

## 14-050 Operation

Federal and California version model year 1977/78/79

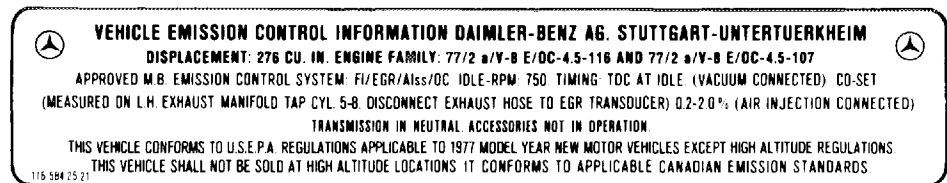
### A. General

#### Information plate

Federal version basic color black.

California version basic color yellow.

Federal version high altitudes basic color red (model year 1977 only).



1074 - 7503

#### Identification of vacuum lines

The basic color of vacuum lines for emission control system is transparent (white).

**Lines originating at a vacuum source** (originating lines) **have only one color stripe.**

Additional color stripes are used to facilitate identification of the individual functions.

**Lines terminating at a vacuum-operated device** (terminating lines) **have two color stripes.** Purple is always the second color.

| Emission control system    | Color coding of originating vacuum line | Color coding of terminating vacuum line |
|----------------------------|---|---|
| <b>Ignition switchover</b> |   |   |
| Advance                    | red                                     | —                                       |
| Retard                     | yellow                                  | yellow/purple                           |
| <b>EGR</b>                 | brown                                   | brown/purple                            |
| <b>Air injection</b>       | blue                                    | blue/purple                             |

Engine 117 is supplied with two different emission control systems:

The two emission control systems differ with regard to air intake and air injection.

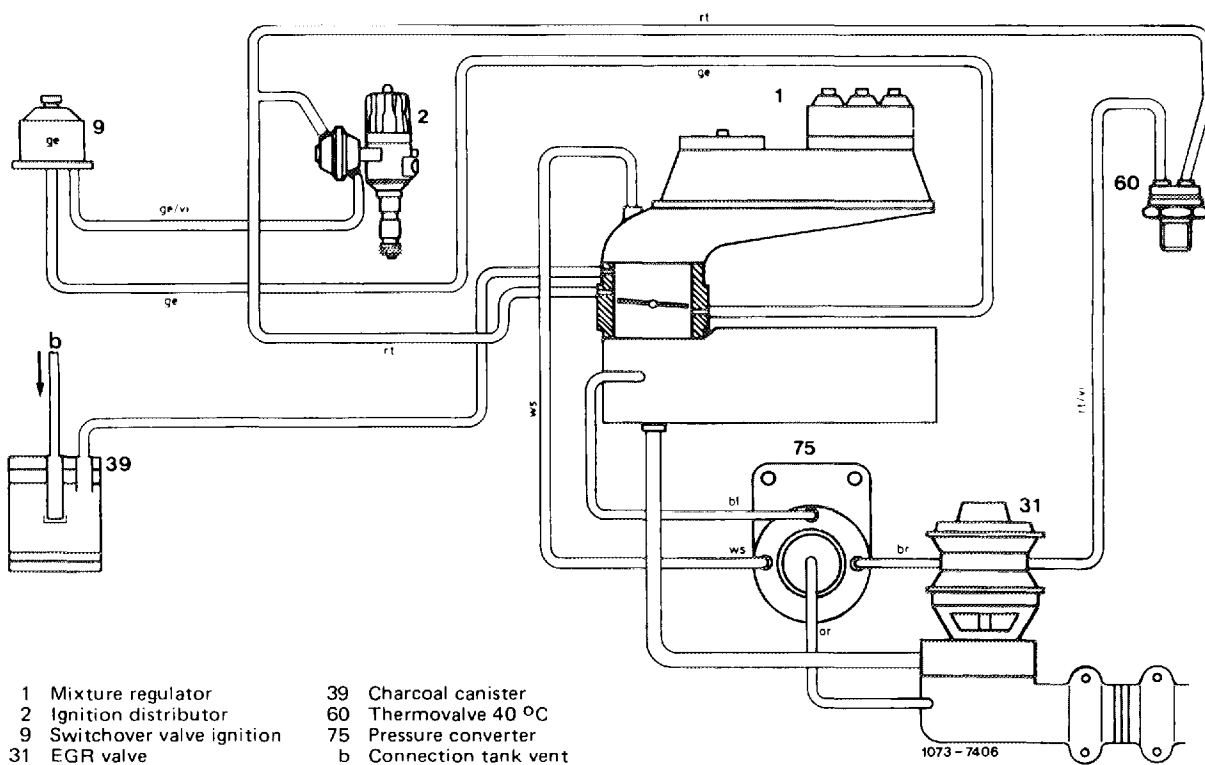
1. Federal emission control system (black information plate).
2. California emission control system (yellow information plate).

## B. EGR (exhaust gas recirculation)

To reduce nitrogen oxides in exhaust gases, a portion of the gases from the exhaust manifold is returned to the intake pipe.

The quantity of the returned exhaust gas is controlled by the throttle valve position and the intake pipe vacuum.

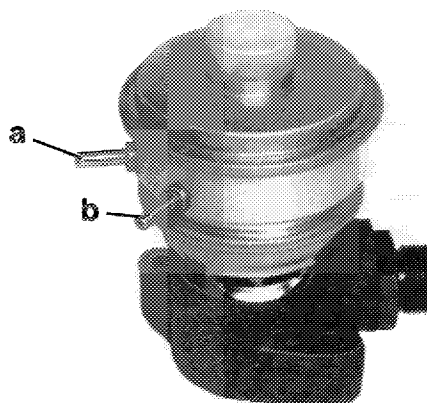
### Function diagram



### EGR components:

#### EGR valve

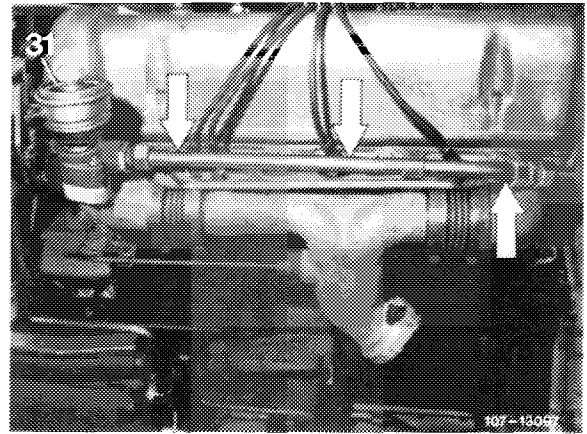
For better adaptation of EGR the EGR valve is designed as a three-diaphragm valve.



107 - 12 620

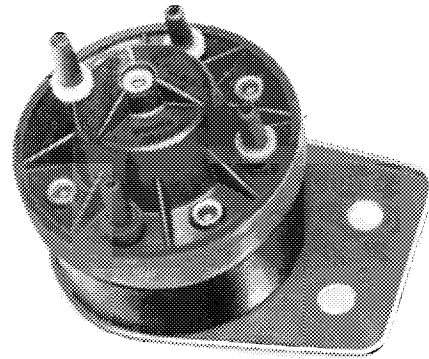
### EGR line (arrows)

The exhaust gases are routed from EGR valve through EGR line into intake pipe.



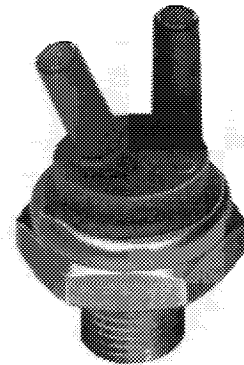
### Pressure transducer

The pressure transducer controls the EGR volume in dependence of exhaust backpressure.



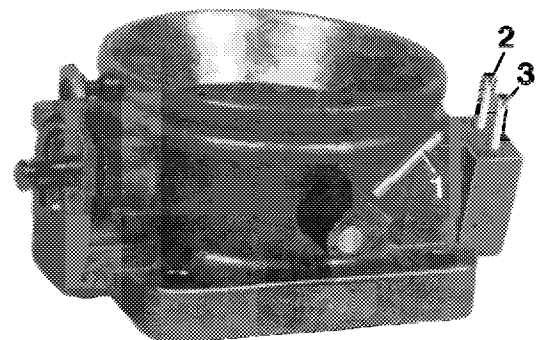
### Thermovalve 40 °C (color code black)

The thermovalve is screwed into coolant-controlled portion of intake pipe and opens at approx. 40 °C coolant temperature.



### Throttle valve housing

A tapping pipe (2) has been attached to throttle valve housing for drawing off vacuum required for controlling EGR and vacuum advance of firing point.



