spring capsule (torque control)
2f Full-load adjusting screw
2g Control lever
2h Sliding sleeve
2i Flyweights (pump governor assembly)
2j Idle speed auxiliary spring shut-off
2k Adjusting screw for idle speed auxiliary spring (tickler)
2l Tension lever
2m Governor spring
2n Idle speed spring
2o Idle speed auxiliary spring (tickler)
2p Control lever
2r Stop lever
2s Emergency stop lever
2t Control rod
4 Vacuum unit idle speed increase
4a Idle speed adjusting nut
6 Vacuum unit (stop)



a) Idle speed regulation

The adjusting lever (2g) contacts the idle speed stop screw (2b). With increasing speed the sliding sleeve (2h) passes through the idle speed stage. The guide lever (2a) pivots around the fulcrum "A" in this way acting against the idle speed spring (2n).



a Start
b Stop
c Idle speed stage

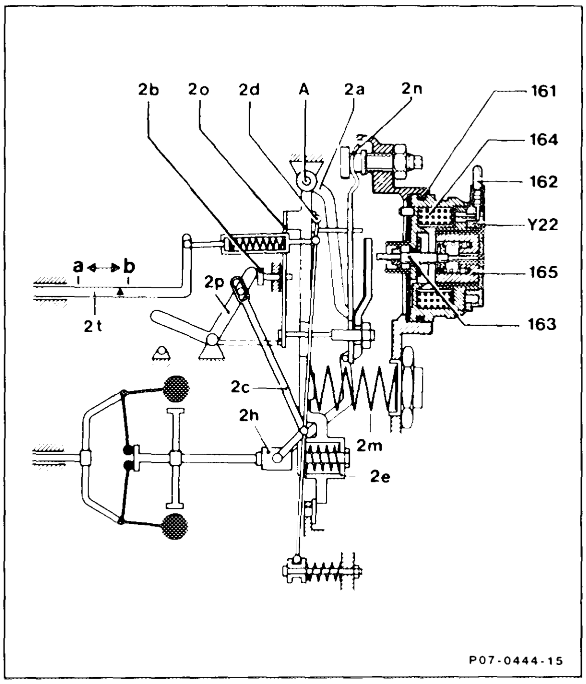
At a certain engine speed (approx. 600/min) the guide lever (2a) contacts the adjusting nut of the idle speed auxiliary spring (2o). The movement of the sliding sleeve (2h) is transferred to the injection pump control rod in the same direction via the reverse-transfer lever (2c) and the control lever (2d). After passing through the idle speed stage the sliding sleeve (2h) contacts the spring capsule (2e).

If the engine speed continues to rise (e.g. while coasting), the spring capsule (2e) and then the governor spring (2m) are overcome at a certain speed. The control rod is then moved into "stop position" (deceleration shut-off).

b) Speed regulation with electromagnetic actuator

The stroke rod (163) contacts the guide lever (2a). The electromagnetic actuator (Y22) is supplied with a timed DC voltage in the frequency range of approx. 50 Hz from the control unit (electronic idle speed control).

If the engine speed drops (e.g. when engaging the driving position or power steering at the end limit), the electromagnetic actuator is given a higher voltage. As a result the stroke rod (163) will push against the guide lever (2a) and the control rod (2t) moves in the direction "a" **more volume.**



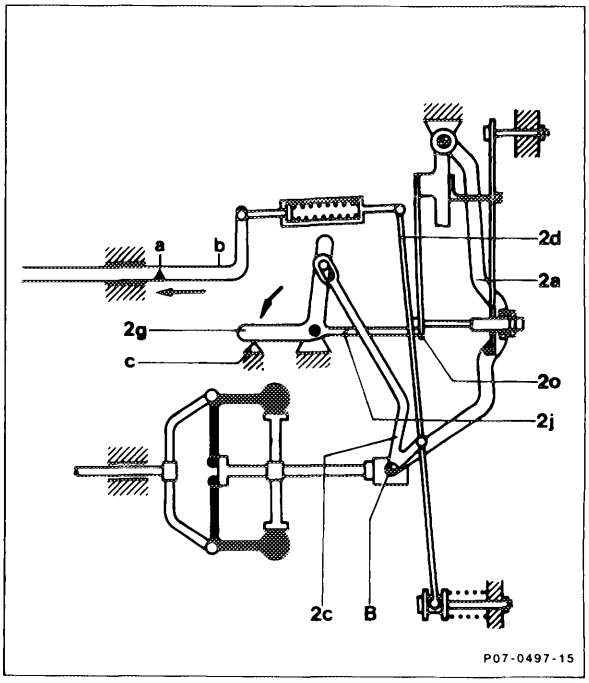
161 Sealing ring
162 Electrical connection
163 Stroke rod
164 Magnetic coil
165 Magnetic core

As soon as the engine speed rises, the voltage is reduced and the control rod (2t) moves in the direction "b" **less volume.**

c) Start position

If, with the engine stationary, the control lever (2g) contacts the full-load stop (c), the reverse-transfer lever (2c) pivots around the fulcrum "B", taking with it the fulcrum lever (2d) in the direction of start.

