BlueTec Diesel Technology (Euro 4 and Euro 5) Engine Model Designation 457.9, 541.9, 542.9, 900.9, 902.9, 924.9, 926.9

Technical status 10 / 06

DaimlerChrysler AG · Teile-Technik und Technische Information (GSP / TI) · D-70546 Stuttgart

Information and Copyright

Ordering workshop information

All printed workshop information from GSP / TI, such as Introduction into Service Manuals, System Descriptions, Function Descriptions, Technology Guides, Technical Data Manuals and adhesive labels, can be ordered as follows:

In Germany
Through our GSP / TI Shop on the internet
Link: http: / / gsp-ti-shop.daimlerchrysler.com

or alternatively
Email: customer.support@daimlerchrysler.com
Phone: +49-18 05 / 0 10-79 79
Fax: +49-18 05 / 0 10-79 78

Outside Germany
Please get in touch with the contact person responsible for your market.

Product Portfolio

Comprehensive information about our full Product Portfolio can also be found at our Internet Portal.
Link: http: / / open-after-sales.daimlerchrysler.com

Questions and Suggestions

If you have any questions or suggestions concerning this product, please write to us.
Email: customer.support@daimlerchrysler.com
Fax: +49-18 05 / 0 10-79 78

or alternatively
Address: DaimlerChrysler AG
GSP / TIS
HPC R822, W002
D-70546 Stuttgart

Image no. of title image: N00.01-2409-00
Order no. of this publication: 6517 1249 02

01 / 07

Contents

Dear reader,

This brochure is intended for the use of technical personnel familiar with the service and maintenance of Mercedes-Benz trucks.

The content of this brochure is subdivided into:

- Function descriptions
- Component descriptions
- Changes to engine (in-engine)

It provides basic information on the Actros, Axor, Atego and Econic commercial vehicle classes with BlueTec diesel technology and is not intended for diagnosis of technical problems.

For diagnosis purposes, the Workshop Information System (WIS) and the Diagnosis Assistance System (DAS) are available.

Function descriptions, in-engine changes, and repair and adjustment work will be incorporated into WIS. The brochure is not stored in this form in WIS.

All the information relating to technical data in this brochure was valid as of October 2006 and may therefore differ from the current production configuration.

We will publicize modifications and new features in the relevant WIS documents only. Individual details in this brochure may therefore differ from more up-to-date versions published in WIS.

DaimlerChrysler AG

After Sales Service Engineering Trucks, GSP / TCST

October 2006

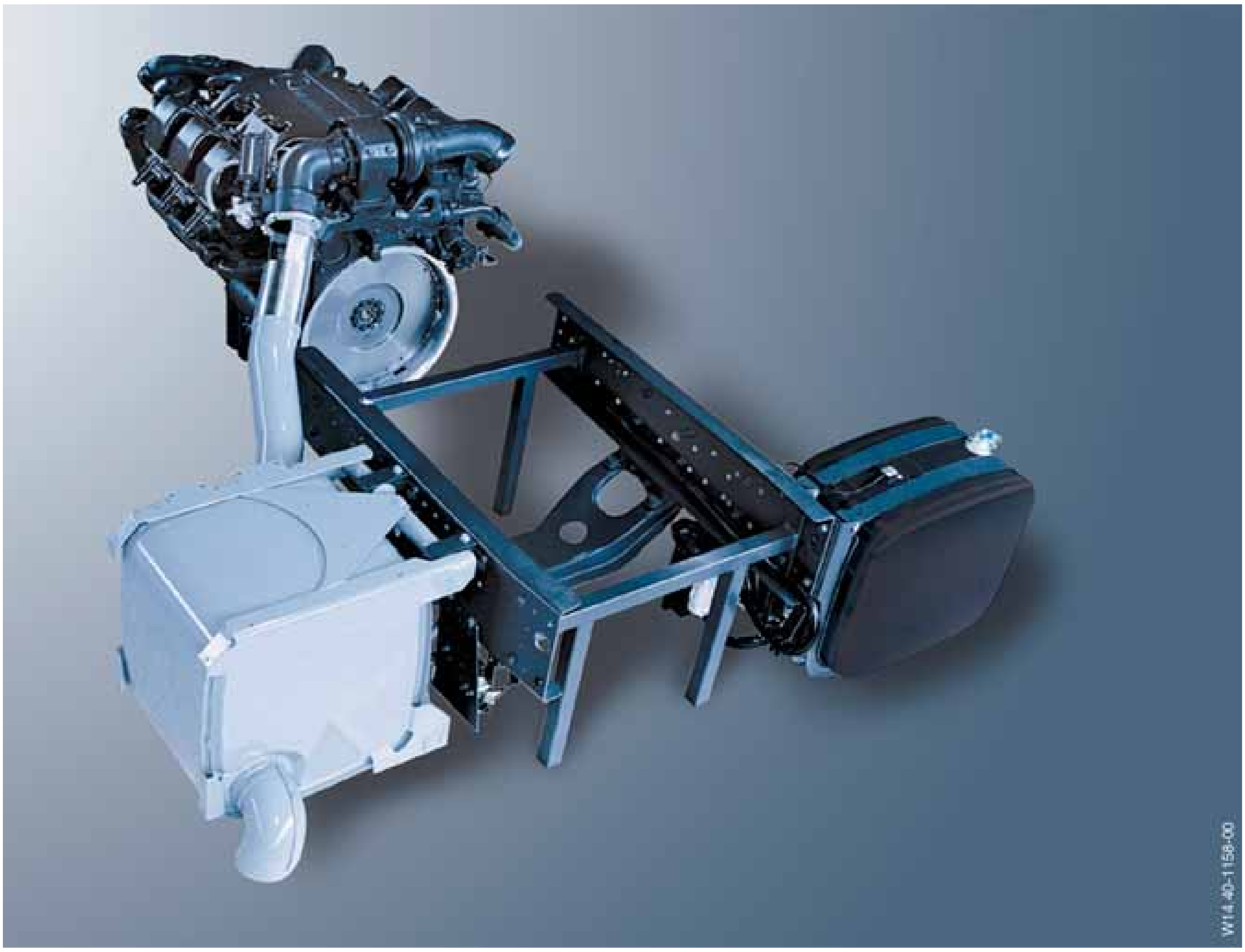
Introduction

BlueTec Diesel Technology

DaimlerChrysler has developed exhaust aftertreatment using BlueTec diesel technology to reduce emissions from diesel engine exhausts and comply with the future emissions standards Euro 4 and Euro 5.

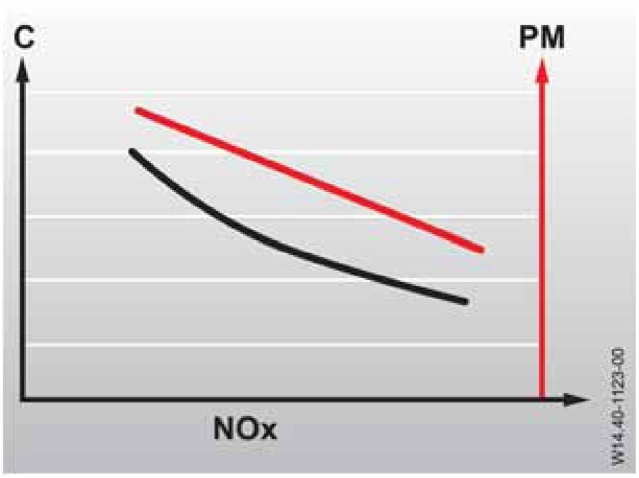
This is based on a procedure known as "Selective Catalytic Reduction" (SCR), which subjects the exhaust to aftertreatment that reduces toxic nitrogen oxides (NO_x) to harmless nitrogen (N_2) and water vapor (H_20).

Vehicles with this new BlueTec diesel technology are equipped with special system components and a more advanced engine that burns fuel with maximum efficiency to minimize soot emissions.



Model with engine 541.9

When an engine is optimized to increase its efficiency and produce the best possible performance with low fuel consumption (C), the result is that more nitrogen oxide (NO_x) is produced. Engineering the combustion process for low emission of nitrogen oxides (NO_x) means accepting higher fuel consumption (C) and higher emissions of soot particles (PM), which are actually unburned fuel.



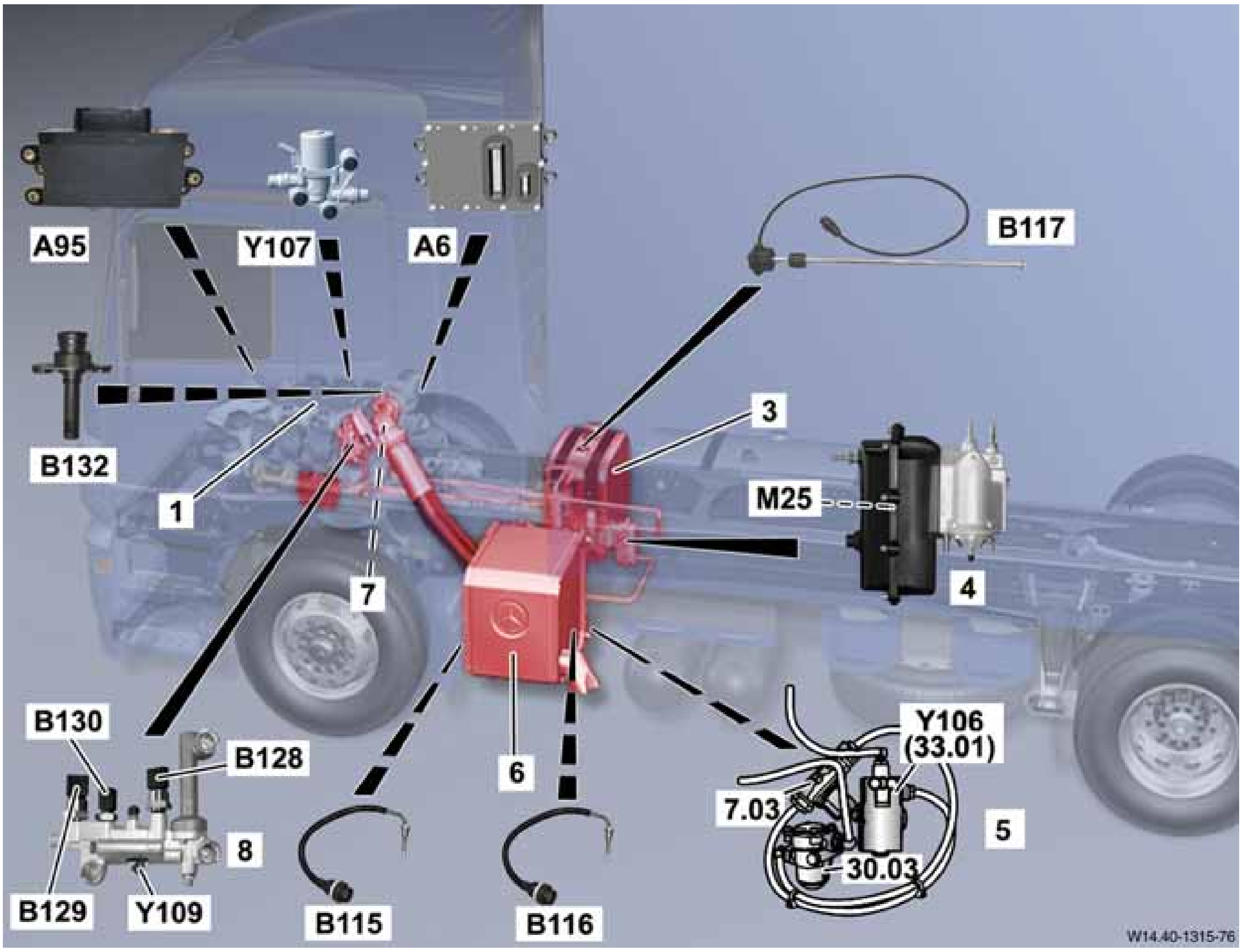
This technical conflict means that it is not possible to combine in-engine optimization with the aim of reducing NO_x and soot emissions and at the same time comply with future statutory standards. Exhaust gas must undergo aftertreatment.

Vehicles equipped with BlueTec diesel technology not only have a more advanced engine, they also have components for the aftertreatment of nitrogen oxides generated during combustion.

In addition, the vehicles require an extra operating fluid: the NO_x reducing agent AdBlue™, which consists of a urea solution and is carried in a separate tank.

Overall system function

Location of components



Shown on engine 541.9

Components

1 Engine
3 AdBlue tank
4 Pump module
5 Compressed-air controller unit
6 Muffler with reduction catalytic converter
7 Injection nozzle (in engine brake flap fitting)
7.03 Overflow valve (without return flow)
8 Metering device
30.03 Pressure limiting valve

Participating control units

A6 Engine control (MR) control unit
A95 SCR frame module control unit

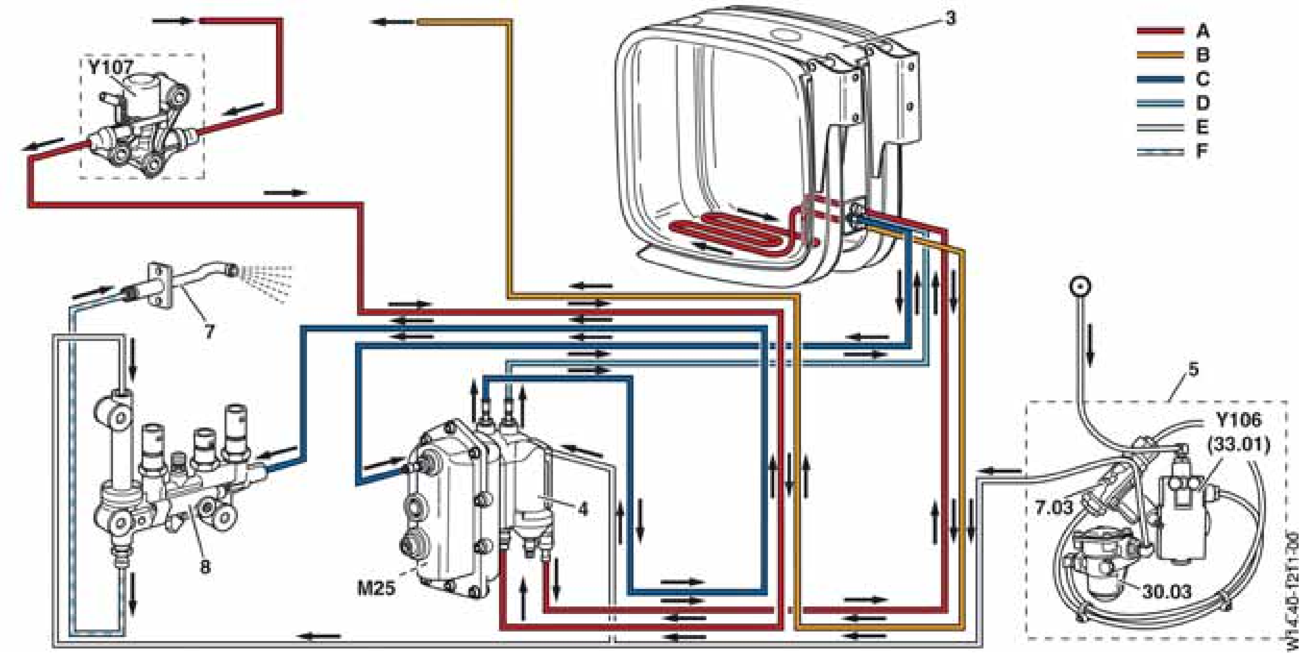
Sensors

B115 Temperature sensor upstream of SCR catalytic converter
B116 Temperature sensor downstream of SCR catalytic converter
B117 Fill level and SCR AdBlue temperature combination sensor
B128 SCR compressed air pressure sensor
B129 SCR AdBlue pressure sensor
B130 SCR AdBlue temperature sensor
B132 SCR air temperature and air humidity combination sensor

Actuators

M25 SCR AdBlue pump
Y106 SCR air pressure limiter solenoid valve (33.01)
Y107 SCR tank heater solenoid valve
Y109 SCR AdBlue metering valve

AdBlue line diagram,
AdBlue heater and compressed air supply



3	*AdBlue tank*	M25	*SCR AdBlue pump*
4	*Pump module*	Y106	*SCR air pressure limiter solenoid valve (33.01)*
5	*Compressed-air controller unit*	Y107	*SCR tank heater solenoid valve*
7	*Injection nozzle*		
8	*Metering device*	A	*Coolant feed line (from engine)*
7.03	*Overflow valve (without return flow)*	B	*Coolant return line (to engine)*
30.03	*Pressure limiting valve (with vent)*	C	*AdBlue feed line*
		D	*AdBlue return line*
		E	*Compressed air*
		F	*Aerosol (AdBlue / air mixture)*

Overall system function

Overall system function

After starting the engine, the engine control (MR) control unit (A6) initially runs an automatic test routine to verify the operational readiness of the BlueTec system. If the system is enabled, the SCR air pressure limiter solenoid valve (Y106) is switched on at the compressed-air controller unit (5) and the compressed air is branched off from ancillary consumer circuit 4, flowing into the compressed-air intake on the metering device (8) and through the downstream injection line and injection nozzle (7).

At the same time, compressed air is fed to the compressed-air intake of the pump module (4). Here, the air ensures that the pneumatic pressure relief valve closes the AdBlue return line which leads from the pump module (4) into the AdBlue tank (3) and that AdBlue pressure build up at the metering device (8) is facilitated.

This takes place irrespective of whether AdBlue is injected or not. The continuous flow through the metering device (8) and the injection line and injection nozzle (7) ensures that the metered AdBlue is always supplied to the injection nozzle (7) located at the engine brake flap fitting in full and without delay. This also ensures that no AdBlue deposits are left in the metering device (8), the injection nozzle (7) and the injection line located between them.

Provided particular sensor values are OK, the engine control (MR) control unit (A6) enables the pump, causing the AdBlue in the AdBlue tank (3) to be taken up by the SCR AdBlue pump (M25) and fed to the pump module (4), where it is filtered and then pumped on to the metering device (8).

In the metering device (8), the AdBlue is at operating pressure at the closed SCR AdBlue metering valve (Y109). When this opens at the intervals set by the engine control (MR) control unit, the AdBlue can then flow through. Under the prevalent pressure and flow conditions, the AdBlue is carried along by the air current towards the injection line and injection nozzle (7).

The injection nozzle (7) is located on the engine brake flap fitting. AdBlue is then injected straight into the hot exhaust flow.

The resulting AdBlue / air mixture disintegrates in the hot exhaust flow during an initial process stage to form ammonia (NH_3). Together with the nitrogen-oxide molecules generated during combustion the resulting ammonia is then fed to the muffler with reduction catalytic converter (6). Located inside the reduction catalytic converter is a coated ceramic honeycombed core. This is where the second stage of the reduction process takes place.

The nitrogen oxide molecules impact on the ammonia molecules, energy is released in the form of heat and harmless nitrogen (N_2) and water vapor (H_20) are the only products left over from the chemical process.

Overall system function

To ensure that during each operating cycle the correct volume of AdBlue is injected at the correct time, a constant exchange of data must take place between the BlueTec sensor system and the engine control (MR) control unit (A6).

For example, the sensors on the metering device (8) provide continuous information on AdBlue pressure, AdBlue temperature and compressed-air pressure. Additional sensors provide data on the exhaust temperature at the catalytic converter intake and inlet chamber. The SCR air humidity and air temperature combination sensor (B132) is used to account for the affects of moisture and the temperature of the intake air on the nitrogen oxide emissions.

The analog data of the frame-side sensors are recorded by the SCR frame module control unit (A95), digitized there and then forwarded per CAN bus to the engine control (MR) control unit (A6).

The engine control (MR) control unit (A6) takes the current engine data and values stored in the performance maps into account to perform continuous calculations on the opening times of the SCR AdBlue metering valve (Y109) and the SCR tank heater solenoid valve (Y107). Calculations are also made here which the SCR frame module control unit (A95) requires for actuation of the SCR AdBlue pump (M25) and SCR air pressure limiter solenoid valve (Y106).

After the ignition is switched off, the metering device (8) is ventilated to avoid any damage from freezing. This occurs during the control unit power-down (max. 300 s) through the opening and closing of the SCR air pressure limiter solenoid valve (Y106) and the SCR AdBlue metering valve (Y109) at defined intervals. The basic influencing variables during ventilation are the pressures applied to the SCR AdBlue pressure sensor (B129) and the SCR compressed-air pressure sensor (B128).

If these values tell the engine control (MR) control unit (A6) that the metering device (8) has been sufficiently filled with air, then the ventilation process is terminated.

AdBlue heater, function

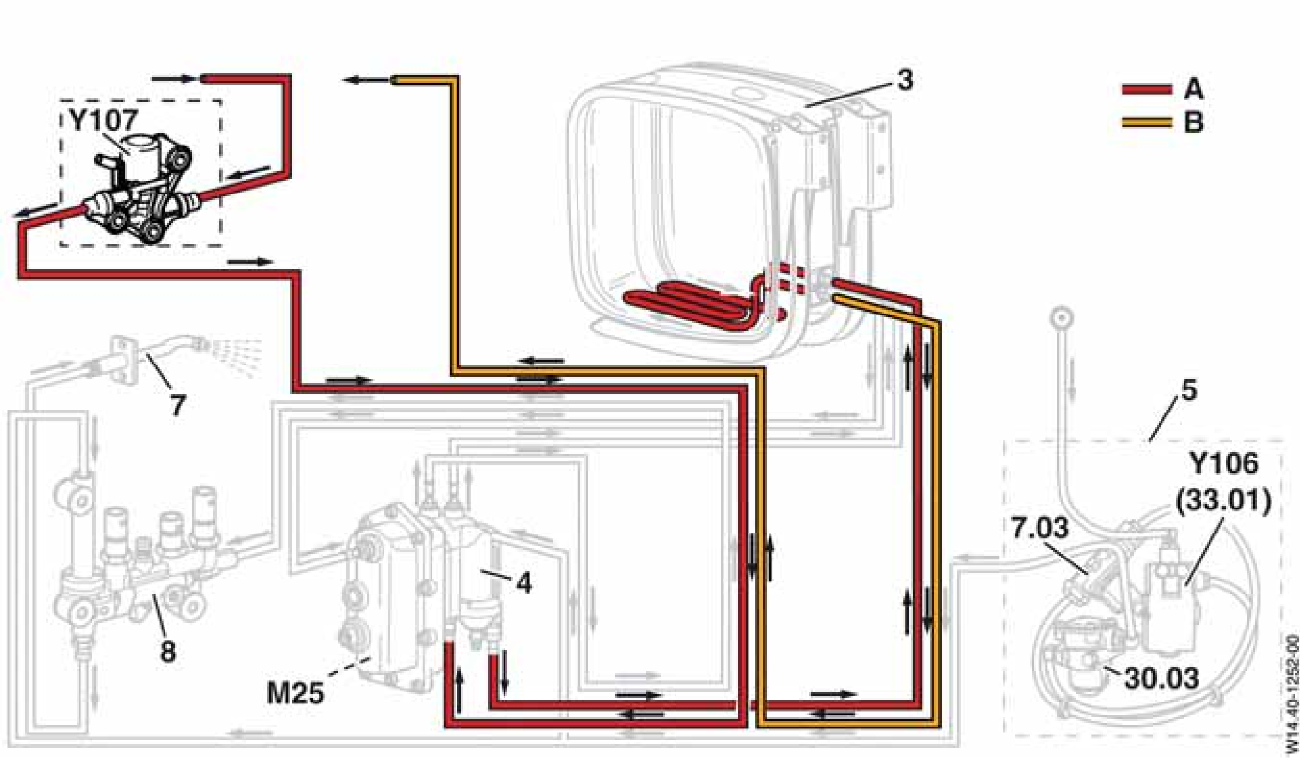
Basic components

The AdBlue heater consists of the SCR tank heater solenoid valve (Y107), located on the right side of the engine, and a coolant line system from the engine to the AdBlue tank.

Individual BlueTec components such as the pump module (4) are flushed directly by ducts or lines.

The heat supply to the AdBlue lines is provided by a bundled line installation and insulating tubing.

Function diagram for AdBlue heater



3	*AdBlue tank*	*M25*	*SCR AdBlue pump*
4	*Pump module*	*Y106*	*SCR air pressure limiter solenoid valve (33.01)*
5	*Compressed-air controller unit*	*Y107*	*SCR tank heater solenoid valve*
7	*Injection nozzle*		
7.03	*Overflow valve (without return flow)*	*A*	*Coolant feed line (from engine)*
8	*Metering device*	*B*	*Coolant return line (to engine)*
30.03	*Pressure limiting valve (with vent)*		

AdBlue heater, function

The AdBlue heater ensures that any AdBlue that has frozen during periods of non-operation is heated and reliquified and prevents AdBlue from freezing while driving in cold outside temperatures.

The SCR tank heater solenoid valve (Y107) is actuated by the engine control (MR) control unit (A6). Using the fill level and SCR AdBlue temperature combination sensor integrated in the AdBlue tank (3), it detects when the temperature of the tank contents is approaching the defined limit value of around 8°C.

As soon as the coolant reaches a temperature of ≥65°C, the SCR tank heater solenoid valve (Y107) receives the signal to open from the engine control (MR) control unit (A6) so that coolant is branched off from the engine coolant circuit.

After the valve has opened, the coolant flows through the lines towards the pump module (4). The pump module (4) and the AdBlue tank (3) both have ducts for the coolant to flow directly through the components. After this the coolant flows back towards the engine.

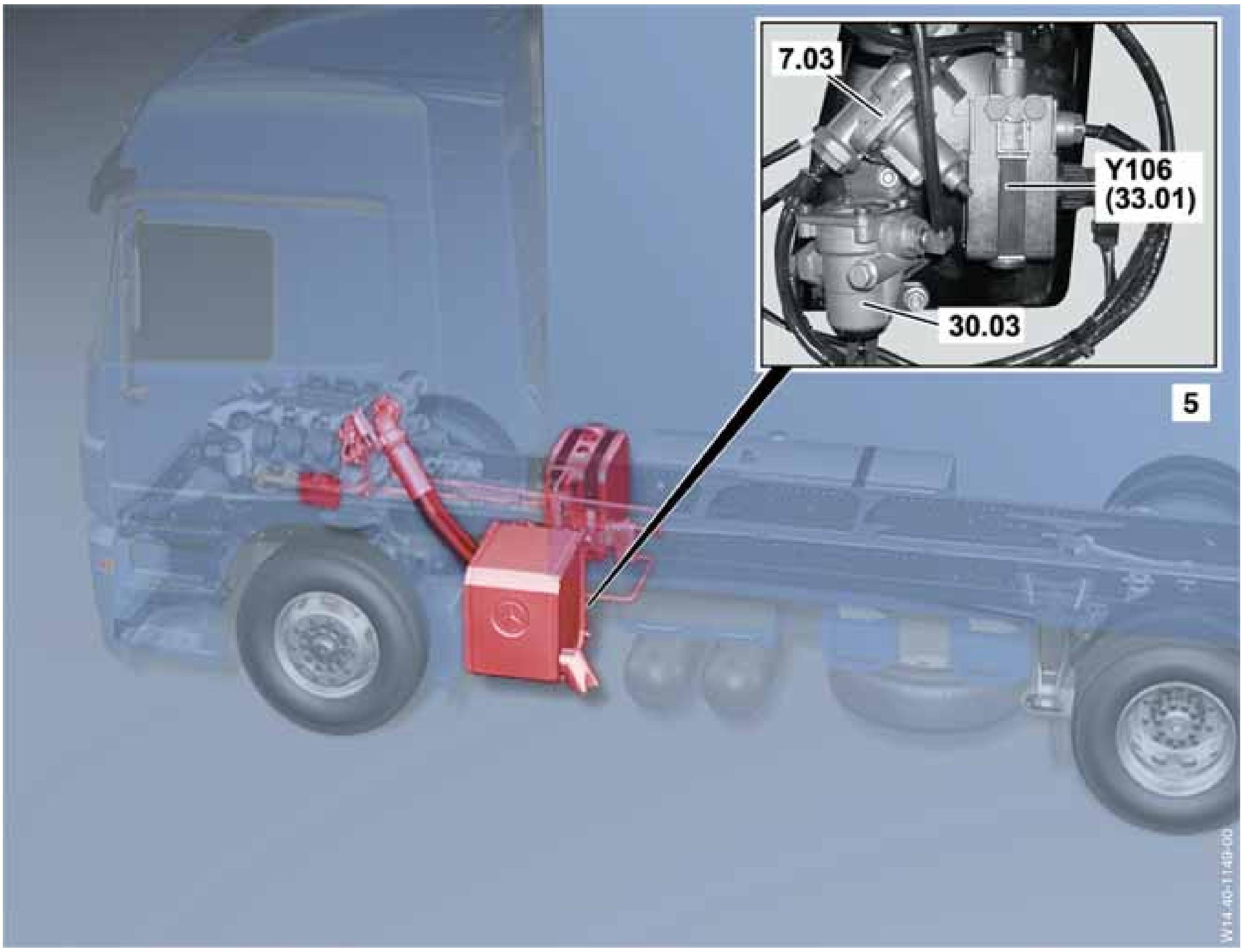
Shown on engine 541.9

Y107 SCR tank heater solenoid valve

Compressed-air supply, function

Basic components

The compressed air is supplied by the compressed-air controller unit (5) which is mounted to the inside of the left longitudinal frame member at the height of the muffler. The compressed air is supplied through a system of lines from the pump module to the metering device.

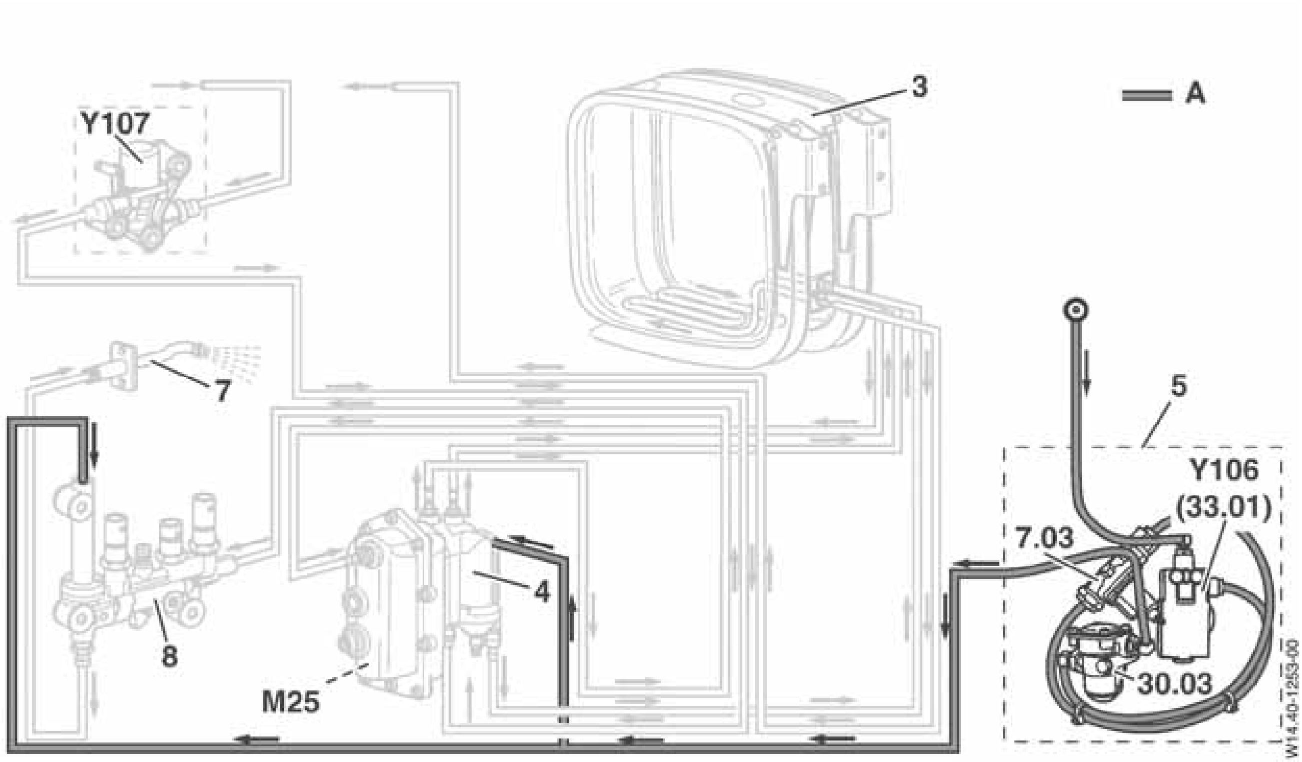


Shown on engine 541.9

5 Compressed-air controller unit
7.03 Overflow valve (without return flow)
30.03 Pressure limiting valve (with vent)

Y106 SCR air pressure limiter solenoid valve (33.01)

Function diagram for compressed-air supply



3	*AdBlue tank*	M25	*SCR AdBlue pump*
4	*Pump module*	Y106	*SCR air pressure limiter solenoid valve (33.01)*
5	*Compressed-air controller unit*	Y107	*SCR tank heater solenoid valve*
7	*Injection nozzle*		
7.03	*Overflow valve (without return flow)*	A	*Compressed air*
8	*Metering device*		
30.03	*Pressure limiting valve (with vent)*		

Compressed-air supply, function

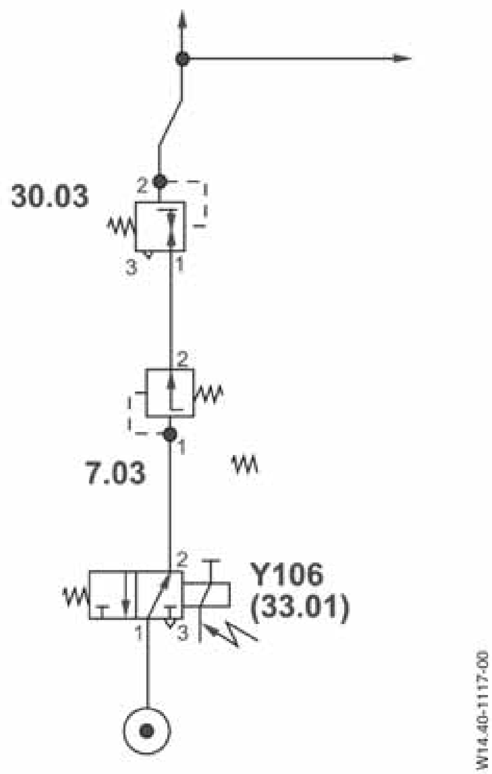
Compressed-air supply, function

The compressed air ensures that the AdBlue is transported from the metering device (8) to the injection nozzle (7) and that the AdBlue is sent back from the pump module (4) to the AdBlue tank (3).

