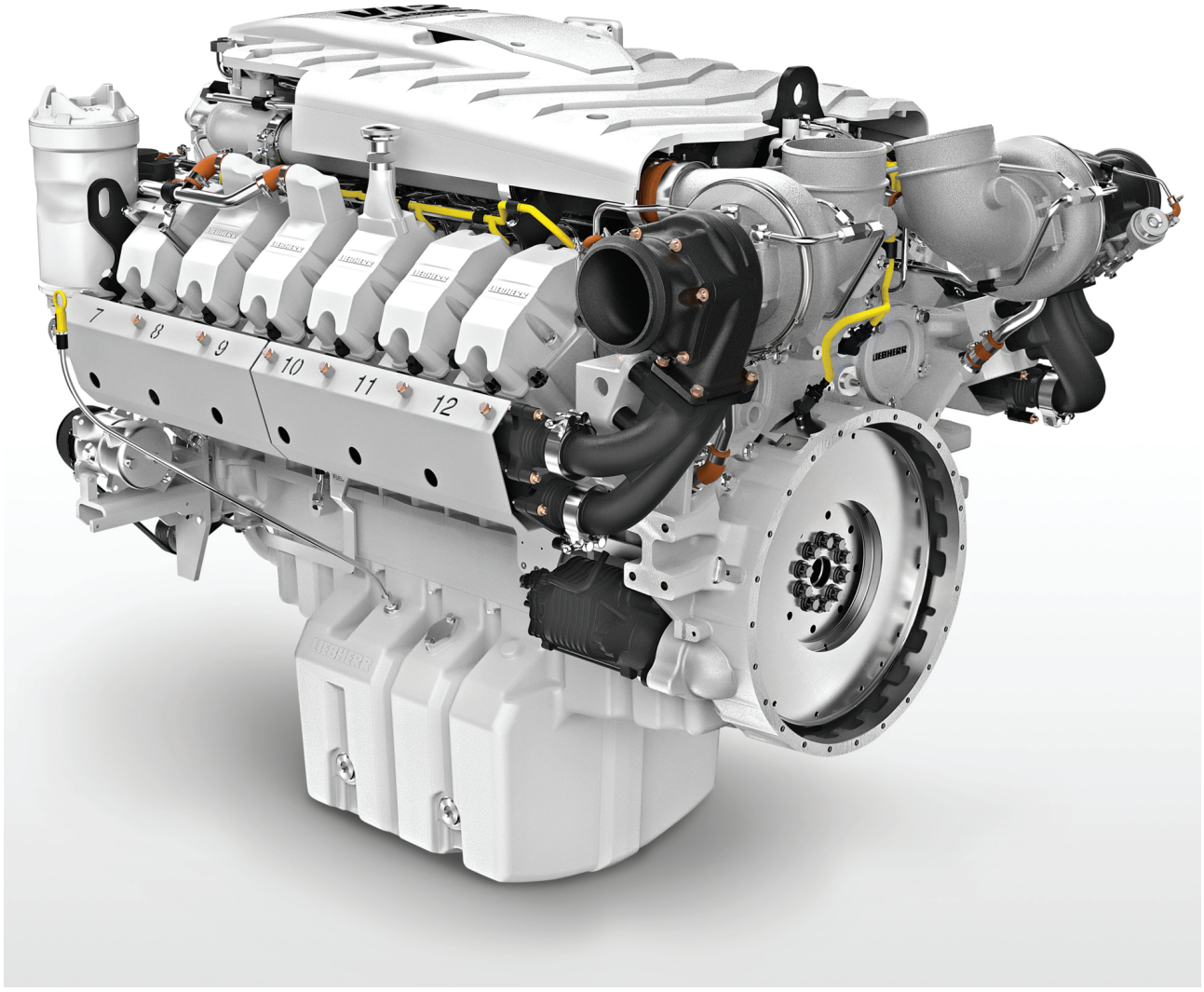
Repair instructions en

Diesel engine

D9512 A7-04 (Stage V / Tier 4)

From serial number 2019160001



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Manufacturer

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Only for the United States

⚠ WARNING

This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer.
For more information go to
www.P65Warnings.ca.gov

⚠ WARNING

This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause birth defects or other reproductive harm.
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⚠ WARNING

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with exhaust system.
- Do not idle the engine except as necessary.

For more information go to
www.P65warnings.ca.gov/diesel

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Change history

Version	From serial number	Changes included	Issue
00	2019 16 0001	Document newly created	05/07/2021

Change history

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Preface

About the document

Content

With these repair instructions, we are providing you with technical documents, in which you can find the removal and installation, dismantling and assembly, setting and technical data of Liebherr diesel engines.

Work instructions

A prerequisite for a proper repair is a flawless and complete basic tool and the necessary devices and special tools.

Only use clean and undamaged tools. Damaged tools may not be continued to be used; replace them in a timely manner.

Cleanliness and order contribute to safety at the workplace.

Clean the diesel engine, and here in particular connections and screw fittings, of oil, fuel and care products at the start of the maintenance / repair. Do not use any aggressive cleaning agents. Use lint-free cleaning cloths. Do not use any flammable liquids to clean the diesel engine.

Sealing material (e.g. o-rings, seals, etc.) must always be replaced.

Removed parts should always be checked for their reusability and replaced, if necessary.

If no specific torques or tensioning instructions are specified, screwed assemblies are to be tightened according to the standard torques; these are included in the chapter “Appendix”.

Spare parts

Only original LIEBHERR parts or spare parts purchased from LIEBHERR may be used for the repair of LIEBHERR diesel engines.

LIEBHERR will cancel all possible obligations undertaken by LIEBHERR and/or its dealers, such as guarantee commitments, service agreements etc., without prior notice if parts other than original LIEBHERR parts or spare parts purchased from LIEBHERR are used for maintenance and repair.

All “part information” in these repair instructions, e.g. identification numbers, thread sizes, dimensions, etc., are only informational. Spare part orders may only be carried out by means of the spare parts catalog pertaining to the scope of delivery.

Lubricating and operating fluids

Only lubricating and operating fluids approved by LIEBHERR may be used for the operation of LIEBHERR diesel engines.

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LIEBHERR will cancel all possible obligations undertaken by LIEBHERR and/or its dealers, such as guarantee commitments, service agreements etc., without prior notice if lubricating and operating fluids other than those approved by LIEBHERR are used.

Usage instructions

Some images in these repair instructions may have details that differ from your diesel engine. The work concerned should then be performed analogously to the work description at hand.

Constructive measures, that are carried out on the diesel engine within the scope of further development, may result in changes, which may not yet be described in these repair instructions.

Further information can be obtained via the Liebherr customer service department or customer service training center. The repair instructions are not subject to an updating service. Depending on the technical requirements, the repair instructions are revised and published in the current version.

The service information released by Liebherr Machines Bulle serves as a supplement after the publication of the repair instructions.

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Graphic symbols in these instructions

Symbol	Meaning
	**Note** Identifies useful information and tips.
☐	**Prerequisite** Identifies conditions for the following action steps.
▶	**Call to action** Identifies action steps.
▷	**Result** Identifies results of one or more action steps.
–	**Itemization** Identifies individual points of a list.

Graphic symbols

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Changes, conditions, copyright

This document is subject to change in the interest of technical progress.