- 1 Vacuum connection ignition retard
- 2 Vacuum connection ignition advance
- 3 Vacuum connection charcoal canister

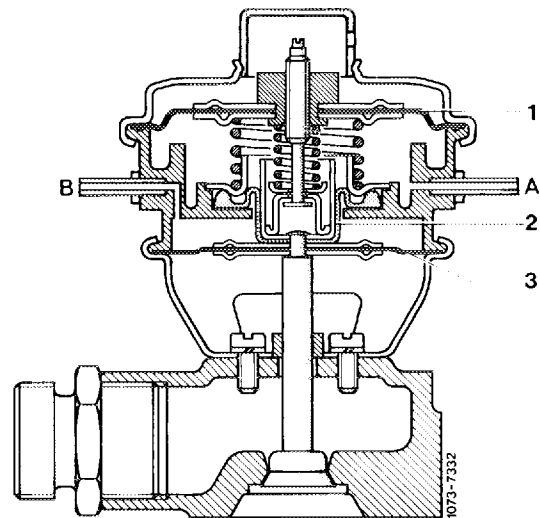
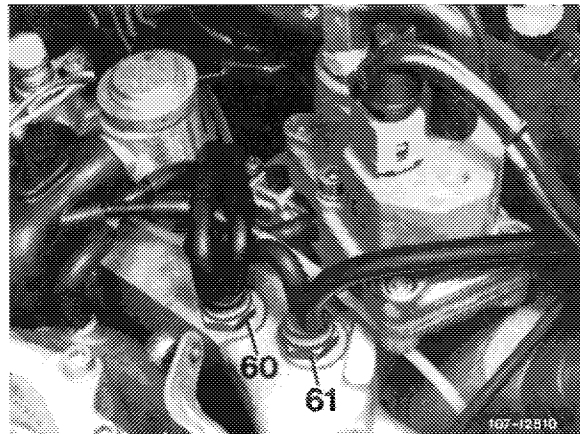
### EGR is activated:

- At 40 °C coolant temperature.
- During acceleration.
- During partial load operation.
- During transition to deceleration (coasting).

### Operation

Above 40 °C, in the driving ranges named above, a part of the exhaust gases is returned from the exhaust manifold to the intake pipe.

The amount of recirculated exhaust gases depends on the throttle valve position (vacuum tapped at throttle valve housing) and the exhaust backpressure in exhaust manifold. Depending on throttle valve position the center diaphragm chamber of the EGR valve is more or less supplied with vacuum via thermostatic valve 40 °C (60) in cylinder head.

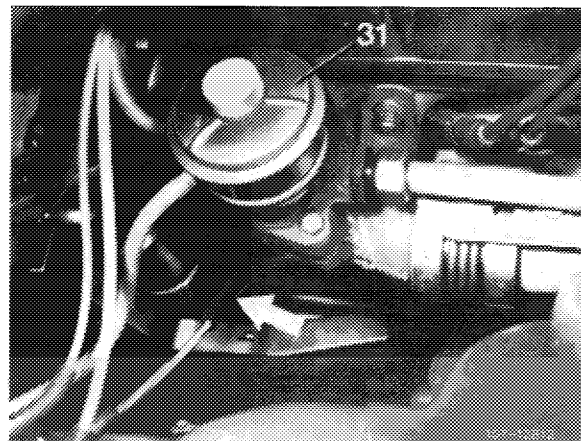


- 1 Shutoff diaphragm
- 2 Cup-type diaphragm
- 3 Working diaphragm
- A Connection vacuum line to thermostatic valve
- B Connection vacuum line from pressure transducer

The upper diaphragm chamber is continuously connected to atmosphere by means of a vent bore.

Depending on vacuum, the shutoff diaphragm (1) is pushed with coupling pin downwards against spring force and the valve can open.

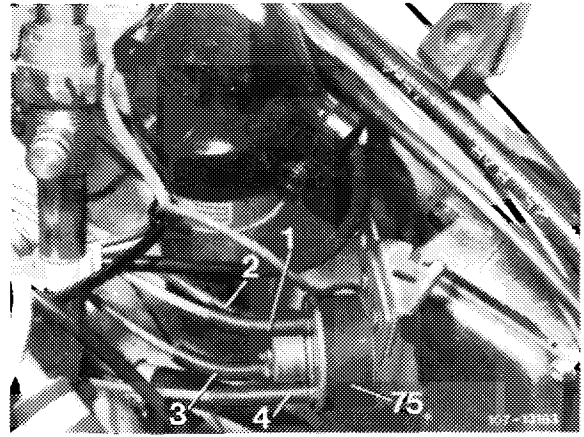
Opening and closing of valve is controlled by pressure transducer which provides the positive or negative ventilation for diaphragm chamber above working diaphragm (3) depending on pressure of exhaust gases in exhaust manifold.



## Pressure transducer

The pressure transducer is subdivided into three chambers by means of two spring-loaded diaphragms, the upper diaphragm (1) and the lower diaphragm (2). Both diaphragms are connected to each other by means of a diaphragm cup.

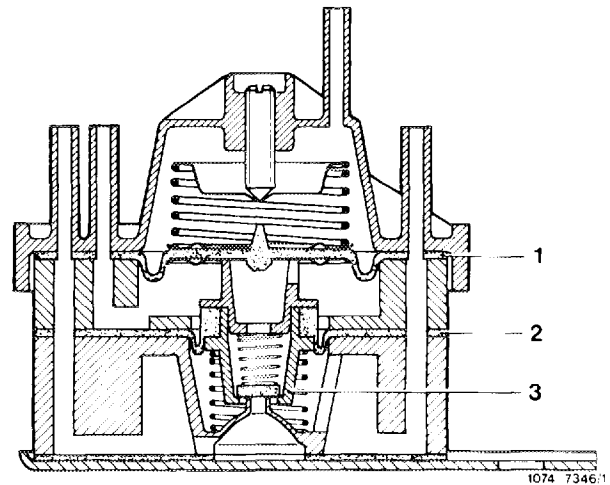
- 1 Connection intake pipe vacuum (blue)
- 2 Connection vent line (white)
- 3 Connection exhaust gas backpressure line (orange)
- 4 Connection vacuum control line to EGR valve (brown)



The exhaust gas backpressure is effective in upper diaphragm chamber. The center diaphragm chamber is continuously and positively vented through air guide housing. This will not influence the position of the diaphragms. The lower diaphragm chamber is positively or negatively vented depending on exhaust gas backpressure.

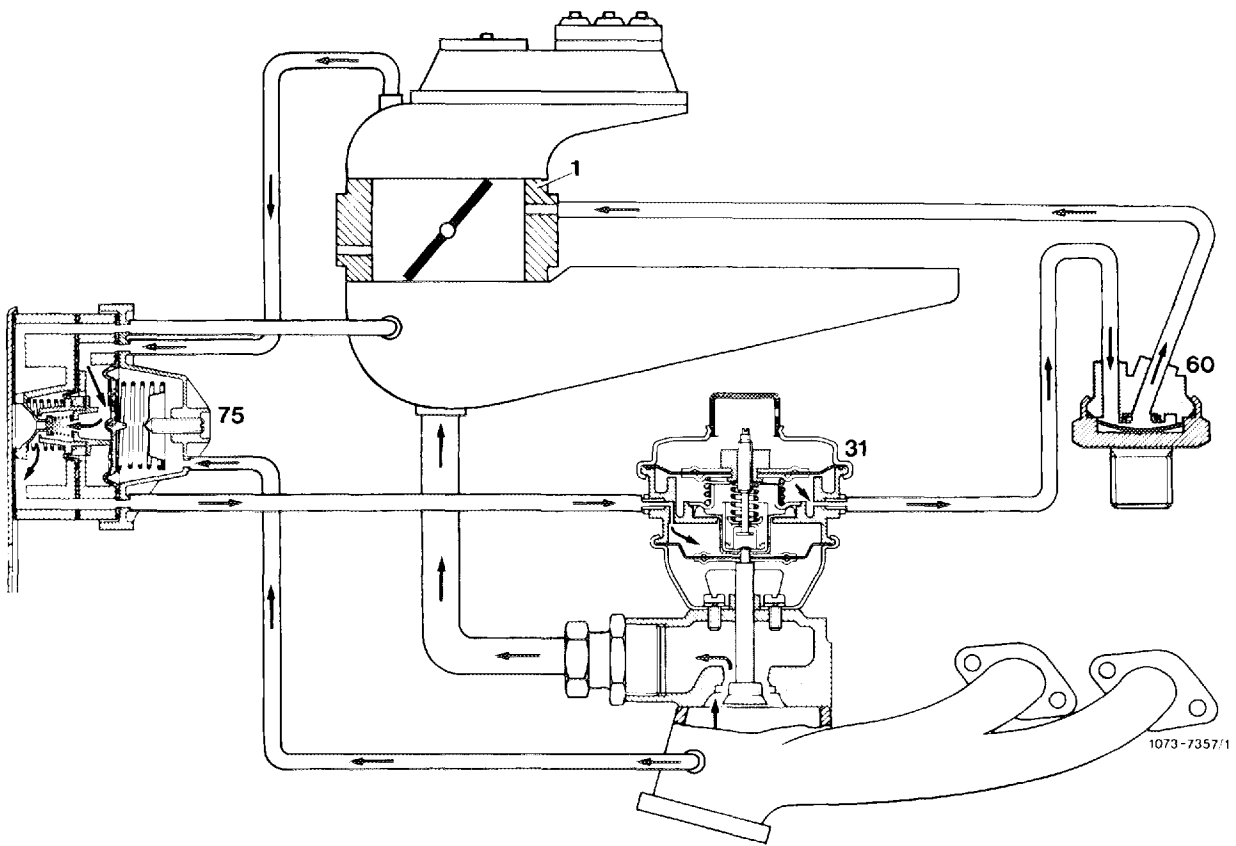
The different driving conditions provide three positions for pressure transducer:

- 1 Upper diaphragm
- 2 Lower diaphragm
- 3 Diaphragm cup

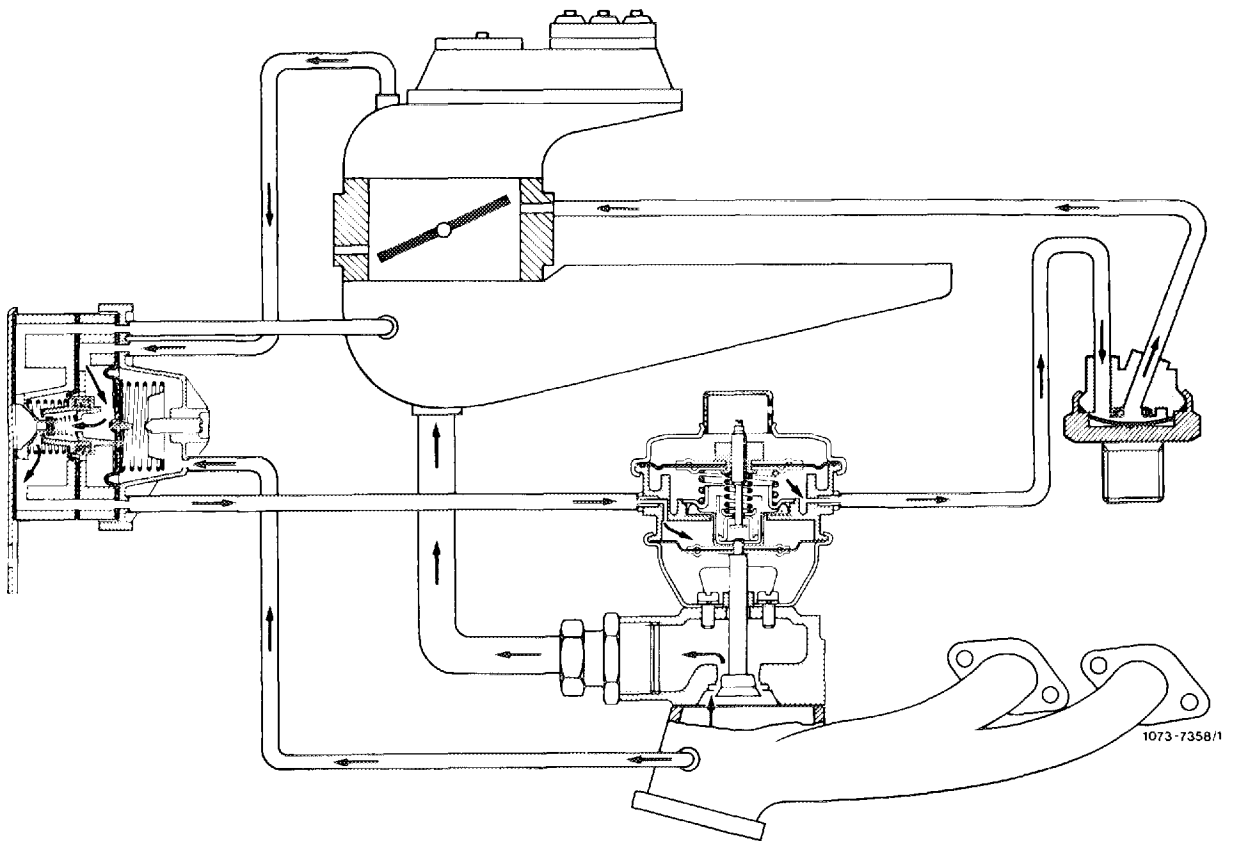


**1. During acceleration** the exhaust gas backpressure increases and forces the upper diaphragm with diaphragm cup and the lower diaphragm in downward direction.

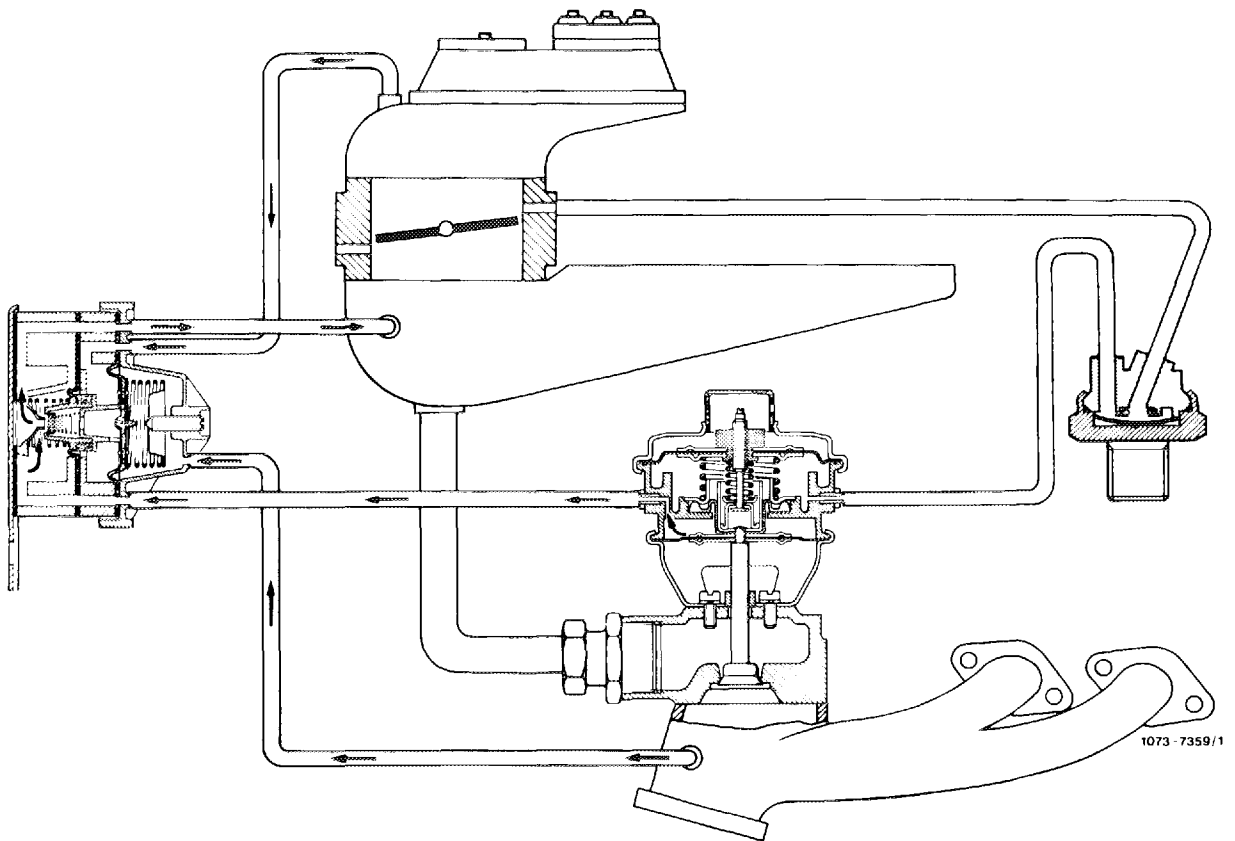
The valve reed in diaphragm cup closes the intake pipe vacuum line in lower diaphragm chamber. Simultaneously, the valve reed opens the positive venting bore from center to lower diaphragm chamber. The lower diaphragm chamber in EGR valve is positively vented by means of the vacuum control line coming from lower diaphragm chamber. The spring in EGR valve pushes the working diaphragm with valve down. The valve opens completely and the largest possible quantity of exhaust gases flows to intake pipe.



**2. During transition to deceleration (coasting)** the exhaust gas backpressure decreases. The upper diaphragm (1) including the diaphragm cup and the lower diaphragm are returning to their starting position. The valve reed opens the intake pipe vacuum line and seats on lower part of diaphragm cup. This will interrupt the positive venting of the lower diaphragm chamber. The intake pipe vacuum now prevailing in this diaphragm chamber provides the negative ventilation for the lower diaphragm chamber in EGR valve via the vacuum control line. Depending on size of vacuum the valve is pulled in closing direction against the spring force. The quantity of fed exhaust gas decreases.



**3. During constant driving** the pressure conditions in upper and lower diaphragm chamber are in balance. The EGR valve remains in its momentary position. The recirculated quantity of exhaust gases remains constant.