With the control lever (2g "full throttle") in full-load position the idle speed auxiliary spring (2o, tickler) is pushed off the guide lever by the idle speed auxiliary spring shut-off (2j). This allows faster speed regulation from the starting position of the governor.



a Start
b Stop

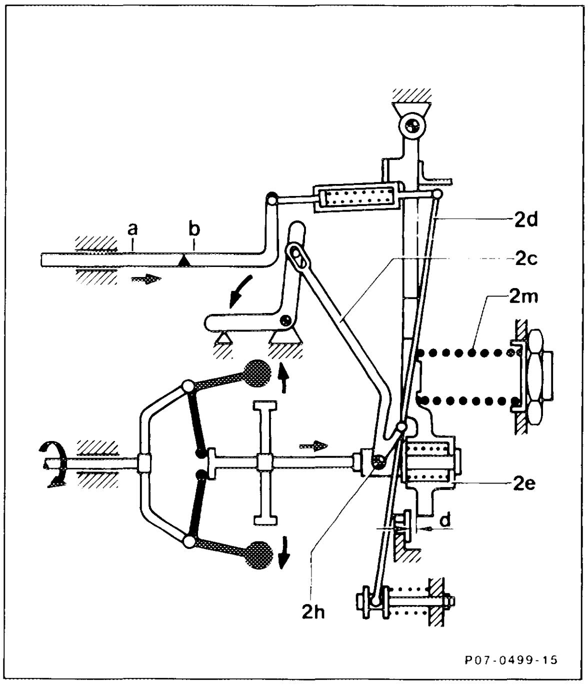
d) Maximum speed regulation/torque control

After passing through the idle speed stage (c) (see figure regulation at idle speed) the sliding sleeve (2h) contacts the spring capsule (2e). In this way the control rod of the injection pump is brought into full-load position via the reverse-transfer lever (2c) and the fulcrum lever (2d).

When a certain speed has been reached, the spring capsule (2e) is pushed on by a specified distance (d) (torque control).

If the speed of the engine rises again, the force of the flyweights is sufficient to overcome the control spring (2m) (maximum speed regulation).

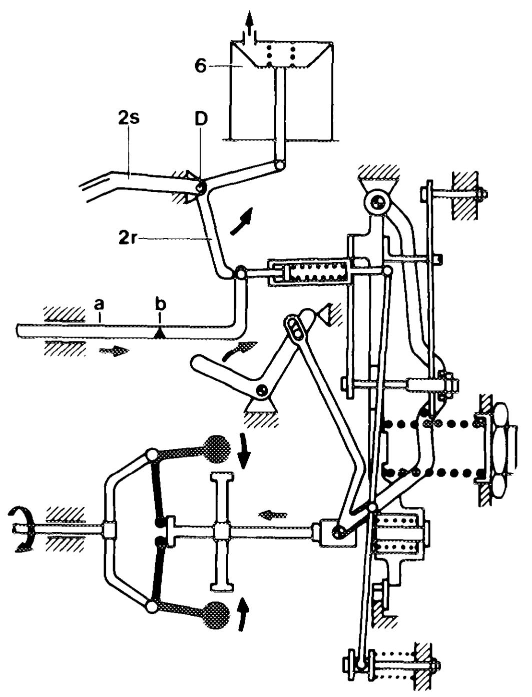
The start of the speed regulation is dependent on the preload of the governor spring (2m).



e) Shut off

The vacuum unit (6) is connected to vacuum from the vacuum pump via the glow starter switch of the vehicle. As a result, the diaphragm of the vacuum unit is pulled against the compression spring.

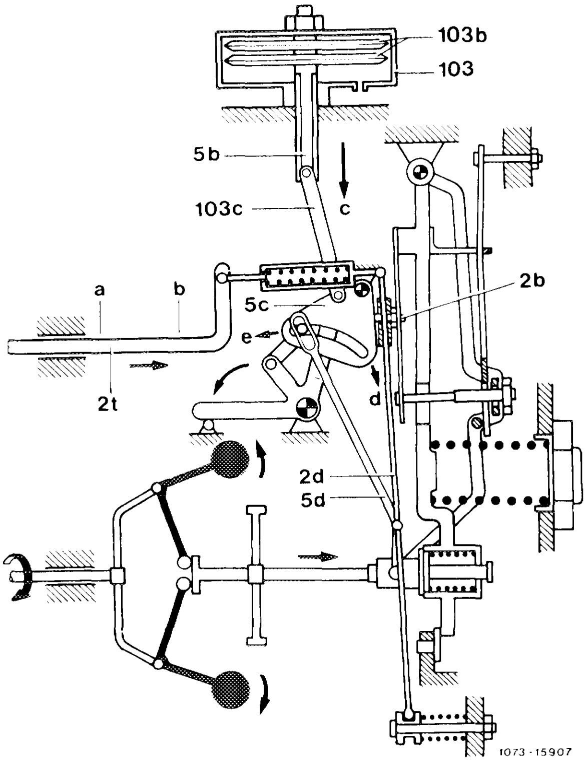
The vacuum unit (6) is connected with a stop lever (2r). This lever pivots around the fulcrum "D" pulling the control rod of the injection pump into the "stop position". The bypass spring of the fulcrum lever is overcome in this process. Via the emergency stop lever (2s) the control rod can likewise be pulled into "stop position" on the outside of the governor.



a Start
b Stop

K. Atmospheric pressure-dependent full-load stop (ADA)

The atmospheric pressure-dependent full-load stop serves to correct the low air density at higher altitudes.