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1 Product description

1.1 Technical description

1.1.1 Engine components

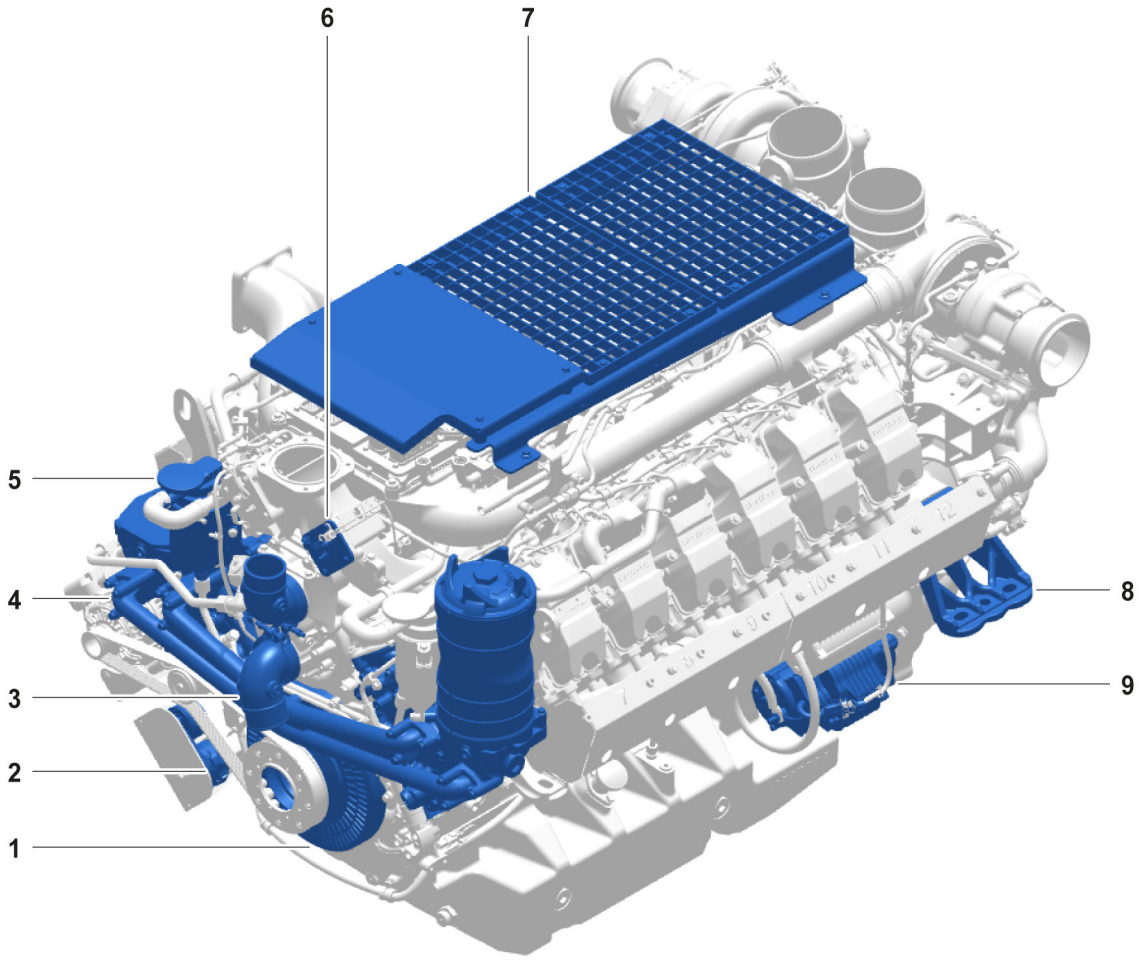

Fig. 1: Overview of ancillary support housing side

1 Torsional vibration damper
2 Tension pulley (self-tensioning)
3 Water line connection (2x)
4 Oil module
5 Crankcase ventilation (2x)
6 Heating flange (2x)
7 Cover plate
8 Engine base (4x)
9 Starter motor (2x)

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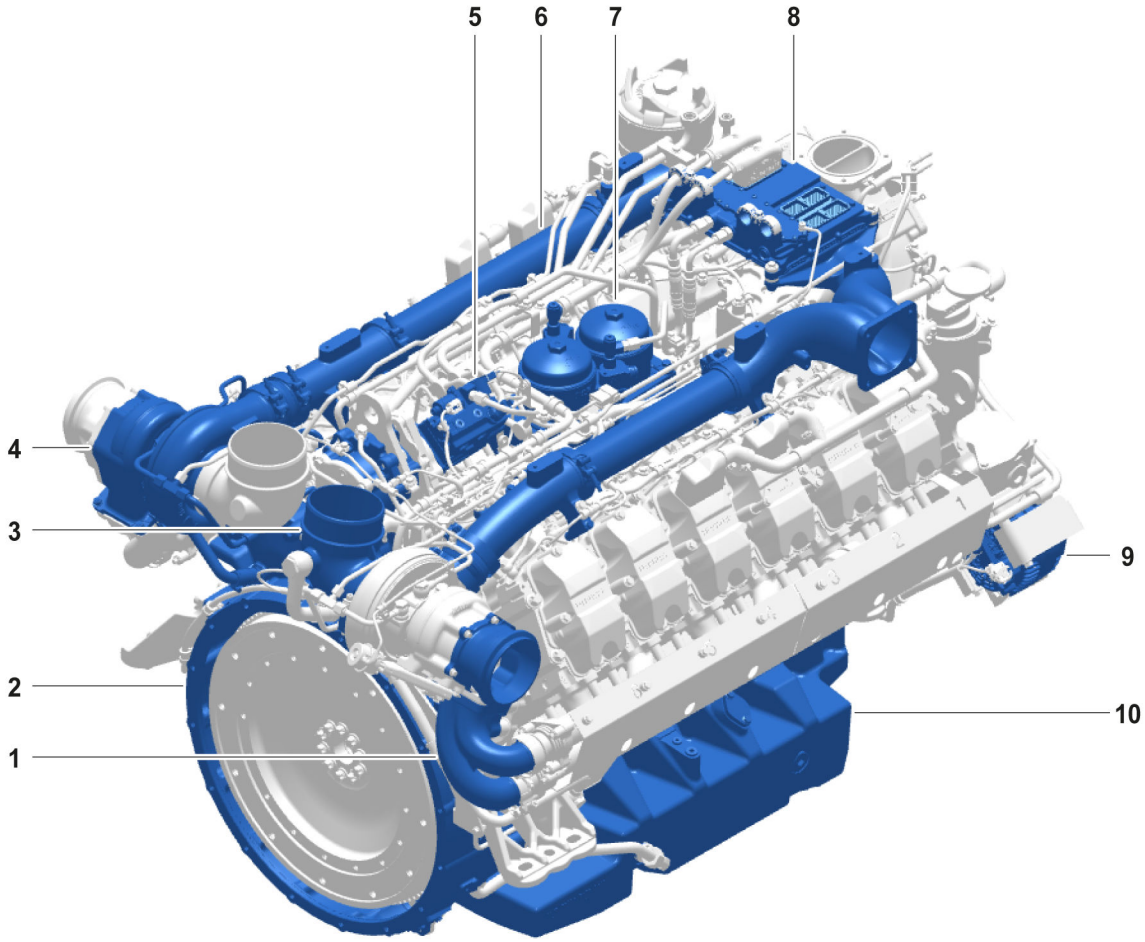

Fig. 2: Overview of flywheel side

1 Exhaust gas stub (2x)
2 Flywheel housing
3 Intake manifold (2x)
4 Exhaust gas turbocharger (2x)
5 Fuel high pressure pump (2x)
6 Charge air pipe
7 Fuel fine filter
8 Engine control unit
9 Alternator
10 Oil pan

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1.1.2 Exhaust aftertreatment system SCRonly