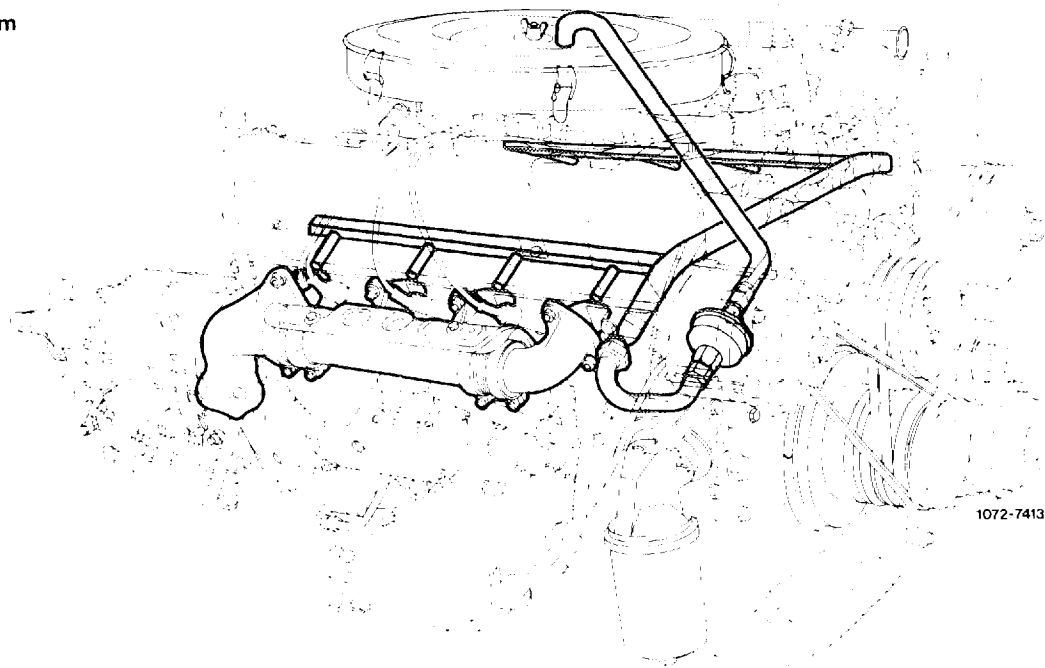
## C. Air injection Federal version

To reduce the incompletely burnt components in the exhaust gases, air is injected into hot zone behind exhaust valves.

Afterburning is controlled by way of the engine temperature and pressure conditions in intake pipe.

To avoid backfiring in exhaust, as well as overheating of catalyst, the air injection is shut off in given driving ranges.

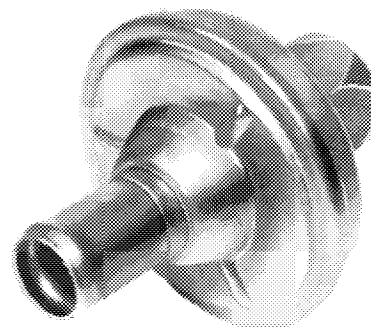
### Function diagram



### Components of air injection:

#### Check valve

The check valve prevents hot exhaust gases from flowing into air filter.

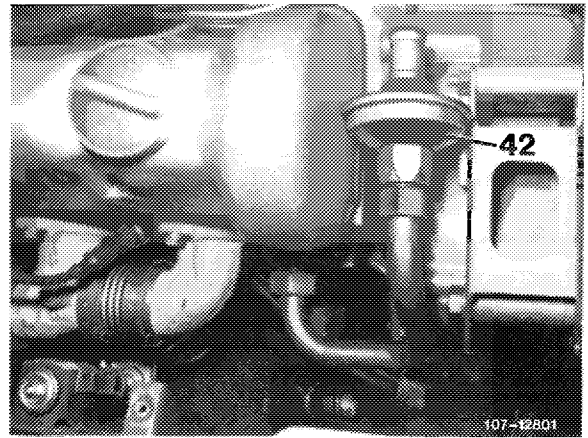


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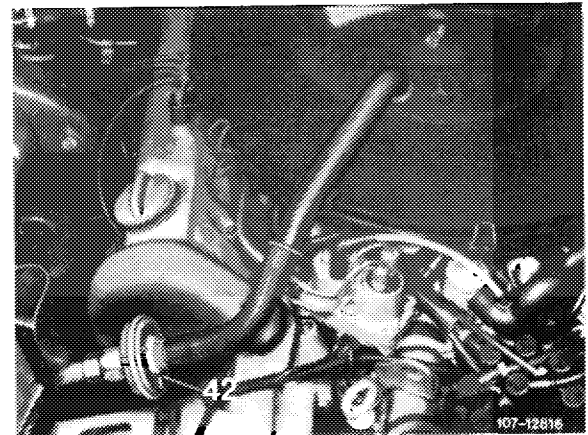
### Intake lines or intake ducts

The drawn-in air flows through intake line or intake ducts behind the exhaust valves.



### Air filter

A connection for the air intake is attached to cover of air filter.

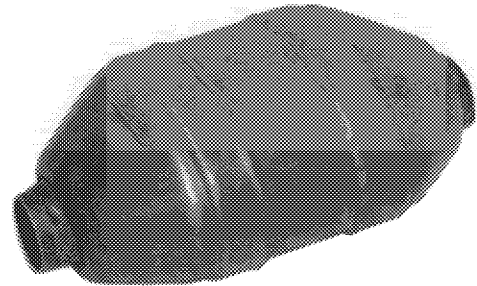


### Catalysts

The catalysts are designed as underfloor catalysts.

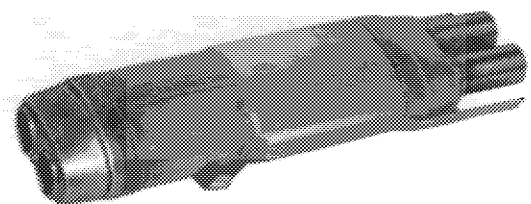
On model 116 one catalyst is installed for each cylinder bank.

On model 107, the center muffler is combined with catalyst.



Model 116

107-12970



Model 107

107-12860

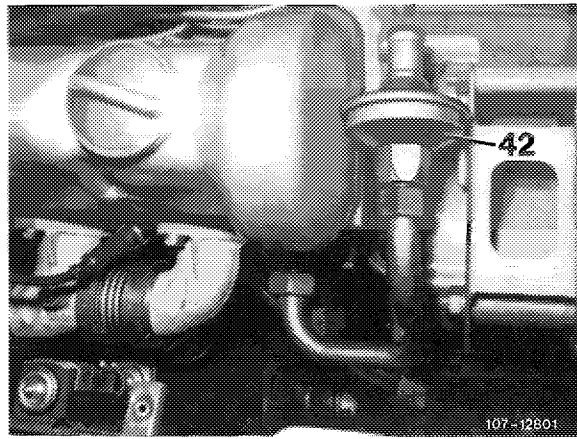
## Operation

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With the engine running, fresh air is constantly drawn in via the air intake ports by the alternating pressures (pressure oscillations) on exhaust valves.

The exhaust gases and the drawn-in air are routed through the exhaust pipes into the catalyts. The oxygen in the air encounters the hot exhaust gases for reaction in catalyts.

The "intake valve" (42) sucks the air from the fresh air side of air filter around a diaphragm which consists of a temperature-resistant material. The diaphragm opens and permits the fresh air to mix with the exhaust gases during the low pressure (vacuum) impulses which are generated behind the exhaust valves and in exhaust manifold. When the pressure is positive, the diaphragm closes and prevents that the exhaust gases are flowing into air filter. The intake valve has its highest efficiency at idle and slightly increased idling speed, when the vacuum is the highest.



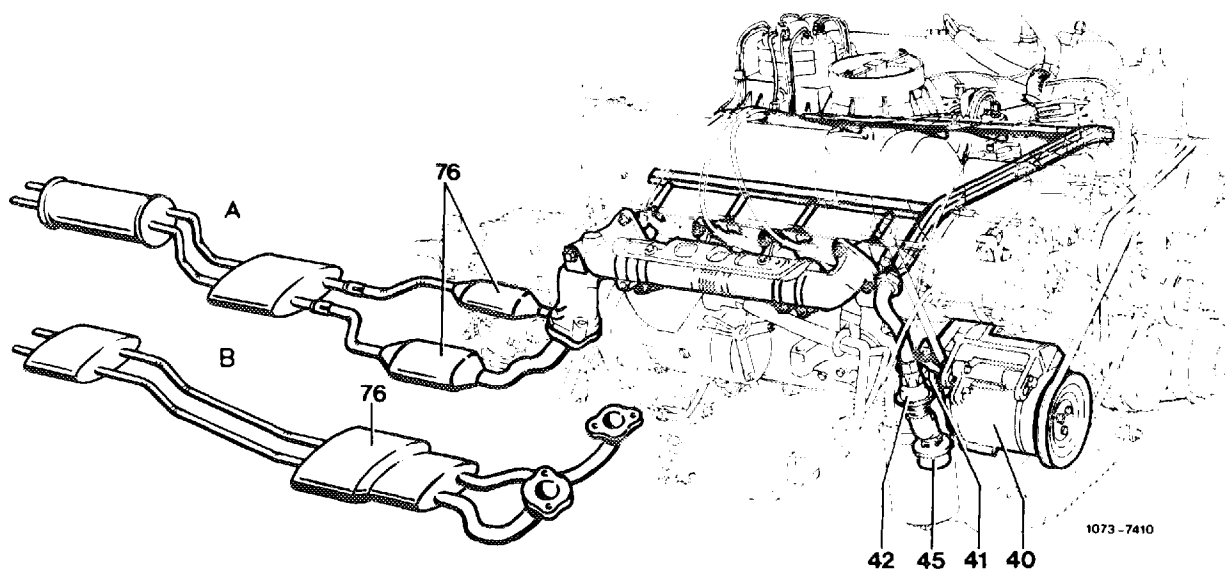
## D. Air injection California version

To reduce the incompletely burnt components in exhaust gas, air is injected into hot zone behind exhaust valves.