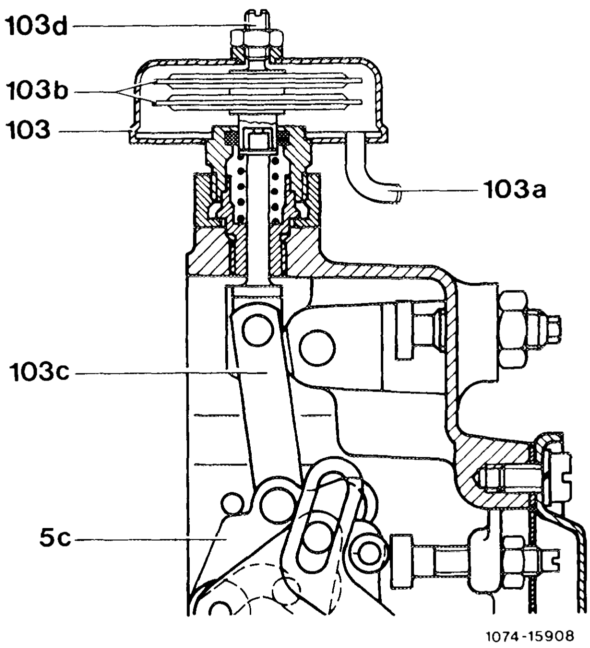


Mode of operation with a **reduction of pressure** with increasing altitude. With diminishing pressure the aneroid boxes (103b) expand, pushing the ADA correction linkage (103c) in direction (c). The ADA guide pin (5b) continues to push the ADA correction linkage (103c) in the direction of (c), pivoting the ADA template (5c) in the direction of (d).
With the ADA template the toggle lever (5c) and the reverse-transfer lever (5d) pivot in the directions of (e) and (d). The reverse-transfer lever now pulls the control rod (2t) in stop direction (b) via the fulcrum lever (2d).
In this way the pressure drop causes a reduction of the full-load volume.

A **pressure rise** results in the process taking place in reverse order.

The atmospheric pressure-dependent full-load stop consists of aneroid boxes vertically installed in a housing, and which have been adjusted to a certain barometric level by means of an adjusting screw and counteracting spring-loaded threaded pin. Within the operating range of the aneroid boxes an expansion takes place with decreasing air pressure. The spring- loaded threaded pin on the lower side of the aneroid boxes and the connected levers transmit the changes in altitude to the control rod of the injection pump.

If the aneroid boxes expand, the control rod is pulled in the direction of "stop" and the delivery volume is reduced; if the altitude decreases, the control rod is moved into the direction of "additional volume", resulting in an increase of the delivery volume.