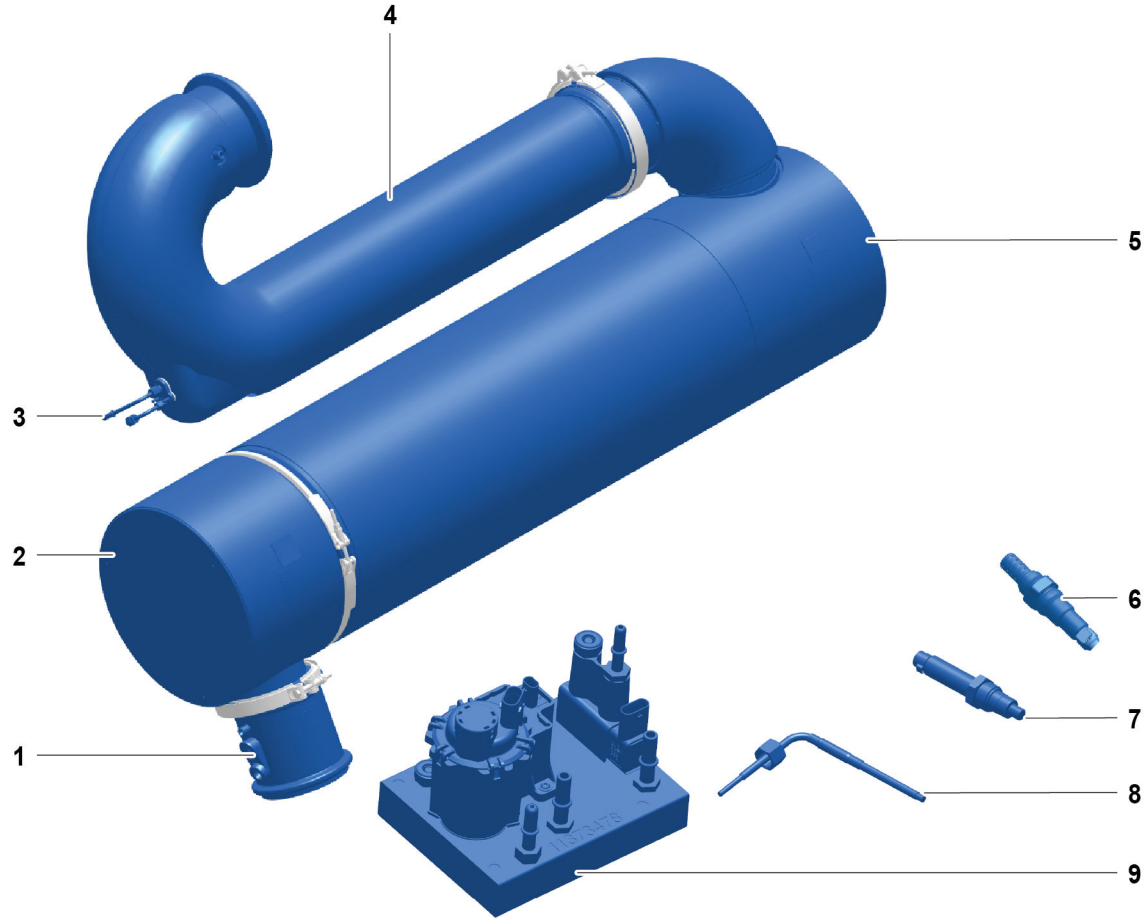

Fig. 3: Exhaust system

1 Sensor pipe
2 Outlet module
3 Reduction agent injector
4 Mixing pipe
5 SCR inlet module
6 SCR NH_3 sensor (optional)
7 NO_x sensor
8 Temperature sensor
9 Reduction agent pump

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1.1.3 Reduction agent pump

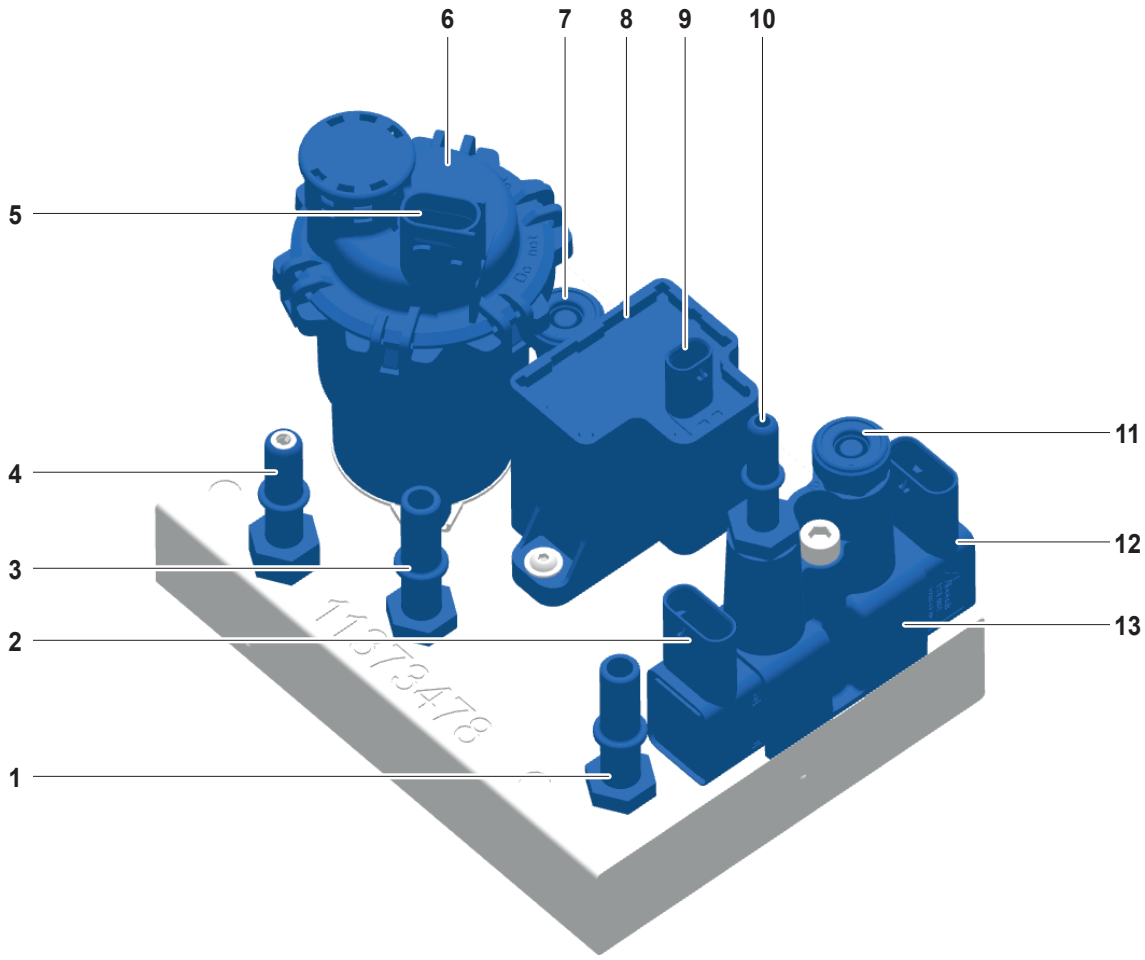

Fig. 4: Reduction agent pump

1 Coolant outlet
2 Reduction agent pressure & temperature sensor
3 Coolant inlet
4 Reduction agent inlet
5 Electrical connection for reduction agent pump module
6 Reduction agent pump module
7 Air inlet
8 Switchover valve
9 Electrical connection for switchover valve
10 Reduction agent outlet
11 Air outlet
12 Compressed air sensor
13 Sensor block

1.1.4 Engine type itemization

					Description
D	**95**	**12**	**A7**	**-04**	**Engine type**
D					Engine type: D = diesel engine
	95				Family (l/cylinder): 95: 2 l/cylinder
		12			Number of cylinders

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					Description
D	95	12	A7	-04	Engine type
			A7		Injection system: A7 = Common Rail System
				-04	Type: Standard Emission standard: (EU) 2016/1628 Stage V / Tier 4 Exhaust aftertreatment system: SCRonly (Selective Catalytic Reduction)

Tab. 1: Engine type itemization

1.1.5 Firing order

Firing order
1 - 12 - 2 - 11 - 3 - 10 - 6 - 7 - 5 - 8 - 4 - 9

Tab. 2: Firing order

1.1.6 Cylinder designation

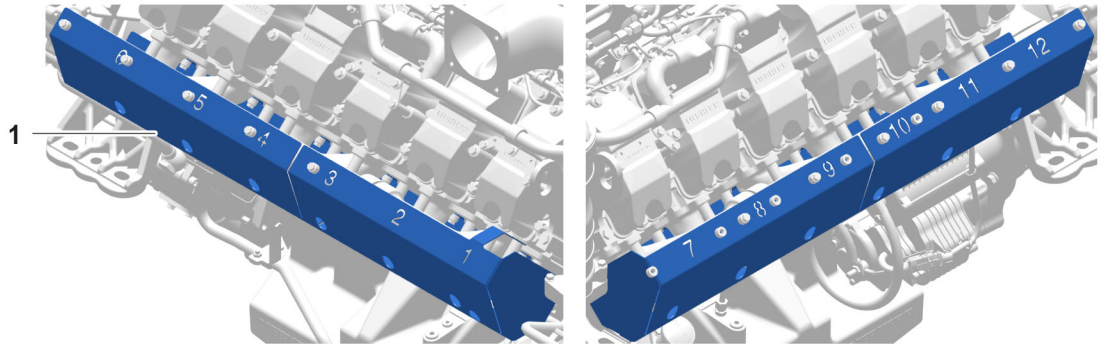

Fig. 5: Cylinder designation

1 Thermal insulation plate (4x)

Cylinder designation is on thermal insulation plates **1**.

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1.1.7 Direction of rotation

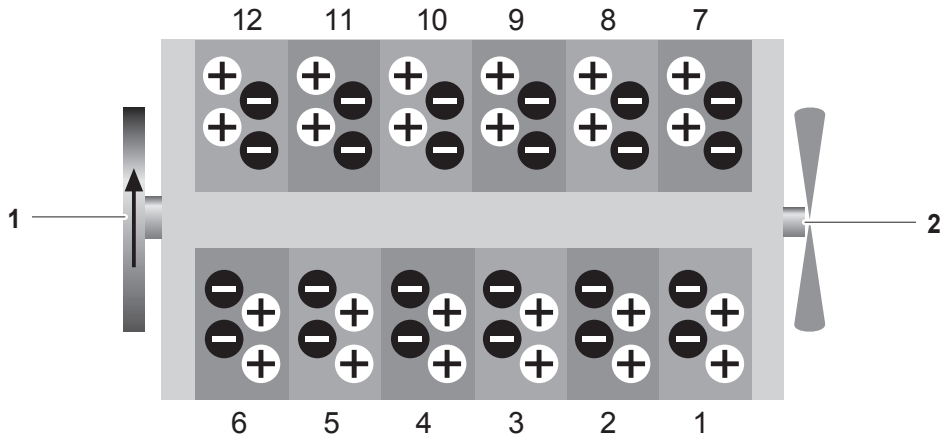

Fig. 6: Cylinder designation and direction of rotation

1 Flywheel side

2 Ancillary support housing side

⊖ = Outlet valve

⊕ = Inlet valve

Cylinder 1 is located on the ancillary support housing side **2**.