Afterburning is controlled by means of the engine temperature and vacuum conditions in intake pipe.

To prevent backfiring in exhaust, as well as overheating of catalyst, the air injection is switched off in given driving ranges.

### Function diagram

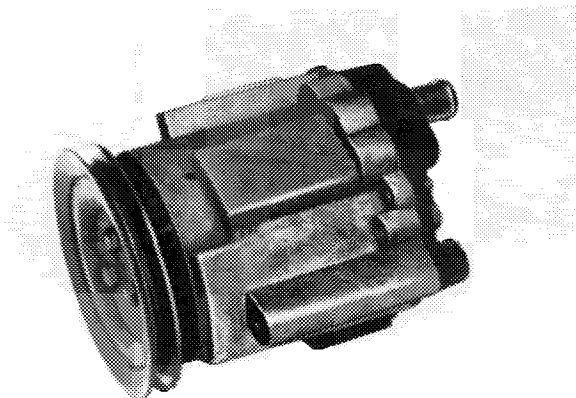


- |                   |                         |
|-------------------|-------------------------|
| 40 Air pump       | 76 Underfloor catalysts |
| 41 Diverter valve | A Model 116             |
| 42 Check valve    | B Model 107             |
| 45 Air filter     |                         |

### Components of air injection:

#### Air pump (Saginaw pump)

The air pump is an impeller pump with maintenance-free centrifugal filter which cleans the drawn-in air.

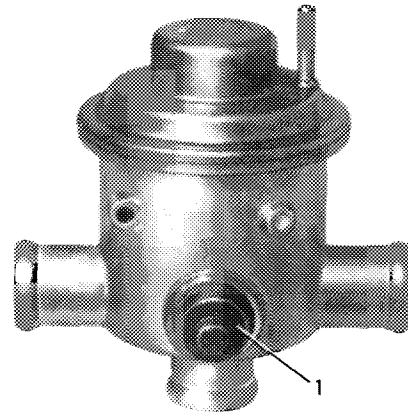


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### Diverter valve

The diverter valve serves the purpose of discharging the delivered air below 17 °C coolant temperature by way of a separate air filter for silencing.

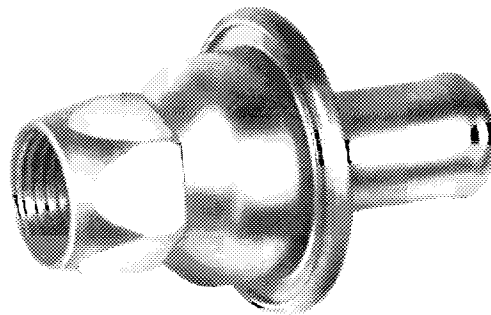
The diverter valve is provided with a safety valve (1) which discharges the delivered air at a given overpressure to protect the pump vanes against overload.



107-10092

### Check valve

The check valve prevents the inflow of hot exhaust gases into air line.

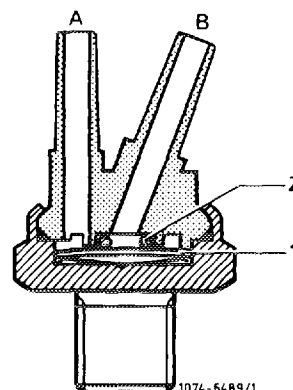
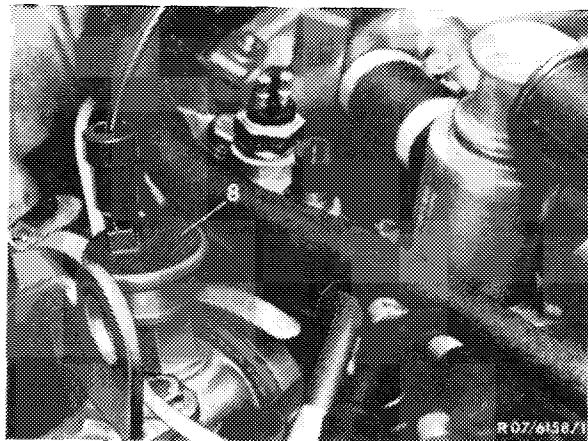


107-9193

### Therموالve 17 °C (color code blue)

The therموالve is screwed into coolant-controlled portion of intake pipe and opens at approx. 17 °C coolant temperature. Below 17 °C coolant temperature the bimetallic plate rests against O-ring and closes connection "B".

Above 17 °C coolant temperature the bimetallic plate snaps downward when heated. Both connections are connected to each other.



- 1 Bimetallic plate
- 2 O-ring
- A To EGR valve
- B To throttle valve housing

1074-6489/1

## Catalysts

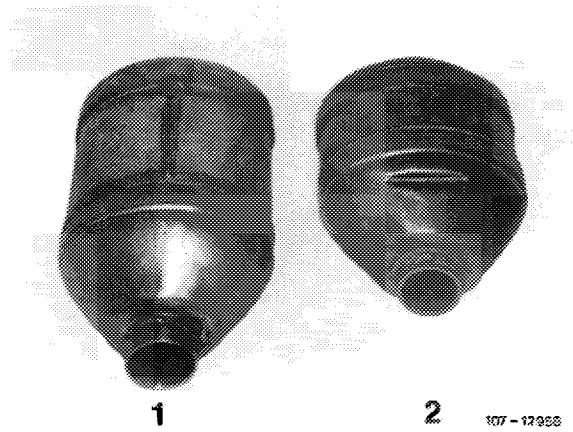
The catalysts are designed as underfloor catalysts.

On model 116, one catalyst per cylinder bank is installed.

On model 107, the catalyst is combined with center muffler to save space.

Model 116

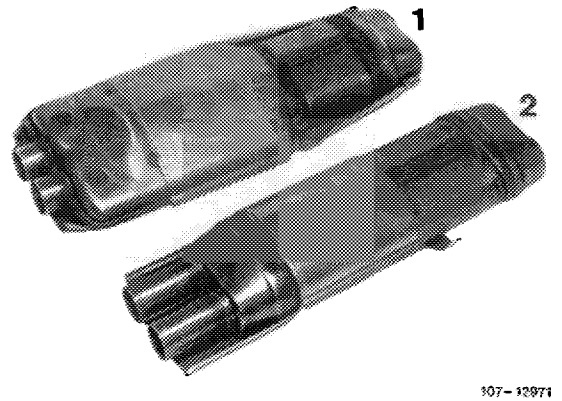
- 1 California version
- 2 Federal version



Due to the stricter emission values in California, this version is provided with larger catalysts.

Model 107

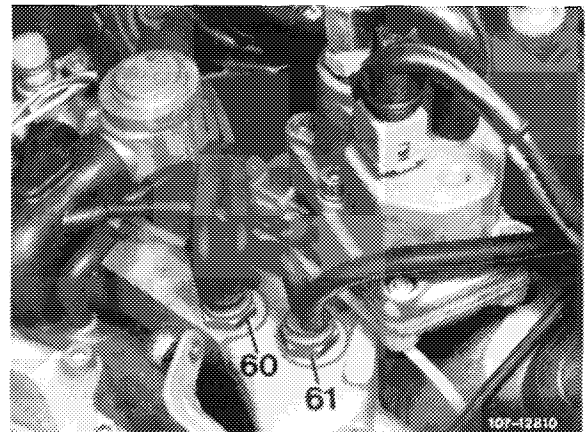
- 1 California version
- 2 Federal version



## Operation

Starting at a coolant temperature of approx. 17 °C in intake pipe, air is diverted into exhaust ducts of cylinder heads during idle, deceleration and under partial load.

- 60 Thermovalve 40 °C
- 61 Thermovalve 17 °C



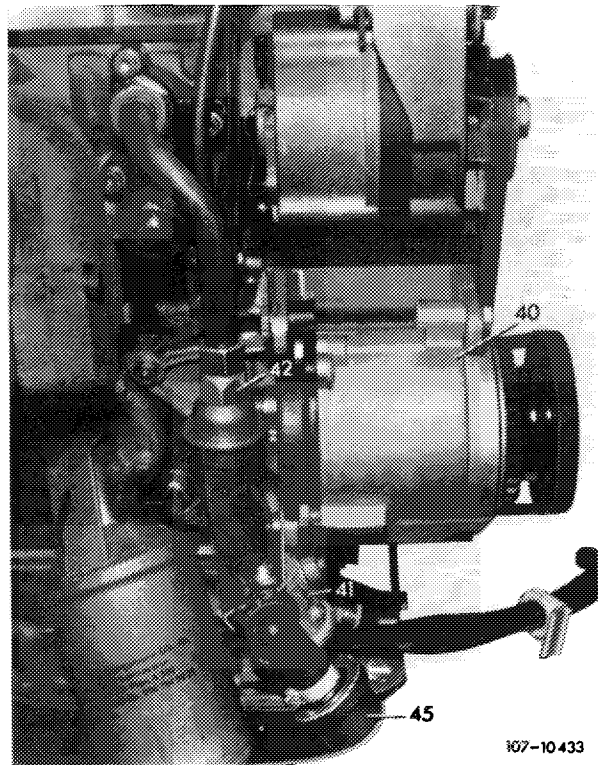
The air pump is driven by the crankshaft via a V-belt and delivers constantly air when the engine is running.