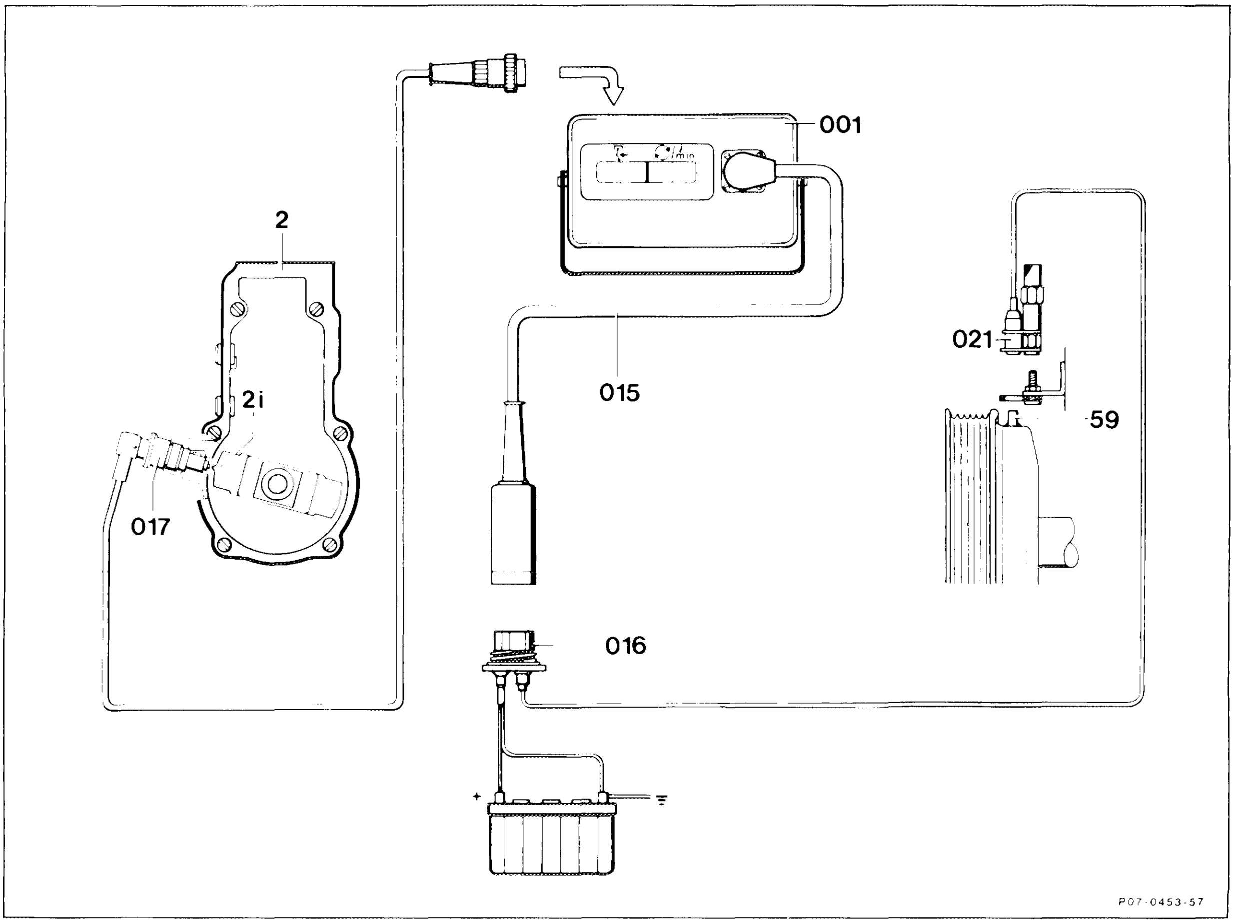
5c Template
103 Pressure box
103a Connection for atmospheric connection line (for registering atmospheric pressure)
103b Aneroid boxes
103c Correction linkage
103d Adjusting screw (adjusted by manufacturer)

L. Governor impulse method (RIV)

In order to be able to register the relationship of the injection pump relative to the engine two signals are required:

- TDC impulse from the crankshaft
- Governor impulse from the injection pump

Both impulses are supplied by pulse generators. In order to obtain a measuring signal the sensor pins must be moved past the pulse generators with a minimum speed (idle speed). A measuring instrument measures the time interval of the two impulses, converting the result into an angular value which is then indicated.
Checking, adjusting start of delivery
(see 07.1-111/112/116/117).



001 Digital tester
015 Test cable
016 Socket
017 RIV generator (governor impulse)
021 TDC pulse generator
059 Sensor pin
2 Governor
2i Flyweight with sensor pin

M. Electronic idle speed control (ELR)

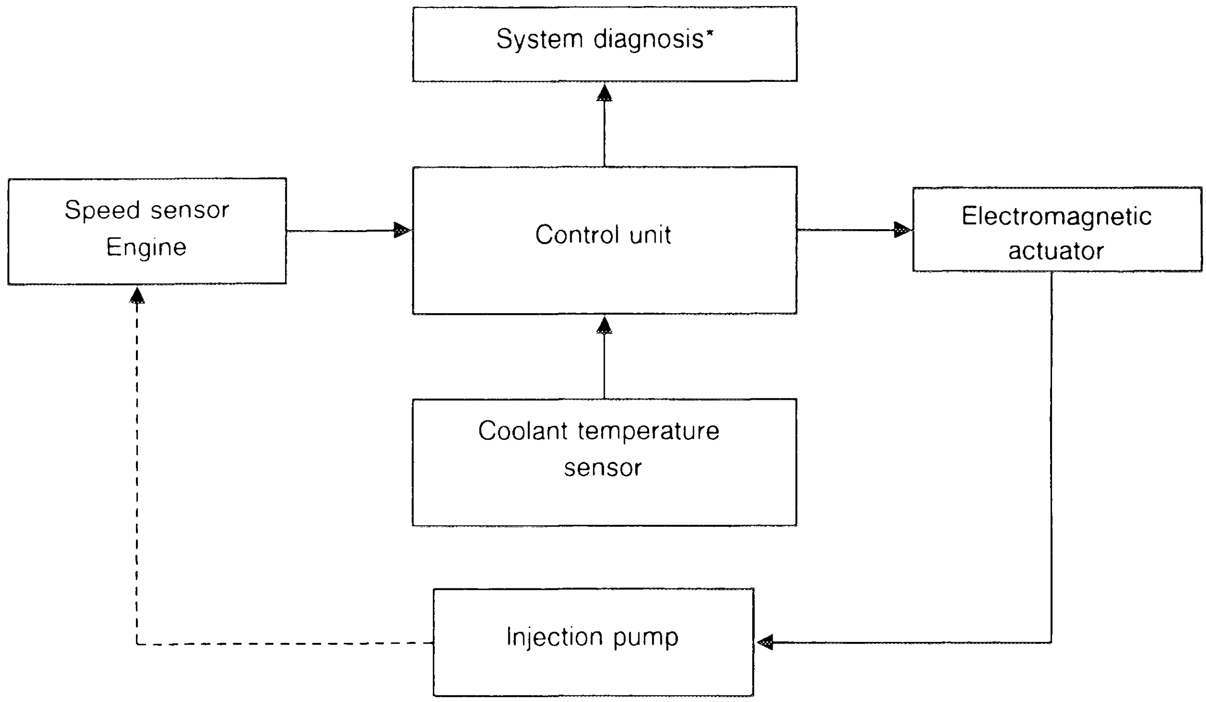
In addition to the mechanical governor an electronic idle speed governor is installed in engine 602 with air conditioner and automatic transmission.