Viewed from the flywheel **1**, the crankshaft turns counterclockwise.

1.1.8 Company nameplate

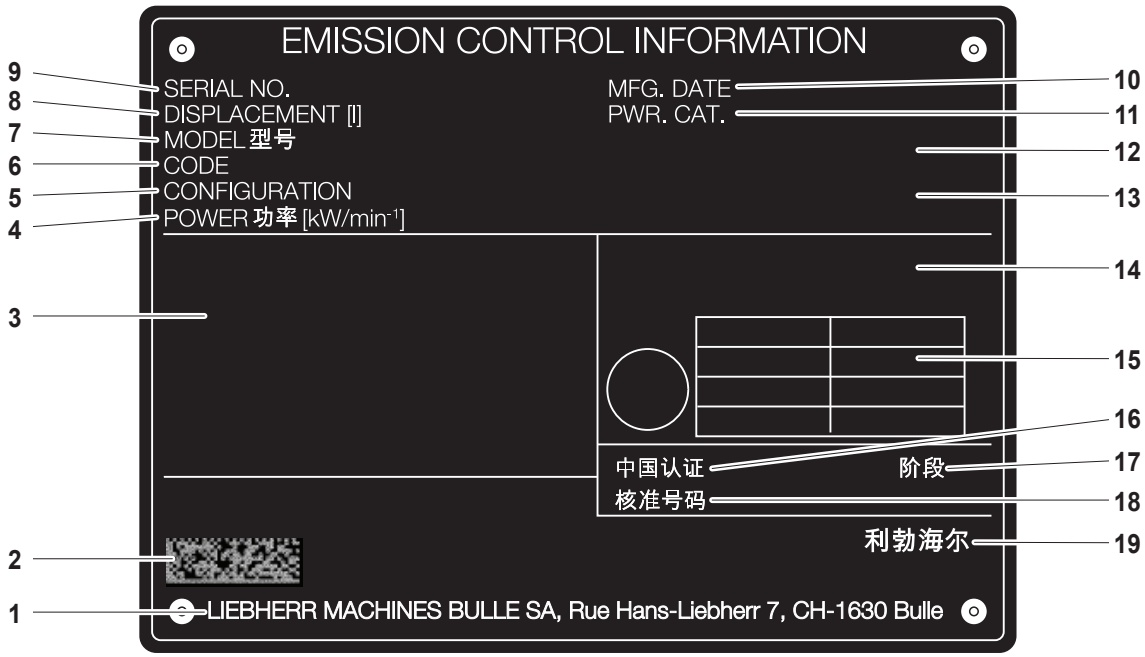

Fig. 7: Company nameplate

1 Manufacturer
2 Data matrix code
3 US type approval information
11 US performance category
12 EU exemption
13 Minimum requirements for fuel

See next page for continuation of the image legend

4 Engine power at rated speed
5 Identification number
6 Engine variant (Liebherr internal type)
7 Engine type
8 Capacity
9 Engine serial number
10 Date of manufacture
14 EU type approval information
15 ECE type approval information
16 Chinese engine family
17 Chinese emission limit stage
18 Chinese type approval number
19 Liebherr

Attachment point

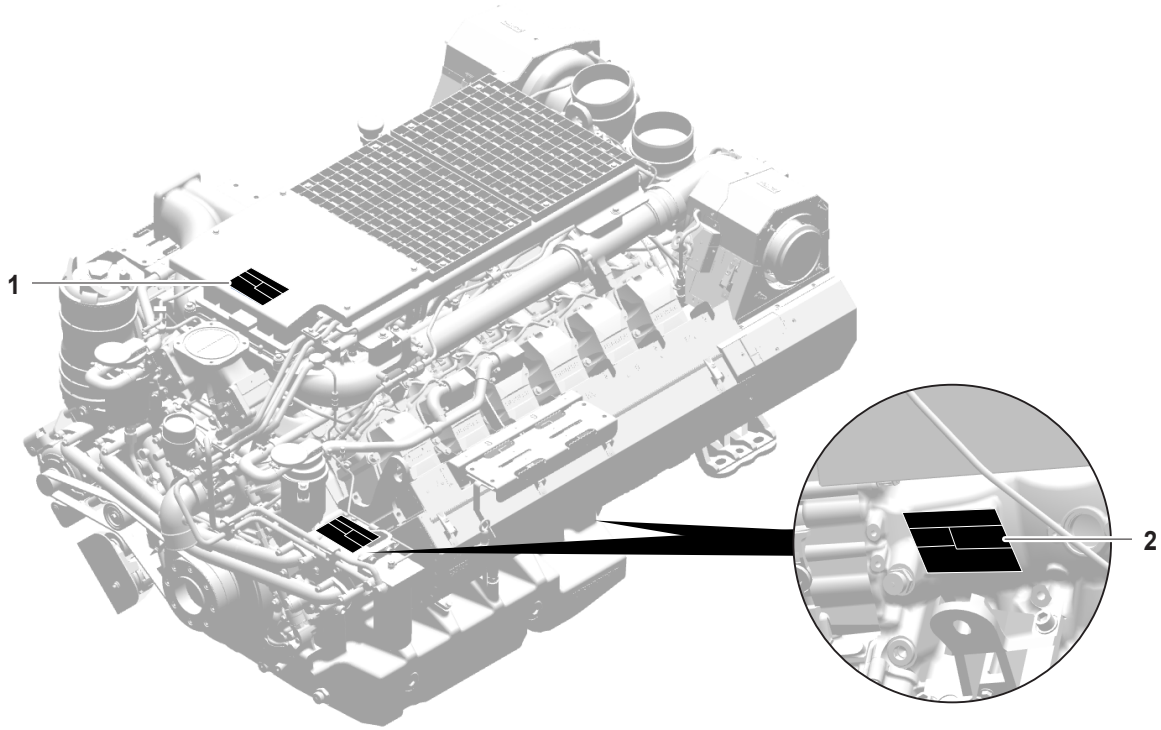

Fig. 8: Company nameplate on the engine (2 pieces: On the crankcase and cover plate or oil filter module)

1 Company nameplate on the cover plate
2 Company nameplate on the crankcase or oil filter module

Itemization of engine serial numbers

The engine serial number is engraved on the company nameplate in the field SERIAL NO..

2019	16	0001	Engine serial number
2019			Year of manufacture
	16		Type series: 16 = D9512
		0001	Sequential production number

Tab. 3: Engine serial number

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1.1.9 Engine control unit type plate

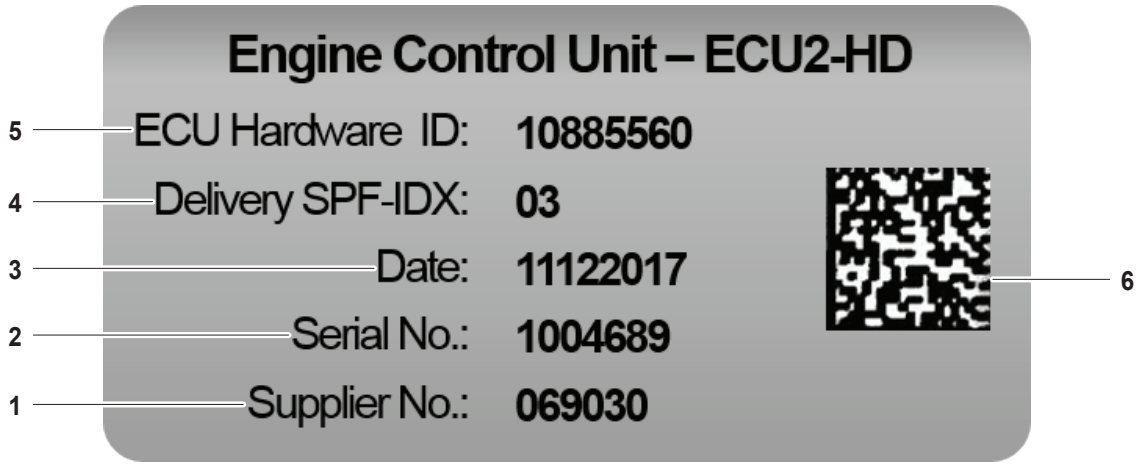

Fig. 9: Engine control unit type plate (example)