The air flows to diverter valve (41). Starting at approx. 17 °C coolant temperature, when the diaphragm of the diverter valve is supplied with a vacuum, the air is ejected into the cylinder heads by way of check valve (42). Below 17 °C coolant temperature, when no vacuum is supplied for diaphragm of diverter valve, the delivered air is blown into the open air through the air filter for silencing (45).

The exhaust gases and the injected air are routed through the exhaust pipes into the catalyts.

The oxygen in the injected air encounters the hot exhaust gases for reaction in catalyts.

- 40 Air pump
- 41 Diverter valve
- 42 Check valve
- 45 Air filter for silencing (muffler)



#### E. Air intake tourist vehicles Federal version

Tourist vehicles are supplied ex factory without a catalyts.

For this reason, only the air intake is different compared with Federal version.

To reduce the incompletely burnt components in exhaust gas, air is drawn into hot zone behind exhaust valves.

Afterburning is controlled via the engine temperature and vacuum conditions in intake pipe.

To prevent backfiring in exhaust, the air intake is shut off in given driving ranges.

#### Components of air intake:

Except for catalyts, components are similar to Federal version.

## F. Air injection tourist vehicles California version

Tourist vehicles are supplied ex factory without catalysts.

For this reason, only the air injection is different from California version.

To reduce the incompletely burnt components in exhaust gas, air is injected into hot zone behind exhaust valves.

Afterburning is controlled via the engine temperature and vacuum conditions in intake pipe.

To prevent backfiring in exhaust, the air injection is shut off in given driving ranges.

### Components of air injection:

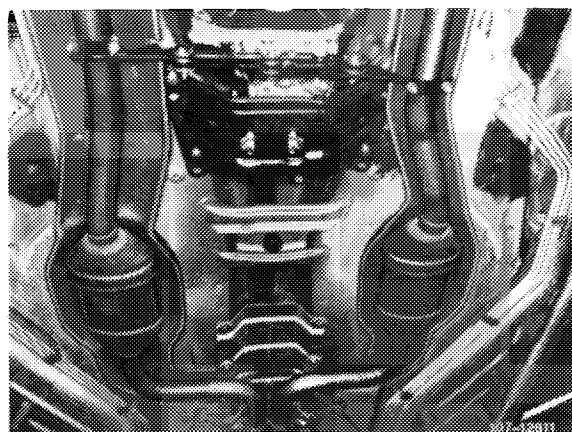
Except for catalysts the components are similar to the California version.

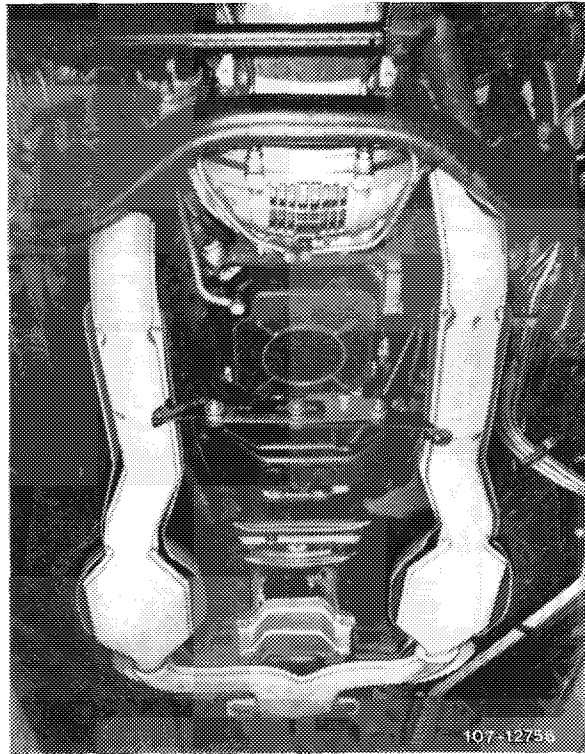
## G. Catalysts

The catalysts are installed in exhaust system in front of mufflers (silencers). Because of the higher temperatures, the front exhaust pipes and the catalysts are covered with heat shields.

Model 116 is provided with two catalysts.

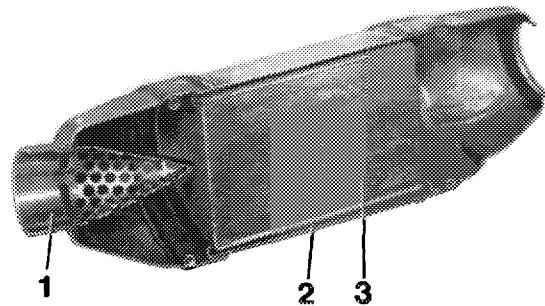
On model 107 the catalyst is combined with center muffler (silencer).





Model 116 with heat shields

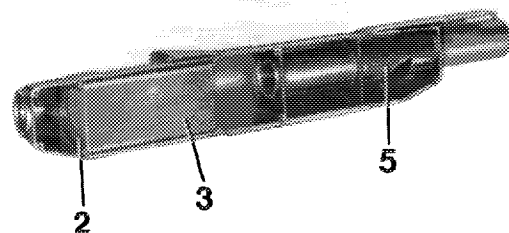
The catalyst comprises an oval monolith (3), a honey-comb-shaped body of ceramic material elastically supported in a wire netting (2). The noble metal evaporated on the monolith, the actual catalyst, accelerates the oxydation of CO and hydrocarbons while adding fresh air at the proper temperature.



Model 116  
 1 Distribution plate  
 2 Wire netting  
 3 Monolith

107-12965

To keep catalyst in functioning condition, operate engine with unleaded fuel **only**.



Model 107  
 2 Wire netting  
 3 Monolith  
 5 Exhaust pipe

107-12964



**Overheating of catalysts should be prevented**

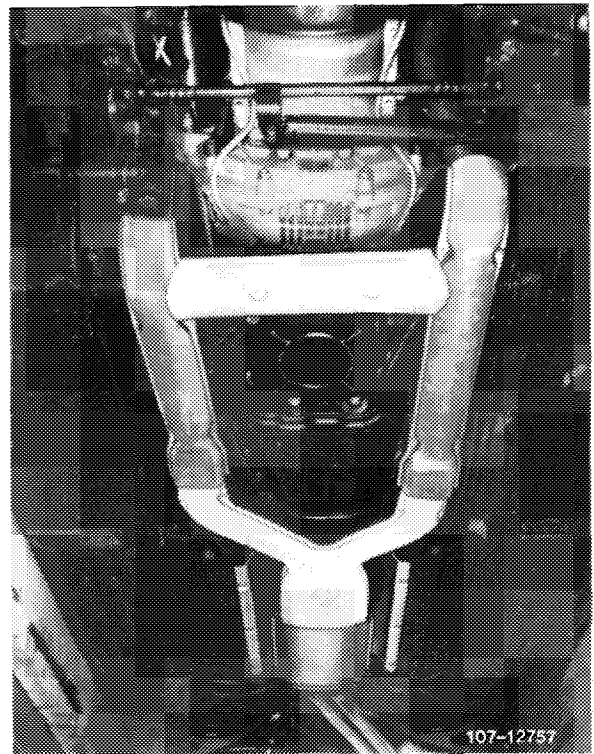
Extended overheating of catalyst will result in catalyst damage, i.e. the monoliths in catalyst may melt.

Overheating of catalyst may occur if:

- a) The specified engine service is not maintained.

Perfect spark plugs are important for life of catalyst.

- b) Irregular operation of engine results in excessively enrichment of fuel-air mixture.
- c) Exhaust gas emission control system is arbitrarily changed.



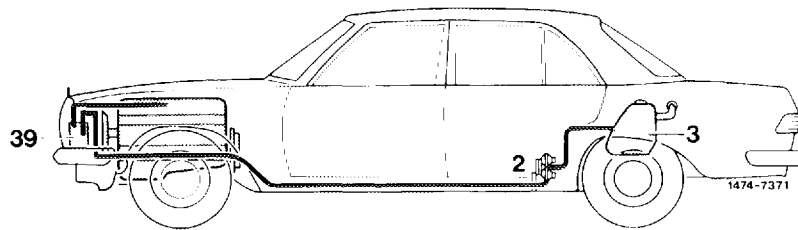
Model 107 with heat shields

## H. Fuel evaporation control model year 1977

A fuel evaporation control system has been installed to improve emissions which are not directly connected with engine combustion.