The speed sensor (L 3) registers the engine speed (144 impulses/revolution) passing it on to the control unit (N8 or N8/1) in form of an AC voltage.

The control unit processes the speed signal and compares set value with actual value. The idle speed is kept constant by the electromagnetic actuator (Y22) independent of the load on the engine.

Initiated by the temperature sensor (B 11/1), with coolant temperatures < 60 °C the idle speed set value is increased according to a predetermined characteristic.

Block diagram idle speed control



System diagnosis (as of approx. June 1988)*
With the self-testing program integrated in the control unit it is possible to test the ELR system.

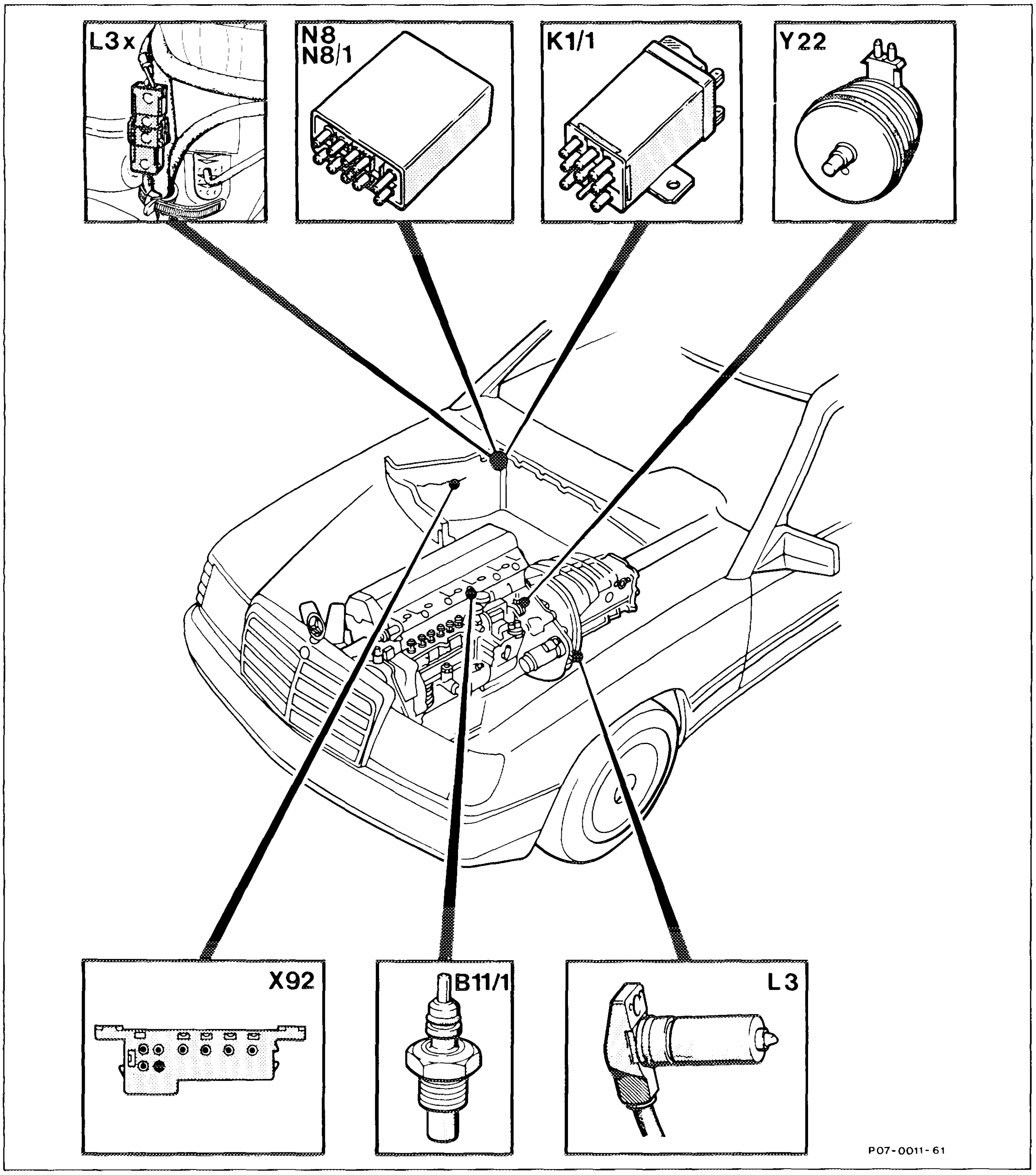
A signal can be called up by way of the test coupling (X92) giving specific information on faults of a component.
However, only permanent faults can be indicated. Faults of a temporary nature cannot be registered and indicated by the control unit.