1 Supplier number
2 Control unit serial number
3 Creation date
4 Software version at delivery
5 Control unit identification number
6 2D bar code

Attachment point

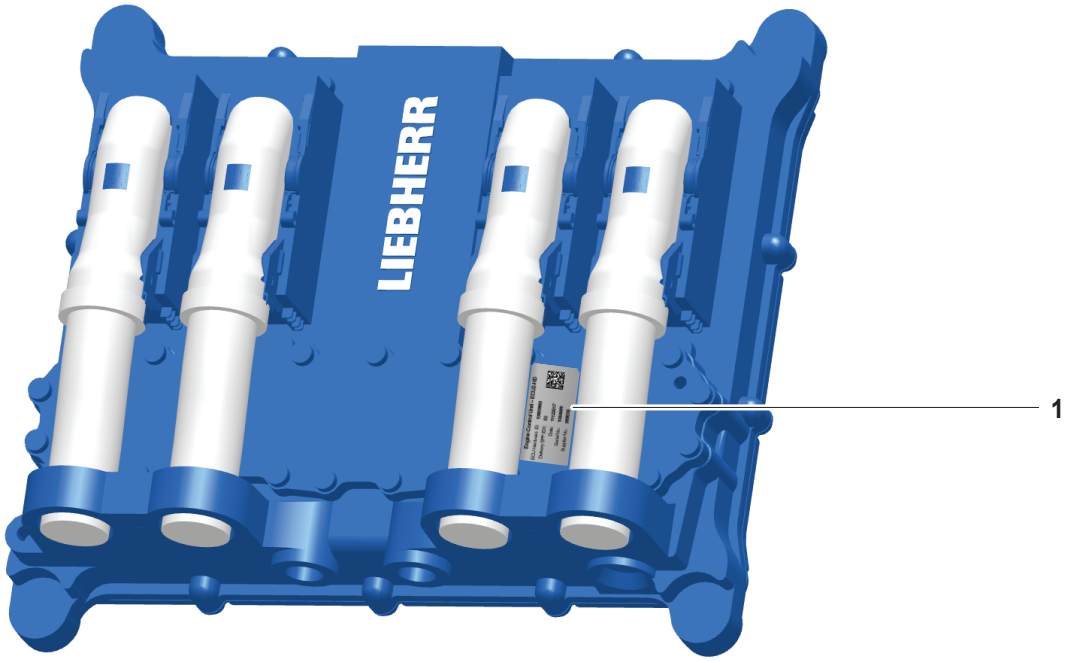

Fig. 10: Type plate on engine control unit

1 Type plate on engine control unit

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1.1.10 Exhaust aftertreatment system type plate

Type plate

Fig. 11: Sample type plate

1 DMC code
2 Identification number
3 Serial number
4 Supplier part number
5 Date of manufacture

Fig. 12: Sample type plate for spacer

1 Identification number

Mixing pipe and sensor pipe

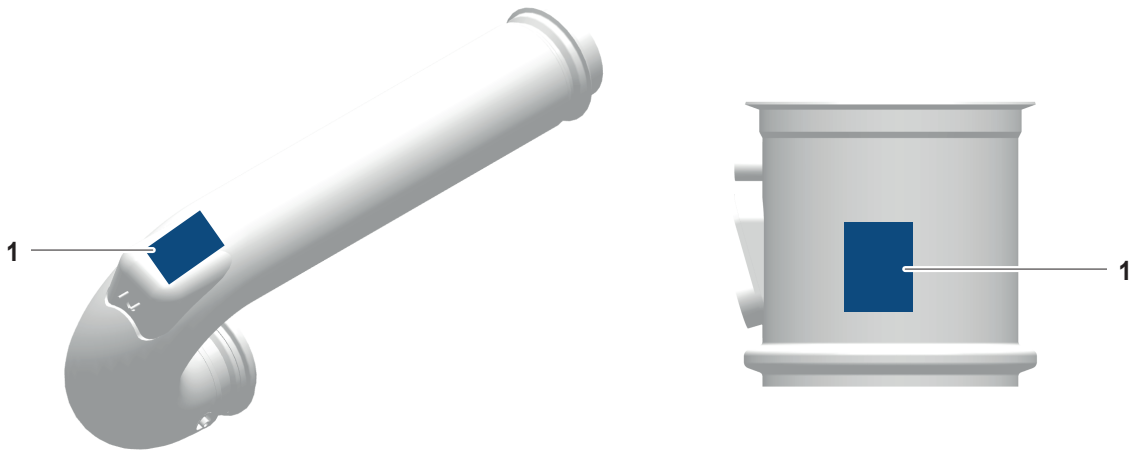

Fig. 13: Type plate on mixing pipe and sensor pipe

1 Type plate for individual components

Exhaust aftertreatment system SCRonly

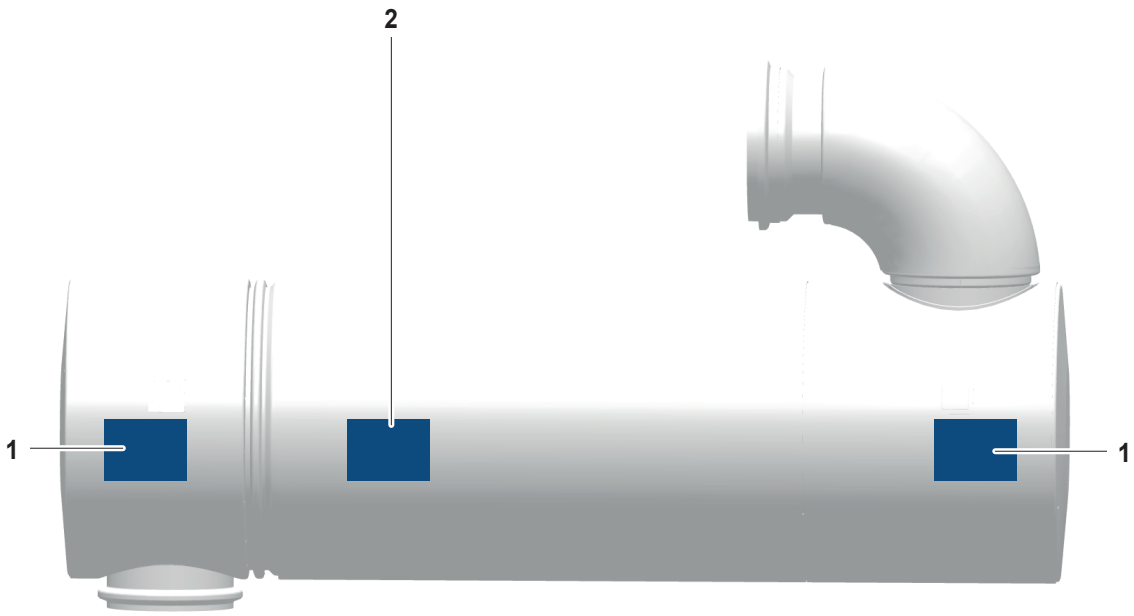

Fig. 14: Type plate on inlet module and outlet module

1 Type plate for individual components **2** Type plate for complete system

1.1.11 Exhaust gas turbocharger type plate

Fig. 15: Placement of the exhaust gas turbocharger type plate

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1.1.12 Injector code

Fig. 16: Placement of the injector code

Itemization of serial numbers			
11	20	000001	Description
11			Year of manufacture: 2011
	20		Part code for injector
		000001	Sequential production number

Tab. 4: Example of a serial number

1.1.13 High pressure pump type plate

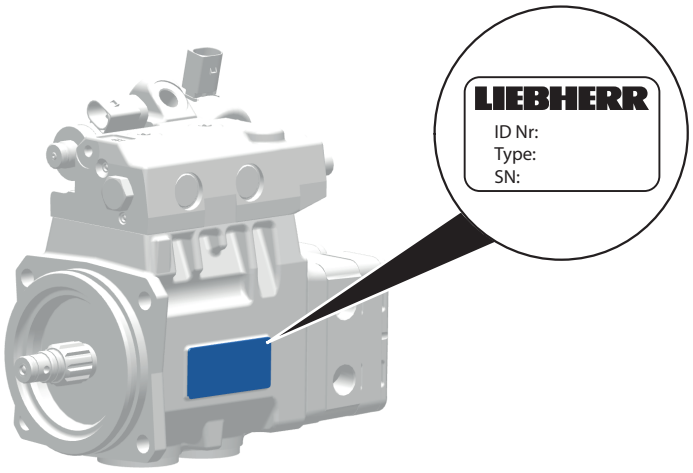

Fig. 17: Placement of the high pressure pump type plate

Itemization of serial numbers			
11	20	000001	Description
11			Year of manufacture: 2011
	10		Part code for high pressure pump
		000001	Sequential production number