After starting the engine, the engine control (MR) control unit (A6) then actuates the SCR air pressure limiter solenoid valve (Y106) via the SCR frame module control unit (A95).

When opened the compressed air is branched off from ancillary consumer circuit 4. The compressed air flows through the SCR air pressure limiter solenoid valve (Y106), and then through the overflow valve (7.03) and the pressure limiting valve (30.03). In the pressure limiting valve (30.03) the original pressure of approx. 8 bar from ancillary consumer circuit 4 is reduced to the operating pressure of the compressed-air supply (approx. 5.5 bar).

The compressed air from the ancillary consumer circuit then flows over a compressed air line through the metering device (8) and through the downstream injection nozzle (7). Similarly, compressed air is fed to the compressed-air connection of the pump module (4). Here the compressed air ensures that a pneumatic switching valve seals the return of AdBlue from the pump module (4) into the AdBlue tank (3). This switching valve is closed if compressed air is applied to it.



7.03 Overflow valve
30.03 Pressure limiting valve
Y106 SCR air pressure limiter solenoid valve

Venting and depressurization of individual BlueTec components

After the ignition is switched off, the metering device (8) is ventilated to avoid any damage caused by freezing. This occurs during the control unit power-down (max. 300 s) through the opening and closing of the SCR air pressure limiter solenoid valve (Y106) and the SCR AdBlue metering valve (Y109) on the metering device (8) at defined and coordinated intervals.

When the SCR air pressure limiter solenoid valve (Y106) closes, the pneumatic pressure relief valve on the pump module (4) also opens because compressed air is not applied there.

This causes the return duct to the AdBlue tank (3) in the pump module (4) to open.

The basic influencing variables during ventilation of the metering device (8) are the pressures applied to the SCR AdBlue pressure sensor (B129) and the SCR compressed-air pressure sensor (B128).

First, the pressure at the SCR compressed air pressure sensor (B128) and the pressure at the SCR AdBlue pressure sensor (B129) are measured. If the pressure difference lies above a specified threshold, or if the measured AdBlue pressure is greater than the measured compressed-air pressure, then the SCR air pressure limiter solenoid valve (Y106) opens.

The compressed air then flows out of the ancillary consumer circuit 4 to the metering device (8) and then against the flow direction of the SCR AdBlue metering valve (Y109) through the metering device (8) and then pushes the remaining AdBlue back into the line between the metering device (8) and pump module (4).

During the next interval the SCR air pressure limiter solenoid valve (Y106) closes. Compressed air no longer flows through the metering device (8) or to the pneumatic switching valve on the pump module (4).

The SCR AdBlue metering valve (Y109) is closed, AdBlue can no longer flow back. The AdBlue pressure built up in the AdBlue line is now reduced by means of the opened return duct to the AdBlue tank (3), because the pneumatic switching valve on the pump module (4) now no longer has compressed air applied to it.

AdBlue flows back into the AdBlue tank (3) and the pressure in the AdBlue line system is reduced to approximately atmospheric pressure.

The AdBlue line between the pump module (4) and the metering device (8) is a flexible hose line. It can accommodate extra volume which may arise if the AdBlue freezes in the line.

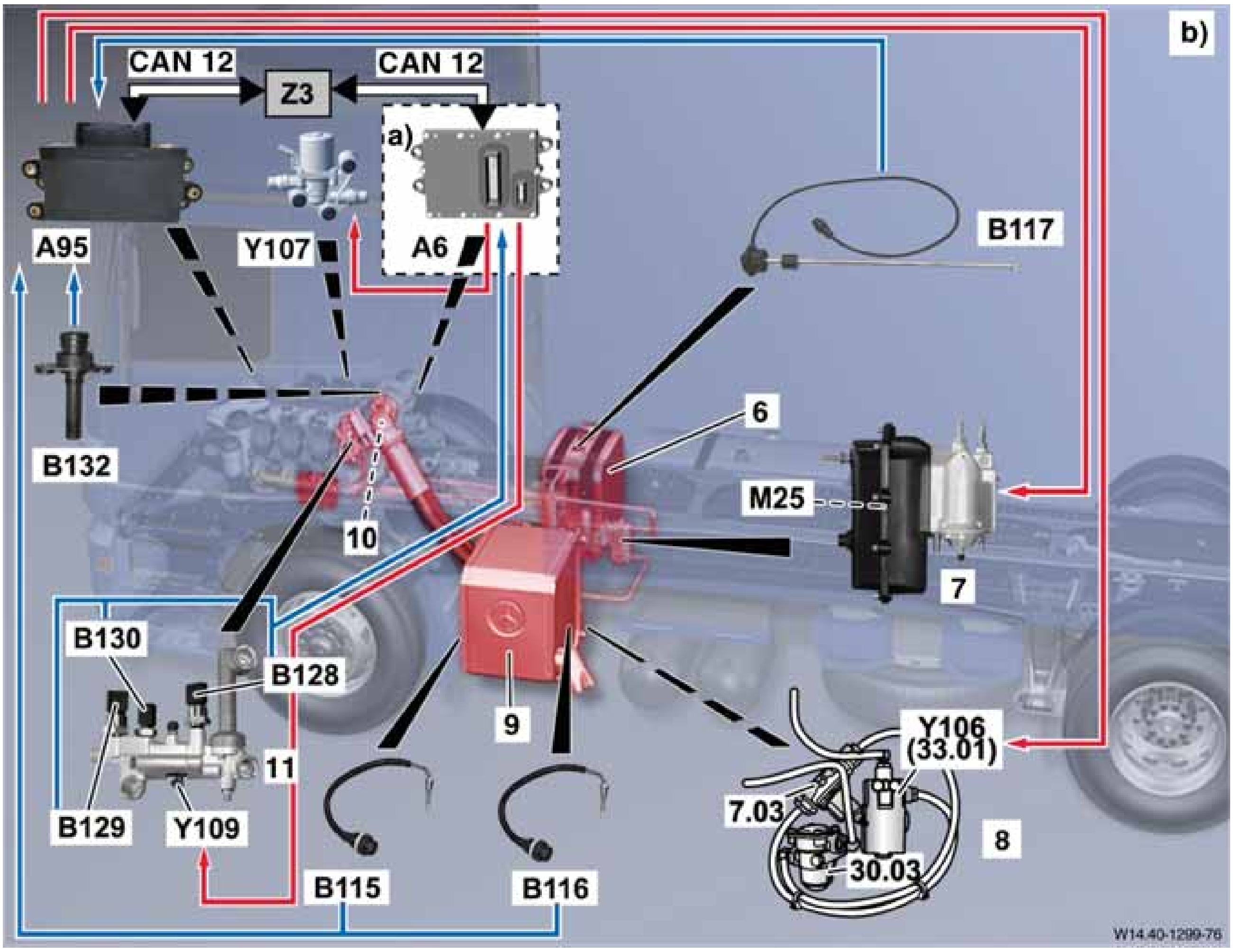
The relevant valves are repeatedly opened and closed until the pressure measured at the SCR compressed air pressure sensor (B128) is greater than the pressure applied to the SCR AdBlue pressure sensor (B129).

If - through the sensor signals - the engine control (MR) control unit recognizes that the metering device (8) has been sufficiently filled with air, and the pressure in the AdBlue line system has been sufficiently reduced, the ventilation process is terminated.

The ventilation of the metering device (8) and pump module (4) after the engine has been switched off is audible and can be heard until the ventilation process is complete.

Integration into overall network

Communication between the exhaust aftertreatment system and the engine control system



Shown on engine 541.9

6	AdBlue tank
7	Pump module
7.03	Overflow valve (without return flow)
8	Compressed-air controller unit
9	Muffler with reduction catalytic converter
10	Injection nozzle (in engine brake flap fitting)
11	Metering device
30.03	Pressure limiting valve
A6	Engine control (MR) control unit
A95	SCR frame module control unit
B115	Temperature sensor upstream of SCR catalytic converter
B116	Temperature sensor downstream of SCR catalytic converter
B117	Fill level and SCR AdBlue temperature combination sensor
B128	SCR compressed air pressure sensor
B129	SCR AdBlue pressure sensor
B130	SCR AdBlue temperature sensor
B132	SCR air temperature and air humidity combination sensor
CAN 12	SCR-CAN
M25	SCR AdBlue pump
Y106	SCR air pressure limiter solenoid valve (33.01)
Y107	SCR tank heater solenoid valve
Y109	SCR AdBlue metering valve
Z3	Additional CAN star point
a)	Engine control (MR)
b)	Exhaust aftertreatment system with BlueTec diesel technology

Engine control (MR) information for the exhaust aftertreatment system

The engine control (MR) control unit (A6) transmits information for actuating the SCR air pressure limiter solenoid valve (Y106) and for actuating the SCR AdBlue pump (M25) to the SCR frame module control unit (A95) via the SCR-CAN (CAN 12). The SCR frame module control unit (A95) operates as a simple A / D converter i.e. it controls the components based on requests from the engine control (MR) system but does not perform any computations. Any faults that occur are not stored in the SCR frame module control unit (A95) but in the engine control (MR) control unit (A6).

Exhaust aftertreatment system information for the engine control (MR) system

In return, the SCR frame module control unit (A95) transmits information on the exhaust temperature upstream and downstream of the catalytic converter, on the air humidity and air temperature of the intake air and on the fluid level and temperature of the AdBlue supply in the AdBlue tank (6) to the engine control (MR) control unit (A6).
Using this information, the engine control (MR) system can detect the operating condition and operational readiness of the BlueTec system and initiate the control processes required for exhaust aftertreatment.

SCR frame module control unit

Location

Engine 457.9, 902.9, 926.9 in model 950.5/6, 952.5/6, 953.6, 954.5 (shown on model 950.5)

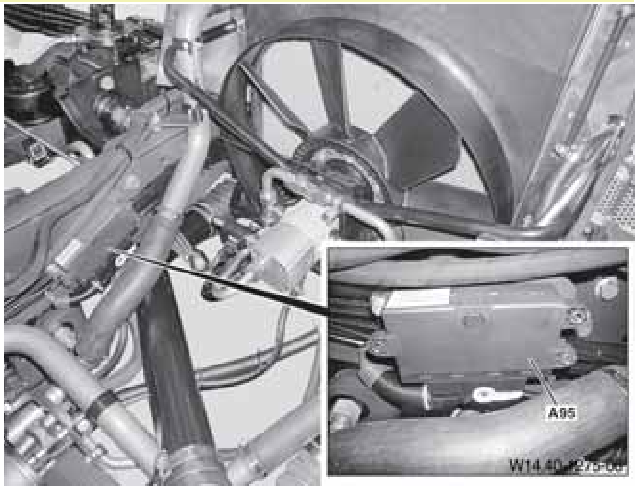
The SCR frame module control unit (A95) is located at the rear of the vehicle on the inside of the right longitudinal frame member.

Engine 541.9, 542.9 (shown on model 930)

The SCR frame module control unit (A95) is located on the right-hand side of the vehicle on a bracket below the cab.

Engine 902.9, 926.9 in model 957

The SCR frame module control unit (A95) is located on the left longitudinal frame member under the cab.



Location on engine 900.9, 902.9, 924.9 in model 970, 972, 974, 975, 976 (shown on model 970)

The SCR frame module control unit (A95) is located in the equipment carrier behind the vehicle batteries.

Task

The SCR frame module control unit (A95) reads the analog signals of the connected sensors, converts them into digital CAN (Controller Area Network) signals and then forwards them to the engine control (MR) control unit (A6) as cyclical status messages.

Apart from this, it provides the supply voltage for the active sensors and receives the signals from the engine control (MR) control unit (A6) for actuation of the connected components.

The SCR frame module control unit (A95) reads the analog signals of the following sensors:

- Temperature sensor upstream of SCR catalytic converter (B115)
- Temperature sensor downstream of SCR catalytic converter (B116)
- Fill level and SCR AdBlue temperature combination sensor (B117)
- SCR air temperature and air humidity combination sensor (B132)

The signals are processed in the engine control (MR) control unit (A6) and corresponding control signals are sent by CAN bus signal to the SCR frame module control unit (A95), which then actuates the following components:

- SCR AdBlue pump (M25)
- SCR air pressure limiter solenoid valve (Y106)

There are no application data in the SCR frame module control unit (A95). No debouncing or saving of fault data occurs here. This is the task of the engine control (MR) control unit (A6), which receives all the necessary data over the CAN bus.

After switching off the ignition, the SCR frame module control unit (A95) continues to run as long as messages are received from the engine control (MR) control unit (A6).

Pump module

Location

Shown on model 944

The pump module (18) is located on the inside of the right longitudinal frame member level with the AdBlue tank.

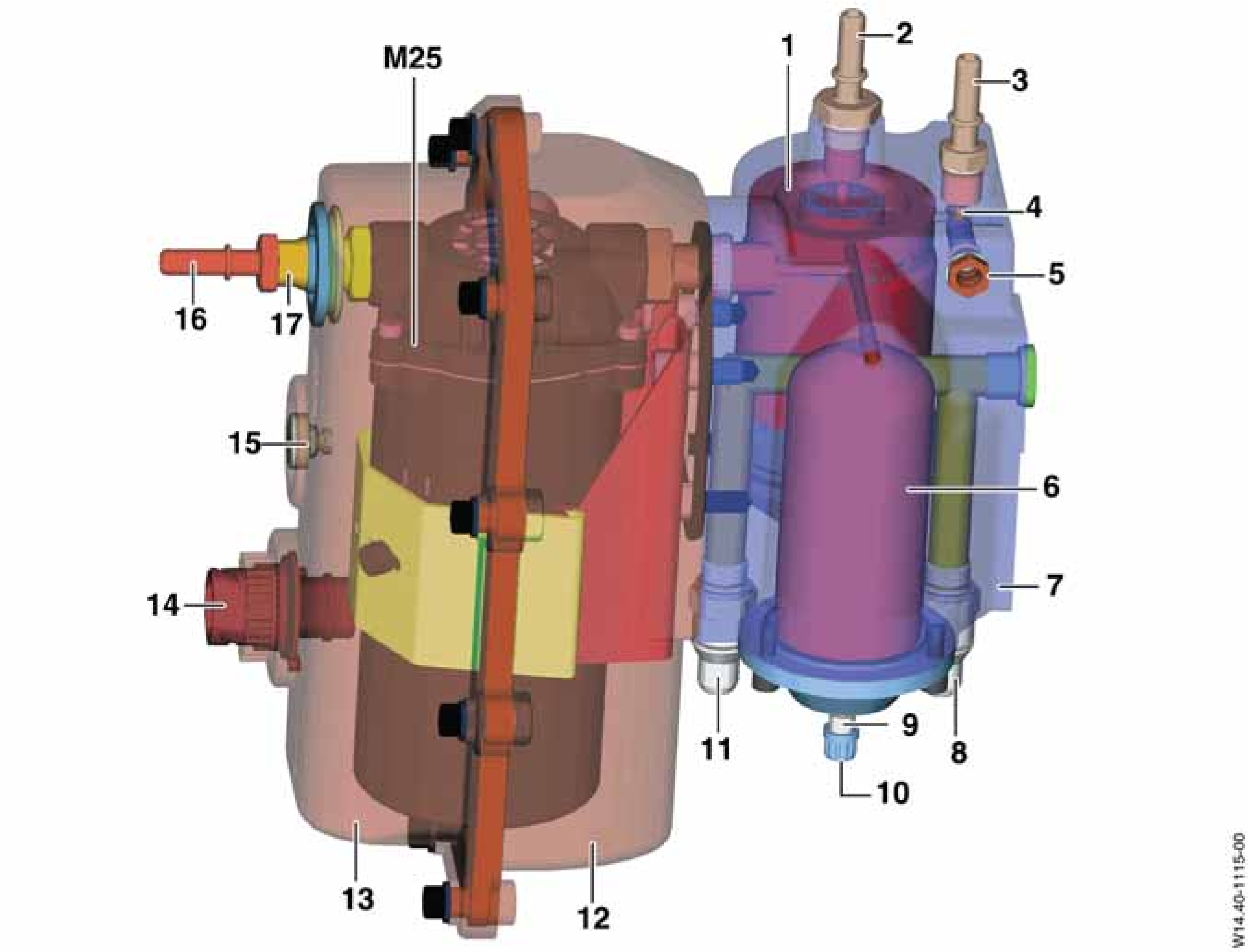
Task

The pump module sucks AdBlue out of the AdBlue tank, filters it and pumps it to the metering device.

Design

The pump module consists of a splash-protected plastic housing - the pump housing (12) - and an aluminum block bolted on to it - the pressure filter and accumulator housing (7). The pump housing (12) contains the SCR AdBlue pump (M25), which is an electrical 3-chamber diaphragm pump.

The pressure filter and accumulator housing (7) contains not only the pressure filter (1) and pressure reservoir (6) but also a pneumatic switching valve (4). Apart from this, it also has connections for coolant lines and a duct for coolant to flow through.



1	*Pressure filter*
2	*AdBlue line fitting (feed line)*
3	*AdBlue line fitting (return line)*
4	*Pneumatic switching valve*
5	*Connection (compressed air)*
6	*Pressure reservoir*
7	*Pressure filter and accumulator housing*
8	*Coolant line fitting (outlet)*
9	*Pressure reservoir filling valve*
10	*Pressure reservoir filling connection*
11	*Coolant line fitting (intake)*
12	*Pump housing*
13	*Housing cover*
14	*Electrical connector*
15	*Cover venting diaphragm*
16	*AdBlue line fitting (suction)*
17	*Suction filter (in intake fitting)*
M25	*SCR AdBlue pump*

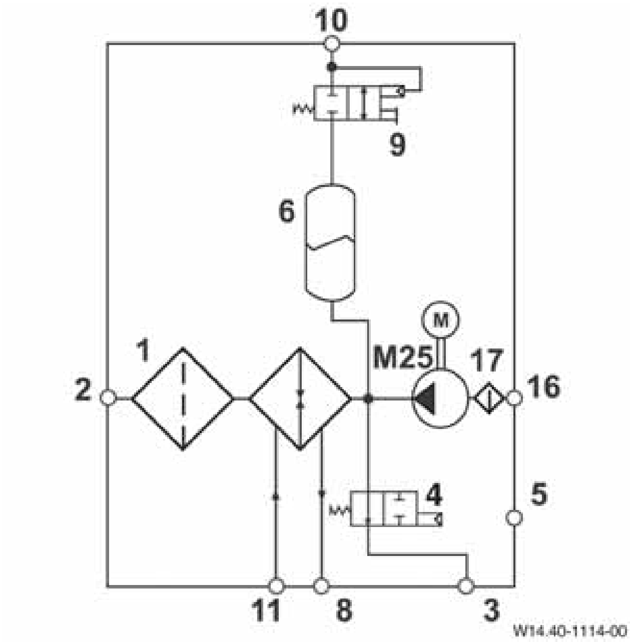
Pump module

Function

When the SCR AdBlue pump (M25) receives the signal to switch-on, it sucks in AdBlue from the AdBlue tank. It is prefiltered in the suction filter (17) integrated into the AdBlue line fitting (16), with a mesh width of 100 µm.

The SCR AdBlue pump (M25) brings the AdBlue up to the operating pressure of roughly 6 bar and pumps it into the pressure filter and accumulator housing (7). To separate any remaining fine-grained dirt particles, the AdBlue passes through the pressure filter (2) with a mesh width of 30 µm, before being pumped onwards to the metering device.

In principle, the pressure reservoir (6) is a gas-filled reservoir bladder made of rubber designed to compensate for surges in pressure and to reduce the cut-in frequency of the SCR AdBlue pump (M25). It has a volume of approx. 0.13 l. It is filled with nitrogen (N_2) at the factory. When refilling it may be charged with air that is free of oil or grease.



1	*Pressure filter*
2	*AdBlue line fitting (feed line)*
3	*AdBlue line fitting (return line)*
4	*Pneumatic switching valve*
5	*Connection (compressed air)*
6	*Pressure reservoir*
8	*Coolant line fitting (outlet)*
9	*Pressure reservoir filling valve*
10	*Pressure reservoir filling connection*
11	*Coolant line fitting (intake)*
16	*AdBlue line fitting (suction)*
17	*Suction filter (in intake fitting)*
M25	*SCR AdBlue pump*

Venting

The pneumatic switching valve (4) and AdBlue line fitting (3) serve to automatically vent the pump module during operation or during initial startup. The pneumatic switching valve (4) is closed when compressed air is applied to it. As a rule, the SCR AdBlue pump (M25) does not deliver when "empty", as it switches off when the fill level sensor in the AdBlue tank drops below a specific limit value.

The SCR AdBlue pump (M25) can however also run when empty for a brief period, if the AdBlue sloshes in the tank. If the SCR AdBlue pump (M25) runs empty for longer than 10 s, however, this is recognized by the engine control (MR) control unit and automatic venting is initiated.

AdBlue depressurization

To prevent any frozen AdBlue from damaging the pump module, the AdBlue pressure is reduced inside the pump module and in the line section between the pump module and the metering device when the ignition is switched off.

Depressurization takes place by venting the compressed-air controller unit. This causes the pneumatic switching valve (4) to open and thus enable the AdBlue to return to the AdBlue tank.

Heating

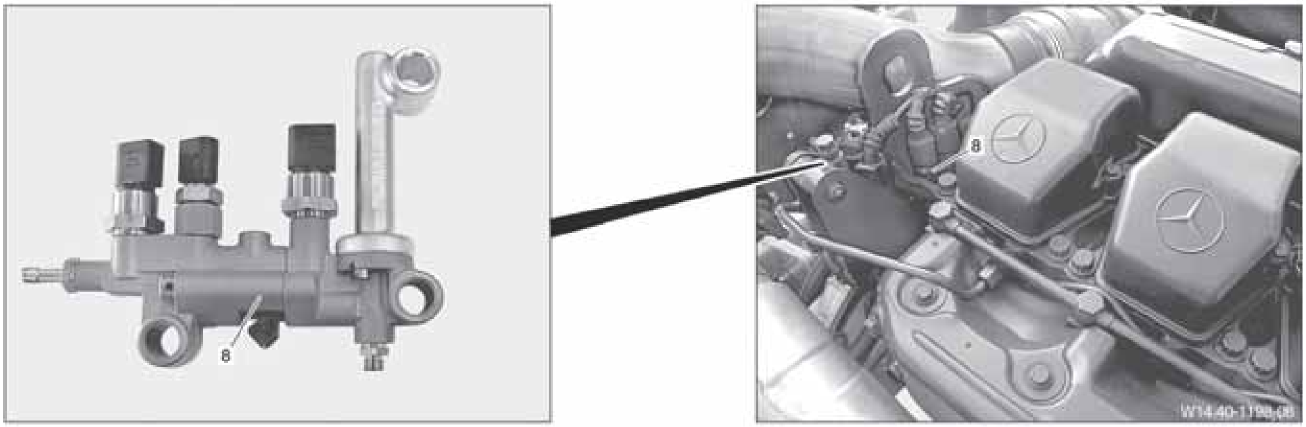
A duct in the pressure filter and accumulator housing (7) is used to allow coolant to flow through it for heating and deicing. Temperature-dependent control of the coolant feed line is performed by the engine control (MR) control unit via a valve mounted to the engine.

Metering device

Location

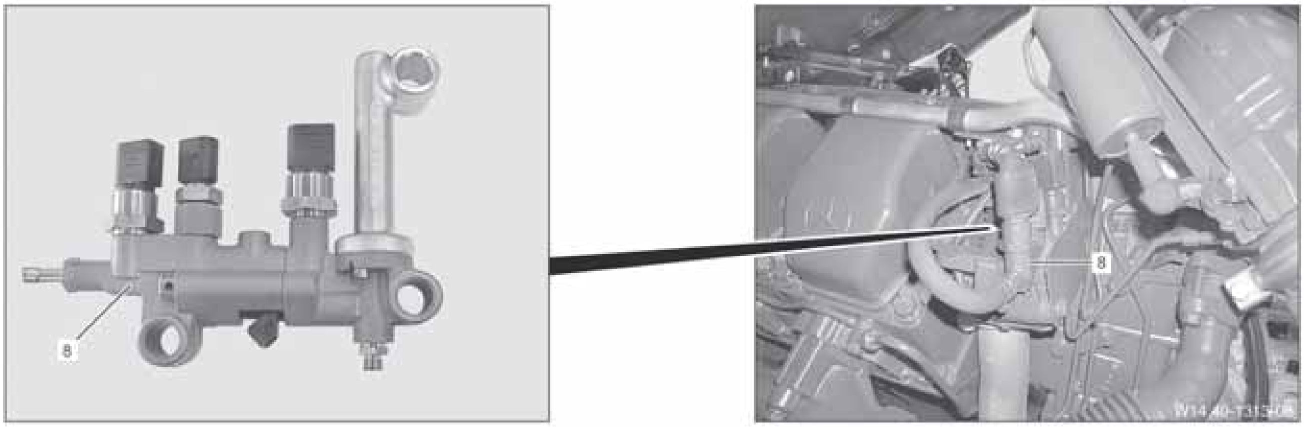
Engine 457.9 (shown on engine 457.9)

The metering device (8) is located near the rear cylinder head.



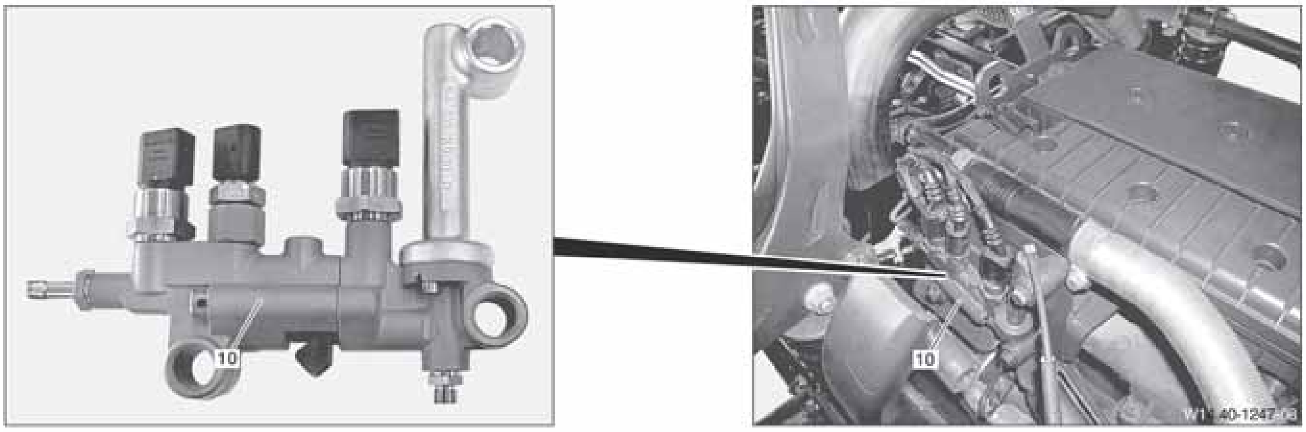
Engine 541.9, 542.9 (shown on engine 541.9)

The metering device (8) is located near the left rear cylinder head.



Engine 900.9, 902.9, 924.9, 926.9 (shown on model 950.5)

The metering device (10) is located near the left rear cylinder head.



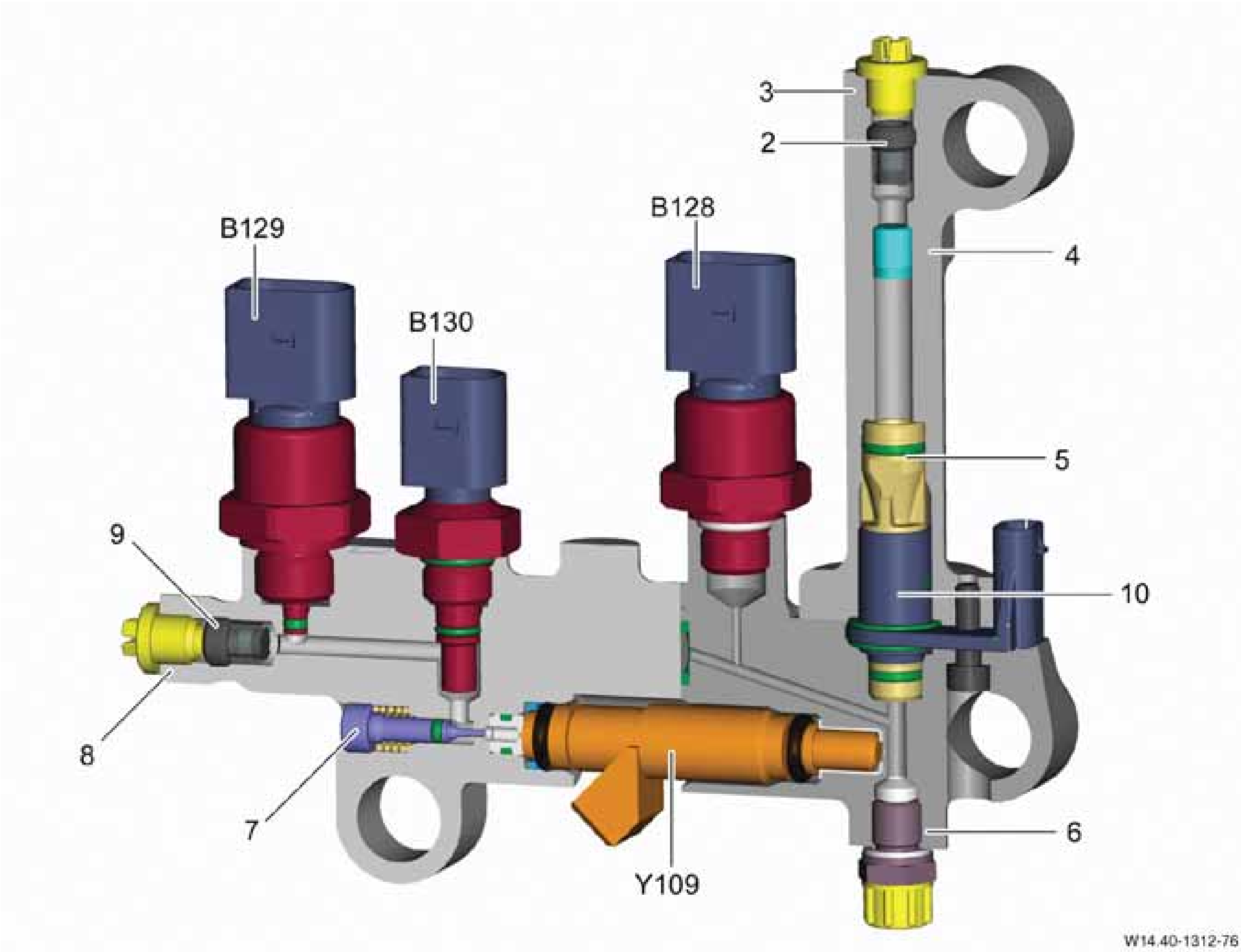
Task

Compressed air and AdBlue are mixed in the metering device to form an aerosol, which is then injected into the exhaust flow in accordance with the control signals from the engine control (MR) control unit.

Design

The metering device consists of a two-piece aluminum housing fitted bolted together. Located on one side are the AdBlue components and on the other side the compressed-air components.

The SCR AdBlue metering valve (Y109) is located between them.



1	*Vent valve*	*B128*	*SCR compressed air pressure sensor*
2	*Compressed-air filter screen*	*B129*	*SCR AdBlue pressure sensor*
3	*Compressed-air intake*	*B130*	*SCR AdBlue temperature sensor*
4	*Check valve*	*Y109*	*SCR AdBlue metering valve*
5	*Diffusor*		
6	*Aerosol outlet*		
7	*Calibrating screw*		
8	*AdBlue intake*		
9	*AdBlue filter screen*		
10	*Metering device heater*		

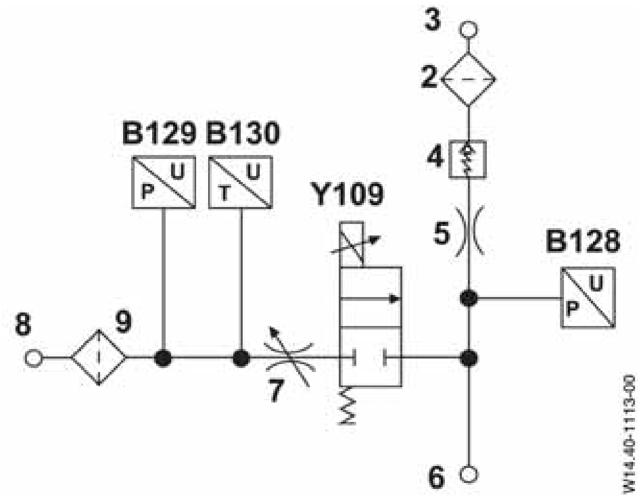
Metering device

Function

The pump module pumps AdBlue through the feed line to the metering device. There it passes through the AdBlue filter screen (9) with a mesh width of 30 µm to free it of any contamination and it is then applied at operating pressure to the closed SCR AdBlue metering valve (Y109). When the engine is started, a continuous flow of air, which previously flowed through the compressed-air filter screen (2), passes through the compressed-air intake (3).

When the SCR AdBlue metering valve (Y109) opens at the intervals calculated by the engine control (MR) control unit, the AdBlue flows past the SCR AdBlue metering valve (Y109) and it is then moved by the air flow towards the injection nozzle because of the prevalent pressure and flow conditions.

The continuous flow through the metering device with compressed air ensures that AdBlue deposits do not remain in the metering device.