The number of signals shows which component is faulty, or whether components in the control circuit are defective.

Impulse display	Component/Control circuit
1	All functions "in order"
2	Speed signal "fault"
3	Coolant temperature "fault"
6	Control circuit ELR "fault"

Arrangement of components

Electrical components

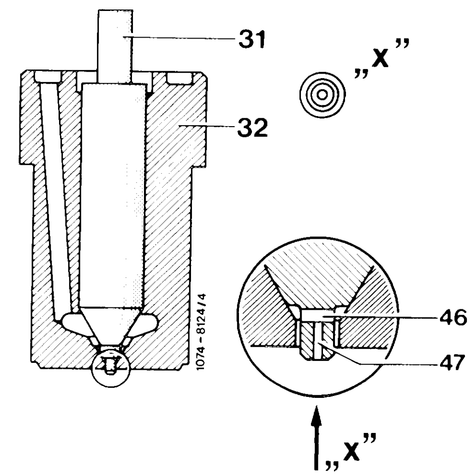


B11/1	Coolant temperature sensor	N8 or	Control unit ELR
K1/1	Overvoltage protection relay	N8/1	
L3	Speed sensor	X92	Test coupling
L3x	Connector speed sensor starter ring gear	Y22	ELR electromagnetic actuator

N. Injection Nozzles

b) Hole-type pintle nozzle

Bosch designation DN 0 SD 240/
This nozzle is distinguished from the pintle nozzle by transverse and longitudinal bores (46 and 47) in the throttling pintle.



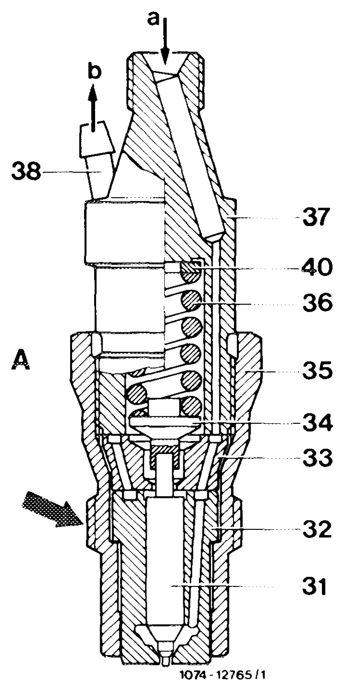
31 Nozzle needle
32 Nozzle body
46 Transverse bore
47 Longitudinal bore

Q. Nozzle holder

Bosch designation
KCA 30 S 44 (without edge-type filter)
(vertical injection)
KCA 30 S 46 (with edge-type filter)
(vertical injection)
KCA 27 S 55
(inclined injection)

The compression spring (36) in the holding body (37) presses on the nozzle needle (31) via thrust pin (34). The preload of the compression spring (36) and the shim (40) determine the opening pressure of the injection nozzle. The injection pressure can be adjusted by means of different shim thickness dimensions. Fuel flows to the nozzle seat via the respective supply bore (a) in the holding body (37), intermediate washer (33) and injection nozzle. During the injection process the injection pressure lifts the nozzle needle and the fuel flows through the circular groove on the throttling pintle into the prechamber.

After the injection pressure has dropped, the compression spring (36) forces the nozzle needle (31) back onto its seat; the injection process is completed.

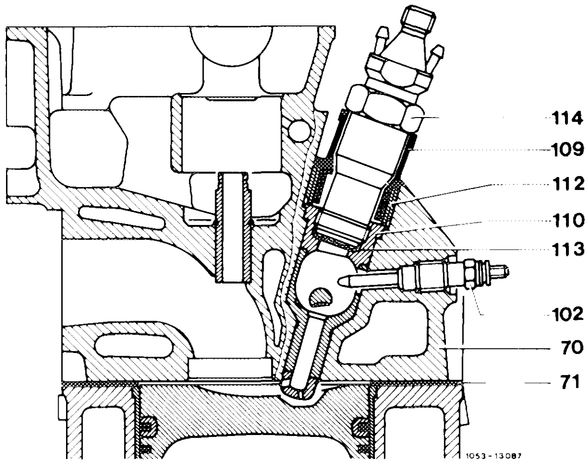


Nozzle holder for vertical injection

5° inclined injection

Engine 602 model years 1987 and 1988

The nozzle holder combination is screwed into the upper prechamber with an inclination of 5° with reference to the prechamber longitudinal axis. The inclined injection results in an even more intensive mixing of air with fuel.