Tab. 5: Example of a serial number

1.2 Technical data

1.2.1 Cylinder liner projection

Description	Unit	Value
Cylinder liner projection	mm	0.070 $^{+0.030/\ -0.045}$

1.2.2 Valve clearance

Description	Unit	Value
Valve clearance, inlet, cold	mm	0.5
Valve clearance, outlet, cold	mm	0.6

1.2.3 Piston ring end gap

Description	Unit	Value
KBA ring (double trapezoidal ring)	mm	0.35 $^{+0.10}$
M ring (minute ring)	mm	1.10 $^{+0.20}$
DSF ring (beveled hose spring ring)	mm	0.25 $^{+0.25}$

1.2.4 Thermostat

Fig. 18: Thermostat

Thermostat	Value
Opening temperature	82 $^{\pm 1.5}$ °C
Stroke at the start of opening	0.1 mm
Temperature at full opening	92 °C

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Thermostat	Value
Stroke at full opening	9.5 mm
Maximum permissible temperature	125 °C

Tab. 6: Technical data

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1.3 Functional description

1.3.1 Fuel system

Fuel diagram

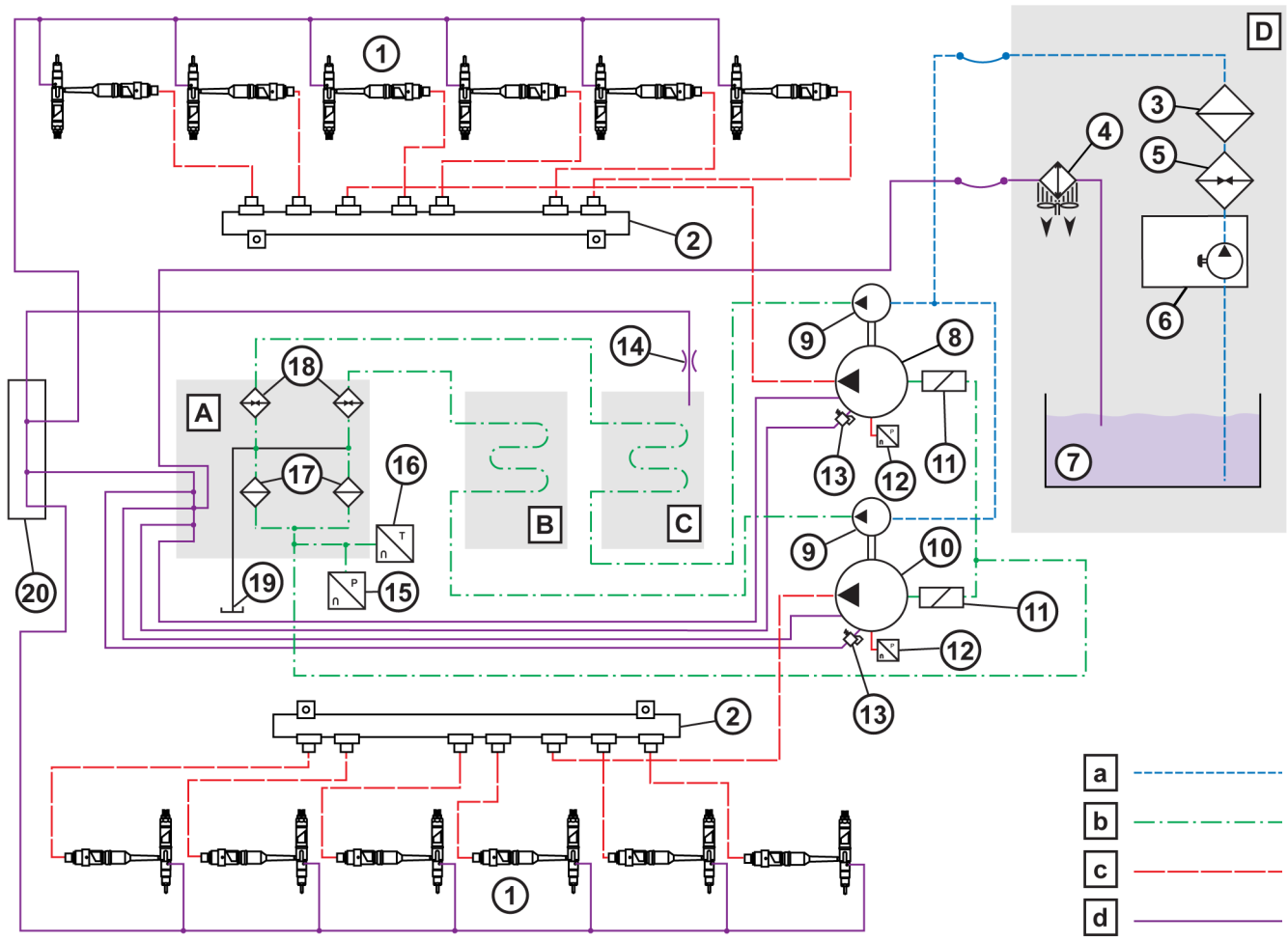

Fig. 19: Fuel diagram 10152283_000

A	Fuel fine filter	**3**	Fuel prefilter	**13**	Pressure control valve (PCV)
B	Top engine control unit	**4**	Fuel air cooler (optional)	**14**	Throttle
C	Bottom engine control unit	**5**	Water separator	**15**	Fuel pressure sensor
D	Device side	**6**	Manual ventilation pump	**16**	Fuel temperature sensor
a	Suction pressure	**7**	Fuel tank	**17**	Filter insert
b	Low pressure	**8**	Bottom fuel high pressure pump	**18**	Fuel heating system (optional)
c	High pressure	**9**	Fuel prefeeding pump	**19**	Emptying
d	Return and continuous ventilation	**10**	Top fuel high pressure pump	**20**	Fuel collecting block leakage
1	Injectors	**11**	Volume control valve (VCV)		
2	Fuel rail	**12**	High pressure sensor		