2 Compressed-air filter screen
3 Compressed-air intake
4 Check valve
5 Diffusor
6 Aerosol outlet
7 Calibrating screw
8 AdBlue intake
9 AdBlue filter screen
B128 SCR compressed air pressure sensor
B129 SCR AdBlue pressure sensor
B130 SCR AdBlue temperature sensor
Y109 SCR AdBlue metering valve

Ventilation of metering device after switching off ignition

After the ignition is switched off, the metering device is ventilated to prevent any damage being caused by frozen AdBlue. This occurs during the control unit power-down (max. 300 s) through the coordinated opening and closing at defined intervals of the air pressure limiter solenoid valve at the compressed-air controller unit and the SCR AdBlue metering valve (Y109).

The basic influencing variables during ventilation are the pressures applied to the SCR AdBlue pressure sensor (B129) and the SCR compressed air pressure sensor (B128).

If the pressure difference lies above a specified threshold then the AdBlue metering valve (Y109) is opened and compressed air flows opposite to the flow direction of the SCR AdBlue metering valve (Y109) into the metering device and pushes the remaining AdBlue back into the line between the metering device and pump module.

If the engine control (MR) control unit recognizes through corresponding sensor signals that the metering device has been sufficiently filled with air, then the ventilation process is terminated. This is the case, when the pressure measured at the SCR compressed air pressure sensor (B128) is greater than the pressure applied to the SCR AdBlue pressure sensor (B129).

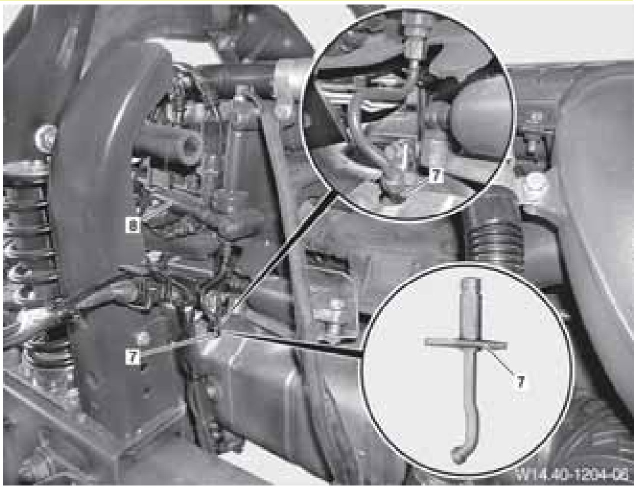
The AdBlue line between the pump module and metering device is a flexible hose. It can accommodate the additional volume when AdBlue freezes. Apart from this, the pressure in this hose is reduced by means of a pressure reducing function of the pump module to approximately atmospheric pressure.

Injection nozzle

Location

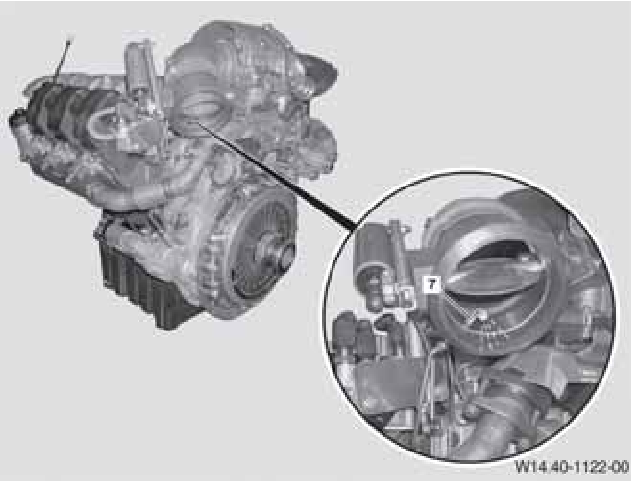
Engine 457.9

The injection nozzle (7) is externally mounted into the engine brake flap fitting.



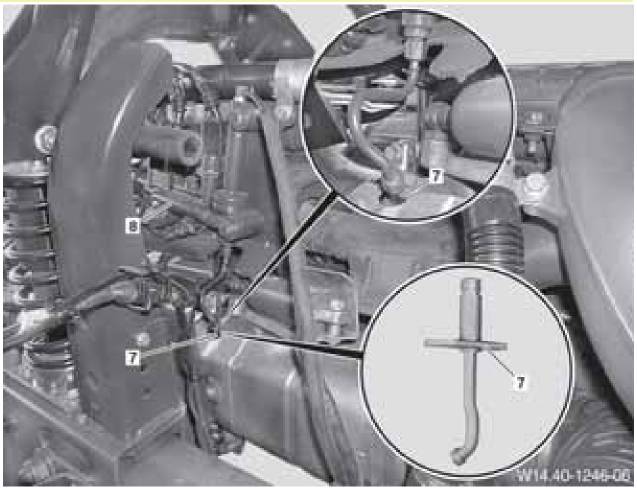
Engine 541.9, 542.9 (shown on engine 541.9)

The injection nozzle (7) is externally mounted into the engine brake flap fitting.



Engine 900.9, 902.9, 924.9, 926.9

The injection nozzle (7) is externally mounted into the engine brake flap fitting.



Injection nozzle

Task

The injection nozzle (7) serves to inject the AdBlue coming from the metering device as uniformly as possible into the exhaust flow.

Design

The injection nozzle (7) is made of aluminum. It has a flange, with which it is bolted from the outside onto the engine brake flap fitting. The nozzle tip faces towards the flow direction. The outlet bore of the nozzle tip has a diameter of 1.5 mm.

Function

The AdBlue coming from the metering device flows through the injection nozzle (7) and it is injected by its nozzle tip straight into the hot exhaust flow in the engine brake flap fitting.

The AdBlue in the exhaust flow requires a certain amount of time for the chemical process that converts AdBlue to ammonia (NH_3). For this reason it is mounted at a precisely-defined distance upstream of the muffler with reduction catalytic converter.

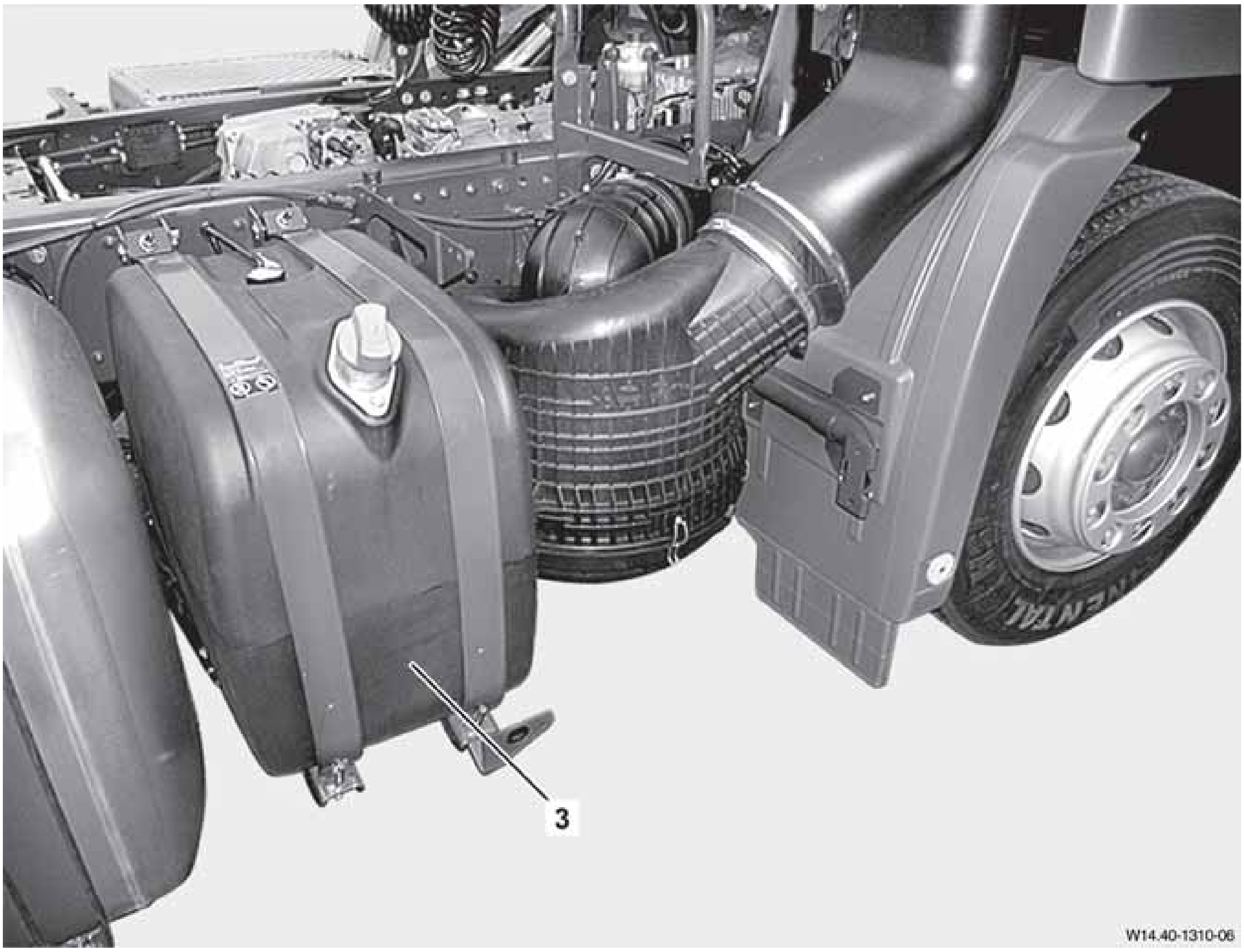
7 Injection nozzle

AdBlue tank

Location

Shown on model 944

The AdBlue tank (3) is mounted to the right longitudinal frame member.



Task

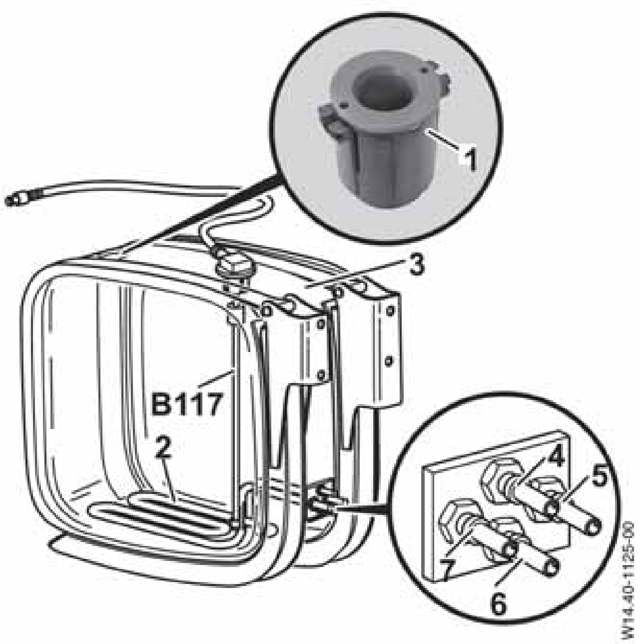
The AdBlue tank holds the AdBlue supply.

Design

The AdBlue tank (3) is made of plastic and has an integrated coolant duct (2) and line fittings (4, 5, 6, 7) to connect AdBlue and coolant lines.

The Elafix filler neck (1) has a smaller diameter (19 mm) than the filler neck of the diesel tank and also has an integrated solenoid adapter in the form of a ring magnet.

The fill level and SCR AdBlue temperature combination sensor (B117) is located in the AdBlue tank (3) to monitor the AdBlue level and AdBlue temperature.



1 *Elafix filler neck*
2 *Coolant duct*
3 *AdBlue tank*
4 *Line fitting (AdBlue return line)*
5 *Line fitting (coolant outlet)*
6 *Line fitting (AdBlue feed line)*
7 *Line fitting (coolant intake)*
B117 *Fill level and SCR AdBlue temperature combination sensor*

Filling AdBlue tank

The AdBlue tank's (3) Elafix filler neck (1) with its special diameter and its integrated solenoid adapter serves to prevent accidental filling with diesel fuel.

When filling the tank, the solenoid adapter's magnetic field actuates a solenoid switch in the outlet pipe of the nozzle thus enabling the filling process.

This system can also be used to ensure that the diesel fuel tank is not filled with AdBlue by mistake, as its filler neck does not come with a solenoid adapter and the solenoid switch in the nozzle only allows refueling when a specified magnetic field is given.

AdBlue heating

The coolant coming from the engine is routed through the line fitting (7) into the AdBlue tank (3).

Once it has passed through the coolant duct (2), it leaves the AdBlue tank (3) through the line fitting (5) and heads back towards the engine.

The coolant duct's (2) heat transfer causes any frozen AdBlue to thaw and prevents liquid AdBlue from freezing.

Muffler with reduction catalytic converter

Location

Shown on model 944

The muffler with reduction catalytic converter (6) is mounted to the left longitudinal frame member.

Task

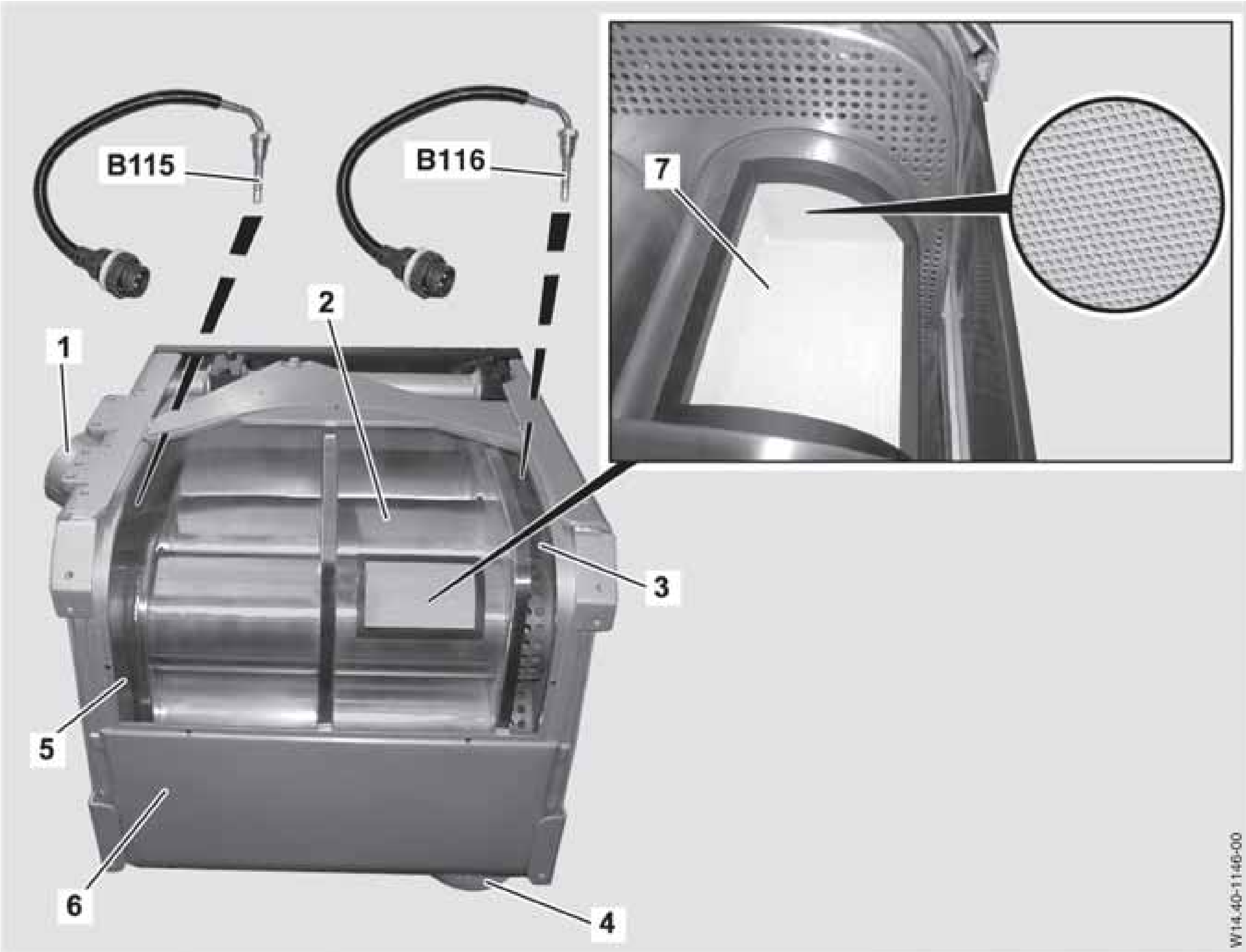
The toxic nitrogen oxides (NO_x) generated during fuel combustion are reduced in the muffler with reduction catalytic converter (6) to harmless nitrogen (N_2) and water (H_2O).

Muffler with reduction catalytic converter

Design

The muffler with reduction catalytic converter (6) has a housing made of stainless steel. Located inside it is the reduction catalytic converter (2). Its core consists of ceramic honeycomb elements (7) that are coated with a layer of titanium dioxide (TiO_2), tungsten oxide (WO_3) and vanadium pentoxide (V_2O_5).

The muffler with reduction catalytic converter (6) also has a temperature sensor upstream of the SCR catalytic converter (B115) for measurement of the temperature in the inlet chamber (5) and a temperature sensor downstream of the SCR catalytic converter (B116) for measurement of temperature in the outlet chamber (3).



1 Intake pipe
2 Reduction catalytic converter
3 Outlet chamber
4 Tailpipe
5 Inlet chamber
6 Muffler with reduction catalytic converter
7 Honeycomb element

B115 Temperature sensor upstream of SCR catalytic converter
B116 Temperature sensor downstream of SCR catalytic converter

Muffler with reduction catalytic converter

Function

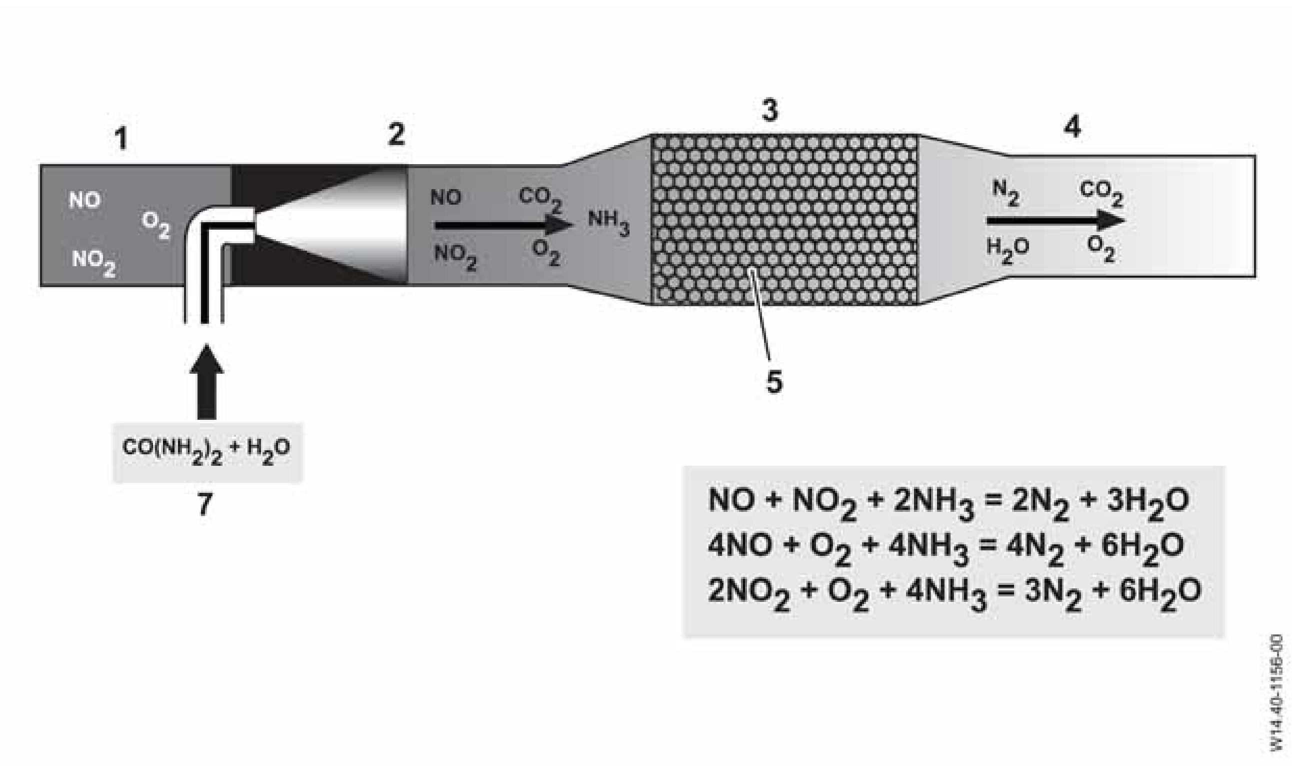
AdBlue (7) is injected into the hot exhaust flow from the engine (1). During a first process stage in the hydrolysis segment (2) it is converted to ammonia (NH_3). Together with the nitrogen oxide molecules (NO_x) created during combustion the ammonia (NH_3) is then sent to the reduction catalytic converter (3).

The second stage of the reduction process takes place in the honeycomb elements (5) inside: The nitrogen oxide molecules meet the ammonia molecules (NH_3) - energy is released in the form of heat. All that remains from this chemical reaction are nonpolluting nitrogen (N_2) and water vapor (H_2O).

For this process, which is known as selective catalytic reduction, the reduction catalytic converter (3) requires a specific operating temperature.

For this purpose it is 250 °C. The temperature sensor in the inlet chamber of the muffler with reduction catalytic converter (6) transmits this temperature at specified intervals via the SCR frame module control unit to the engine control (MR) control unit.

Muffler with reduction catalytic converter



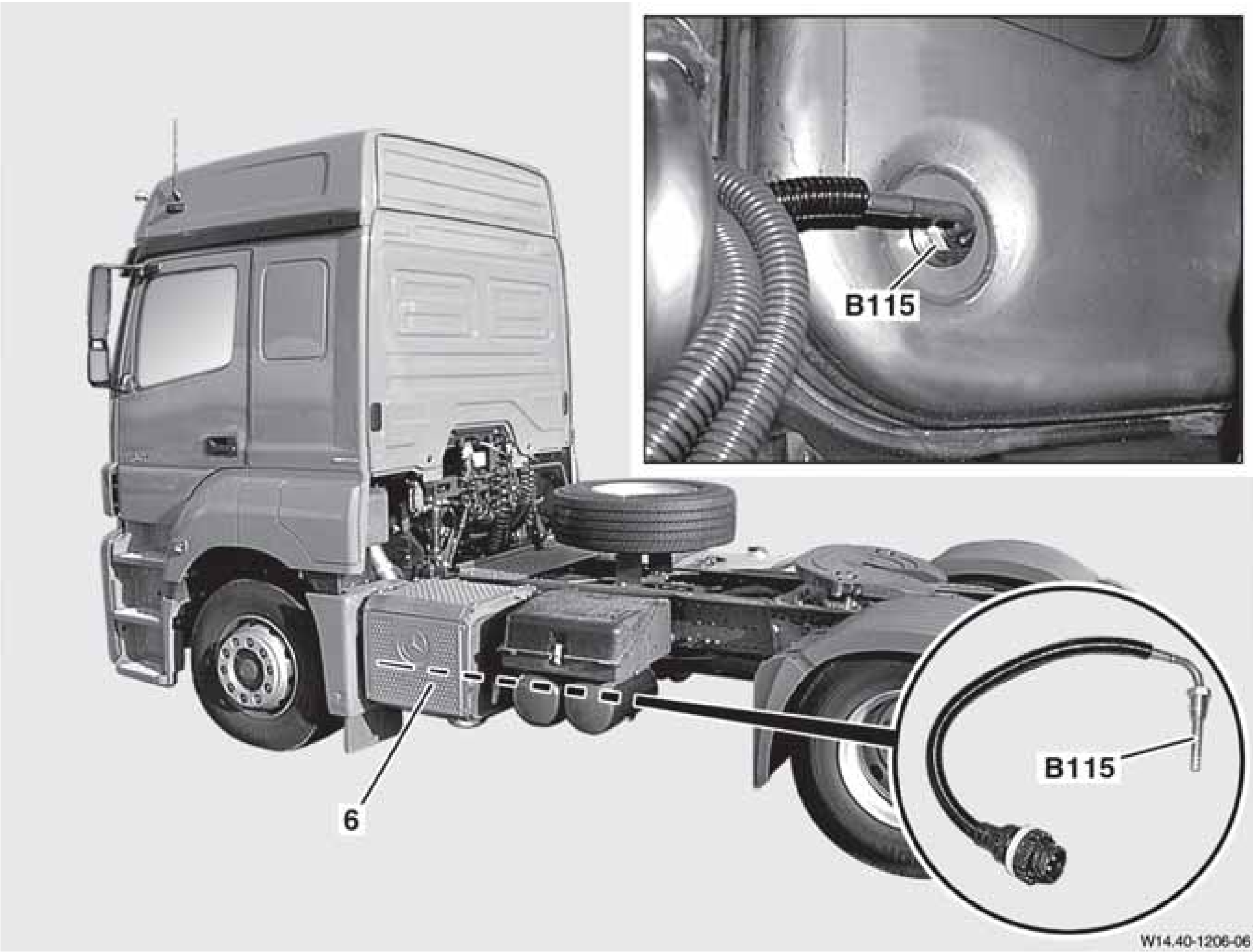
1 *Exhaust flow from engine (input product)*
2 *Hydrolysis segment*
3 *Reduction catalytic converter*
4 *Exhaust (end product)*
5 *Honeycomb*
7 *AdBlue*

Temperature sensor upstream of SCR catalytic converter

Location

Shown on model 944

The temperature sensor upstream of SCR catalytic converter (B115) is externally screwed into the inlet chamber of the muffler with reduction catalytic converter (6).



Task

The temperature sensor upstream of the SCR catalytic converter (B115) records the temperature of the exhaust flow in the inlet chamber of the muffler with reduction catalytic converter (6) and routes this information as an electrical voltage signal to the SCR frame module control unit.

Temperature sensor upstream of SCR catalytic converter

Design

The temperature sensor upstream of the SCR catalytic converter (B115) consists of a stainless steel housing with thread and an electrical connector.

A PTC resistor is located inside the sensor as a measuring element. PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as temperature rises.

The temperature sensor upstream of SCR catalytic converter (B115) is a passive sensor, i.e. it is not supplied with voltage.

Function

The exhaust gas which flows past the temperature sensor upstream of the SCR catalytic converter (B115) influences the measuring element inside the sensor in correlation with its temperature and thus the magnitude of electrical resistance.

The values of the changing electrical resistance are transmitted at defined intervals as an analog signal to the SCR frame module control unit, digitized there and then forwarded to the engine control (MR) control unit.

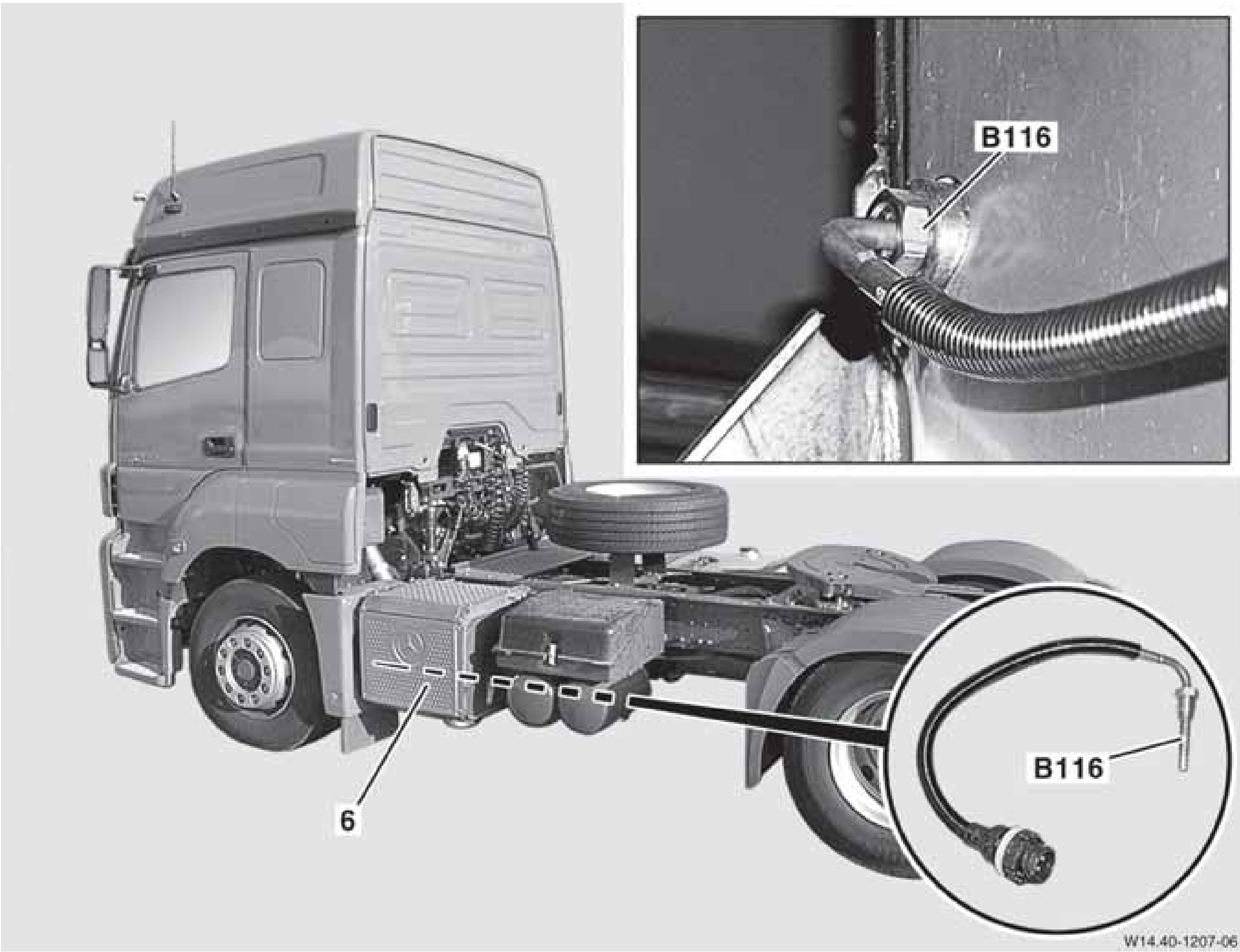
Using this resistance value, the engine control (MR) control unit calculates the associated temperature.

Temperature sensor downstream of SCR catalytic converter

Location

Shown on model 944

The temperature sensor downstream of SCR catalytic converter (B116) is externally screwed into the outlet chamber of the muffler with reduction catalytic converter (6).



Task

The temperature sensor downstream of SCR catalytic converter (B116) records the temperature of the exhaust flow in the outlet chamber of the muffler with reduction catalytic converter (6) and routes this information as an electrical voltage signal to the SCR frame module control unit.

Temperature sensor downstream of SCR catalytic converter

Design

The temperature sensor downstream of SCR catalytic converter (B116) consists of a stainless steel housing with thread and an electrical connector.

A PTC resistor is located inside the sensor as a measuring element. PTC stands for "Positive Temperature Coefficient" and means that the electrical resistance increases as temperature rises.

The temperature sensor downstream of the SCR catalytic converter (B116) is a passive sensor, i.e. it is not supplied with voltage.

Function

The exhaust gas which flows past the temperature sensor downstream of the SCR catalytic converter (B116) influences the measuring element inside the sensor in correlation with its temperature and thus the magnitude of electrical resistance.

The values of the changing electrical resistance are transmitted at defined intervals as an analog signal to the SCR frame module control unit, digitized there and then forwarded to the engine control (MR) control unit.

Using this resistance value, the engine control (MR) control unit calculates the associated temperature.

SCR air temperature and air humidity combination sensor

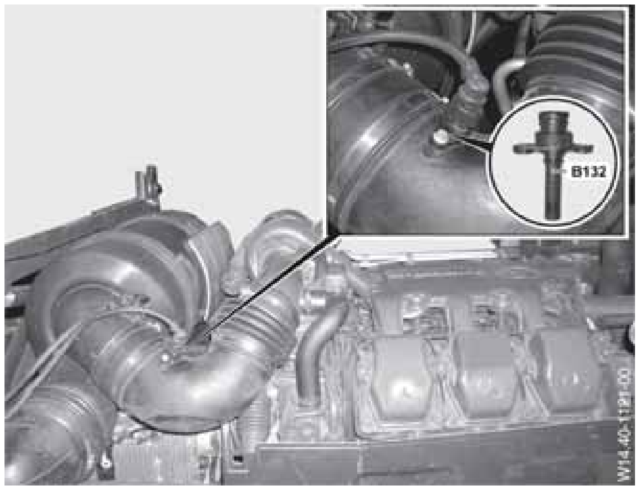
Location

Shown on engine 457.9

The SCR air temperature and air humidity combination sensor (B132) is screwed into the clean-air pipe (1) between the air filter and the turbocharger.

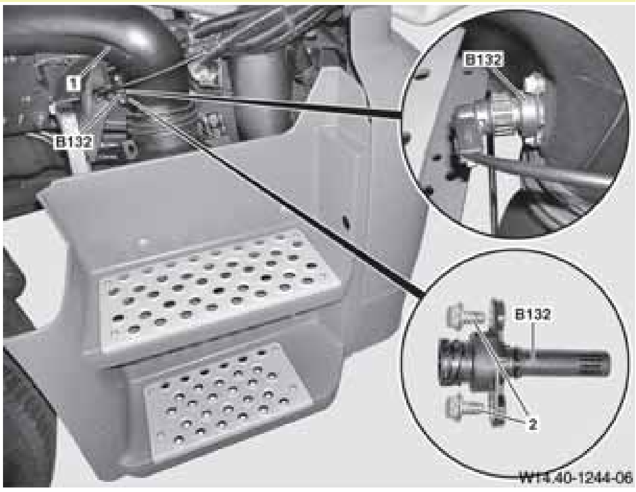
Engine 541.9, 542.9 (shown on engine 541.9)

The SCR air temperature and air humidity combination sensor (B132) is screwed into the clean-air pipe (1) between the air filter and the turbocharger.