### Function diagram

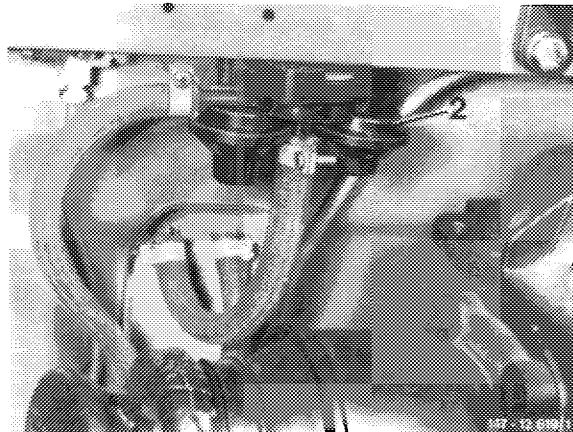
- 2 Valve system
- 3 Fuel tank
- 39 Charcoal canister



### Components of fuel evaporation control system:

#### Valve system

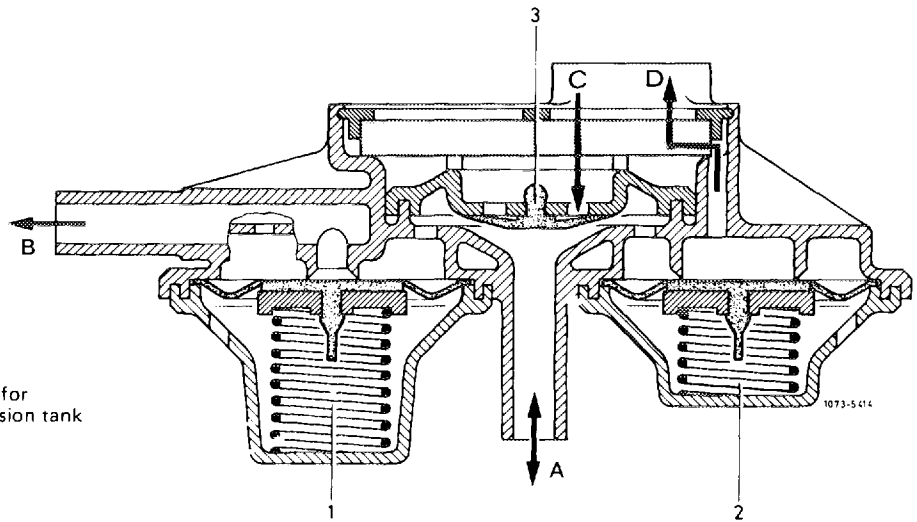
The valve system is mounted underneath vehicle at level of rear legroom.



The valve system comprises three valves:

1. Negative vent valve
2. Pressure relief valve
3. Positive vent valve

The **negative vent valve** opens at a slight overpressure. The evaporation vapors are flowing via negative vent valve into a line toward charcoal canister.



Sectional view valve system

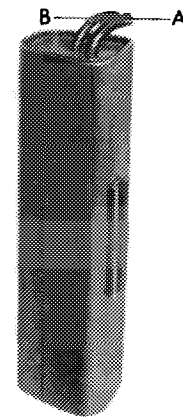
- 1 Negative vent valve
- 2 Pressure relief valve
- 3 Positive vent valve
- A Input to valve system/output for positive venting of fuel expansion tank
- B To charcoal canister
- C Fresh air input
- D Output pressure relief valve

The **pressure relief valve** opens as a safety valve in the event of an overpressure in fuel evaporation control system. The fuel vapors are bled directly into the open air.

The **positive vent valve** opens whenever cooling down of fuel tank or reduced contents result in a vacuum.

**Charcoal canister**

The fuel evaporation vapors from fuel tank are stored in charcoal canister and are drawn again out of canister when driving.

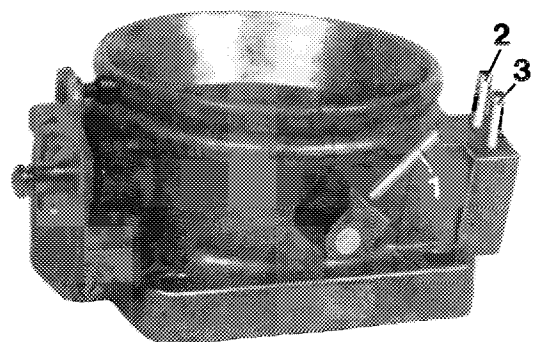


- A Connection tank vent
- B Draw-off connector

107-9128

**Throttle valve housing**

The throttle valve housing is provided with a connection to draw evaporation vapors from charcoal canister.



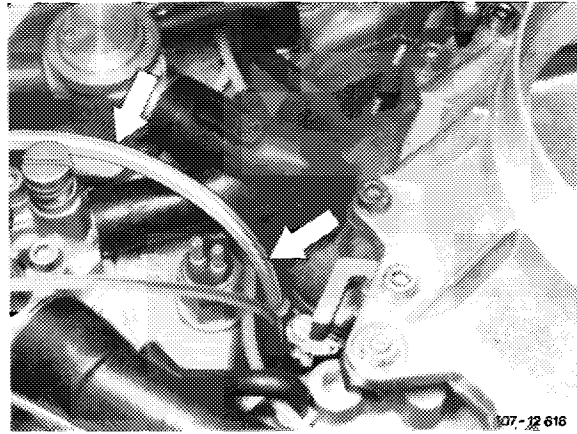
- 1 Vacuum connection ignition adjustment retard
- 2 Vacuum connection ignition adjustment advance
- 3 Vacuum connection charcoal canister

107-13054

## Operation

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The fuel evaporation vapors from fuel tank are routed to charcoal canister via valve system (2). In the charcoal canister the fuel evaporation vapors are stored when the engine is stopped and are drawn off into throttle valve housing starting at a given throttle valve position when the engine is running.



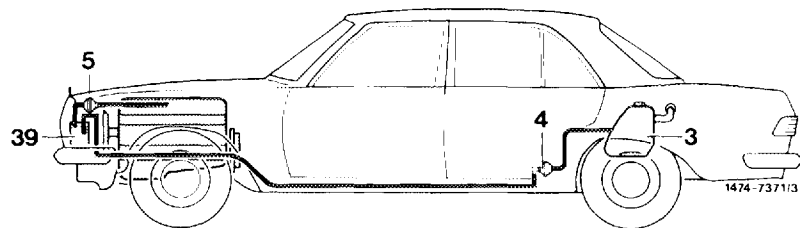
Arrow = draw-off line to throttle valve housing

## I. Fuel evaporation control system model year 1978/79

A fuel evaporation control system has been installed to improve emissions which are not directly connected with engine combustion.

### Function diagram

- 2 Fuel tank
- 4 Vent valve unit
- 5 Regenerating valve
- 39 Charcoal canister

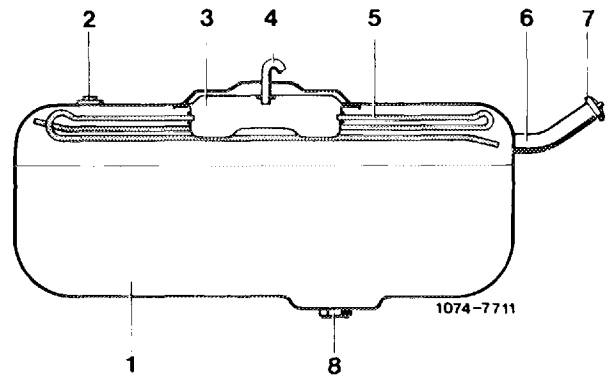


## Components of fuel evaporation control system:

### Fuel tank

A collecting tray connected to pipe system is installed in fuel tank. The connection to vent valve unit enters into the tray.

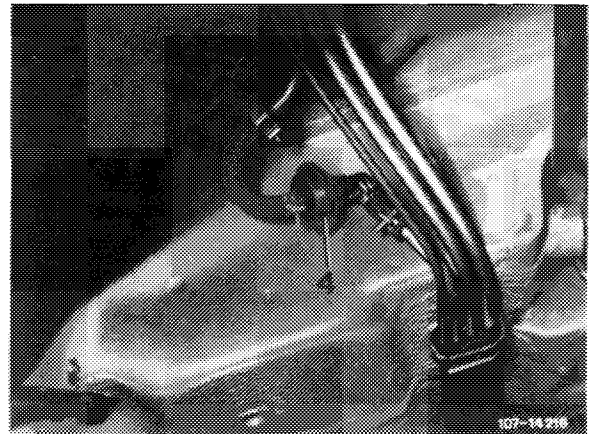
- |                              |                             |
|------------------------------|-----------------------------|
| 1 Fuel tank                  | 5 Pipe system               |
| 2 Immersion tube transmitter | 6 Filler neck               |
| 3 Expansion tank             | 7 Closing cover             |
| 4 Connection vent valve unit | 8 Connection fuel feed line |



### Vent valve unit

The vent valve unit (4) is mounted underneath vehicle at level of rear legroom and takes the place of the valve system known from model year 1977.

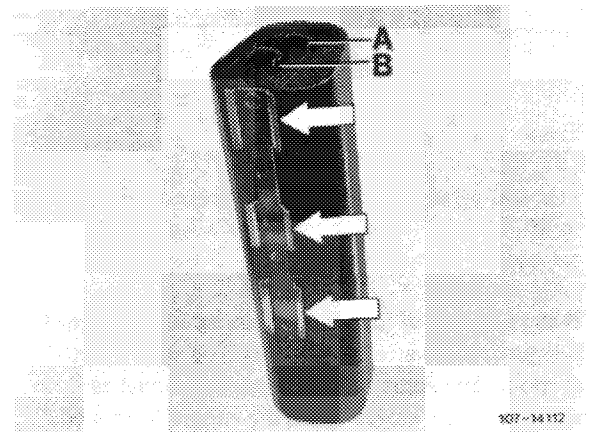
The valve unit comprises a negative vent valve (pressure relief valve) and a positive vent valve (vacuum relief valve).