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1.3.2 Lubrication system

Engine oil diagram

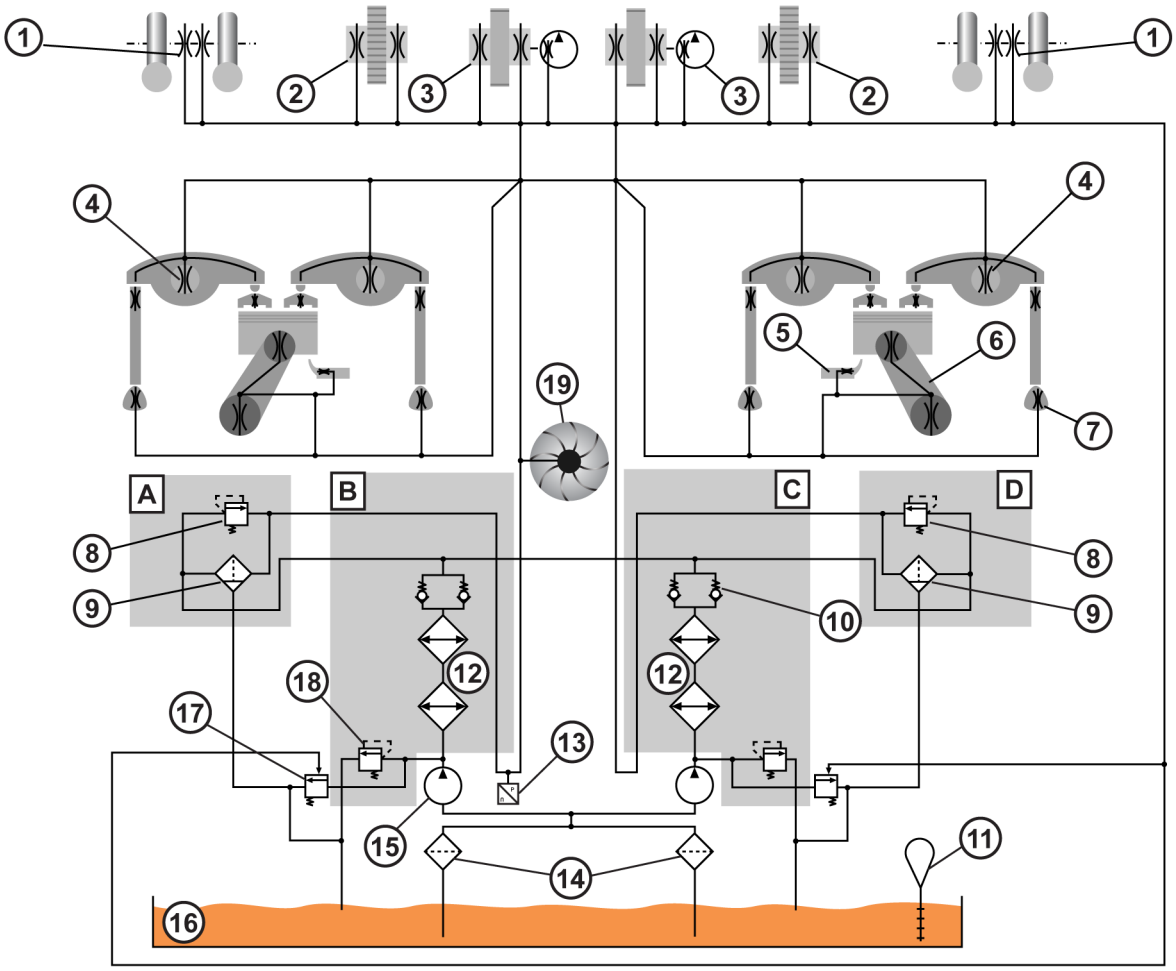

Fig. 20: Engine oil diagram 10123991-000

A Right oil module (optional)
B Right oil filter module
C Left oil filter module
D Left oil module (optional)
1 Exhaust gas turbocharger
2 Power take off drive
3 Fuel high pressure pump
4 Rocker arm bracket
5 Piston cooling nozzle
6 Connecting rod
7 Camshaft bearing
8 Filter bypass valve
9 Oil filter
10 Non-return valve
11 Oil dipstick
12 Oil cooler
13 Oil pressure sensor
14 Sieve insert (double or single)
15 Oil pump
16 Oil pan
17 End control valve
18 Pressure limiting valve (cold start)
19 Coolant pump

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1.3.3 Cooling system

Coolant system

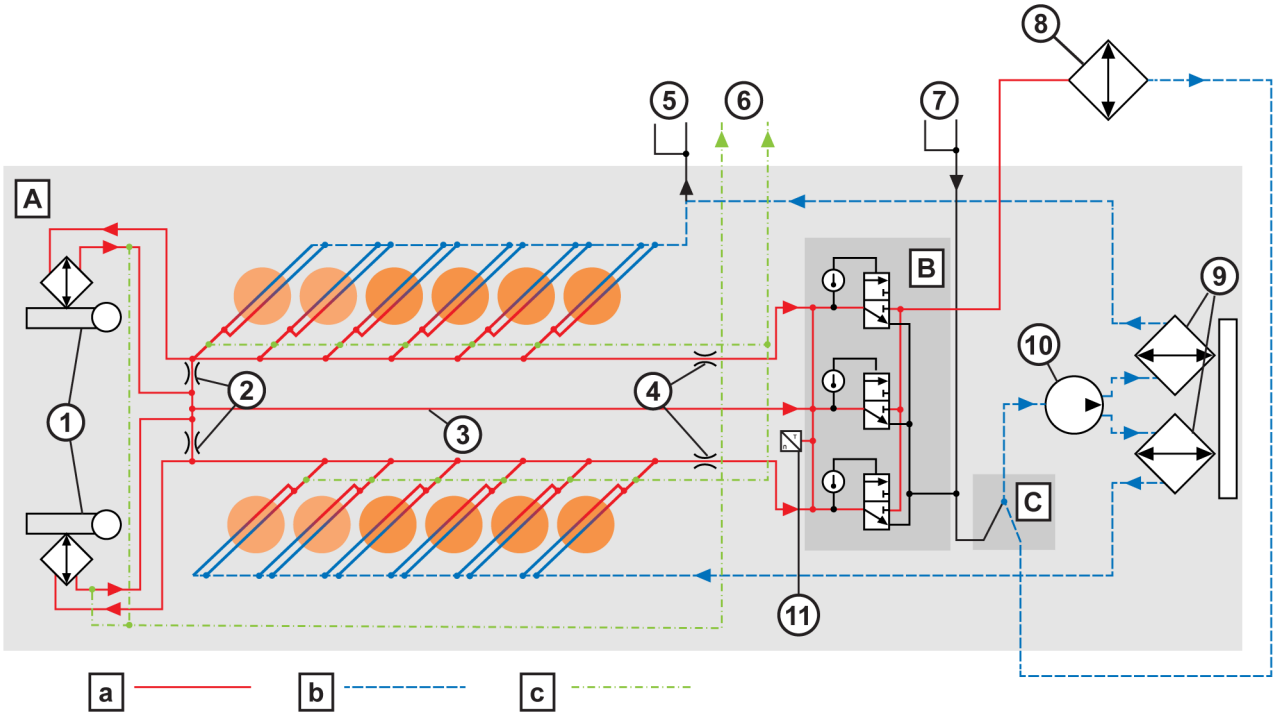

Fig. 21: Coolant diagram

A	Engine	**1**	Exhaust gas turbocharger	**7**	Return from auxiliary consumers
B	Thermostat housing with three thermostats	**2**	Cross section constriction (throttling)	**8**	Cooler
C	Coolant manifold	**3**	Central water recirculation	**9**	Oil cooler
a	Coolant, heated	**4**	Screen	**10**	Coolant pump
b	Coolant, cooled	**5**	Auxiliary consumer supply	**11**	Temperature sensor
c	Ventilation	**6**	Ventilation		

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1.3.4 Charge air system

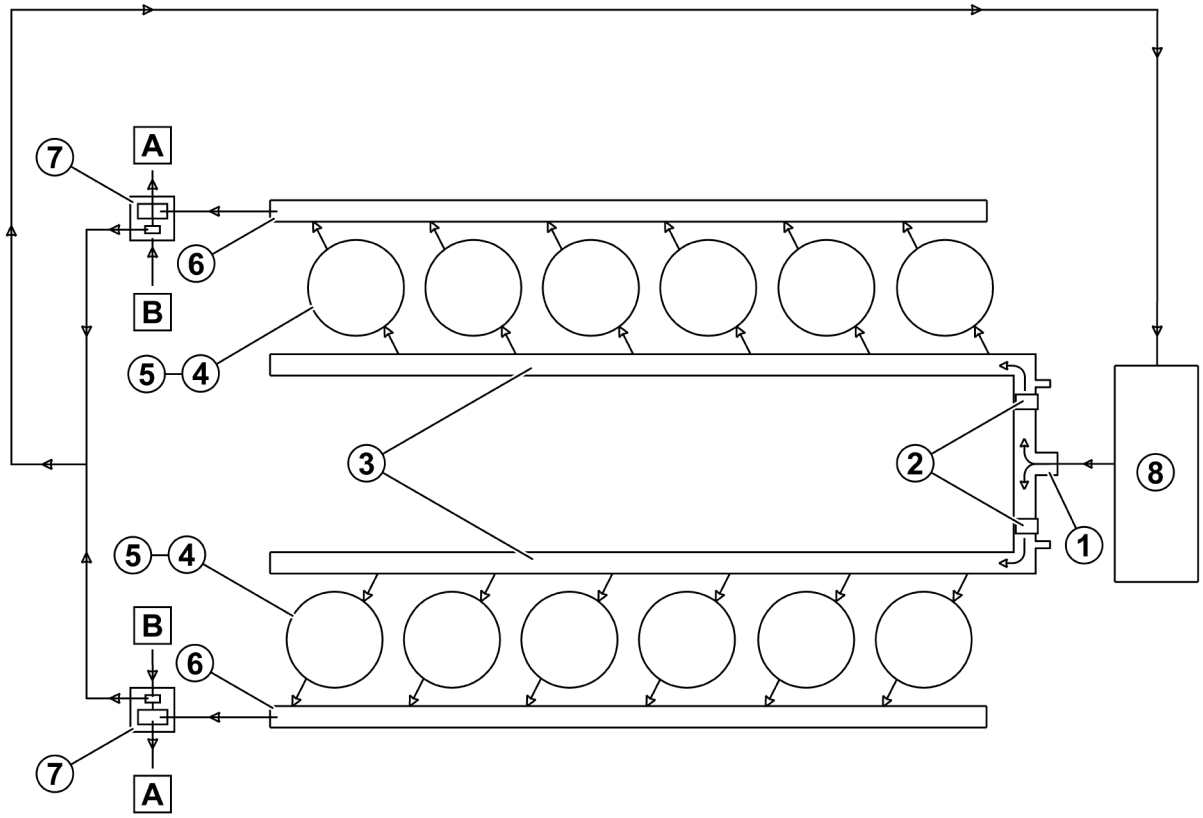

Fig. 22: Charge air diagram

A Exhaust outlet
B Air inlet
1 Connection line
2 Heating flange
3 Air intake manifold
4 Cylinder head
5 Cylinder
6 Exhaust pipe
7 Exhaust gas turbocharger
8 Charge air cooler