Engine 900.9, 902.9, 924.9, 926.9 (shown on model 950.5)

The SCR air temperature and air humidity combination sensor (B132) is screwed in from outside into the clean-air pipe between the air filter and turbocharger.



SCR air temperature and air humidity combination sensor

Task

The SCR air temperature and air humidity combination sensor (B132) measures the temperature and determines the water vapor content in the intake air.

Design

The SCR air temperature and air humidity combination sensor (B132) includes separate components for measurement of air humidity and determination of air temperature. The components for determining air humidity are "active" i.e. they are supplied with voltage (in contrast to the "passive" components for measuring temperature).

For air humidity measurement, the interior of the SCR air temperature and air humidity combination sensor (B132) has a plate capacitor inside with two plates and a moisture-sensitive plastic layer as insulator. The insulator is mounted to the lower plate. The upper plate is a water vapor-permeable electrode.

For measuring temperature, the SCR air temperature and air humidity combination sensor (B132) contains an NTC resistor. NTC stands for "Negative Temperature Coefficient" and means that the electrical resistance drops as temperature increases.

Function

Air temperature measurement:

The blowby air influences the measuring element inside the SCR air temperature and air humidity combination sensor (B132) in correlation with its temperature and thus the magnitude of electrical resistance.

The values of the changing electrical resistance are sent in defined intervals as an analog signal to the engine control (MR) control unit. This uses the resistance value to determine the relevant temperature.

Determination of air humidity:

The plastic layer between the two capacitor plates is sensitive to moisture and can store water molecules. According to the humidity value of the intake air, its electrical capacity and conductivity changes.

As this change in resistance is highly dependent on temperature, this influence has to be compensated through measurement of the air temperature.

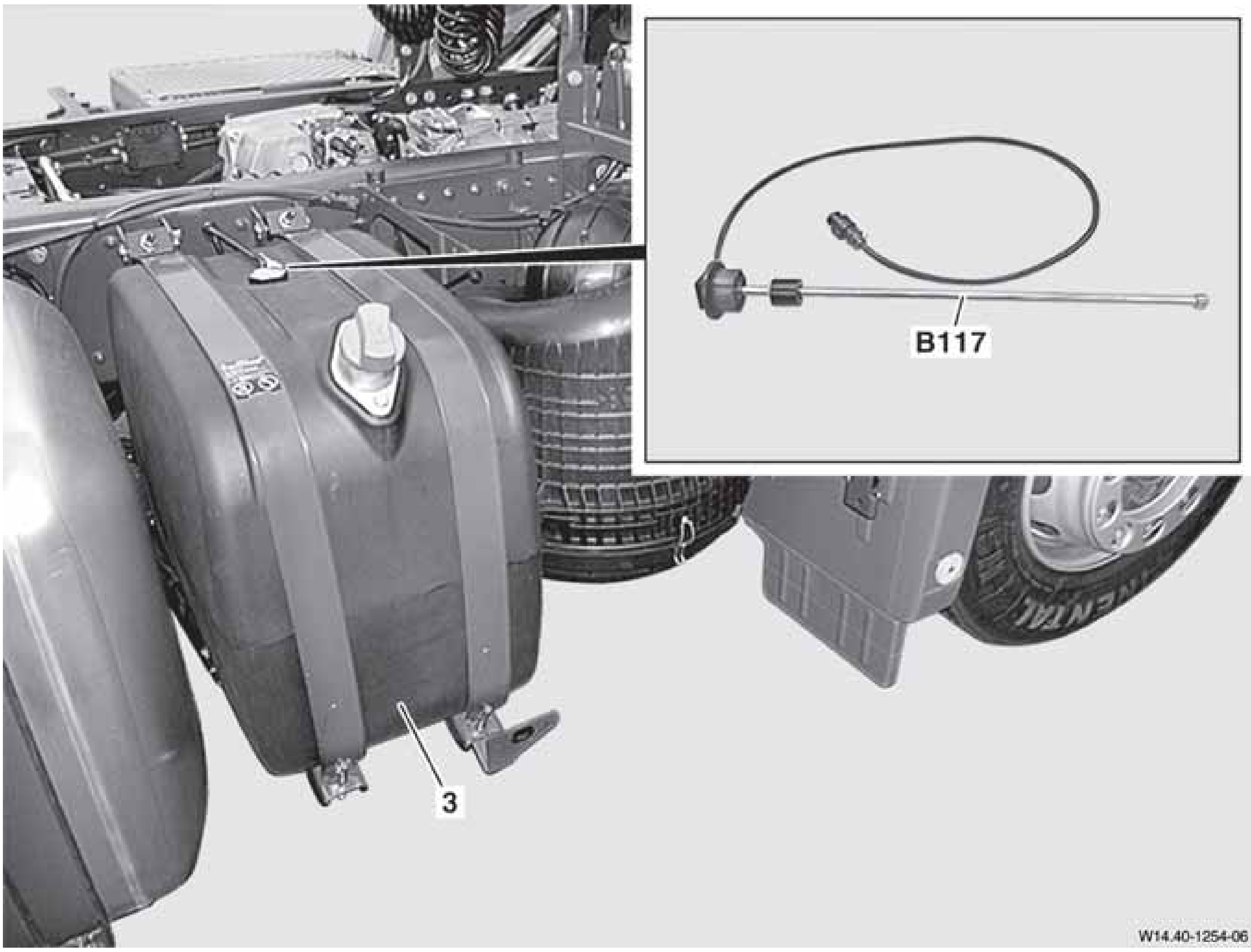
The values of the changing electrical capacity are sent in defined intervals as an analog signal to the engine control (MR) control unit. Using the determined value of the air temperature, the engine control (MR) control unit calculates the associated air humidity.

Fill level and SCR AdBlue temperature combination sensor

Location

Engine 457.9, 541.9, 542.9, 900.9, 902.9, 924.9, 926.9 (shown on model 944)

The fill level and SCR AdBlue temperature combination sensor (B117) is screwed on from outside into the AdBlue tank (3). The tank is located on the right longitudinal frame member.



Task

The fill level and SCR AdBlue temperature combination sensor (B117) records the fluid level and temperature of the AdBlue supply in the AdBlue tank (3).

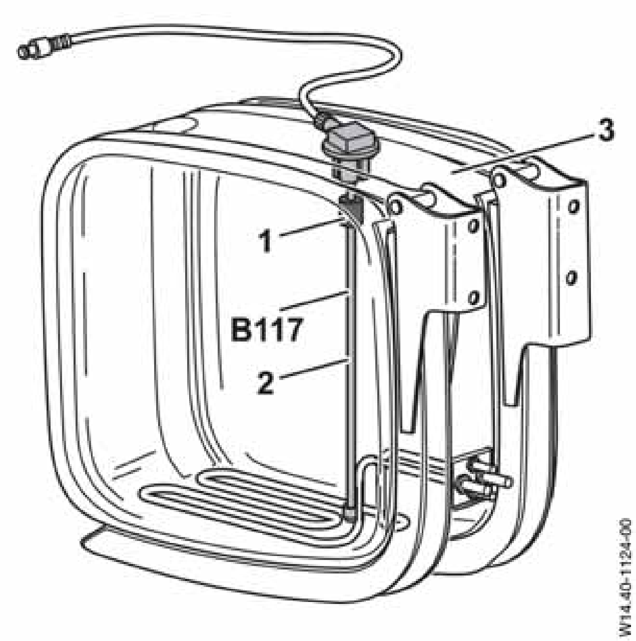
Fill level and SCR AdBlue temperature combination sensor

Design

The fill level and SCR AdBlue temperature combination sensor (B117) contains separate components for determining fill level and temperature.

To determine the fill level, the fill level and SCR AdBlue temperature combination sensor (B117) contains an immersion tube (2) fitted with a resistance measuring chain made of reed contacts and a float (1) which contains a permanent magnet.

For temperature measurement, an NTC resistor is placed at the end of the immersion tube (2). NTC stands for "Negative Temperature Coefficient" and means that the electrical resistance drops as temperature increases.



1 Float
2 Immersion tube
3 AdBlue tank
B117 Fill level and SCR AdBlue temperature combination sensor

Function

Determination of fill level

The sensor for determination of the fill level operates according to the float principle with magnetic transfer. A ring magnet integrated into the float projects its magnetic field through the wall of the immersion tube (2) to actuate very small reed contacts, which pick up a measurement voltage continuously on a resistance measurement chain (voltage divider principle), which is proportional to the level of the fill level. The values of the electrical resistance which change with the float position (1) are sent in defined intervals as an analog signal over the SCR frame module control unit to the engine control (MR) control unit. This uses the resistance value to determine the relevant fill level.

Determination of temperature

The AdBlue surrounding the fill level and SCR AdBlue temperature combination sensor (B117) influences the measurement element dependent on temperature and thus the magnitude of the electrical resistance.

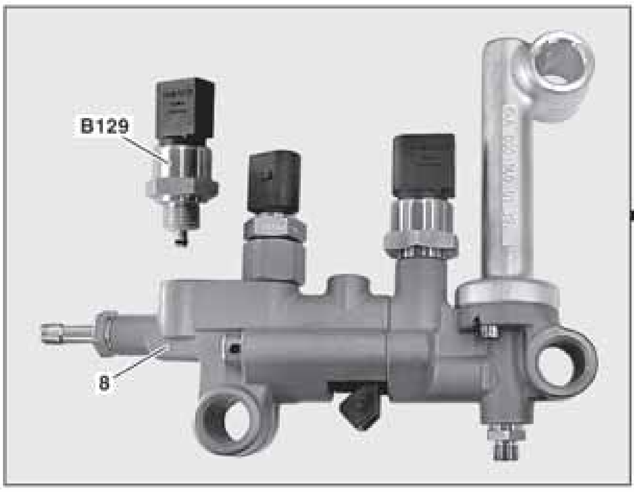
The values of the changing electrical resistance are sent in defined intervals as an analog signal over the SCR frame module control unit to the engine control (MR) control unit. This uses the resistance value to determine the relevant temperature.

SCR AdBlue pressure sensor

Location

Shown on engine 457.9

The SCR AdBlue pressure sensor (B129) is screwed on from outside into the metering device (8). The metering device (8) is located at the rear of the engine.



Task

The SCR AdBlue pressure sensor (B129) records the pressure with which the AdBlue is applied at a measuring position inside the metering device (8) and routes this data as an electrical voltage signal to the engine control (MR) control unit.

SCR AdBlue pressure sensor

Design

The SCR AdBlue pressure sensor (B129) consists of a stainless steel housing with thread and an electrical connector. Located inside as a measurement element is a diaphragm made of silicon to which measuring strips are attached. These measuring strips are electrical resistors, which change their resistance as they expand (piezoresistive principle). The SCR AdBlue pressure sensor (B129) is equipped with a bore through which AdBlue can penetrate up to the diaphragm.

The SCR AdBlue pressure sensor (B129) is an active sensor, i.e. it is supplied with voltage.

Function

The AdBlue pressure present at the SCR AdBlue pressure sensor (B129) presses against the diaphragm inside the sensor. This expands to the rear, which in turn induces a change in the electrical resistance of the measurement strips attached to it. As the pressure changes the diaphragm and the measurement strips attached to it are expanded to a lesser or greater degree.

The values of the changing electrical resistance are sent in defined intervals as an analog signal to the engine control (MR) control unit.

Using the resistance values, the engine control (MR) control unit calculates the associated pressure.

8 Metering device
B129 SCR AdBlue pressure sensor

SCR AdBlue temperature sensor

Location

Shown on engine 457.9

The AdBlue temperature sensor (B130) is screwed into the metering device (8) from the outside.
The metering device is located at the rear of the engine.

Task

The SCR AdBlue temperature sensor (B130) records the temperature, with which the AdBlue is present at a measuring position inside the metering device (8), and routes this data as an electrical voltage signal to the engine control (MR) control unit.

Design

The SCR AdBlue temperature sensor (B116) consists of a stainless steel housing with thread and an electrical connector.

An NTC resistor is located inside it as a measurement element. NTC stands for "Negative Temperature Coefficient" and means that the electrical resistance drops as temperature increases.

The SCR AdBlue temperature sensor (B130) is a passive sensor, i.e. it is not supplied with voltage.

Function

Depending on its temperature, the AdBlue present at the SCR AdBlue temperature sensor (B130) influences the measurement element inside the SCR AdBlue temperature sensor (B130) and thus the magnitude of the electrical resistance.

The values of the changing electrical resistance are sent in defined intervals as an analog signal to the engine control (MR) control unit.

Using the resistance values, the engine control (MR) control unit calculates the associated pressure.

8 Metering device
B130 SCR AdBlue temperature sensor

SCR compressed air pressure sensor

Location

Shown on engine 457.9

The SCR compressed air pressure sensor (B128) is screwed on from outside into the metering device (8). The metering device is located at the rear of the engine.

Task

The SCR compressed-air pressure sensor (B128) records the pressure of the compressed air at a measuring position inside the metering device (8), and routes this data as an electrical voltage signal to the engine control (MR) control unit.

SCR compressed air pressure sensor

Design

The SCR compressed-air pressure sensor (B128) consists of a stainless-steel housing with thread and an electrical connector. Located inside as a measurement element is a diaphragm made of silicon to which measuring strips are attached.

These measuring strips are electrical resistors, which change their resistance as they expand (piezoresistive principle). The SCR compressed-air pressure sensor (B128) is equipped with a bore through which compressed air can penetrate up to the diaphragm.

The SCR compressed-air pressure sensor (B128) is an active sensor, i.e. it is supplied with voltage.

Function

The compressed air present at the SCR compressed-air pressure sensor (B128) presses against the diaphragm inside the SCR compressed air pressure sensor (B128). This expands to the rear, which in turn induces a change in the electrical resistance of the measurement strips attached to it. As the pressure changes the diaphragm and the measurement strips attached to it are expanded to a lesser or greater degree.

The values of the changing electrical resistance of the measurement strips are transmitted to the engine control (MR) control unit in defined intervals as an analog signal.

Using the resistance values, the engine control (MR) control unit calculates the associated pressure.

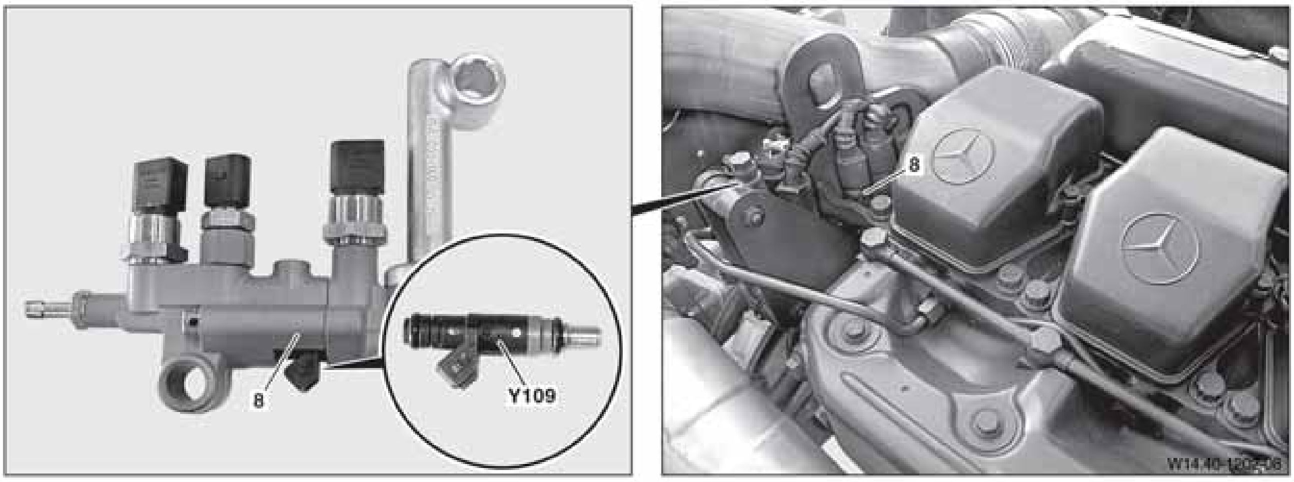
8 Metering device
B128 SCR compressed air pressure sensor

SCR AdBlue metering valve

Location

Shown on engine 457.9

The SCR AdBlue metering valve (Y109) is installed inside the metering device (8), which is located at the rear of the engine.

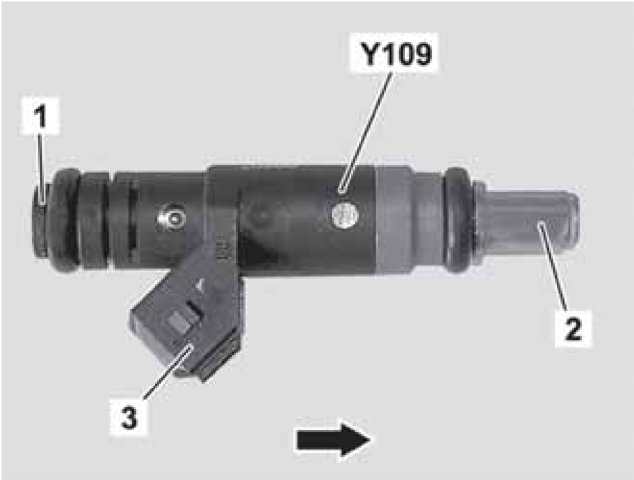


Task

The SCR AdBlue metering valve (Y109) is regulated by the engine control (MR) control unit, and prepares AdBlue for injection at the injection nozzle.

Design

The SCR AdBlue metering valve (Y109) is a 2 / 2-way valve. The valve body in the shape of a solenoid armature is located inside.



1	*AdBlue intake*
2	*AdBlue outlet*
3	*Electrical connector*
Y109	*SCR AdBlue metering valve*

Function

The SCR AdBlue metering valve (Y109) is actuated by the engine control (MR) control unit. This operates the SCR AdBlue metering valve (Y109) relative to the engine operating point and various environmental variables.

AdBlue is present at the closed valve body inside the SCR AdBlue metering valve (Y109) at the operating pressure generated by the SCR AdBlue pump A push spring acts on the valve body to keep the passage between the AdBlue intake (1) and the AdBlue outlet (2) closed.

When current flows, the valve body shifts to open the passage so that AdBlue can flow through.

If the current supply to the valve body is interrupted, the spring pushes it back to its starting position and the passage is blocked again.

SCR tank heater solenoid valve

Location

Shown on engine 457.9

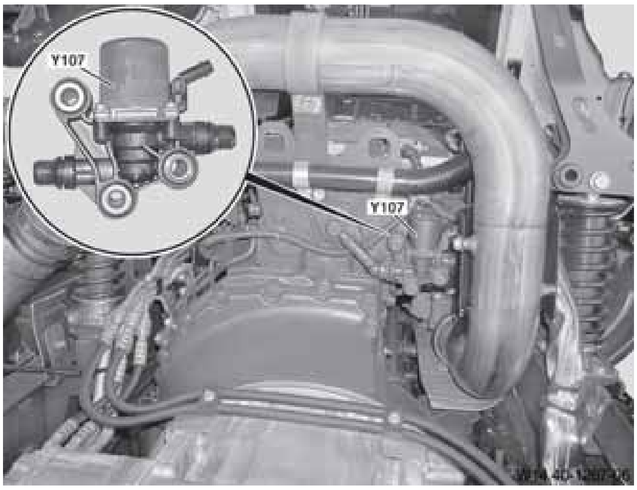
The SCR tank heater solenoid valve (Y107) is located on the right-hand side of the engine underneath the starter.

Engine 541.9, 542.9 (shown on engine 541.9)

The SCR tank heater solenoid valve (Y107) is located on the right hand side of the engine above the engine control (MR) control unit.

Engine 900.9, 902.9, 924.9, 926.9 (shown on model 950.5)

The SCR tank heater solenoid valve (Y107) is located at the rear of the engine, level with the cylinder head.



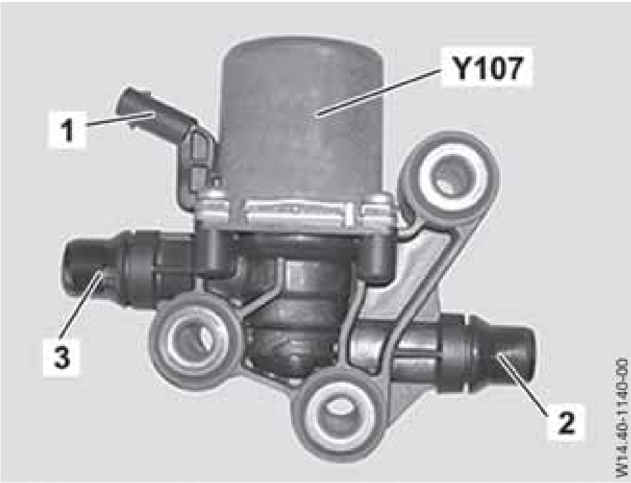
SCR tank heater solenoid valve

Task

The SCR tank heater solenoid valve (Y107) branches off coolant from the engine coolant circuit to heat the AdBlue line circuit and the AdBlue tank.

Design

The SCR tank heater solenoid valve (Y107) is a 2 / 2-way valve with line fittings (2, 3) for coolant lines. The valve body in the shape of a solenoid armature is located inside.



1 Electrical connector
2 Line fitting (coolant feed line)
3 Line fitting (coolant operating line)
Y107 SCR tank heater solenoid valve

Function

The SCR tank heater solenoid valve (Y107) is regulated by the engine control (MR) control unit. The fill level and SCR AdBlue temperature combination sensor integrated in the AdBlue tank recognizes if the temperature of the tank contents approaches the limit value of approx. 8 °C.

As soon as the coolant reaches a temperature of ≥ 65 °C the SCR tank heater solenoid valve (Y107) receives the signal to open from the engine control (MR) control unit so that coolant is branched off from the engine coolant circuit..

The coolant feed line is connected to the line fitting (2). If the SCR tank heater solenoid valve (Y107) is not open then the coolant is present inside the closed valve body component.

This valve body keeps the passage between the coolant feed line and the coolant operating line closed by means of a push spring.

When current is applied the valve body is displaced and the passage opened so that coolant flows into the coolant operating line.

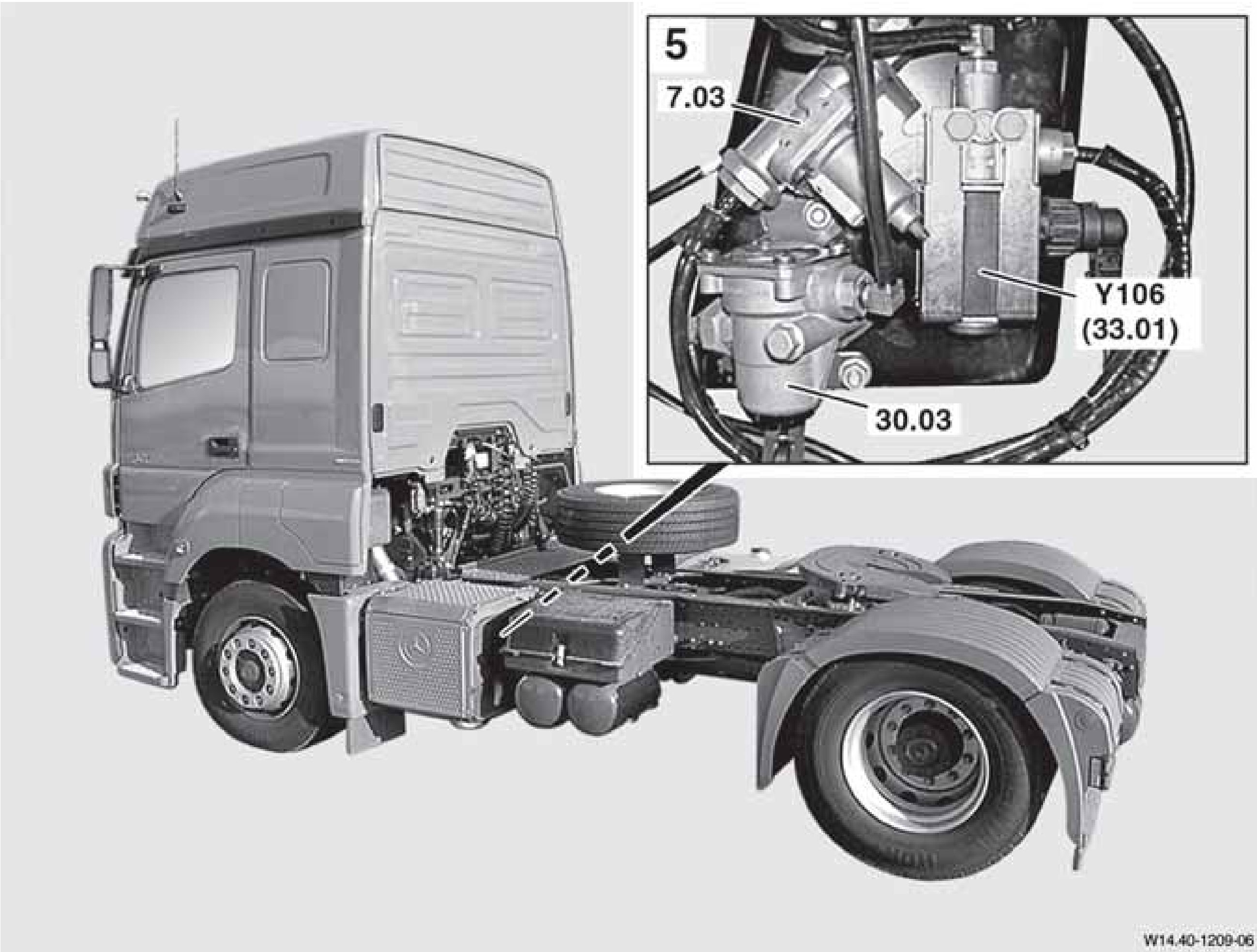
If the current supply to the valve body is interrupted then the spring pushes it back into its starting position. After this the passage between the coolant feed line and the coolant operating line is blocked again.

SCR air pressure limiter solenoid valve

Location

Shown on model 944

The SCR air pressure limiter solenoid valve (Y106) is part of the compressed-air controller unit (5) and is located on the inside of the left longitudinal frame member level with the muffler.



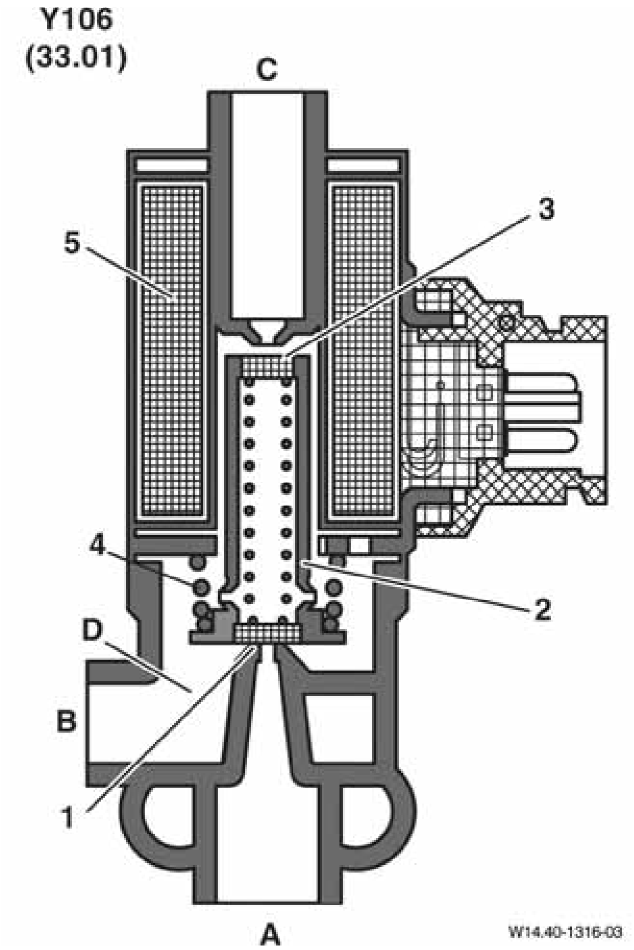
Task

The SCR air pressure limiter solenoid valve (Y106) opens and closes the connection to the compressed-air ancillary consumer circuit 4.

SCR air pressure limiter solenoid valve

Design

The SCR air pressure limiter solenoid valve (Y106) is a 3 / 2-way valve with electronically-controlled venting.



1 Intake
2 Solenoid armature
3 Outlet
4 Push spring
5 Solenoid
A Connection (feed line)
B Connection (operating line)
C Vent
D Compressed-air chamber
Y106 SCR air pressure limiter solenoid valve (33.01)

Function

When the SCR frame module control unit issues the signal based on the calculation from the engine control (MR) control unit, the SCR air pressure limiter solenoid valve (Y106) opens and branches off compressed air from the ancillary consumer circuits 4 into the feed line.

The feed line is connected to connection (A).

The valve body is a solenoid armature (2), which keeps the intake (1) closed by the pressure of the push spring (4).

When a current is supplied to the solenoid (5), the solenoid armature (2) moves upwards and the intake (1) is opened.

The compressed air coming from the compressed air reservoir flows via the compressed air chamber (D) and the connection (B) into the working line.

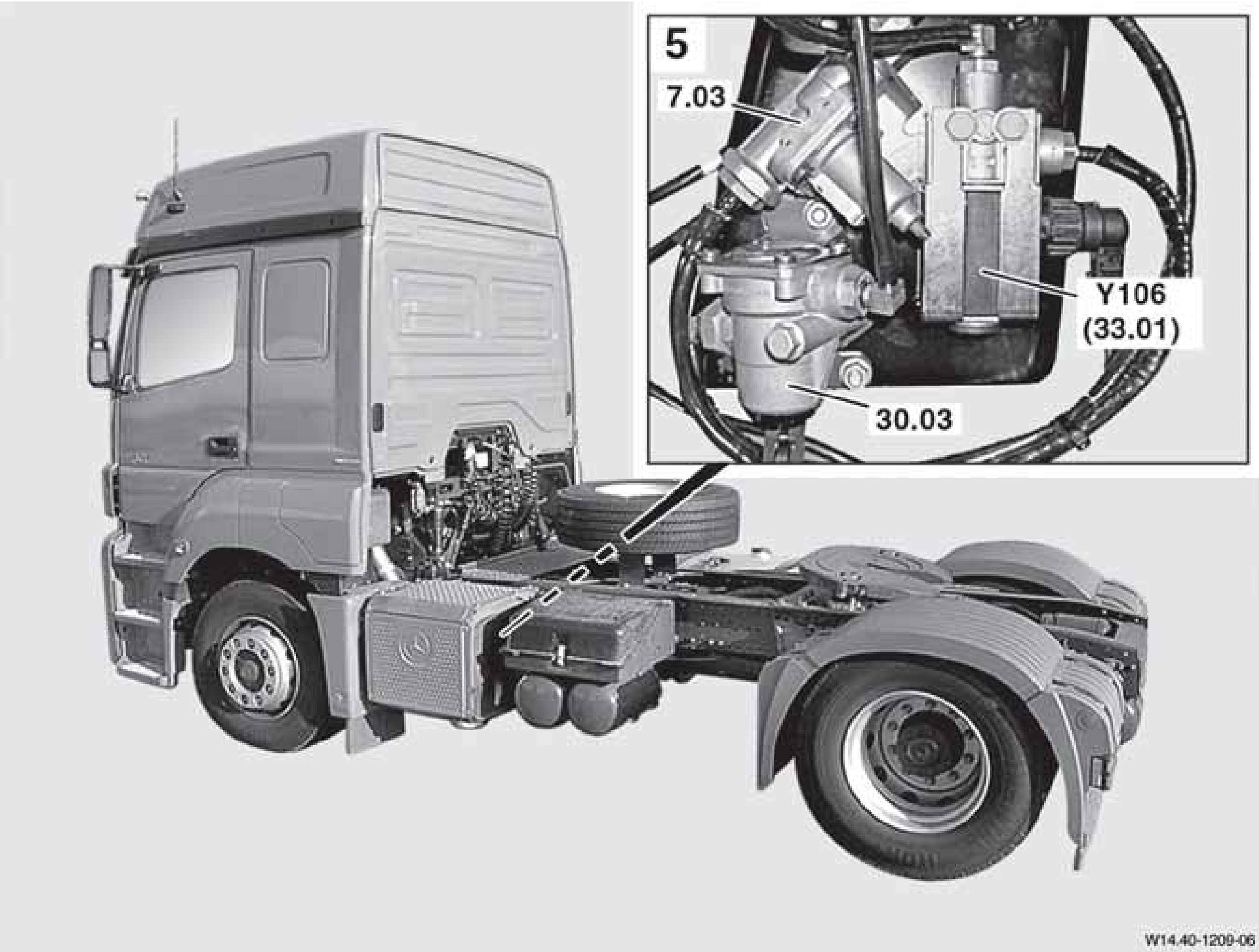
When the current to the solenoid (5) is interrupted, the push spring (4) presses the solenoid armature (2) back into its starting position.

Pressure limiting valve

Location

Shown on model 944

The pressure limiting valve (30.03) is part of the compressed-air controller unit (5) and is located on the inside of the left longitudinal frame member level with the muffler.