### Charcoal canister

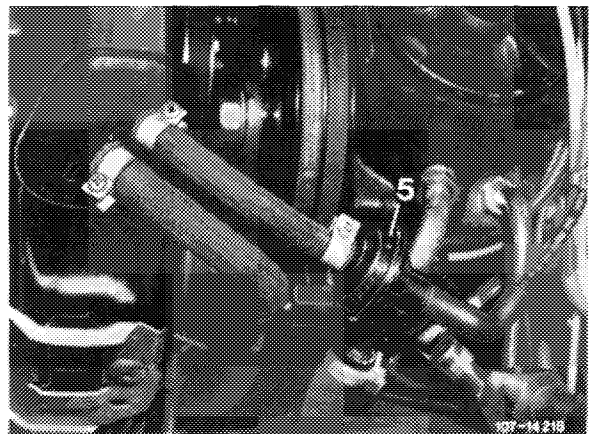
The fuel evaporation vapors from fuel tank are stored in charcoal canister and are drawn off again while driving.

- A Draw-off connection  
B Tank vent connection



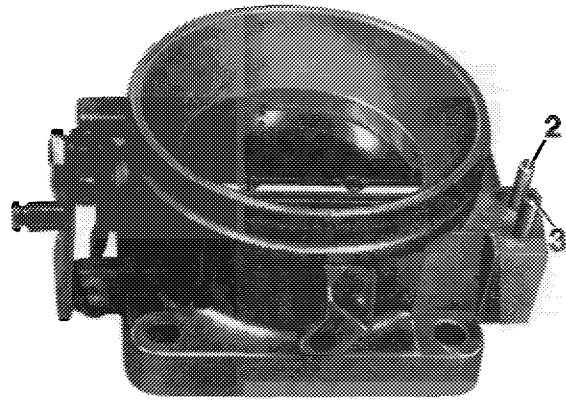
### Regenerating valve

The regenerating valve (5) is located in regenerating line from charcoal canister to throttle valve housing.



### Throttle valve housing

The throttle valve housing has been slightly changed compared with model year 1977. To avoid mixing up the vacuum connections, the OD of the vacuum connection to charcoal canister has been increased from 4 to 5 mm. Two regenerating bores were added above throttle valve for drawing off evaporation vapors from charcoal canister.

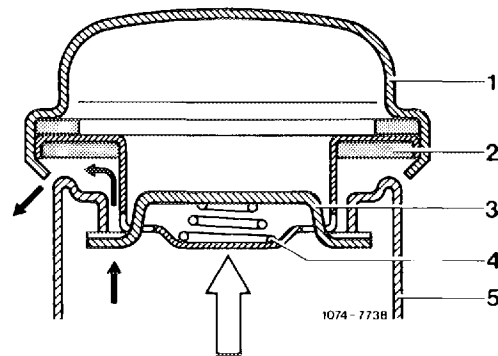


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- 2 Vacuum connection ignition advance
- 3 Vacuum connection charcoal canister

### Fuel tank cap

To avoid increased overpressure in fuel tank, the fuel tank cap has been modified.



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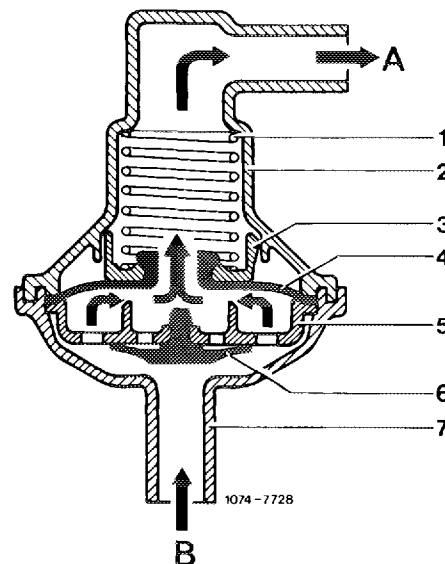
- 1 Cap
- 2 Sealing ring
- 3 Clamp
- 4 Compression spring
- 5 Filler neck

### Operation

#### Evaporation system

The vent valve unit increases the pressure in fuel tank to 30–50 mbar, so that these fuel evaporation vapors can escape from fuel tank.

If the pressure in fuel tank arrives at 30–50 mbar the pressure relief valve (4) opens and permits the fuel evaporation vapors to flow toward charcoal canister where they are stored when the engine is stopped.

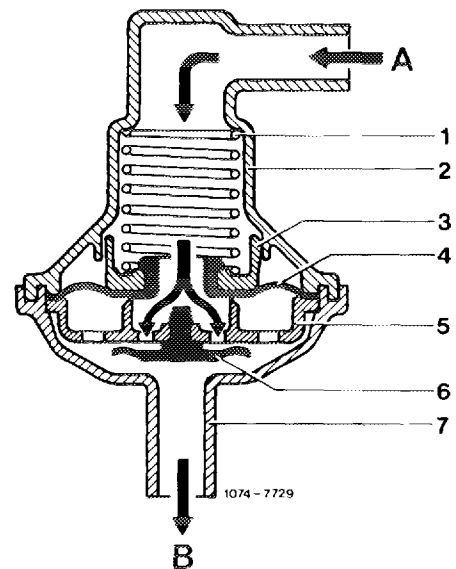


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Vent valve unit open to charcoal canister

- 1 Compression spring
- 2 Valve housing
- 3 Spring seat
- 4 Pressure relief valve (negative vent valve)
- 5 Valve disc
- 6 Vacuum relief valve (positive vent valve)
- 7 Connection
- A Connection charcoal canister
- B Connection fuel tank

When the fuel cools down, the decreasing volume is compensated by the intake of air or fuel evaporation vapors from charcoal canister via vacuum relief valve (6) starting at a vacuum of 1–16 mbar. If the vacuum in fuel tank drops below 1 mbar, the vacuum relief valve (6) will close.



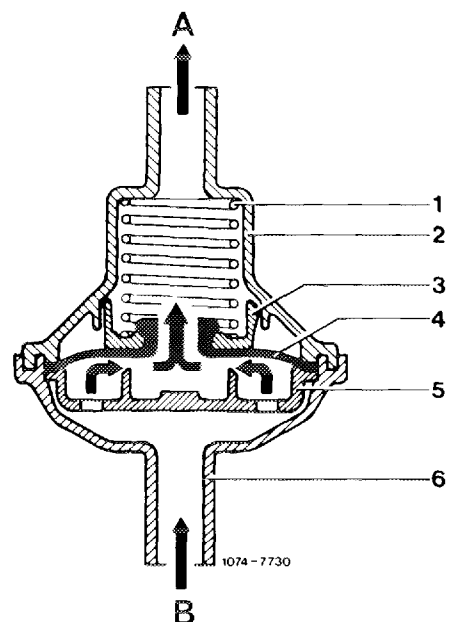
Vent valve unit open to fuel tank

If the pressure in the fuel tank increases above 0.1–0.3 bar due to a malfunction in the fuel evaporation system, the fuel vapors escape via the fuel tank cap.

### Regenerating system

The charcoal canister is connected to the throttle valve housing by means of a line in which the regenerating valve is enclosed.

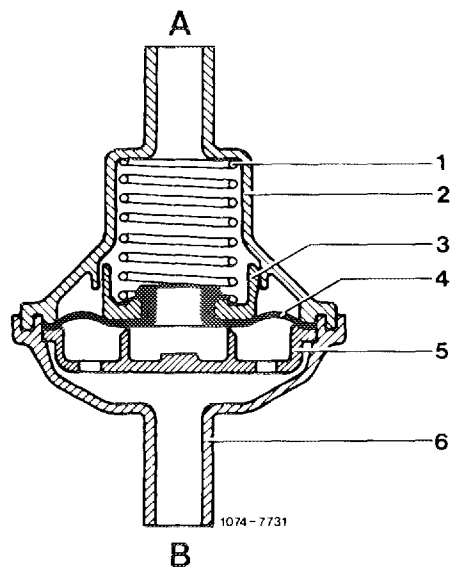
When the engine is running and the vacuum in the regenerating line exceeds 30–50 mbar, the regenerating valve opens. The fuel vapors stored in charcoal canister can be drawn off depending on the throttle valve position.



- Regenerating valve (open)
- 1 Compression spring
  - 2 Valve housing
  - 3 Spring seat
  - 4 Pressure relief valve
  - 5 Valve disc
  - 6 Connection
  - A Connection throttle valve housing
  - B Connection charcoal canister

When the throttle valve opens, the two regenerating bores in throttle valve housing, which are entering a common duct, are both passed over one after the other. As a result, regeneration in lower partial load range begins in dosages which are not influencing the driving characteristics.

At idle and during deceleration (throttle valve closed) the two regenerating bores are at atmospheric side of throttle valve. There is no regeneration of charcoal in canister.



Regenerating valve (closed)