70 Cylinder head
71 Cylinder head gasket
109 Sealing sleeve
110 Prechamber
112 Threaded ring
113 Sealing plate
114 Nozzle holder

5°/180 °inclined injection

Production breakpoint: Standard version January 1989

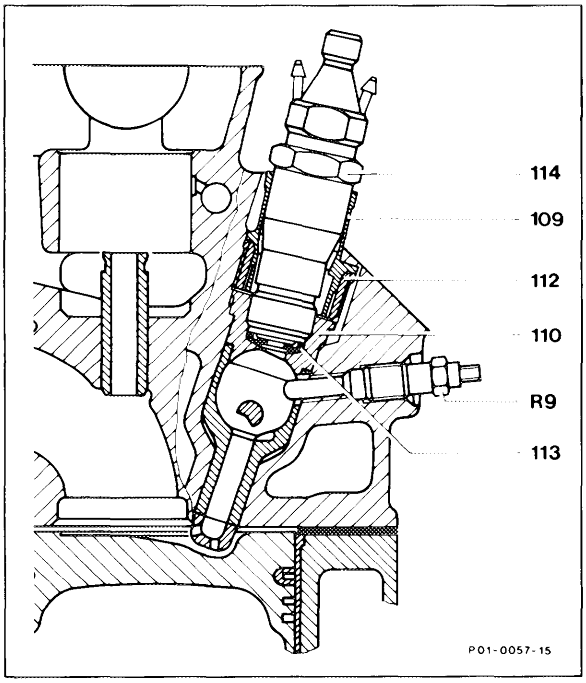
Model	Engine	Engine end no. Manual transmission	Engine end no. Automatic transmission
201.126	602.911	-	014820

Engine 602 and Code 830 as of model year 1989

The nozzle holder combination inclined by 5° is twisted by 180° and installed into the upper prechamber.

This has the following advantages:

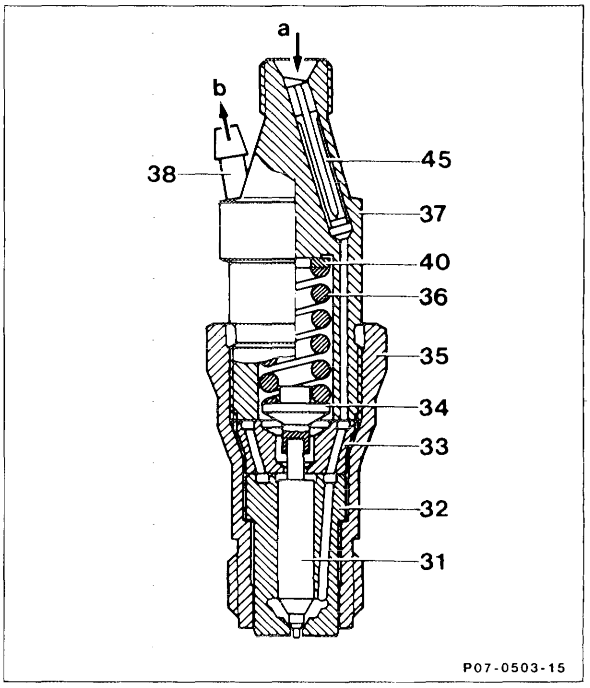
- Improved cold starting
- Improved mixing of air and fuel due to shortened glow plug (23 mm previously 27 mm) in connection with recess and spherical indentation in the ball pin.
- Particle reduction and improvement in the emission of hydrocarbons and carbon monoxide.



R9 Glow plug
109 Sealing sleeve
110 Prechamber
112 Threaded ring
113 Nozzle plate
114 Nozzle holder combination

31	Nozzle needle
32	Nozzle body
33	Intermediate washer
34	Thrust pin
35	Nozzle mounting nut
36	Compression spring
37	Holding body
38	Fuel bleed connection
40	Shim
45	Supply bore
a	Fuel supply
b	Leak-off fuel (return)

Nozzle holder for inclined injection

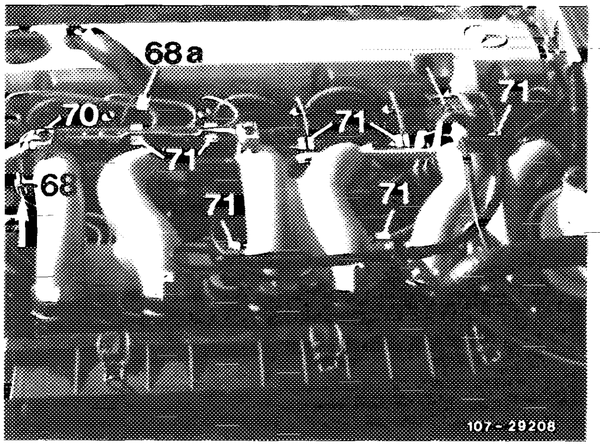


O. Injection lines

The injection lines are so designed that the injection pump can be pivoted with the engine running.

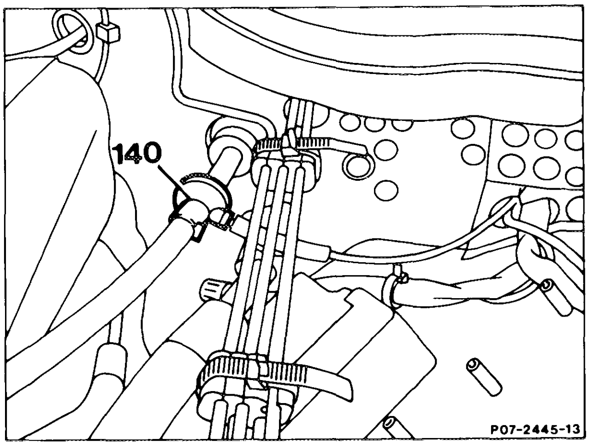
Note

Due to vibration the plastic clips 68 and 68a must be mounted as closely as possible to the radius of the injection lines (arrows). The plastic clips (71) must be fully engaged.