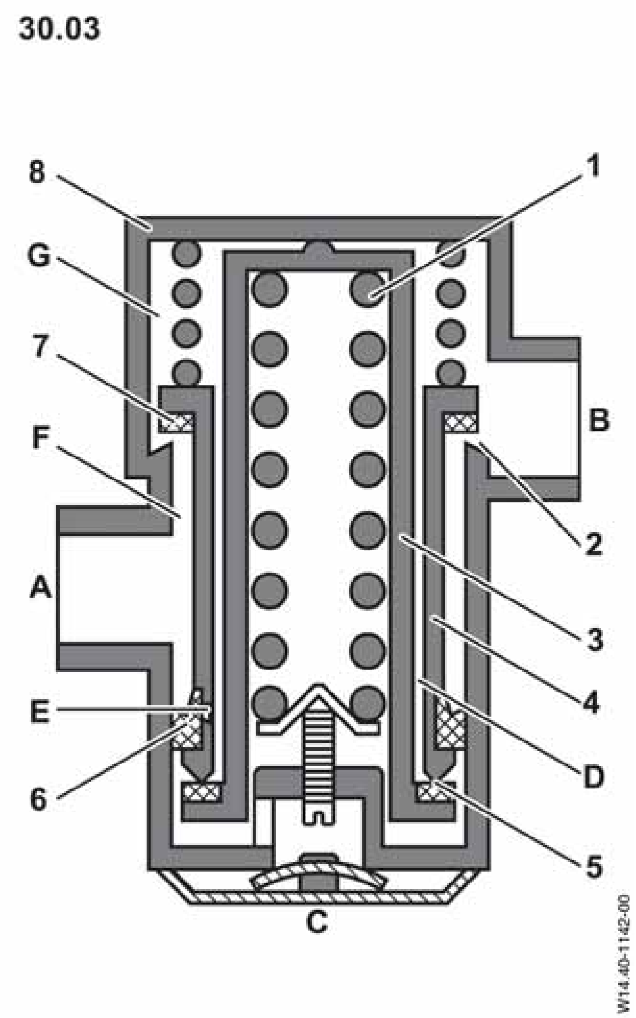


Task

The pressure limiting valve (30.03) reduces the regulated compressed air to the set value of approx. 5.5 bar.

Pressure limiting valve

Body



1 Push spring
2 Intake
3 Piston
4 Piston
5 Outlet
6 Valve
7 Valve
8 Housing
30.03 Pressure limiting valve
A Connection (feed line)
B Connection (low-pressure side operating line)
C Vent
D Compressed-air chamber
E Bore
F Compressed-air chamber
G Compressed-air chamber

Function

The pressure limiting valve (30.03) is set such that it can only apply one specific pressure to the operating line connection (B). The push spring (1) acts continuously on the pistons (3) and (4). This pushes the piston (3) back to its end position, where it makes contact with the housing (8) and is held there. The intake (2) is opened. The feed air which enters at the connection (A) flows from compressed-air chamber (F) into compressed-air chamber (G) and flows over connection (B) to the downstream devices.

If the pressure which is generated in the compressed-air chamber (G) exceeds the force of the push spring (1), the pistons (3) and (4) move downwards. The valve (7) closes the intake (2) and reaches its end position.

As a consequence of air consumption on the low-pressure side the pressure equilibrium at the piston (3) is canceled. The push spring (1) pushes the pistons (3) and (4) down again. The intake (2) opens and air is fed in until the pressure reaches the set value and an equilibrium is reached again.

If the pressure on the low-pressure side at connection (B) exceeds the specified value, piston (3), which is designed as a safety valve, opens the outlet (5). The excess pressure escapes into the open through the vent (C).

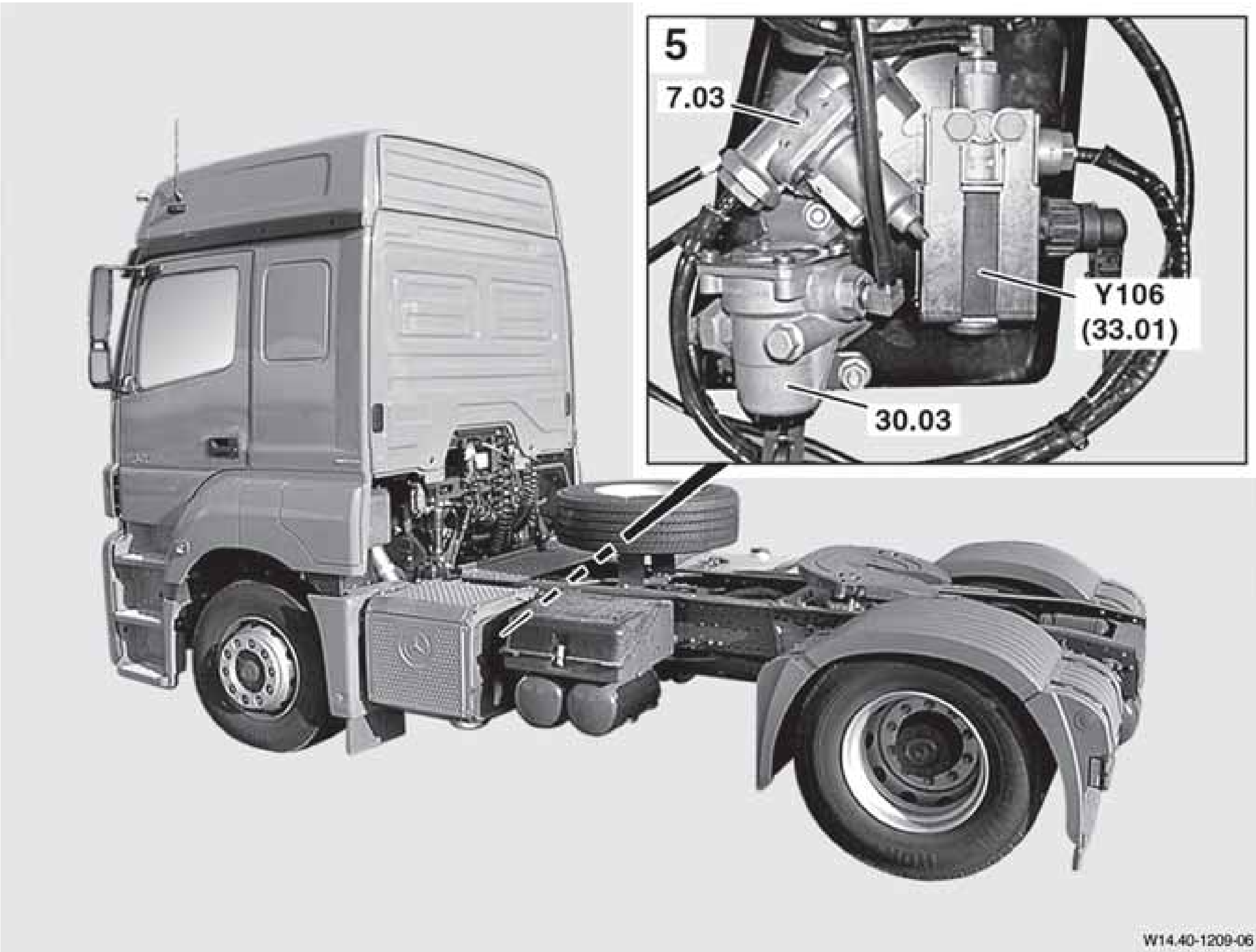
If the pressure in compressed-air chamber (F) drops below the value of the pressure in compressed-air chamber (G), valve (6) opens. Compressed air then flows from compressed-air chamber (G) through the hole (E) back to the connection (A) until the push spring (1) force is greater again and the intake (2) opens. Pressure compensation takes place between connections (B) and (A).

Overflow valve

Location

Shown on model 944

The overflow valve (7.03) is part of the compressed-air controller unit (5) and is located on the inside of the left longitudinal frame member level with the muffler.



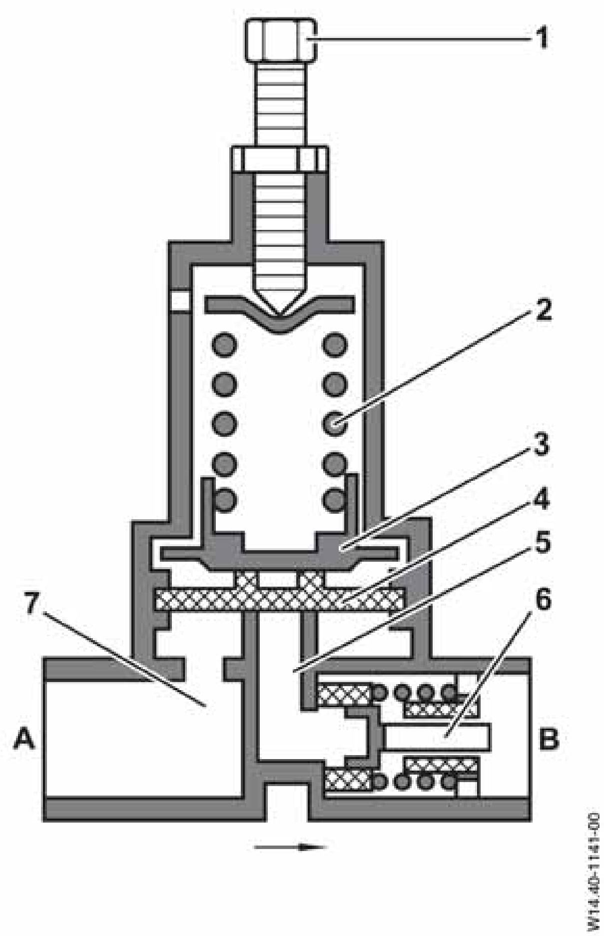
Task

The overflow valve (7.03) opens the passage from the compressed-air ancillary consumer circuit 4 when a specified pressure is reached.

Overflow valve

Design

7.03



1	*Adjusting screw*
2	*Adjuster spring*
3	*Piston*
4	*Diaphragm*
5	*Bore*
6	*Check valve*
7	*Bore*
7.03	*Overflow valve (without return flow)*
A	*Connection (feed line)*
B	*Connection (operating line)*

Function

The compressed air enters the housing of the overflow valve (7.03) via the connection (A) and then moves through the bore (7) into the area underneath the diaphragm (4), which is pressed into its seat by the adjuster spring (2) and piston (3). When the overflow pressure is reached, the adjuster spring (2) force is overcome so that the diaphragm (4) lifts off its seat and opens the bore (5). The compressed air then flows in the direction of the arrow immediately (or after the check valve (6) is opened) to the downstream devices.

Cylinder head, cylinder block

General

The following engine components were changed with the introduction of engine 457.9 with code (MS4) BlueTec 4 or with code (MS5) BlueTec 5 (Euro 4 and Euro 5 emissions standards).

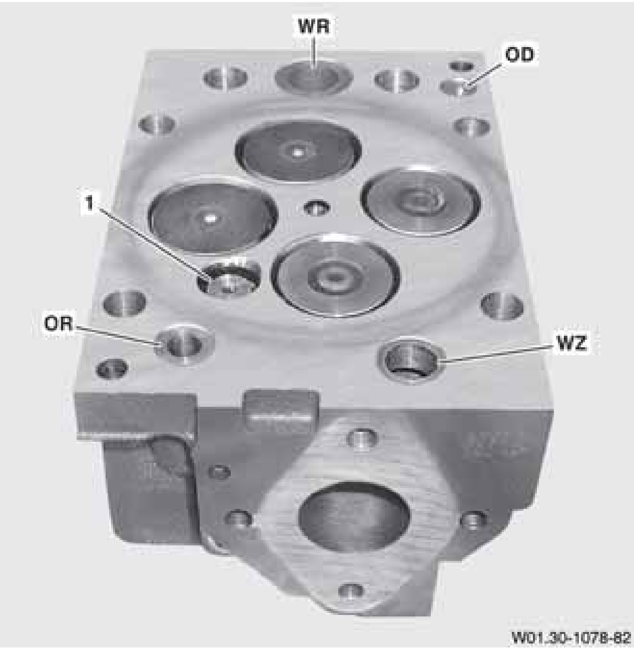
These in-engine modifications were primarily required because of the higher ignition pressure.

Cylinder head

Countersinks of 1.0 mm depth were applied to the following bores at the base of the cylinder head:

- Engine oil thrust side (OD)
- Engine oil return (OR)
- Coolant feed (WZ)
- Coolant return (WR)

The valve seat ring of the constant throttle valve (1) has been changed to a different material (PL-Ni40CRMo6).



1 Constant throttle valve

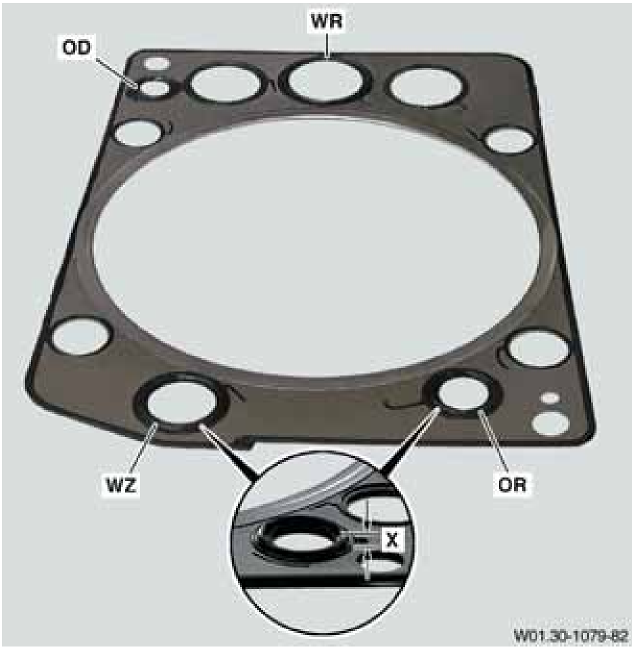
OD Engine oil thrust side
OR Engine oil return
WR Coolant return
WZ Coolant feed

Cylinder head gasket

The elastomer sealing elements on the cylinder head gasket have been increased in height by dimension (X) at the following bores:

- Engine oil thrust side (OD)
- Engine oil return (OR)
- Coolant feed (WZ)
- Coolant return (WR)

The raised elastomer sealing elements have improved the sealing between the cylinder head and cylinder block.



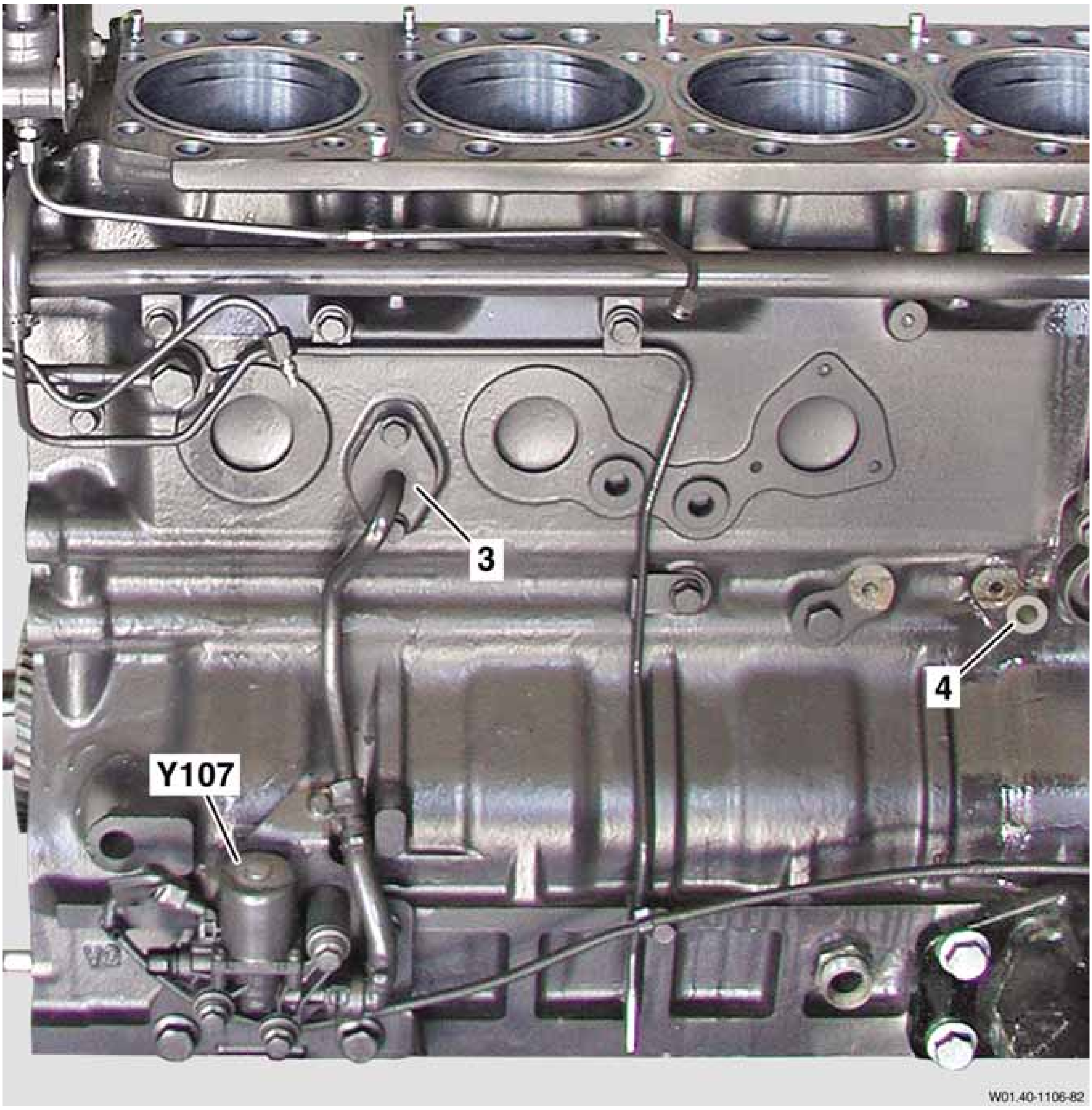
OD Engine oil thrust side
OR Engine oil return
WR Coolant return
WZ Coolant feed
X Dimension

Cylinder head, cylinder block

Cylinder block

A flange for the coolant line (3) to the SCR tank heater solenoid valve (Y107) has been installed on the right-hand side of the cylinder block.

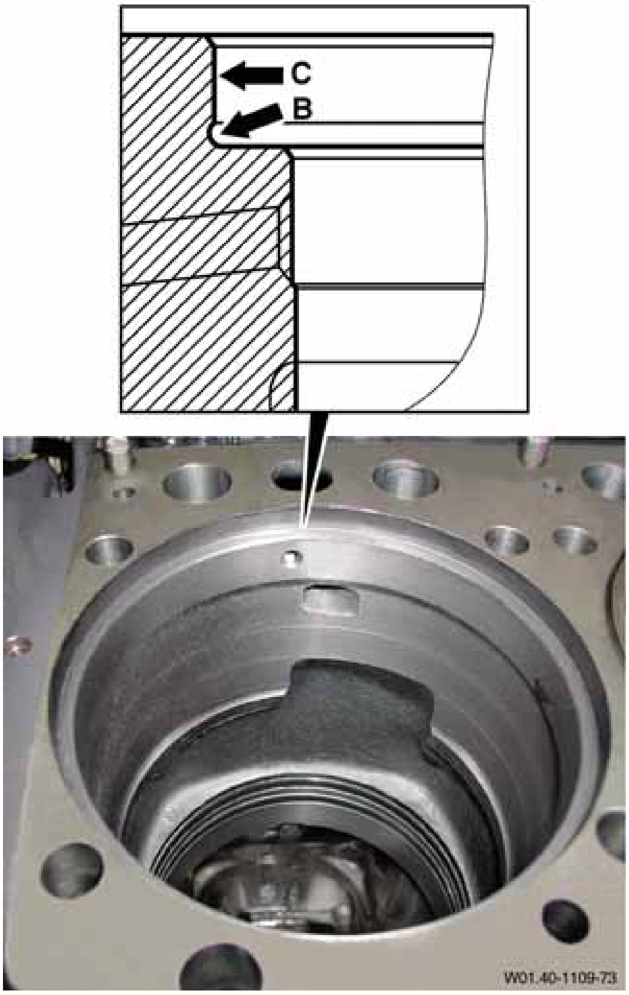
The bore (4) in the cylinder block for the oil line to the turbocharger with wastegate valve (bypass valve) has been moved further to the front.



3 Coolant line
4 Bore
Y107 SCR tank heater solenoid valve

A notch (arrow B) has been turned into the cylinder block on the collar seat for the cylinder liner. This is necessary because the fit of the liner collar (arrow C) has been changed from tolerance H9 to H7 and a cylindrical support is required.

The relative movement of the cylinder liner in the cylinder block is reduced by these changes.



B *Notch*
C *Liner collar*

Cylinder head, cylinder block

Cylinder liner

An oil scraper ring (6) has also been integrated into the cylinder liner (5).

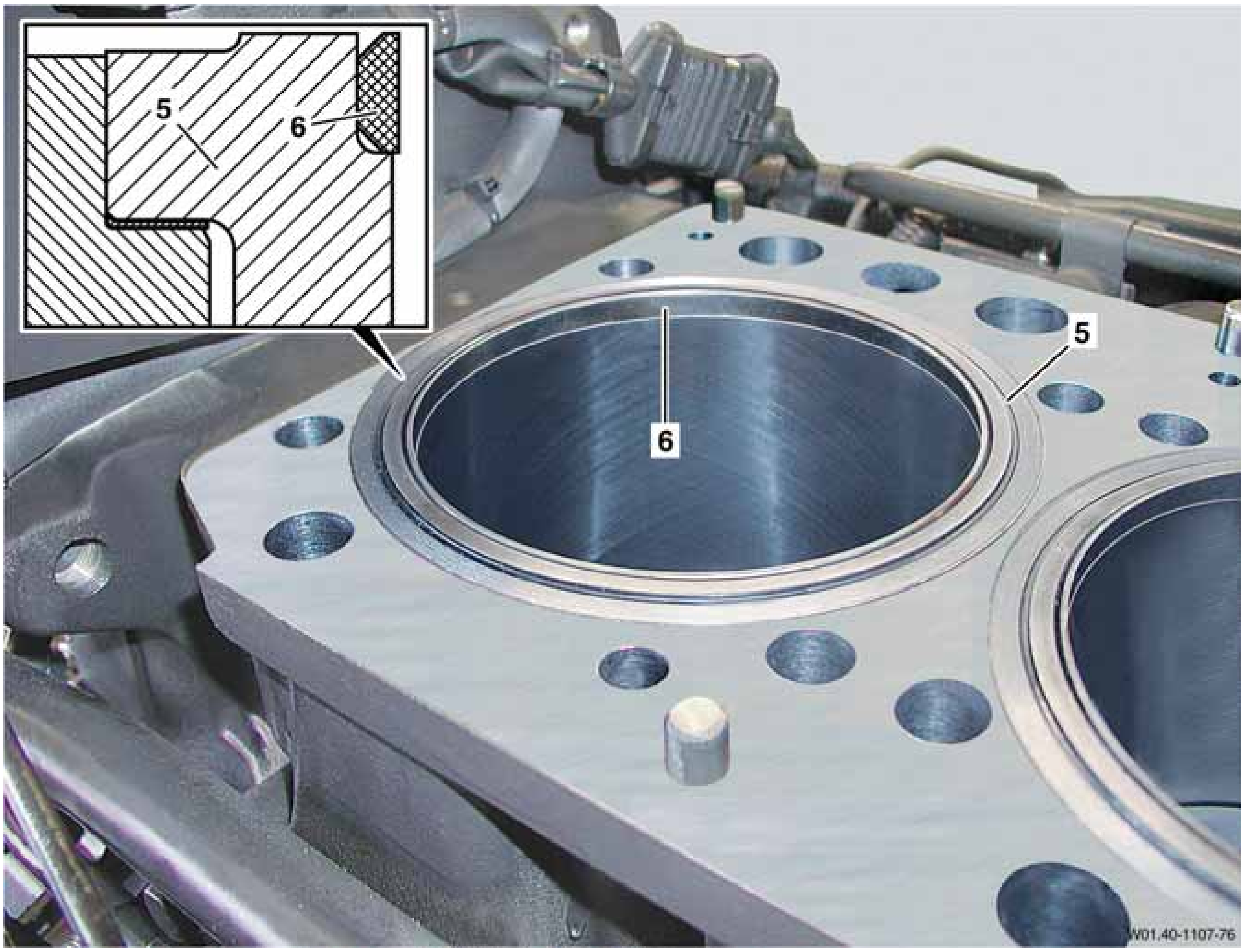
The oil scraper ring (6) has a height of 6.5 mm and a protrusion of 0.15 mm relative to the inside diameter of the cylinder barrel in the cylinder liner (5).

The oil scraper ring (6) protrusion reduces the carbon deposits on the top land of the piston (area of piston crown up to first piston ring groove).

This serves to reduce any wear on the cylinder barrel of the cylinder liner (5).

Due to the additional oil scraper ring (6), an assembly aid is required for piston installation.

The outside diameter at the collar of the cylinder liner (5) has been increased.

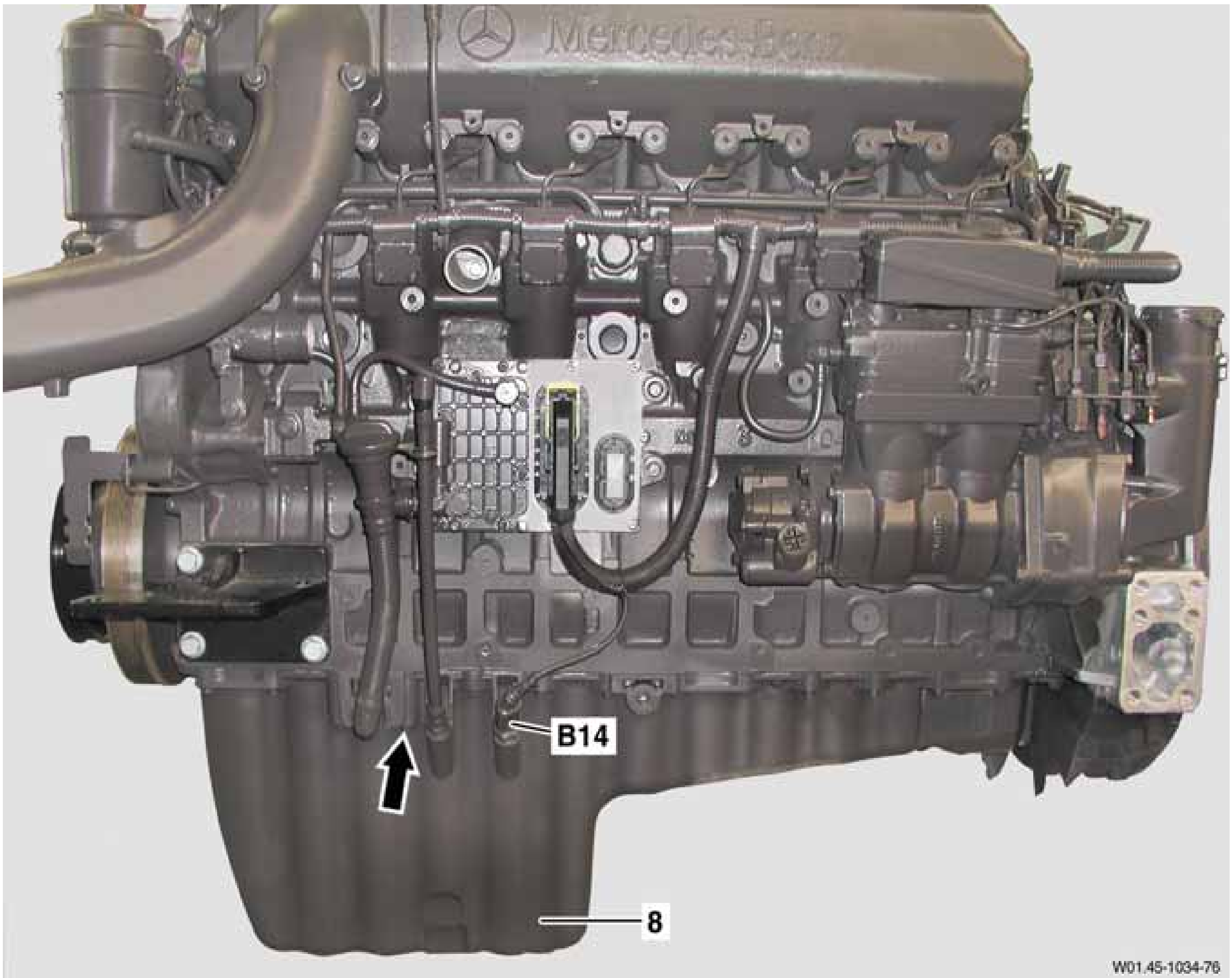


5 Cylinder liner
6 Scraper ring

Oil pan

The area of the mounting holes (arrow) has been reinforced on both sides of the oil pan (8). Two longer bolts are required on each side due to the reinforcement.

The oil level sensor (B14) has been moved from the bottom to the left side of the oil pan (8) and projects down into the oil pan (8) at an angle.



8 Oil pan
B14 Oil level sensor

Crank assembly

Connecting rod

The connecting rod has been reinforced and the shape changed. The oil duct in the connecting rod is no longer present. The diameter of the large connecting rod eye has been increased.

These changes increase the strength of the connecting rod.

The connecting rod bearing bushing (1) at the small connecting rod eye has been form bored and two oil holes (arrows A) have been added, which are lubricated via the cooling duct of the piston.

These changes improve the lubrication of the piston pin in the connecting rod bearing bushing (1).

1 Connecting rod bearing bushing
A Oil hole

Pistons

The piston material has been changed. The new material has a fine-grit structure and thus greater heat resistance.

The recess diameter on the piston crown has been reduced.

This means that the compression ratio epsilon (ε) has been increased to 18.5 and the soot percentage during combustion reduced. The edge of the recess on the piston crown is polished. This change increases the strength of the edge of the recess.

The top land (area from piston crown up to first piston ring groove) has been increased to 15 mm.

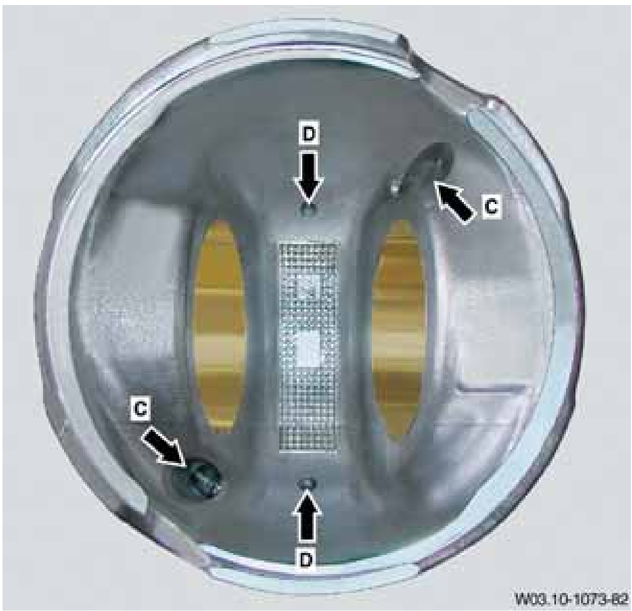
The piston dimensions have been adapted to the oil scraper ring in the cylinder liner.

The ring-shaped cooling duct in the piston is supplied with engine oil by the piston cooling oil spray nozzle though one of the two injection bores (arrow C). Each opposite lying bore (arrow C) is a drain bore.

A greater engine oil flow rate is provided in the piston cooling duct by a coaxial oil spray from the piston cooling oil spray nozzle in combination with the optimized oil supply funnel in the piston.

In addition to this, improved lubrication of the piston pin and connecting-rod bearing bushing is provided by two bores (arrow D) in the cooling duct of the piston.

The previous piston variants for heavy-duty service have been discontinued.



Crank assembly

Piston rings

The coating has been changed on the piston rings in groove 1 (keystone ring with interior angle at top) and in groove 3 (bevel-edged ring with spring expander). This reduces wear.

The piston ring in groove 2 (taper-faced ring with interior angle) has not been changed.

Piston pin

The piston pin has been reinforced by reducing the inside diameter to 22 mm. This strengthens the piston pin.

Crankshaft

On the crankshaft, the diameter of the connecting rod journals has been increased and the crank webs have been reinforced.

This has strengthened the crankshaft.

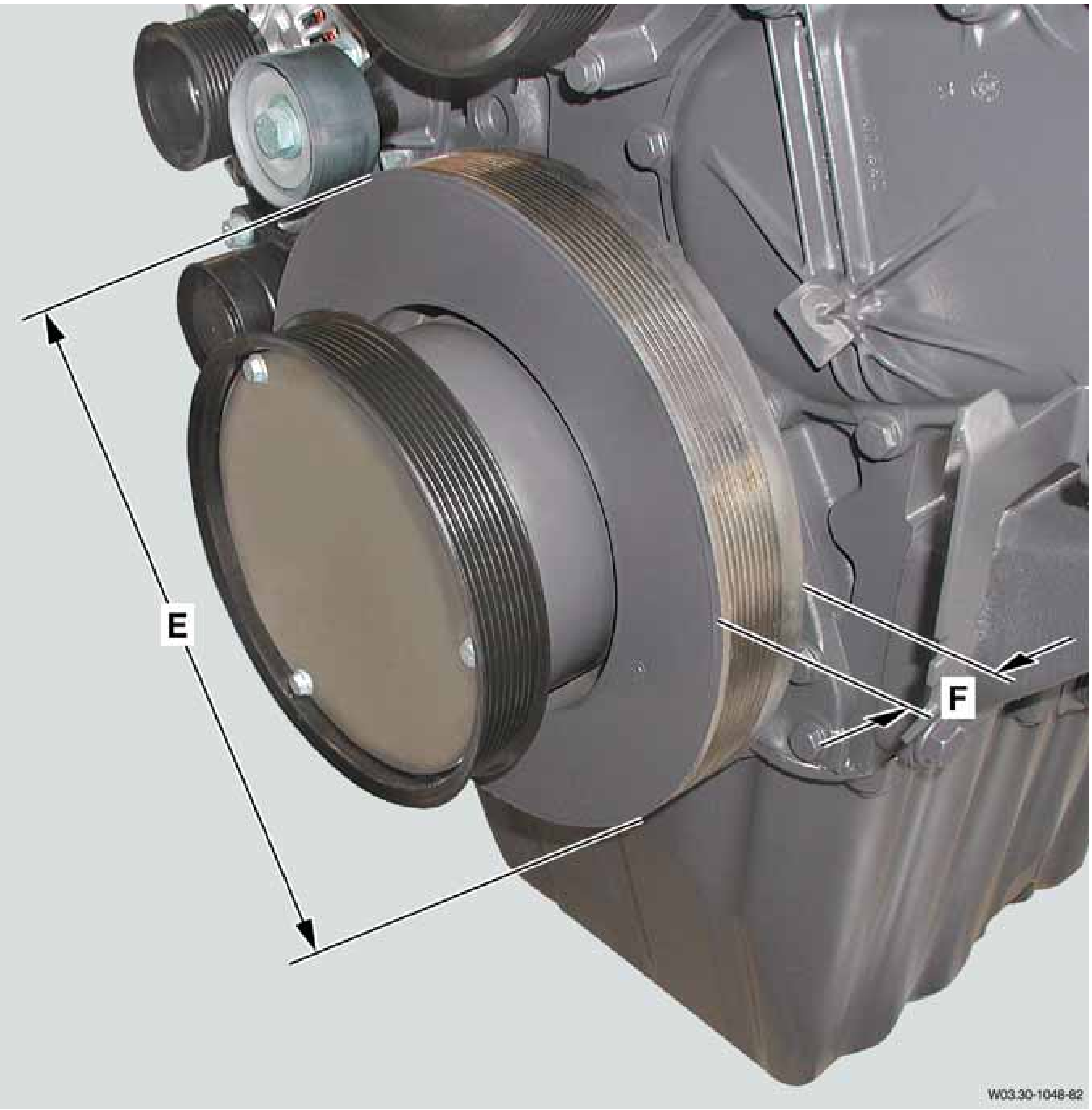
To prevent greater torsional vibration on the crank-shaft, a higher-performance vibration damper has been installed.

Crank assembly

Vibration dampers

On the vibration dampers, the outside diameter (E) and width (F) have been enlarged.

The increase in mass allows the increase in torsional vibrations of the crankshaft to be compensated for.



E Outside diameter
F Width

Intake valves, intake valve seat rings

The valve disks have been reinforced on the intake valves. This increases the strength while reducing deformation and wear. The intake valve seat rings are still made of Tribaloy.

Valve guides, valve stem seals

As of the introduction of engines with code (MS4) BlueTec 4 and code (MS5) BlueTec 5, a groove (arrow) was added to the valve guide to improve the seal to the valve stem.

Previously, an O-ring (4) was additionally installed in this groove.

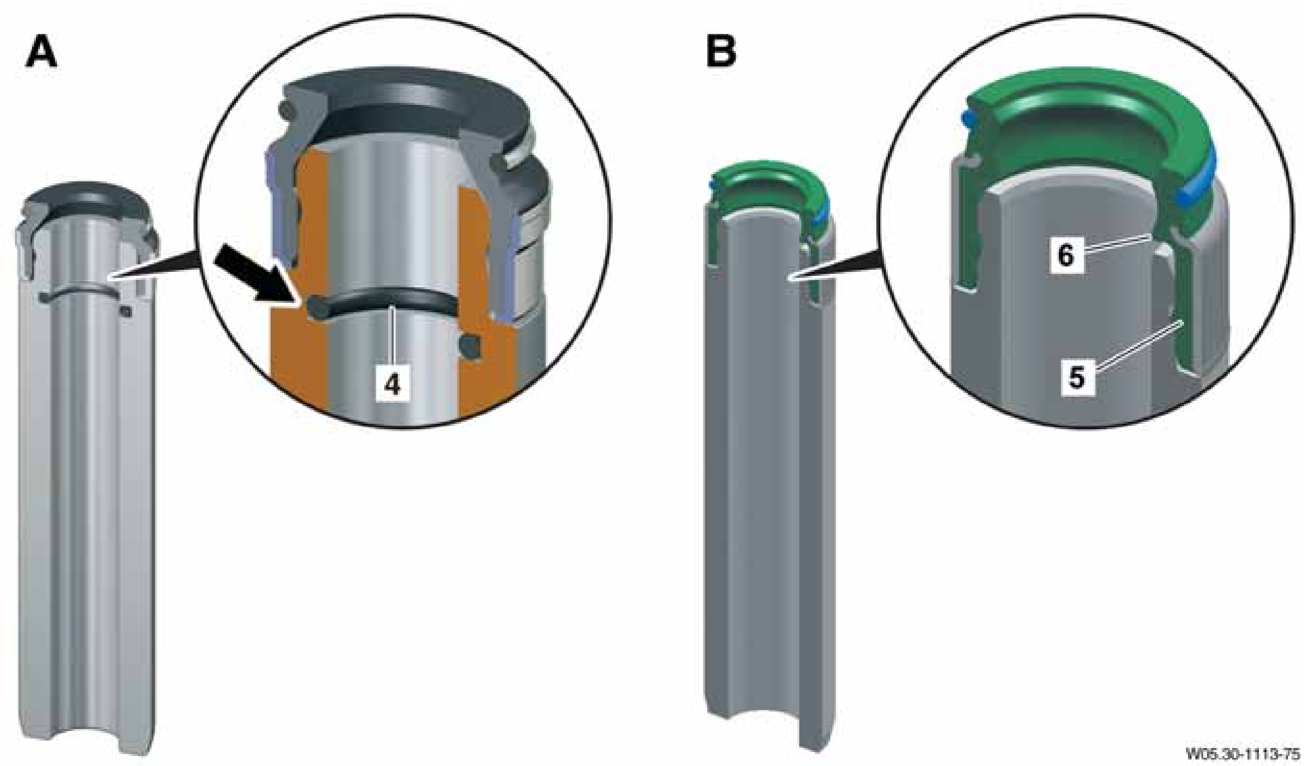
As of 2007, the groove and O-ring (4) are no longer present in the valve guide.

To maintain the improved seal between valve stem and valve guide, an additional sealing lip (6) has been added to the valve stem seal (5).

Exhaust valves, exhaust valve seat rings

The valve seat angle on the exhaust valves and exhaust valve seat rings has been changed to 36°.

This change increases the contact surface on the valve seats to counteract increased wear.



A ***Previous design***

4 O-ring

B ***New design***

5 Valve stem seal
6 Sealing lip

Mixture formation

Nozzle holder assembly

A 7-hole nozzle with a heat protection sleeve has been installed in the nozzle holder assembly.

This change, along with the modified piston combustion cavity, optimizes the combustion. This reduces the amount of soot particles in the exhaust and the fuel consumption.

Turbocharger with wastegate valve (bypass valve)

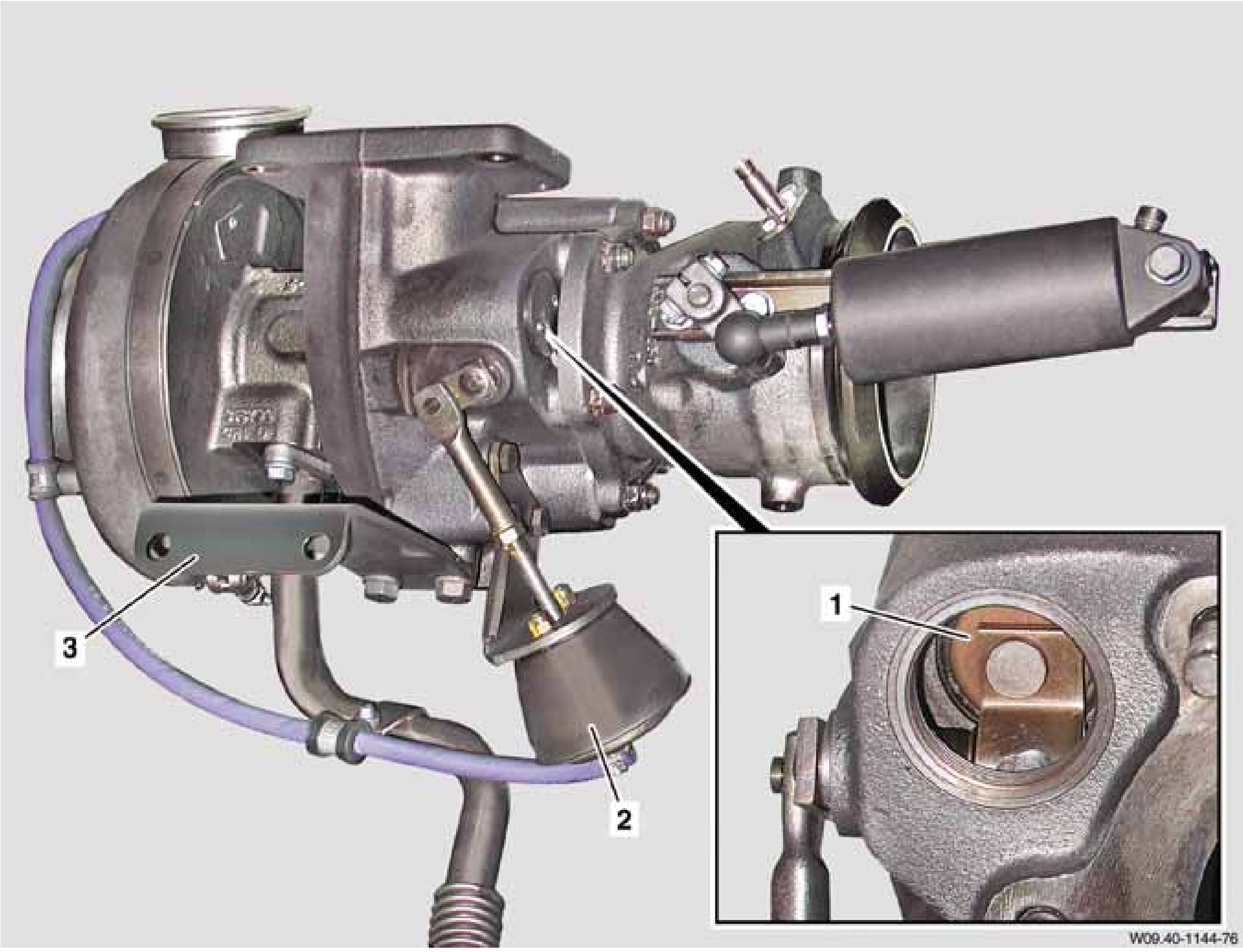
The turbocharger has been designed so that a higher boost pressure is available in the lower and medium engine rpm ranges.

The wastegate valve (bypass valve) (1) in the turbocharger is actuated by a vacuum cell (2).

The vacuum cell (2) is pressurized by the boost pressure and actuates the wastegate valve (bypass valve) (1) located in the exhaust flow depending on the boost pressure.

When the set boost pressure limit value is reached, the wastegate valve (bypass valve) (1) opens and some of the exhaust gas flows past the turbocharger turbine. The boost pressure no longer increases.

The turbocharger is also supported by a bracket (3) on the cylinder block.

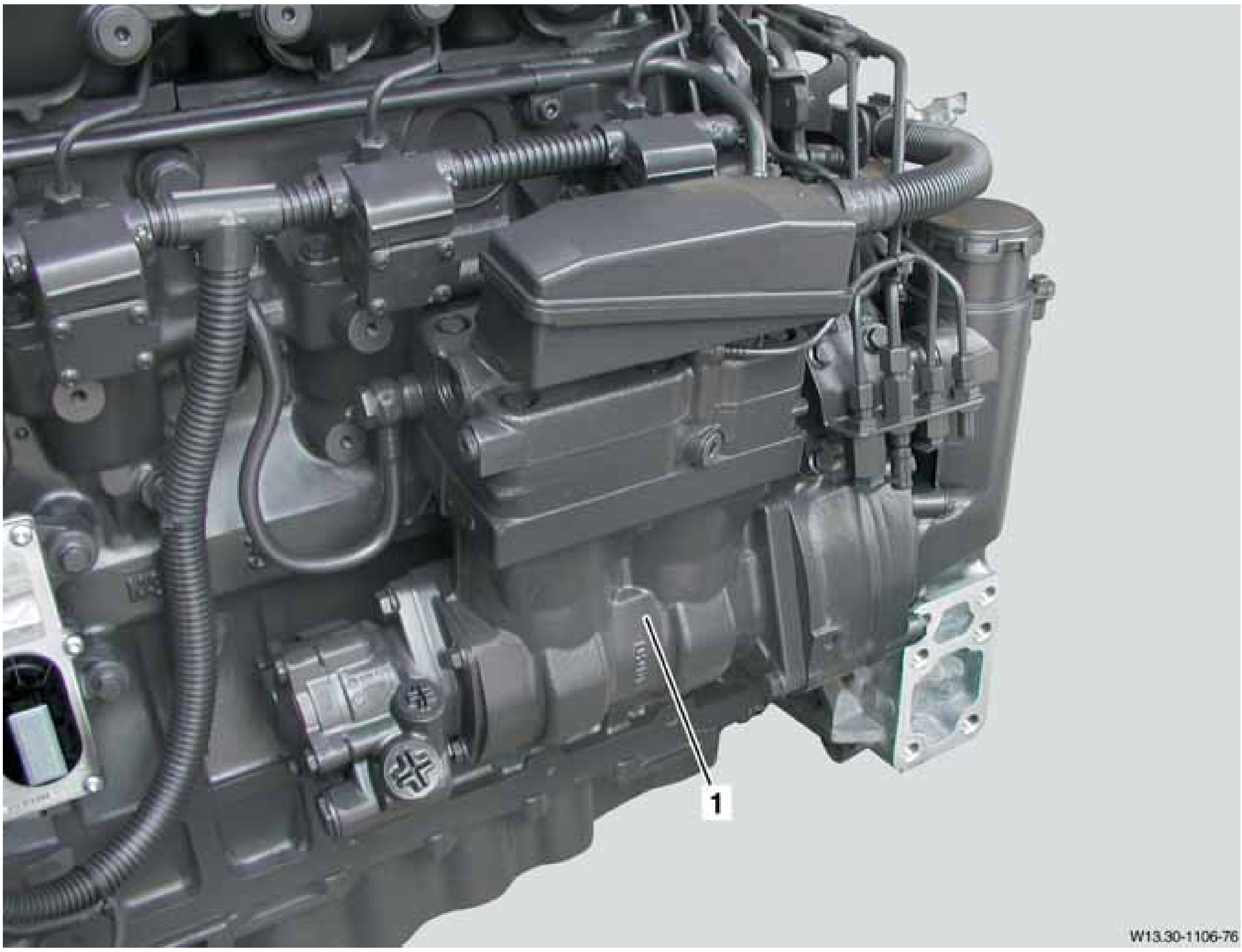


1 Wastegate valve (bypass valve)
2 Vacuum cell
3 Bracket

Compressor

Compressor

The engine with code (MS4) BlueTec 4 or code (MS5) BlueTec 5 has a higher compressed-air requirement because of the AdBlue injection, this in turn makes a dual cylinder compressor (1) necessary.

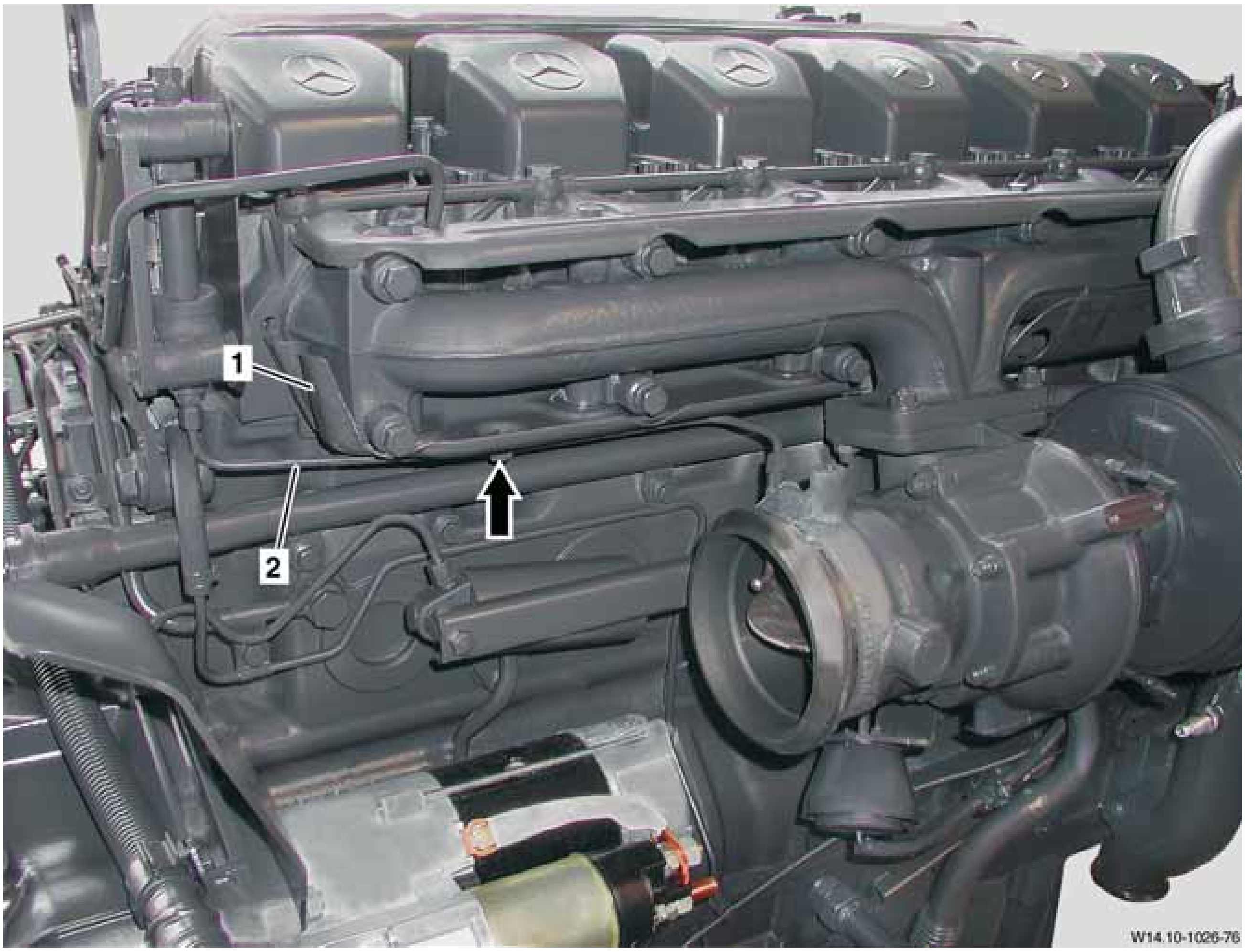


1 *Dual cylinder compressor*

Exhaust manifold

An additional heat shield (1) has been installed on the exhaust manifold to protect the AdBlue injection line.

The AdBlue injection line (2) is attached to this heat shield (1) with a clip (arrow).



1 Heat shield
2 AdBlue injection line

Engine lubrication, engine oil cooling

Piston cooling oil spray nozzle

The spray direction of the oil spray nozzle for the piston has been changed to a coaxial oil spray, which is injected into the piston cooling duct. The piston cooling is improved by the greater engine oil flow rate.

The oil spray nozzle pipe diameter has been enlarged to 4 mm and the diameter at the orifice at the end of the nozzle has been calibrated to 3 mm. This change increases the oil flow rate of the oil spray nozzle and the oil spray fans out less, improving the piston cooling.

Camshaft lubrication oil spray nozzle

The oil spray nozzle for the camshaft has three holes for lubricating the intake, exhaust and unit pump cams.

Oil pump

The diameter of the gear wheels (1) has been increased to 63 mm and the shaft diameter to 18 mm.

The width of the gear wheels (1) is 43 mm. This results in a higher delivery volume of 173 l / min at a motor speed of 1 800 rpm.

The mounting (arrows) in the oil pump housing and housing cover (2) for the two gear wheels (1) has been changed to bushings.

The gear ratio from the crankshaft gear to the oil pump drive gear is 46 : 49.

These changes to the oil pump were necessary to achieve the higher oil flow rate for the oil spray nozzle due to the greater piston cooling demand and camshaft lubrication.

1 Gear wheel
2 Housing cover

Cylinder head, cylinder block

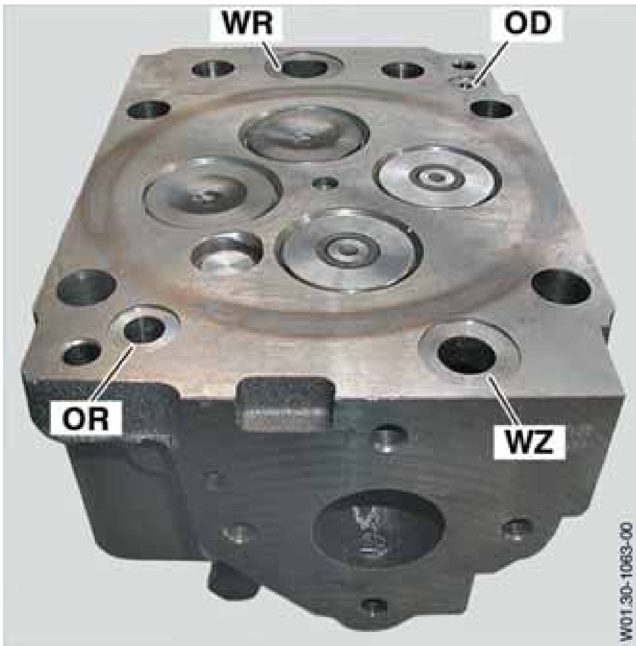
General

The following engine components were changed with the introduction of engines 541.9, 542.9 with code (MS4) BlueTec 4 or code (MS5) BlueTec 5 (Euro 4 and Euro 5 emissions standards).
These in-engine modifications were primarily required because of the higher ignition pressure.

Cylinder head

Countersinks of 1.0 mm depth were applied to the following bores at the base of the cylinder head:

- Engine oil thrust side (OD)
- Engine oil return (OR)
- Coolant feed (WZ)
- Coolant return (WR)



OD Engine oil thrust side
OR Engine oil return
WR Coolant return
WZ Coolant feed

Cylinder head gasket

The elastomer sealing elements on the cylinder head gasket have been increased in height by dimension (X) at the following bores:

- Engine oil thrust side (OD)
- Engine oil return (OR)
- Coolant feed (WZ)
- Coolant return (WR)

The raised elastomer sealing elements improve the seal between the cylinder head and cylinder block.

In addition to this the coolant feed hole (WZ) has had a fire protection plate (arrow) molded on to it. This fire protection plate (arrow) serves as an additional protection for the elastomer sealing element in the event of any slight gas leakage at the cylinder head gasket.

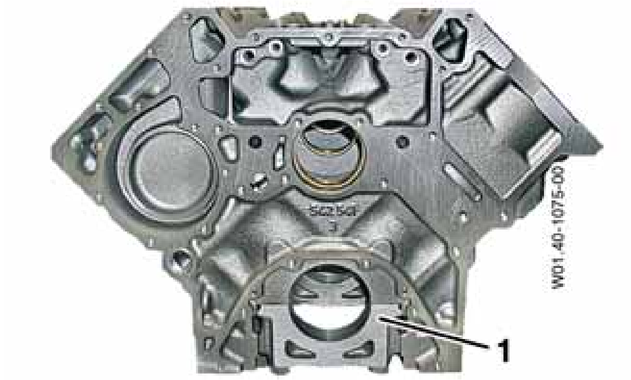
OD Engine oil thrust side
OR Engine oil return
WR Coolant return
WZ Coolant feed
X Dimension

Cylinder block

For engines with an output of 270 kW and higher, the cylinder block is now made of cast iron with vermicular graphite (GGV 40).

This gives the cylinder block a higher degree of strength to withstand the greater ignition pressure.

The main bearing cap (1) has been changed to cast-iron with nodular graphite iron (GGG 70).



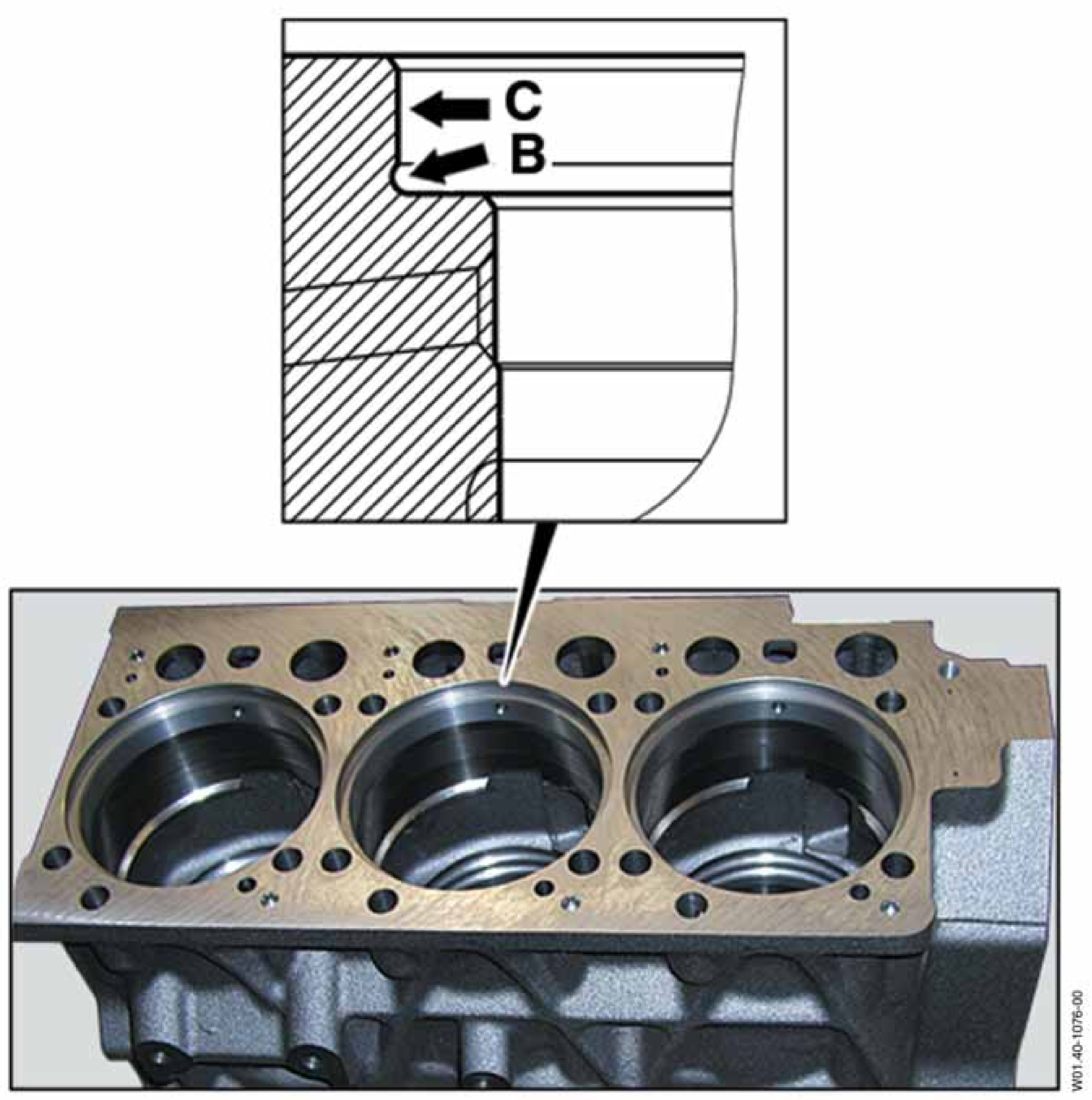
1 Main bearing cap

Cylinder head, cylinder block

Cylinder block

A notch (arrow B) has been turned into the cylinder block on the collar seat for the cylinder liner. This is necessary because the fit of the liner collar (arrow C) has been changed from tolerance H9 to H7 and a cylindrical support is required.

The relative movement of the cylinder liner in the cylinder block is reduced by these changes.



B Notch
C Fitting surface of liner collar

Cylinder liner

A scraper ring (3) was also integrated into the cylinder liner (2) for oil carbon deposits. The scraper ring (3) has a height of 13.5 mm and a protrusion of 0.15 mm relative to the inside diameter of the cylinder barrel in the cylinder liner (2).

The oil scraper ring (3) replaces the induction hardening in the upper section of the cylinder liner (2).

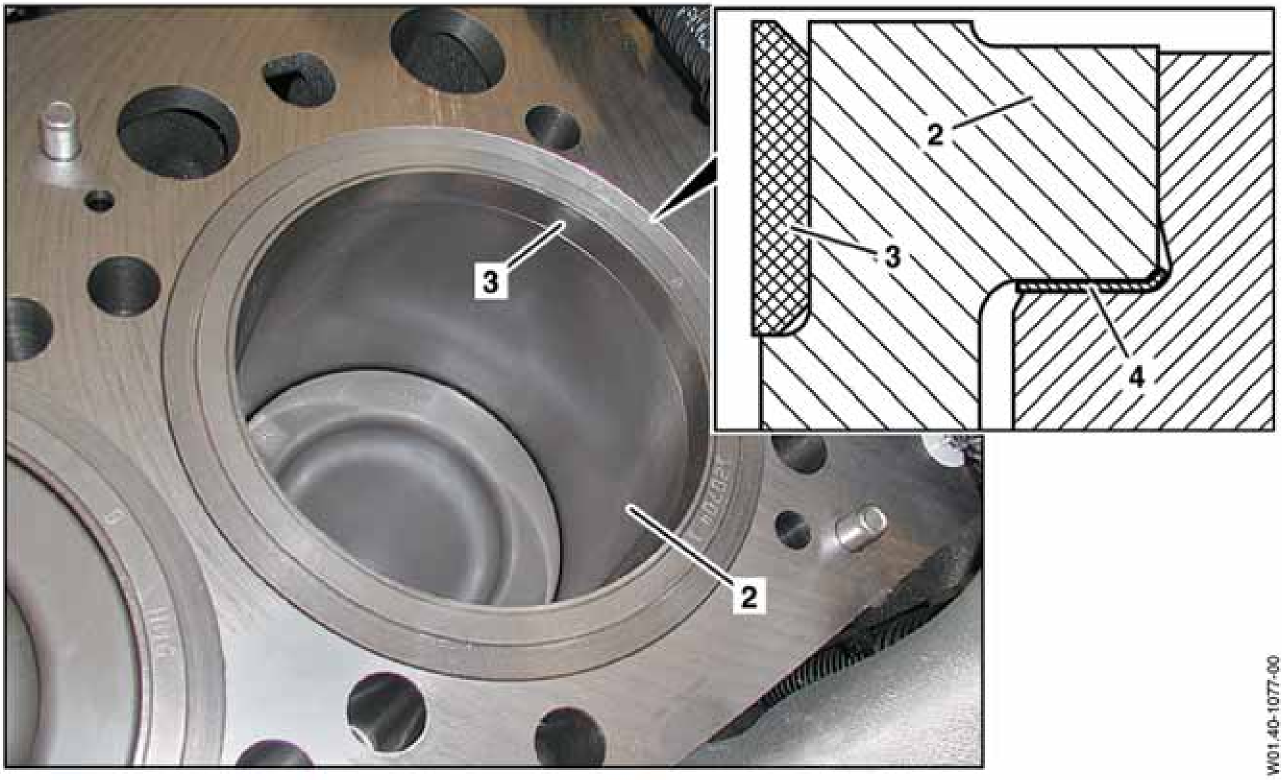
The oil scraper ring (3) protrusion reduces the carbon deposits on the top land of the piston (area of piston crown up to first piston ring groove).

This serves to avoid any wear on the cylinder barrel of the cylinder liner (2).

The outside diameter on the collar of the cylinder liner (2) has been enlarged to enable the fitting into the cylinder block. The material of the sealing ring (4) between the collar of the cylinder liner (2) and the cylinder block has been changed to stainless steel (X5CrNi 18-10) and the outside diameter has been enlarged.

This resulted in a higher abrasion resistance, less wear and improved installation of the sealing ring (4).

The additional oil scraper ring (3) in the cylinder liner (2) means that an assembly aid is required when fitting pistons.



2 *Cylinder liner*
3 *Scraper ring*
4 *Sealing ring*

Oil pan

Oil pan

On engine 541.9 with code (MY8) with oil change intervals of up to 150,000 km, the engine oil volume of the oil pan (1) has been increased.

The material of the oil pan (1) has been changed to a thermoplastic. It differs from the previous oil pan due to the two indentations (arrows).

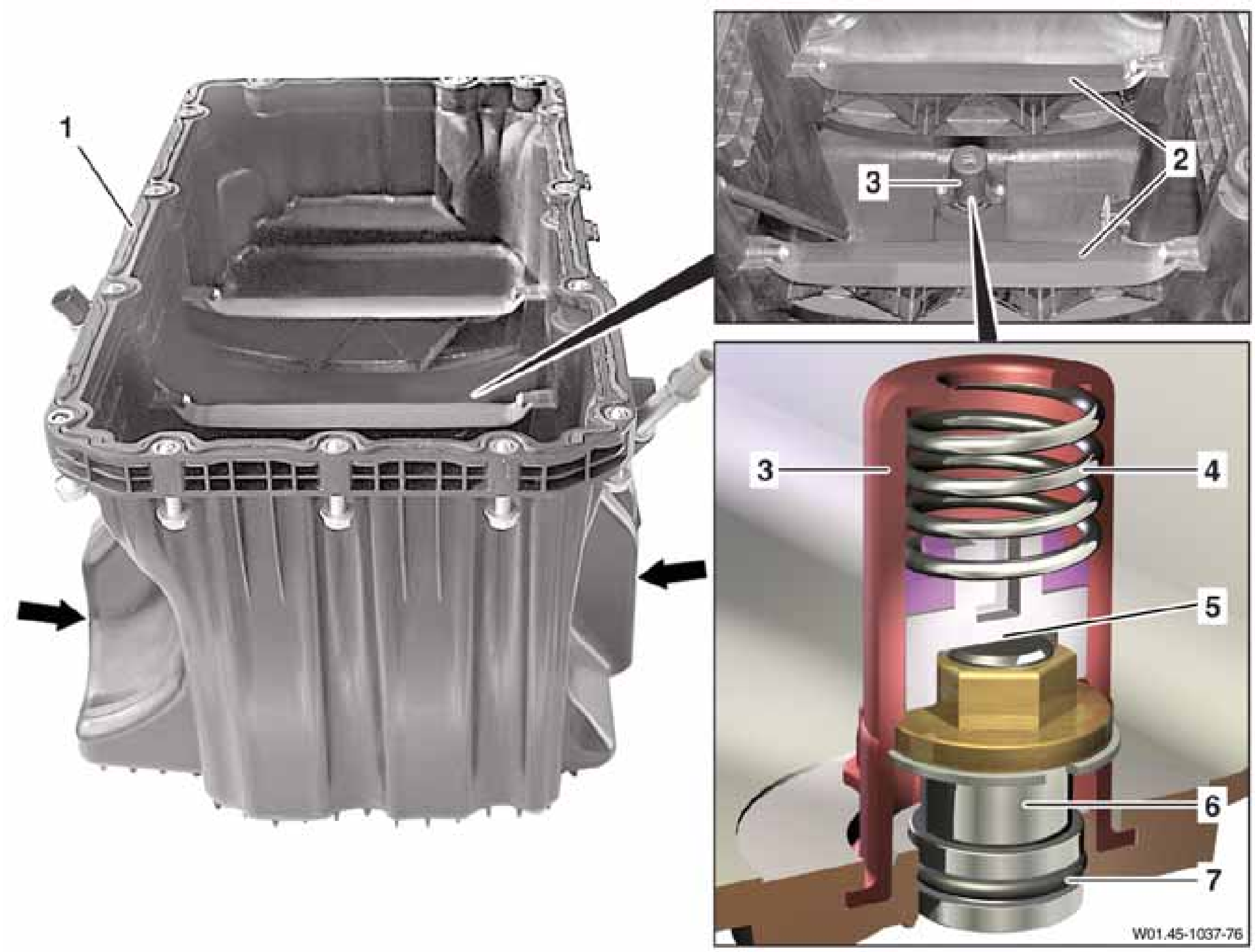
Two reinforcements (2) and an oil drain module (3) are installed in the oil pan (1).