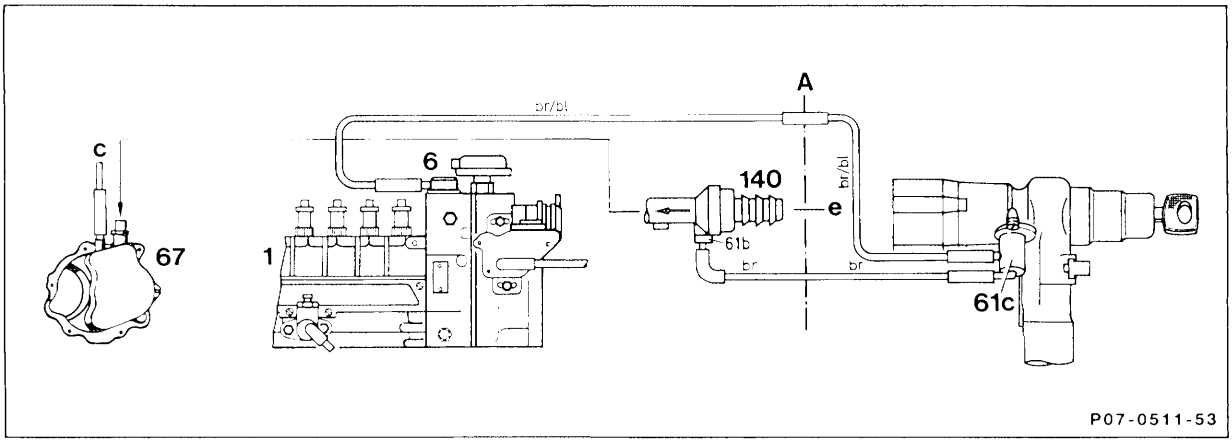
P. Vacuum shut-off with vehicle key (glow starter switch)

The vacuum for the key shut-off has been supplied by the check valve (140) of the main vacuum line since July 1987.



Production breakpoint: July 1987

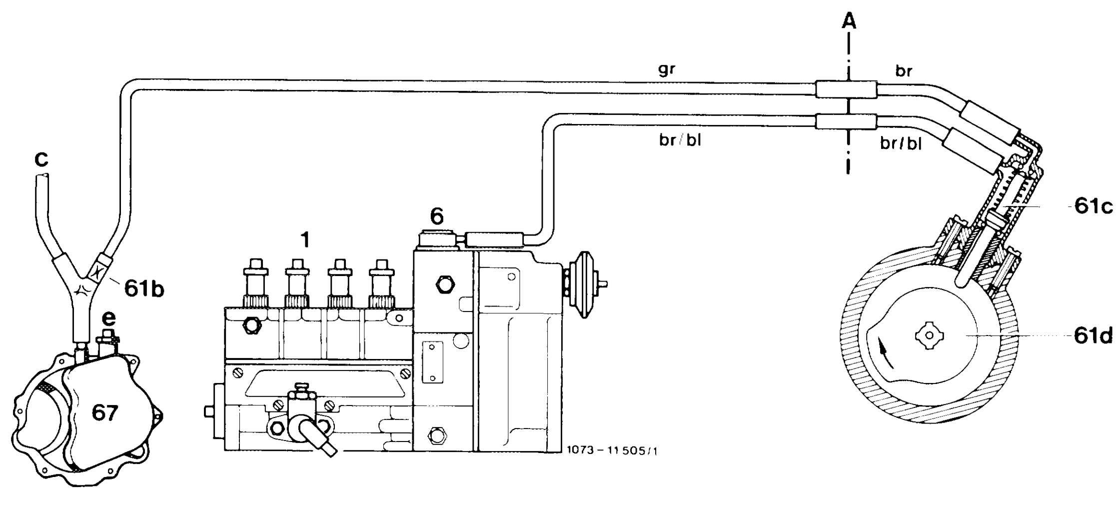
Model	Engine	Vehicle identification end no.	
		A	F
201.126	602.911	384857	383987



Vacuum line routing

1	Injection pump	A	Partition panel
6	Vacuum unit (stop)	c	Remaining users
61c	Valve glow starter switch	e	To brake booster
67	Vacuum pump		
140	Check valve/main vacuum line		

Key shut-off version prior to July 1987



Function diagram

1	Injection pump	A	Partition panel
6	Vacuum unit (stop)	c	Remaining users
61b	Choke 0.5 mm orifice diameter	e	To brake booster
61c	Valve glow starter switch	bl	blue
61d	Cam glow starter switch (valve open)	br	brown
67	Vacuum pump		