The overload coupling (5) integrated in the oil drain module (3) limits the tightening torque of the oil drain screw (6).

At a torque defined by the coil spring (4), approx. 10 Nm, the overload coupling (5) slips and a clicking noise is heard when the oil drain screw is tightened (6).

The oil drain screw (6) is sealed radially by an O-ring (7). This means that the seal does not depend on the tightening torque.

This change protects the oil pan against overtightening and eliminates the risk of the oil pan (1) breaking.



1 Oil pan
2 Reinforcement
3 Oil drain module
4 Coil spring
5 Overload coupling
6 Oil drain screw
7 O-ring

Connecting rod

On the large connecting rod eye, the bearing surface for the connecting rod bearing shells has been precision turned and four laser-structured areas (arrows A) added. These serve to improve the anti-twist properties of the connecting rod bearing shells.

The connecting rod bearing bushing (1) at the small connecting rod eye has been form bored and two oil holes (arrows A) have been added, which are lubricated via the cooling duct of the piston.

This change improves the lubrication of the piston pin in the connecting rod bearing bushing (1).

1 Connecting rod bearing bushing
A Laser-structured surface
B Oil hole

Crank assembly

Connecting rod bearing shells

The connecting rod bearing shell materials have been changed.

The bearing material of the connecting rod bearing shell in the connecting rod has been changed to a copper-lead-tin alloy (CuPb 10 Sn 10).

The backing material is a quenched and tempered steel (C22) and the barrel coating a sputtered aluminum-tin alloy (AlSn 20).

The bearing material of the connecting rod bearing shell in the connecting rod bearing cap has been changed to a copper-lead-tin alloy (CuPb 10 Sn 10).

The backing material is a quenched and tempered steel (C22). The barrel coating of the connecting rod bearing shell consists of a lead-tin-copper alloy (PbSn 14 Cu 8).

These changes mean that the connecting rod bearing shells have been adapted to the higher loads thus giving them greater strength.

Pistons

The piston material has been changed. The new material has a fine-grit structure and thus greater heat resistance.

The recess diameter on the piston crown has been reduced. This means that the compression ratio epsilon (ε) has been increased to 18.5 and the soot percentage during combustion reduced. The edge of the recess on the piston crown is polished. This change increases the strength of the edge of the recess.

The top land (area from piston crown up to first piston ring groove) has been increased to 15 mm.

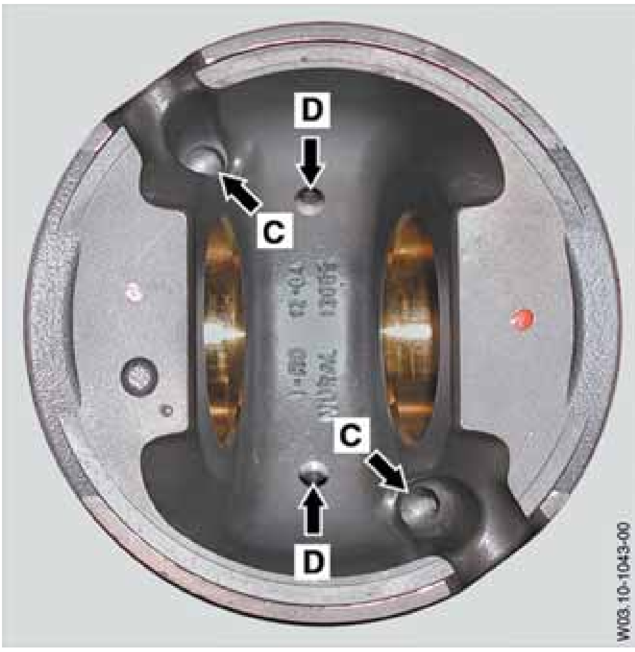
The piston dimensions have been adapted to the oil scraper ring in the cylinder liner. The carbon deposits on the piston top land have been reduced together with the scraper ring protrusion in the cylinder liner.

This serves to avoid any wear on the cylinder barrel of the cylinder liner.

The ring-shaped cooling duct in the piston is supplied with engine oil by the piston cooling oil spray nozzle though one of the two injection bores (arrow C). Each opposite lying bore (arrow C) is a drain bore.

A greater engine oil flow rate is provided in the piston cooling duct by a coaxial oil spray from the piston cooling oil spray nozzle in combination with the optimized oil supply funnel in the piston. In addition to this, improved lubrication of the piston pin and connecting rod bearing bushing is provided by two bores (arrow D) in the cooling duct of the piston

The previous piston variants for heavy-duty service have been discontinued.



Crank assembly

Piston rings

The coating has been changed on the piston rings in groove 1 (keystone ring with interior angle at top) and in groove 3 (bevel-edged ring with spring expander). This reduces wear.

The piston ring in groove 2 (taper-faced ring with interior angle) has not been changed.

Piston pin

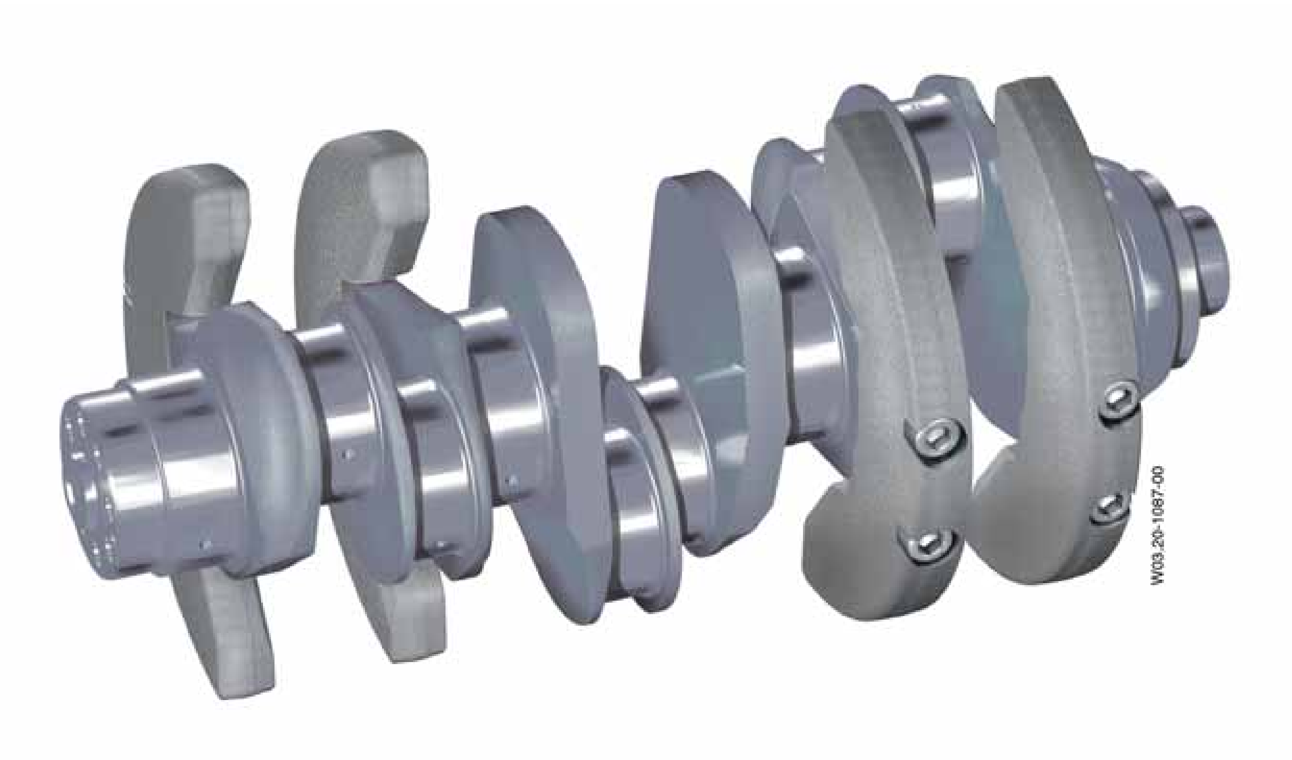
The piston pin has been reinforced by reducing the inside diameter to 22 mm. This strengthens the piston pin.

Crankshaft

The crankshaft is made of manganese-vanadium (46 MnVS 6BY) material.

This has strengthened the crankshaft. This modification was made necessary by the greater firing pressure.

To prevent greater torsional vibration on the crankshaft, a higher-performance vibration damper has been installed.



Crank assembly

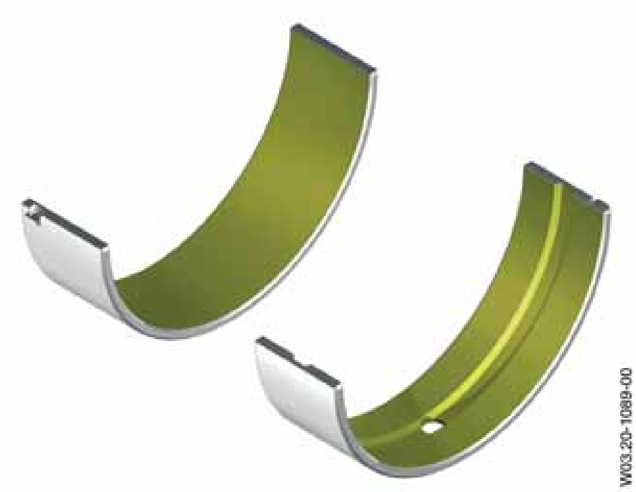
Main bearing shells

The main bearing shell materials have been changed. On the main bearing shell in the cylinder block, the backing material has been changed to a quenched and tempered steel (C22) and the barrel coating to a lead-tin-copper alloy (PbSn 14 Cu 8). The bearing material is a copper-lead-tin alloy (CuPb 22 Sn).

On the main bearing shell in the main bearing cap, the backing material has been changed to a quenched and tempered steel (C22).

The bearing material is a copper-lead-tin alloy (CuPb 10 Sn 10) and the barrel coating is a sputtered aluminum-tin alloy (AlSn 20).

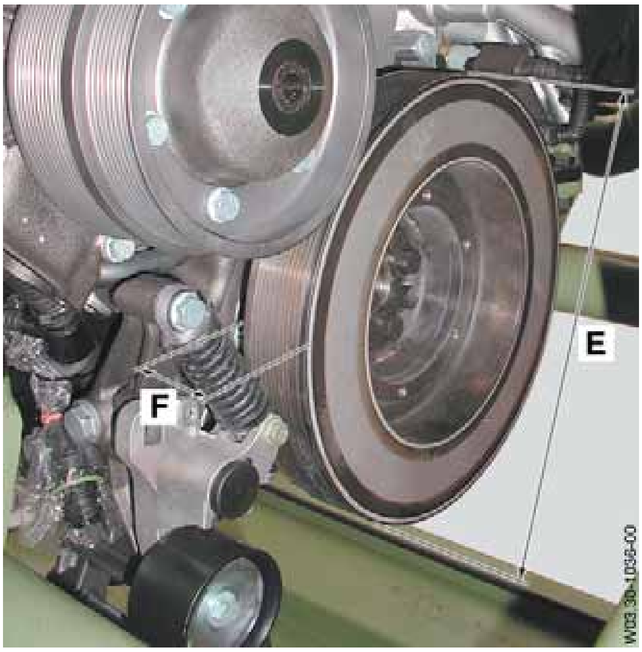
These changes mean that the main bearing shells have been adapted to the higher loads thus giving them greater strength.



Vibration damper

On the vibration dampers, the outside diameter (E) and width (F) have been enlarged.

This increases the performance capability of the vibration dampers to compensate for the greater torsional vibrations of the crankshaft.

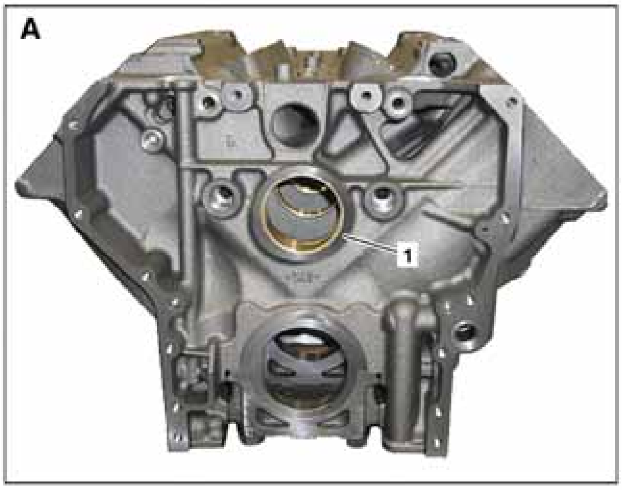


E Outside diameter of vibration damper
F Width of vibration damper

Camshaft

As of the introduction of engines with code (MS4) BlueTec 4 and with code (MS5) BlueTec 5, the rear camshaft thrust bearing (1) in the cylinder block has been designed without a thrust collar. The camshaft acts directly on the cylinder block.

Since 05 / 2006, the version without thrust collar (A) has been discontinued and replaced by the version with thrust collar (B). The camshaft acts on the thrust collar of the camshaft thrust bearing (2).



A ***Previous design***

1 *Camshaft thrust bearing without thrust collar*

B ***New design***

2 *Camshaft thrust bearing with thrust collar*

Engine control

Intake valves, intake valve seat rings

The valve disks have been reinforced on the intake valves. This increases the strength while reducing deformation and wear.

The intake valve seat rings are still made of Tribaloy.

Exhaust valves, exhaust valve seat rings

The valve seat angle on the exhaust valves and exhaust valve seat inserts has been changed to 36°.

This change means that the contact surface has been increased at the valve seats, to counteract increased wear as a consequence of higher firing pressure.

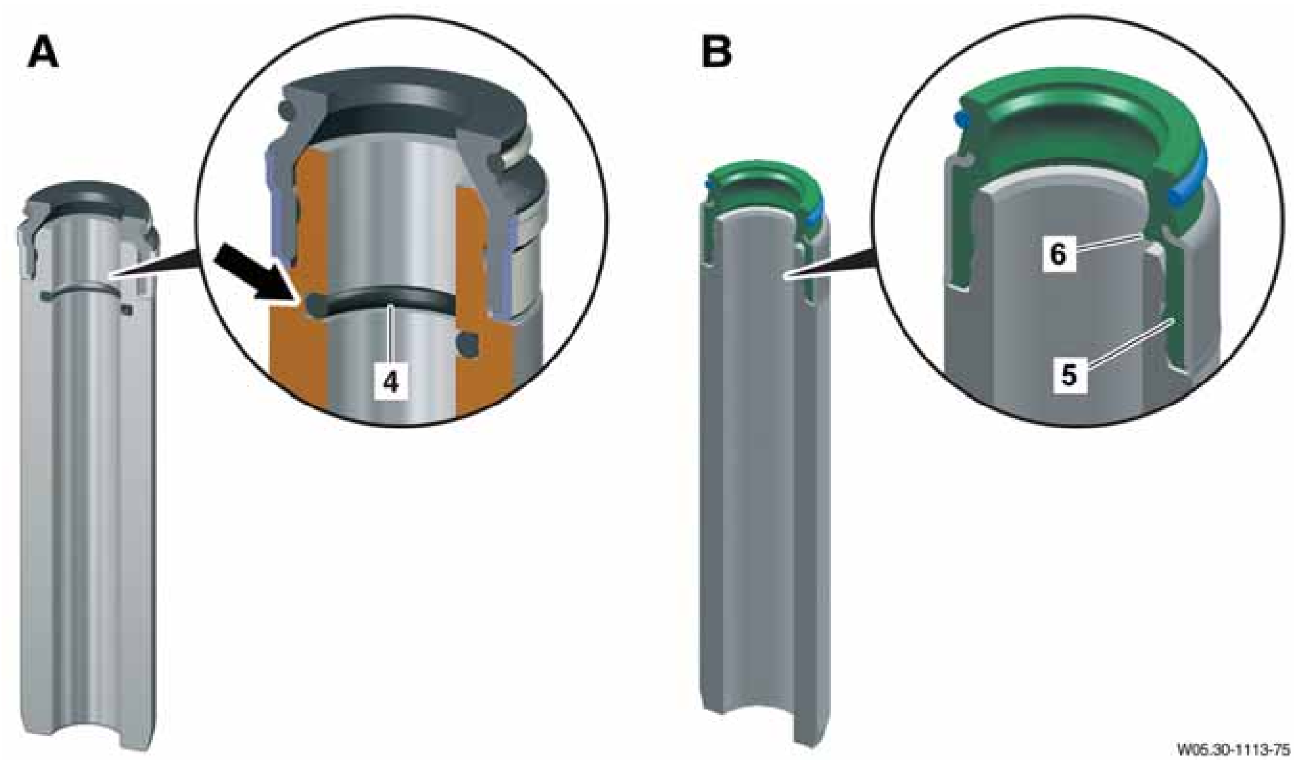
Valve guides, valve stem seals

As of the introduction of engines with code (MS4) BlueTec 4 and code (MS5) BlueTec 5, a groove (arrow) was added to the valve guide to improve the seal to the valve stem.

An O-ring (4) was additionally installed in this groove.

As of 2007, the groove and O-ring (4) are no longer present in the valve guide.

To maintain the improved seal between valve stem and valve guide, an additional sealing lip (6) has been added to the valve stem seal (5).



A Previous design

4 O-ring

B New design

5 Valve stem seal
6 Sealing lip

Mixture formation

Nozzle holder assembly

A 7-hole nozzle with a heat protection sleeve has been installed in the nozzle holder assembly.

This change, along with the modified piston combustion cavity, optimizes the combustion.

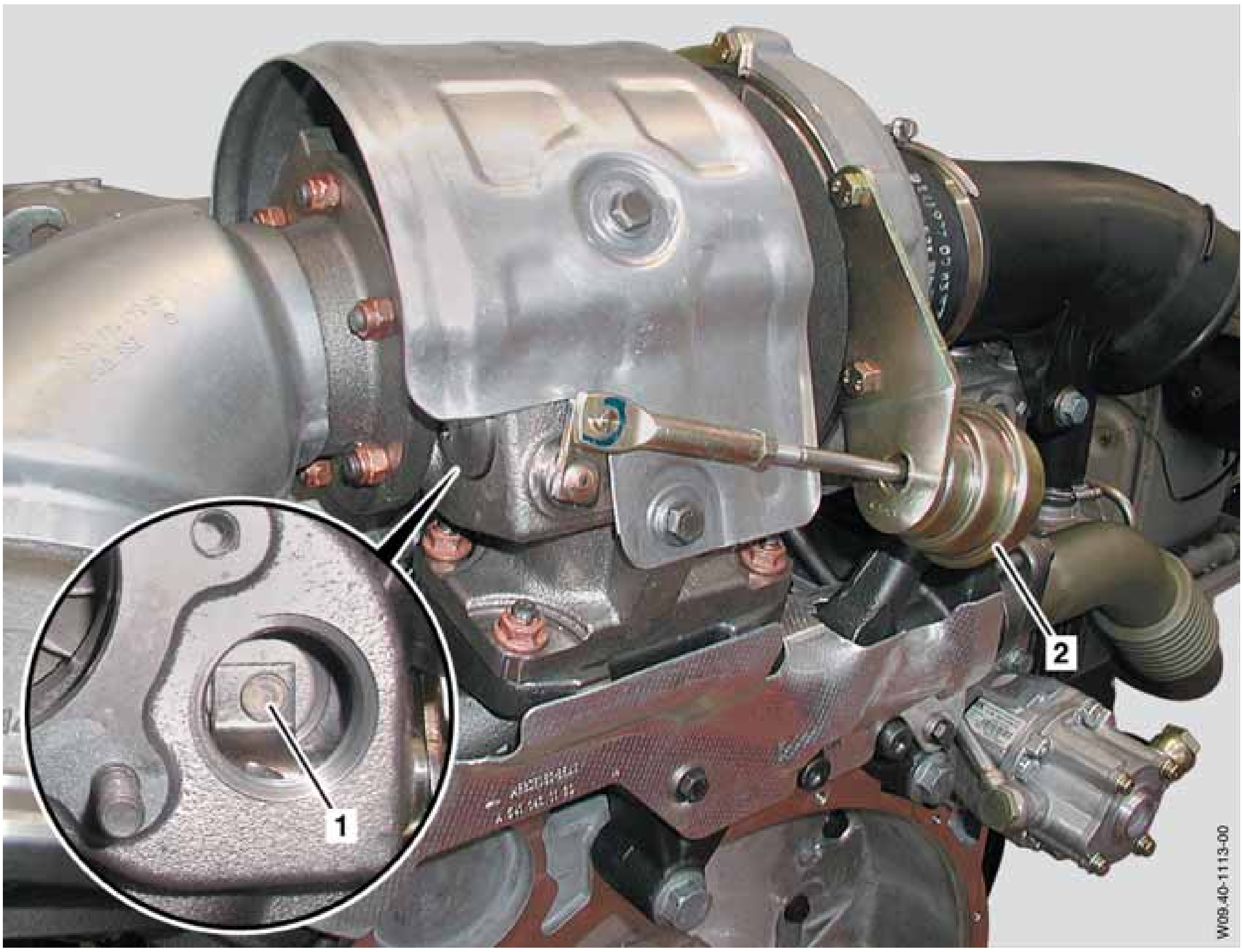
This reduces the amount of soot particles in the exhaust and the fuel consumption.

Turbocharger with wastegate valve (bypass valve)

On engine 541.9, the turbocharger has been designed so that a higher boost pressure is available in the lower and medium engine rpm ranges. The wastegate valve (bypass valve) (1) in the turbocharger is actuated by a vacuum cell (2).

The vacuum cell (2) is pressurized by the boost pressure and actuates the wastegate valve (bypass valve) (1) located in the exhaust flow depending on the boost pressure.

When the set boost pressure limit value is reached, the wastegate valve (bypass valve) (1) opens and some of the exhaust gas flows past the turbocharger turbine. The boost pressure no longer increases.



Shown on engine 541.9

1 Wastegate valve (bypass valve)
2 Vacuum cell

Compressor

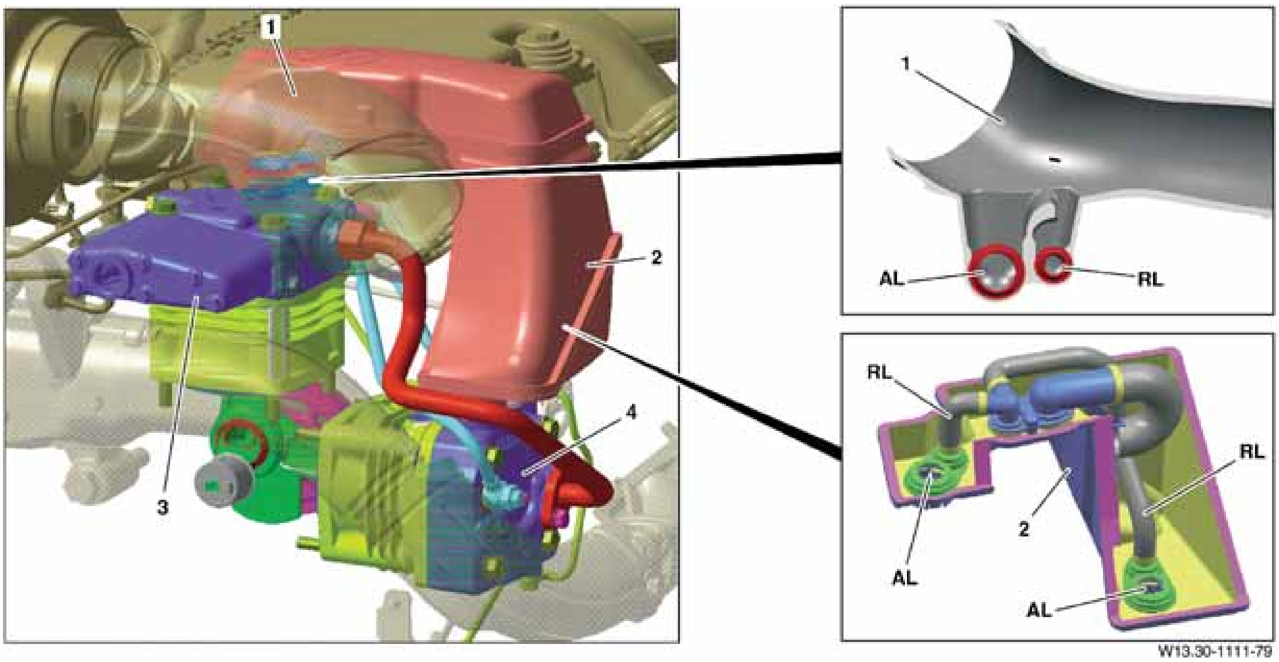
Compressor

The engine with code (MS4) BlueTec 4 or code (MS5) BlueTec 5 has a higher compressed-air requirement because of the AdBlue injection, this in turn makes modifications to the compressor necessary:

- On the single-cylinder compressor the stroke has been increased to 56 mm and thus displacement increased to 439 cm^3 .
- On the dual-cylinder compressor (code (MZ9) Dual compressor) the stroke has been increased to 46 mm and the displacement increased to 722 cm^3.
- On single and dual cylinder compressors the connecting rod, crankshaft and drive gear have been adapted to the greater displacement.
- The connecting rod was shortened and the bearing diameter in the large connecting rod eye for the crankshaft was increased. The single-cylinder and dual-cylinder compressor have a standard connecting rod.

To optimize air exchange "Advanced-Power-Reduction (APR)", the following parts were modified on the compressor:

- In addition to the intake air fitting (AL) the intake manifold (1) now has a separate fitting for returning residual air (RG) when in non-delivery mode.
- The residual air (RG) returned from the cylinder head (3, 4) is returned by way of a line in the resonator (2) located directly behind the intake air fitting (AL) in the intake manifold (1) and then aspirated by the turbocharger.
- Two separate ducts have been integrated into the resonator (2). One duct for the intake air (AL) and one duct to return the residual air (RG) from the cylinder head (3, 4). For the duel-cylinder compressor the two ducts for returning residual air (RG) have been joined to form a single duct at the outlet to the intake manifold (1).
- The resonator (2) and intake lines have been designed for lower noise development.



1	*Intake manifold*
2	*Resonator*
3	*Cylinder head*
4	*Cylinder head*
AL	*Intake air*
RL	*Residual air*

Cylinder head of vertical compressor

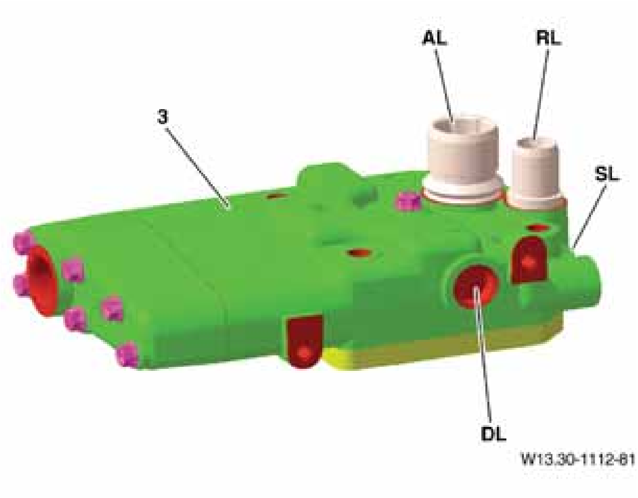
The following parts of the cylinder head (3) have been changed:

- Suction lamella
- Pressure valve shims
- Pressure holes

The following parts were added to the cylinder head (3):

- A control valve
- A fitting for returning residual air (RL)

The intake air (AL) and residual air (RL) fittings have been designed for snap-on fasteners for resonator installation. Nothing has been changed on the compressed air fitting (DL). The control valve is actuated over a control line (SL) by the pressure regulator; this control valve is ventilated and opened when the pressure regulator is deactivated. The compressor drops to minimum delivery and the residual air (RL) is routed through the resonator into the intake manifold. This in turn reduces the power consumption when in non-delivery mode and produces an energy saving through lower fuel consumption.



3 Cylinder head
AL Intake air (fitting)
DL Compressed air (fitting)
RL Residual air (fitting)
SL Control line (fitting)

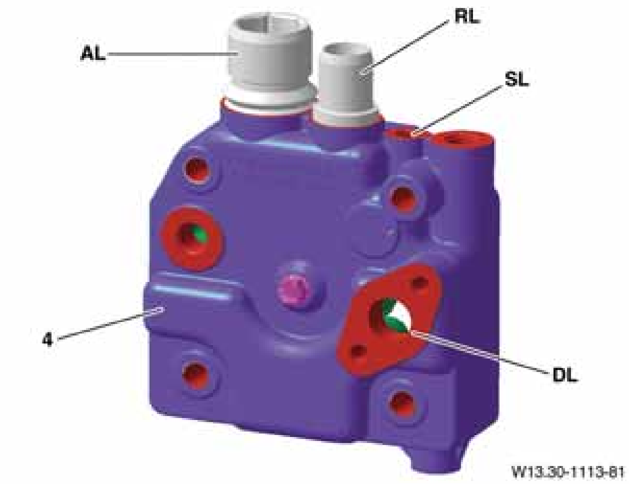
Compressor

Cylinder head of horizontal compressor (for dual compressor only)

On the horizontal cylinder head (4), the same modifications have been made as for the vertical cylinder head.

The fittings for the returning residual air (RL), intake air (AL), compressed air (DL) and the connection for the control line (SL) have been mounted in accordance with the installation position.

The optimized air exchange "Advanced Power Reduction" (APR) is realized by the new control system in the cylinder head (4) and the residual air (RL) returned through the resonator into the intake manifold.



4 Cylinder head
AL Intake air (fitting)
DL Compressed air (fitting)
RL Residual air (fitting)
SL Control line (fitting)

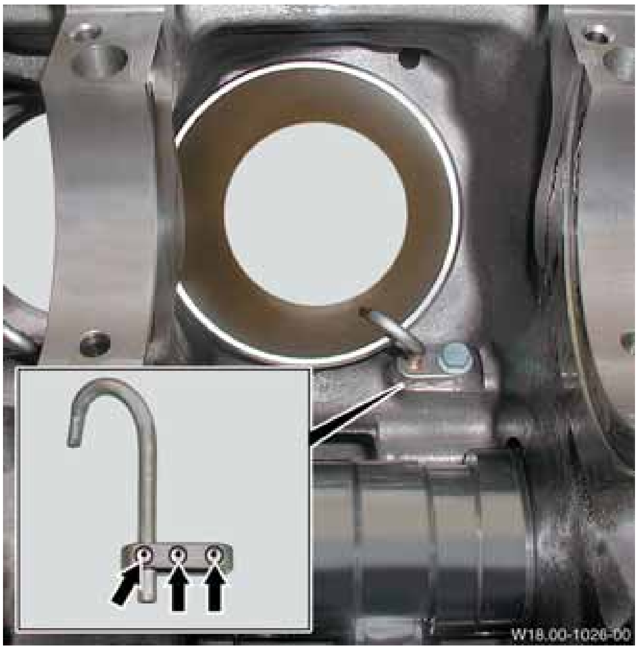
Oil pump

On engine 541.9, the diameter of the gear wheels (1) has been increased to 63.8 mm and the shaft diameter to 28 mm.The width of the gear wheels (1) is 43 mm. This produces an increased delivery rate of 173 l / min at a motor speed of 1800 rpm. On engine 542.9, the diameter of the gear wheels (1) has been increased to 63.8 mm and the shaft diameter to 28 mm. The width of the gear wheels (1) is 49 mm. This produces an increased delivery rate of 198 l / min at a motor speed of 1800 rpm. In the oil pump housing and housing cover (2), the bearing type (arrows) for both gear wheels (1) has been changed to bearing bushings. In addition to this, the gear ratio from the crankshaft gear to the oil pump drive gear has been increased to 46 : 43. These changes to the oil pump had to be made to achieve a higher oil flow rate for the oil spray nozzle which was necessary because of the higher piston cooling demand and additional camshaft lubrication.

1 Gear wheel
2 Housing cover

Piston cooling oil spray nozzle

The spray direction of the oil spray nozzle for the piston has been changed to a coaxial oil spray, which is injected into the piston cooling duct. This change improves piston cooling as a consequence of the higher engine oil flow rate. The oil spray nozzle pipe diameter has been enlarged to 4 mm and the diameter at the orifice at the end of the nozzle has been calibrated to 3 mm. This change increases the oil flow rate of the oil spray nozzle and the oil spray fans out less, improving the piston cooling. Located at the base of the oil spray nozzle are three holes (arrows) for lubrication of the intake, exhaust and unit pump cams on the camshaft.

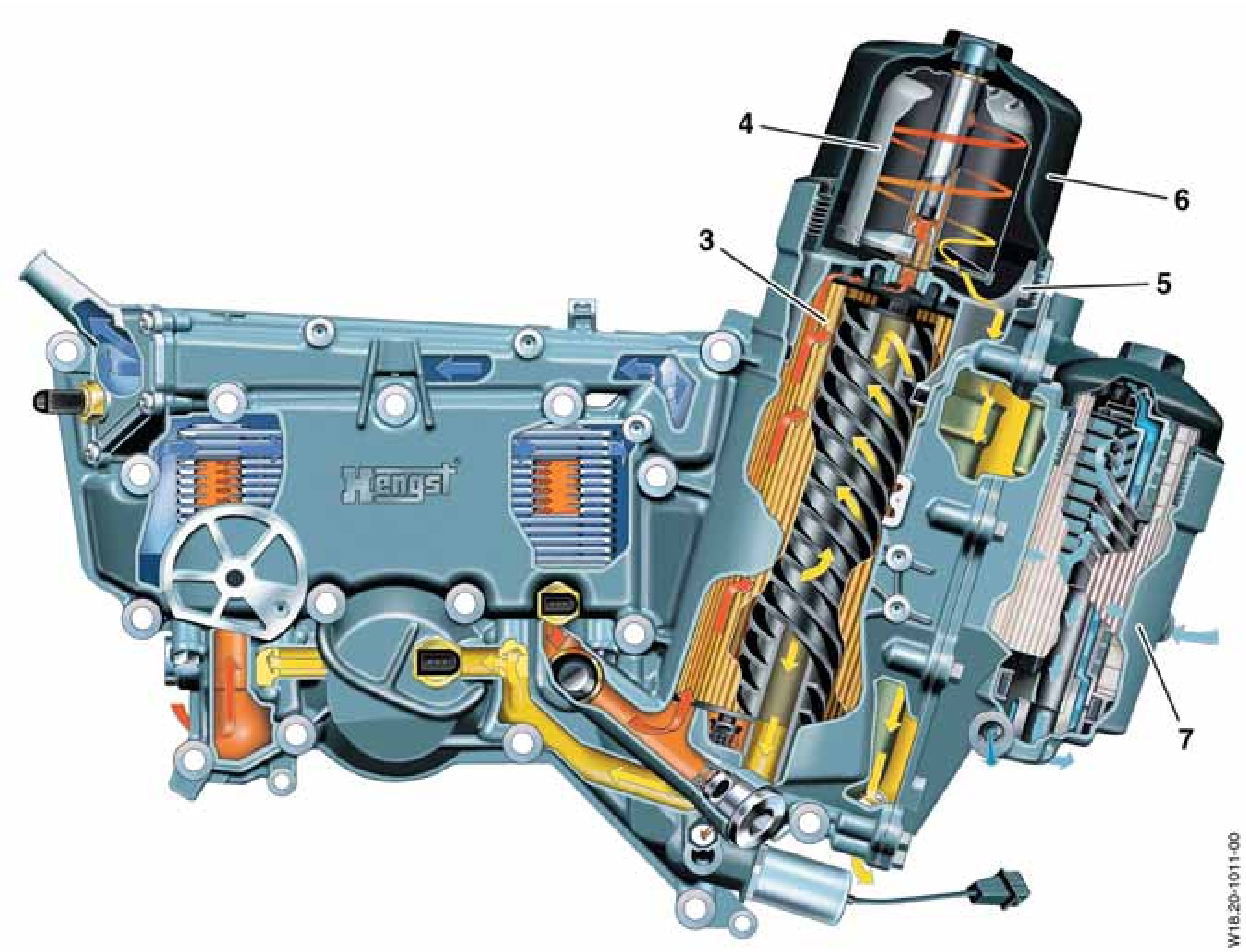


Engine lubrication

Oil filter

On engine 541.9 with code (MY8) with engine oil change intervals of up to 150,000 km, an oil centrifuge has also been installed.

The oil centrifuge is mounted in the oil filter engine oil ancillary circuit at the top on the oil filter element (3).



3 Oil filter element
4 Rotor
5 Intermediate cover
6 Screw cap
7 Fuel filter

The oil centrifuge consists of the following components:

- Rotor (4)
- Intermediate cover (5)
- Threaded cap (6)

Some of the engine oil flows through the oil centrifuge but only from an engine oil pressure > 2 bar. Located in the lower range of the rotor (4) are two tangentially mounted nozzles, through which cleaned engine oil flows thus generating a rotation of the rotor (4).

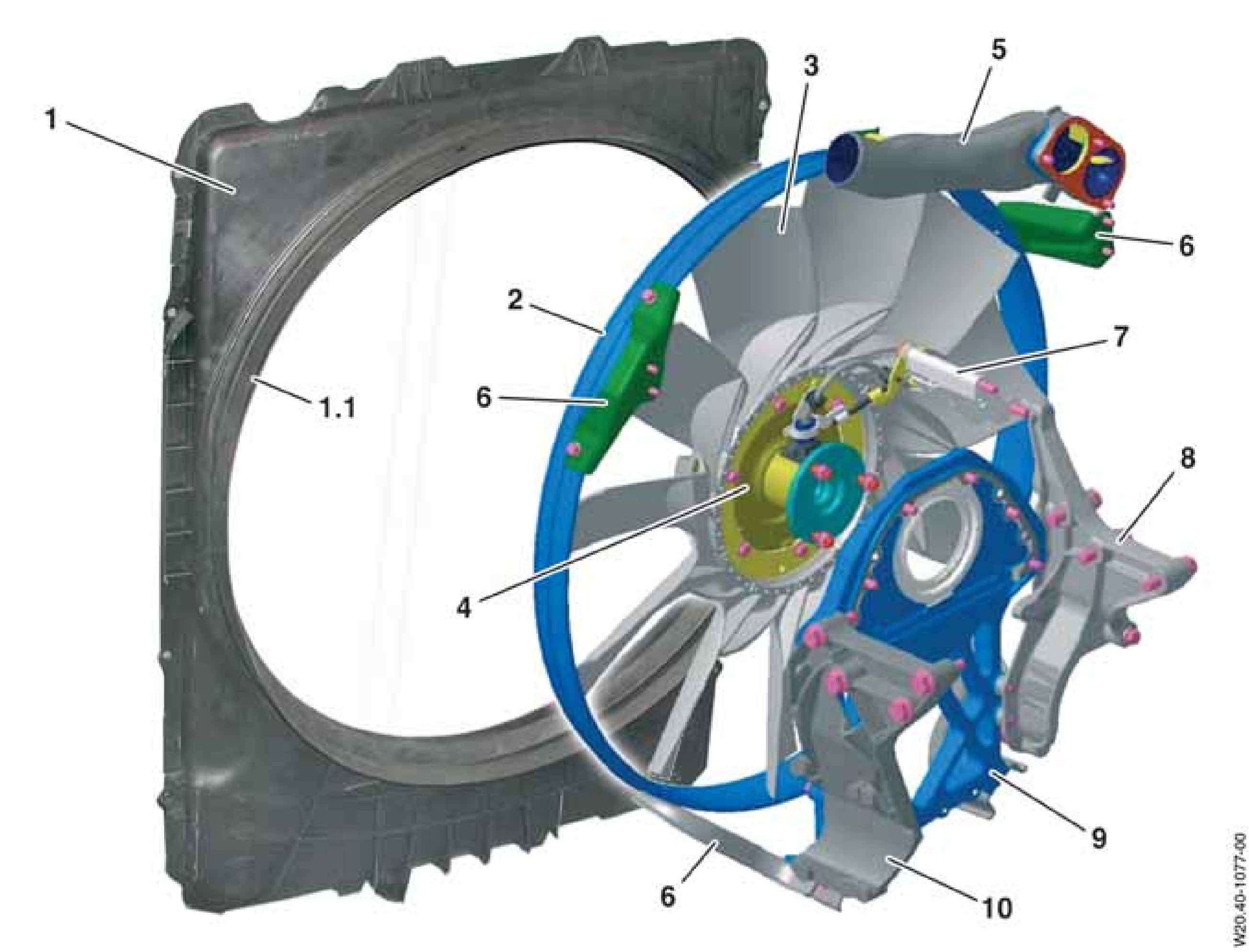
The rotor (4) can reach a rotational speed of up to 7 000 rpm. The cleaned engine oil then flows back into the oil pan. As the rotor (4) rotates, soot particles, and miniscule metal particles, which flow past the oil filter element (3), are separated from the engine oil and collected on the inside walls of the rotor (4) as deposits. When performing maintenance operations the rotor (4) and oil filter element (3) must be replaced. The fuel filter (7) was flange-mounted straight onto the oil filter with oil-water heat exchanger.

Engine cooling

Fan with increased performance

The fan variant with code (M58) Fan with increased performance is currently only installed on engines with an engine output of 350 kW, 375 kW and 480 kW.

The fan (3) has been changed to an axial fan with eleven blades. On the axial fan, the radiator side fan shroud (1) is connected by means of a vulcanized, closed boot (1.1) to the engine-side fan shroud (2).



1 Radiator-side fan shroud
1.1 Boot
2 Engine-side fan shroud
3 Fan
4 Viscous fan clutch
5 Coolant outlet connection
6 Auxiliary bracket
7 Support
8 Alternator support
9 Housing cover with bracket
10 Refrigerant compressor carrier

The boot (1.1) has to be pulled back when removing or installing the radiator or fan (3).

The new fan (3) with viscous fan clutch (4) and the modified cooling-air flow increases the cooling air flow rate at the radiator and improves the cooling performance.

The engine-side fan shroud (2) is mounted to the engine as follows:

- Through several additional brackets (6)
- On the modified top coolant outlet nipple (5) and coolant pump housing
- On the modified alternator support (8)
- On the modified front housing cover with bracket (9) for installation to the alternator support (8) and refrigerant compressor carrier (10) or on the new bracket
- On the modified refrigerant compressor carrier (10) or on the new bracket, where a refrigerant compressor is not installed

An electrically actuated viscous fan clutch (4) "System BorgWarner" has been installed in the fan (3) with a support (7).

This has the following advantages:

- Cooling demand-oriented actuation by the engine control (MR) control unit
- Minimized idle speed (~250 rpm) of fan (3), this saves energy through reduced fuel consumption.
- Short fan (3) response time

Cylinder head, cylinder block

General

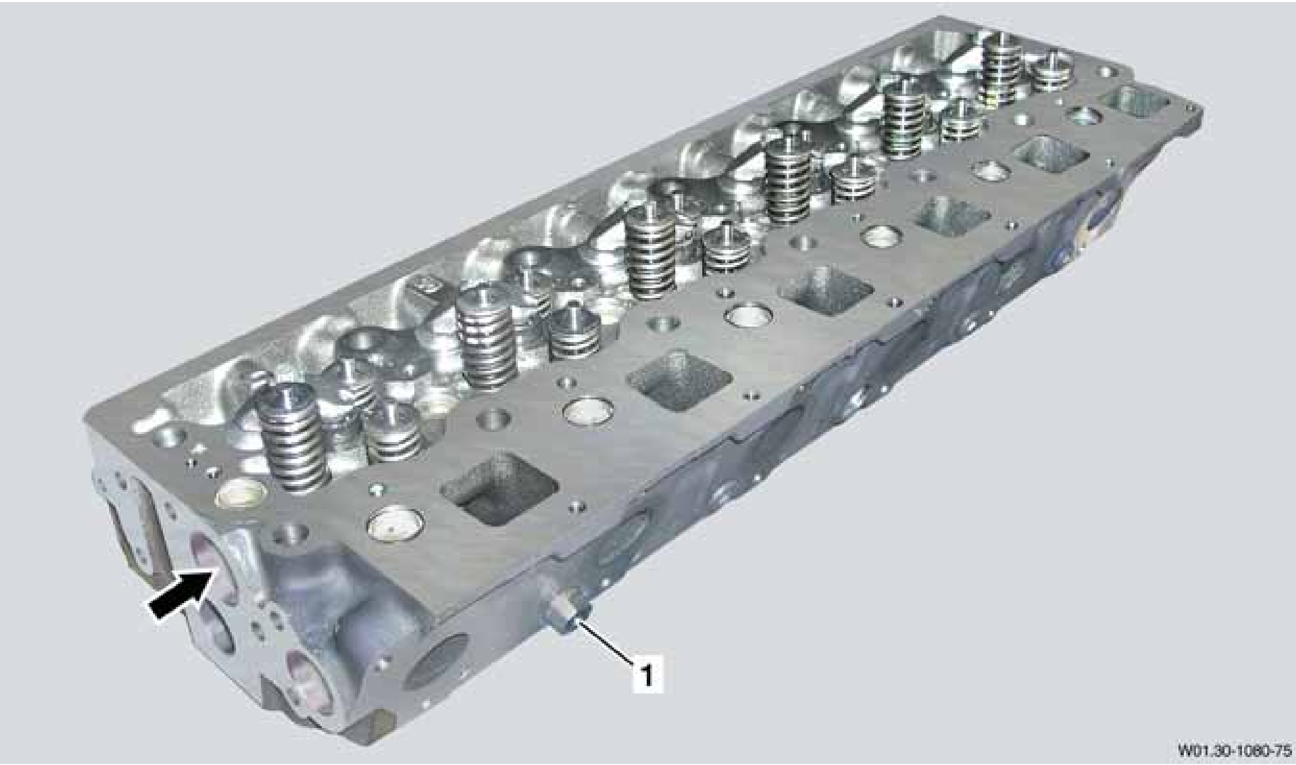
The following engine components were changed with the introduction of engines 900.9, 902.9, 924.9, 926.9 with code (MS4) BlueTec 4 or code (MS5) BlueTec 5 (Euro 4 and Euro 5 emissions standards).

Cylinder head

A cap at the rear section of the cylinder head which seals a hole necessary for production has been replaced by the coolant flange for the SCR tank heater solenoid valve (arrow).

A screw plug on the side of the cylinder head has been replaced by a threaded sleeve (1) which is used to attach the bracket for the metering device.

The material of the cylinder head has been changed to cast iron with vermicular graphite (GJV-400) on engines 924.9 and 926.9. This strengthens the cylinder head.



1 Threaded sleeve

Cylinder head gasket

On engines 924.9 and 926.9, the elastomer sealing elements (arrow A) and the crimped parts (arrow B) have been changed on the cylinder head gasket.

These changes improve the seal between the cylinder head and cylinder block.

A Elastomer sealing element
B Crimped part

Cylinder head, cylinder block

Cylinder block

On engines 924.9 and 926.9, the material of the cylinder block has been changed to cast iron with vermicular graphite (GJV-400).

This material change strengthens the cylinder block, allowing it to withstand greater loads.

Connecting rod

At the connecting rod big end and connecting rod bearing cap, the width (A) of the contact surface for the connecting rod bearing shells (1) has been reduced to suit the changed connecting rod journals of the crankshaft.

On engines 924.9 and 926.9, the material of the connecting rod has been changed and the connecting-rod shank reinforced.

This strengthens the connecting rod.

The connecting rod bush (2) is form bored and the inside diameter of the connecting rod bush (2) has been changed to 44 mm.

1 Connecting rod bearing shell
2 Connecting rod bushing
A Width of contact surface for connecting rod bearing shell

Connecting rod bearing shells

The width of the connecting rod bearing shells has been reduced to suit the changed connecting rod journals of the crankshaft.

The connecting rod bearing shells are made from a lead-free material. This material complies with the directive on end-of-life vehicles.

Crank assembly

Pistons

The shape of the combustion cavity has been changed at the piston crown, reducing the amount of soot during combustion.

On engines 900.9 and 902.9, the compression ratio is epsilon (ε) 17.4 and epsilon (ε) 17.5 on engines 924.9 and 926.9. On engines 900.9 and 902.9, the ignition pressure has been increased to 180 bar and to 190 bar on the bored and stroked engines 924.9 and 926.9.

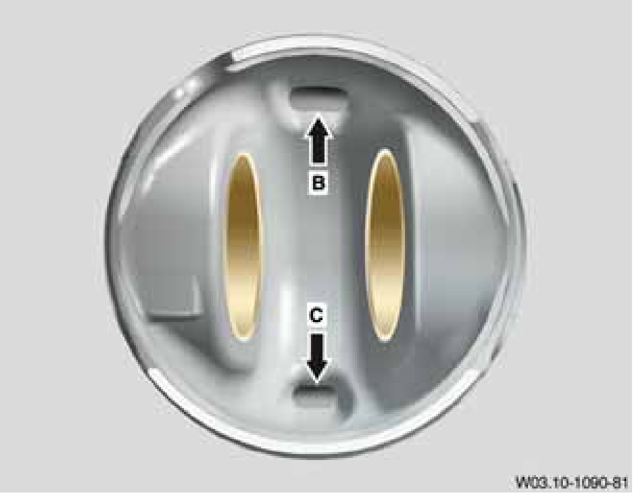
On engines 924.9 and 926.9, the piston material has been changed. The top land (area from piston crown up to first piston ring groove) has been reduced.

These changes strengthen the piston crown.

Bushings (3) are shrink-fitted to the pin holes of the piston. These bushings (3) have an inside diameter of 44 mm and are form bored.

The pistons of engines 924.9 and 926.9 have a ring-shaped cooling duct. Engine oil is sprayed into this cooling duct through the injection bore (arrow B) by the oil spray nozzle. The oil drains out through the opposite bore (arrow C).

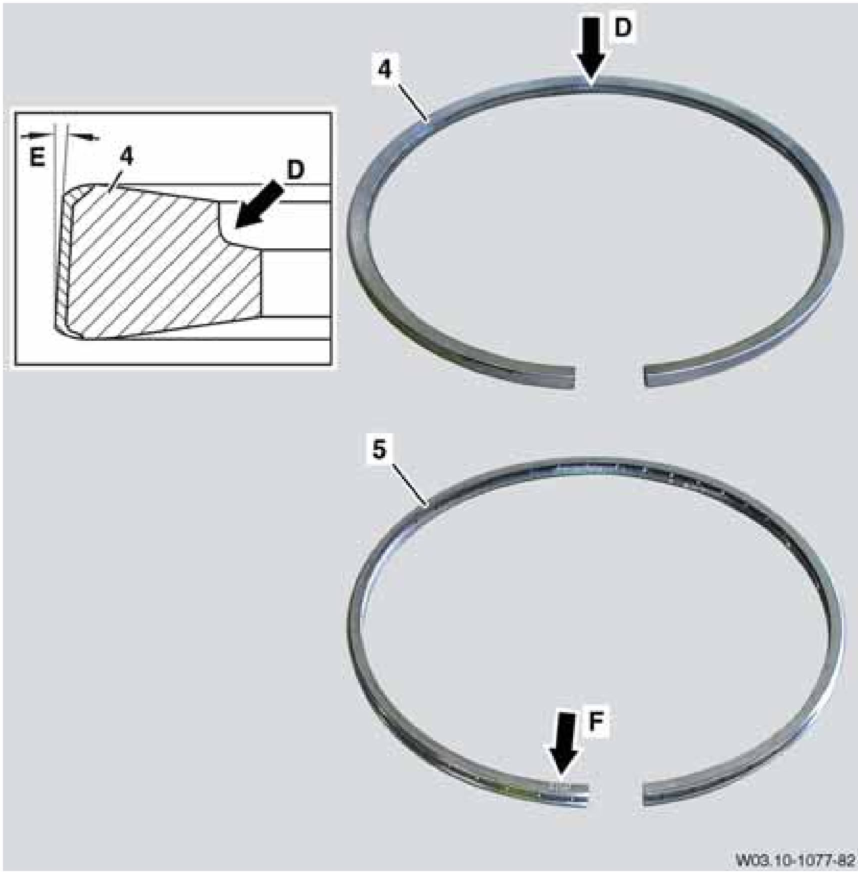
3 Bushing



Piston rings

On engines 924.9 and 926.9, a higher piston ring (4) is used in groove 1 (keystone ring with interior angle). In addition, the trapezoid angle (E) has been changed and an interior angle (arrow D) added. The coating and shape of the piston ring have been changed on the piston ring (5) in groove 3 (bevel-edged ring with spring expander).

Due to the change in piston ring shape (beveled), the installation position marking "TOP" (arrow F) must be observed when installing the piston ring (5) into the piston. This change improves the scraping effect and optimizes engine oil consumption. The piston ring in groove 2 (taper-faced ring with interior angle) has not been changed.



4 Piston ring
5 Piston ring

D Interior angle
E Trapezoid angle
F "TOP" marking

Crank assembly

Piston pin

On engines 924.9 and 926.9, the outside diameters of the piston pins have been increased to 44 mm to improve the strength.

Crankshaft

The fillet radiuses (arrows) on the connecting rod journals have been increased to 4 mm.

The larger fillet radiuses (arrows) increase the strength of the crankshaft.

W03.20-1107-75

Main bearing shells

The main bearing shells are made from a lead-free material. This material complies with the directive on end-of-life vehicles.

Engine control

Camshaft

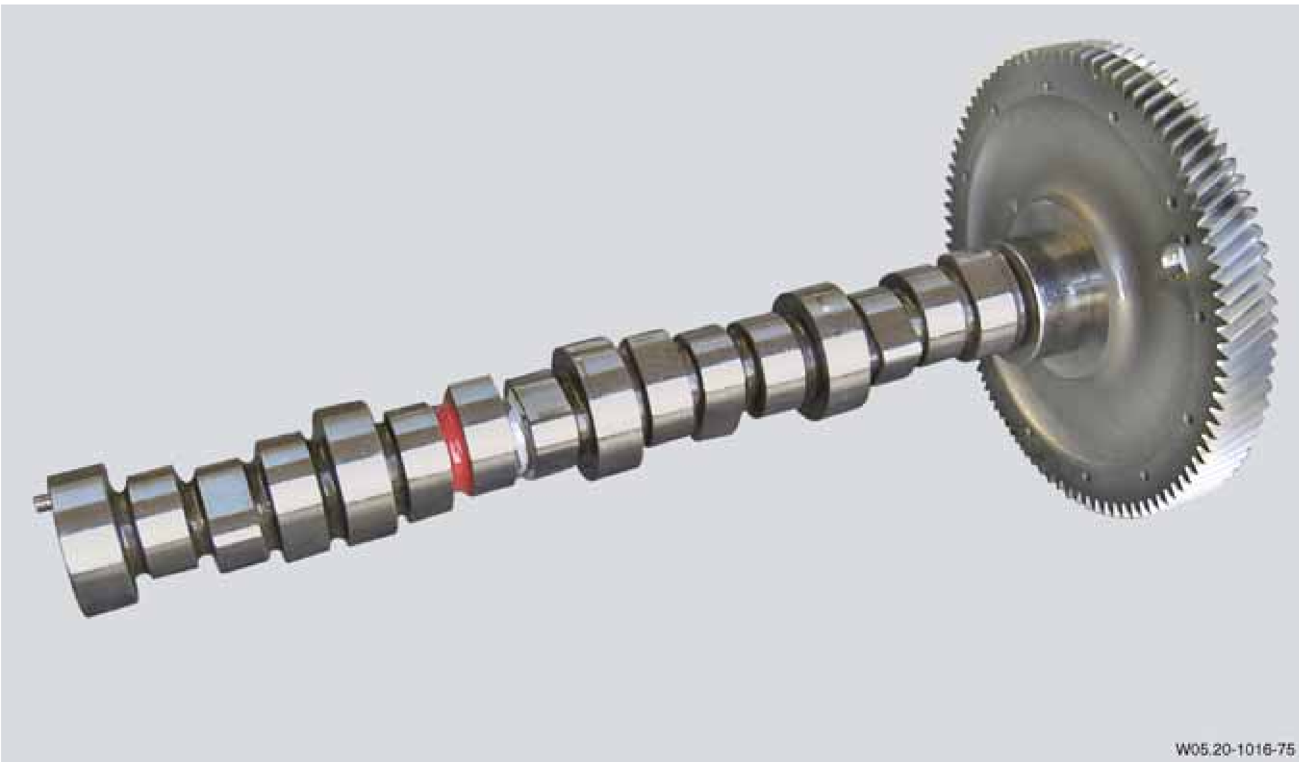
The camshaft for engines 924.9 and 926.9 is made from cold-worked, case-hardened steel alloy.

This change was necessary due to the increase in force from the unit pumps.

The contour of the unit pump cams on the camshaft has been changed. This also changes the start of delivery of the unit pumps.

The camshaft bearing (1) in the cylinder block has been adapted to the increased load on engines 924.9 and 926.9.

1 Camshaft bearing



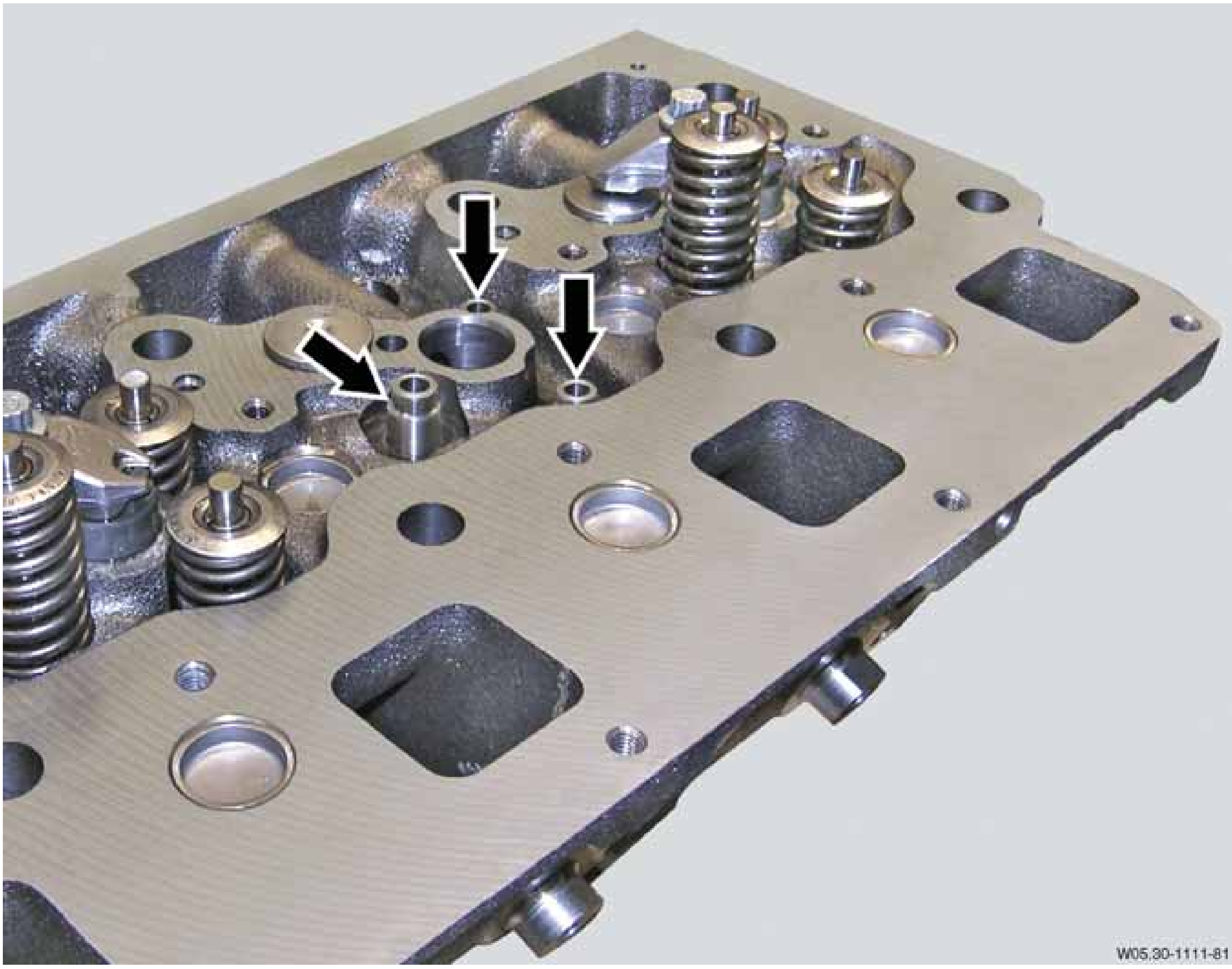
Valve guides

The lubrication of the valve stems in the valve guides (arrows) is diminished due to the lower proportion of soot during combustion.

To counteract the increased wear, the material of the valve guides (arrows) has been changed.

Intake valve and exhaust valve seat rings

The material of the intake and exhaust valve seat rings has been changed to counteract the increased wear.



Mixture formation

Nozzle holder assembly

Changes have been made to the nozzle holder assembly to optimize combustion so that the proportion of soot particles in the exhaust and the fuel consumption is reduced.

The injection pressure on engines 900.9 and 902.9 has been increased to 2 000 bar.

On engines 924.9 and 926.9, the injection pressure is 2 200 bar. In addition, the material of the nozzle holder assembly has been changed to withstand the greater injection pressure.

Pressure pipe connections and injection lines

Due to the greater injection pressure, the steel alloy for the pressure pipe connections has been changed on engines 924.9 and 926.9.

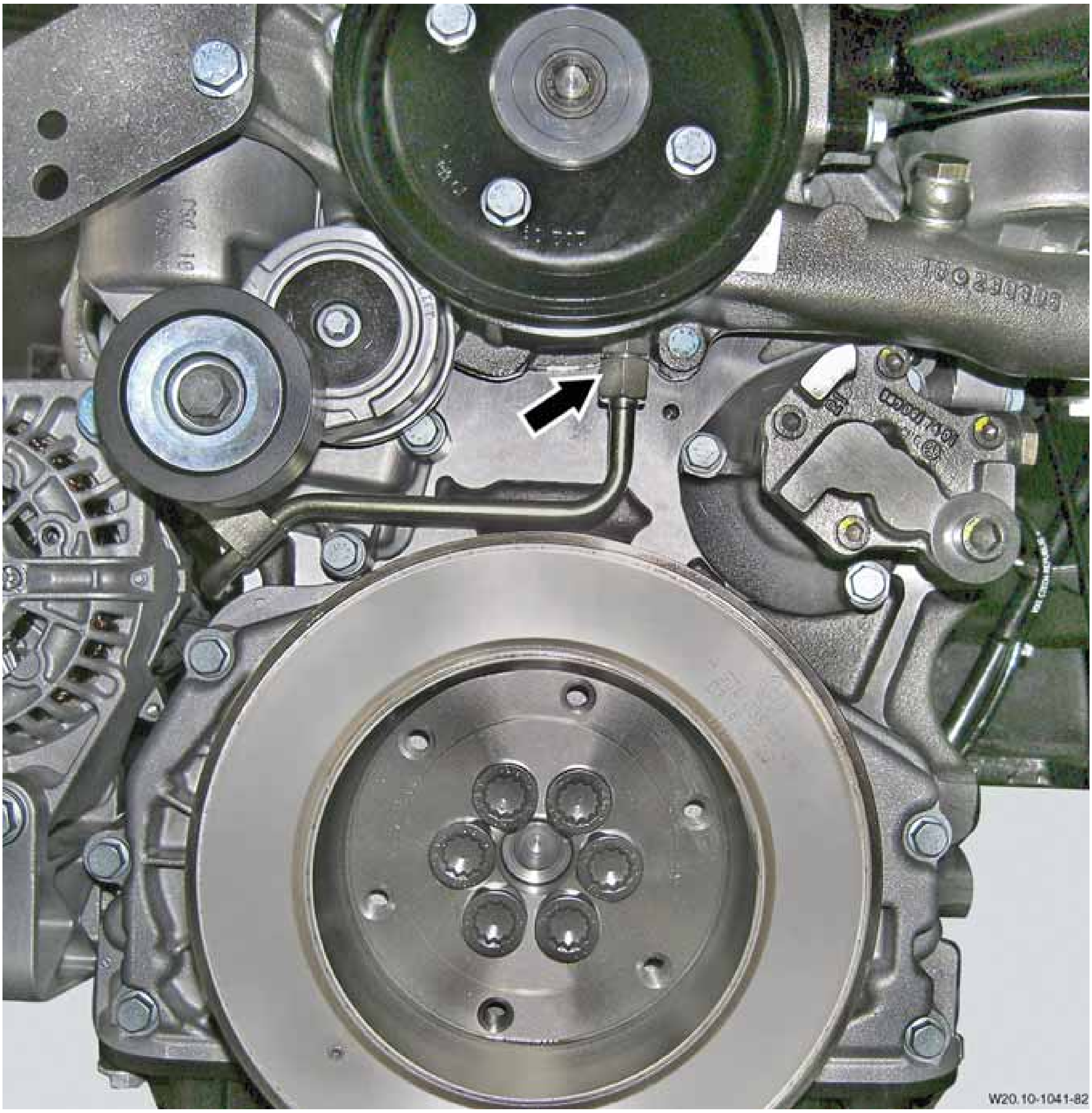
The material of the injection lines has also been adapted to the increased loads.

Unit pumps

Due to the greater injection pressure (2 200 bar), the stroke of the unit pumps has been increased on engines 924.9 and 926.9.

Coolant pump

A threaded fitting has been added to the coolant pump for installing a coolant line (arrow) for the SCR exhaust aftertreatment system.



Abbreviations

A / D

Analog / Digital

C

Carbon

CAN

Controller Area Network

DAS

Diagnosis Assistance System

H_2O

Water vapor

MR

Engine control

N_2

Nitrogen

NH_3

Ammonia

NO_X

Nitrogen oxides

NTC

Negative Temperature Coefficient

PM

Particulate Matter (soot particles)

PTC

Positive Temperature Coefficient

SCR

Selective Catalytic Reduction

TiO_2

Titanium dioxide

V_2O_5

Vanadium pentoxide

WIS

Workshop Information System

WO_3

Tungsten oxide