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1.3.5 Assignment of the channels in the crankcase and in the cylinder head

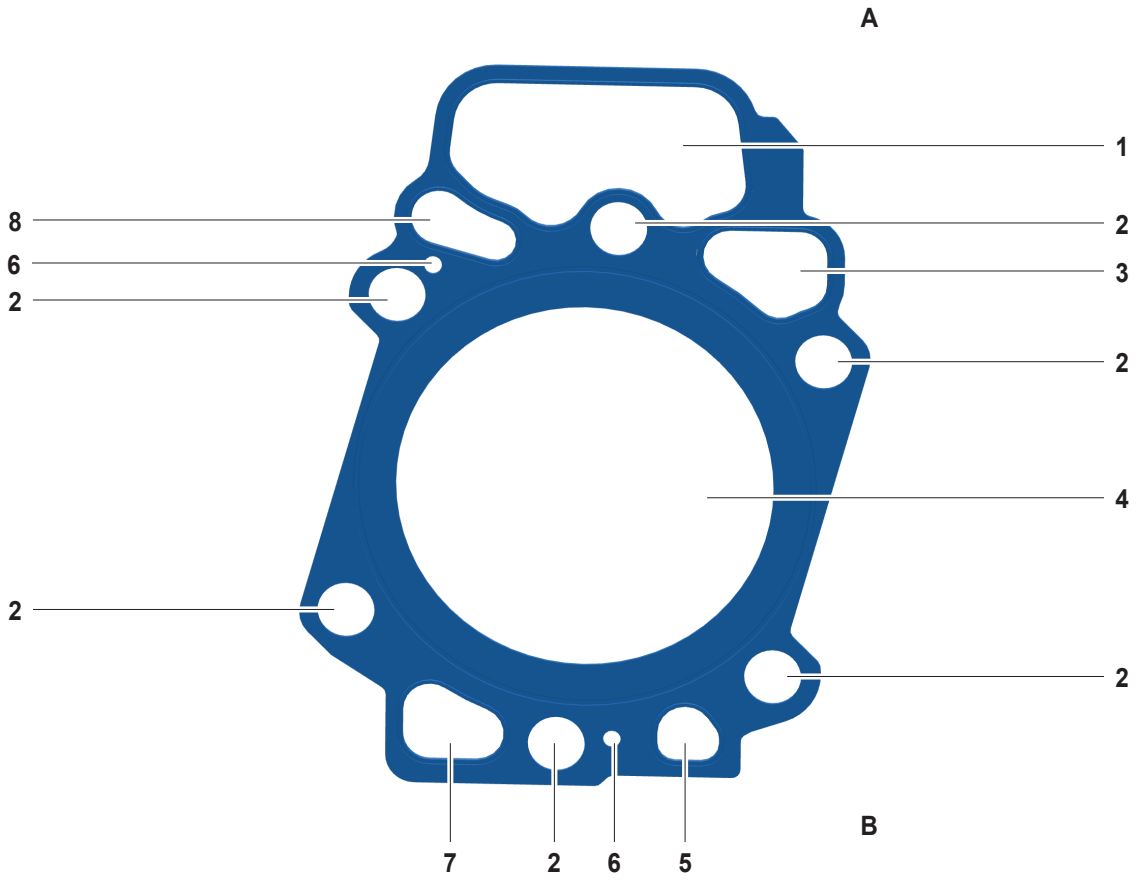

Fig. 23: Assignment of the channels

A Intake side
B Exhaust side
1 Push rod
2 Cylinder head screw
3 Coolant return
4 Combustion chamber
5 Oil return
6 Parallel pin
7 Coolant supply
8 Oil supply

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1.3.6 Exhaust aftertreatment system SCRonly

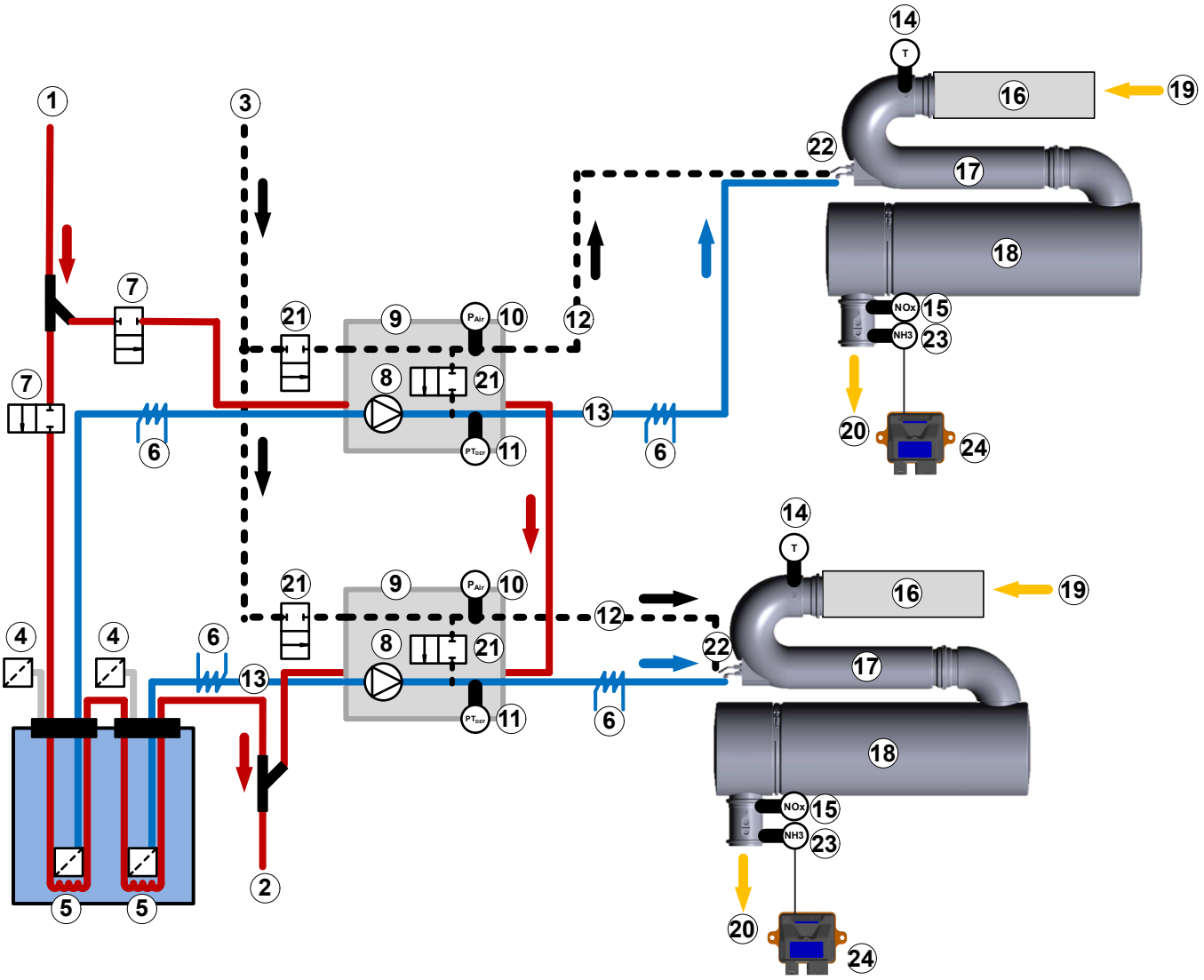

Fig. 24: Exhaust aftertreatment system

1	Coolant supply	**9**	Reduction agent dosing system	**17**	Mixing pipe
2	Coolant return	**10**	Air pressure sensor	**18**	Inlet module
3	Compressed air	**11**	Reduction agent pressure and temperature sensor	**19**	Exhaust inlet (device side)
4	Ventilation	**12**	Air line	**20**	Exhaust outlet
5	Reduction agent suction module	**13**	Reduction agent line	**21**	Air switch over valve
6	Reduction agent line heater	**14**	SCR temperature sensor	**22**	Reduction agent injector
7	Coolant control valve	**15**	NO_x sensor	**23**	SCR NH_3 sensor (optional)
8	Reduction agent pump	**16**	Engine exhaust pipe	**24**	Control unit SCR NH_3 sensor (optional)

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1.3.7 Reduction agent pump

Functional diagram

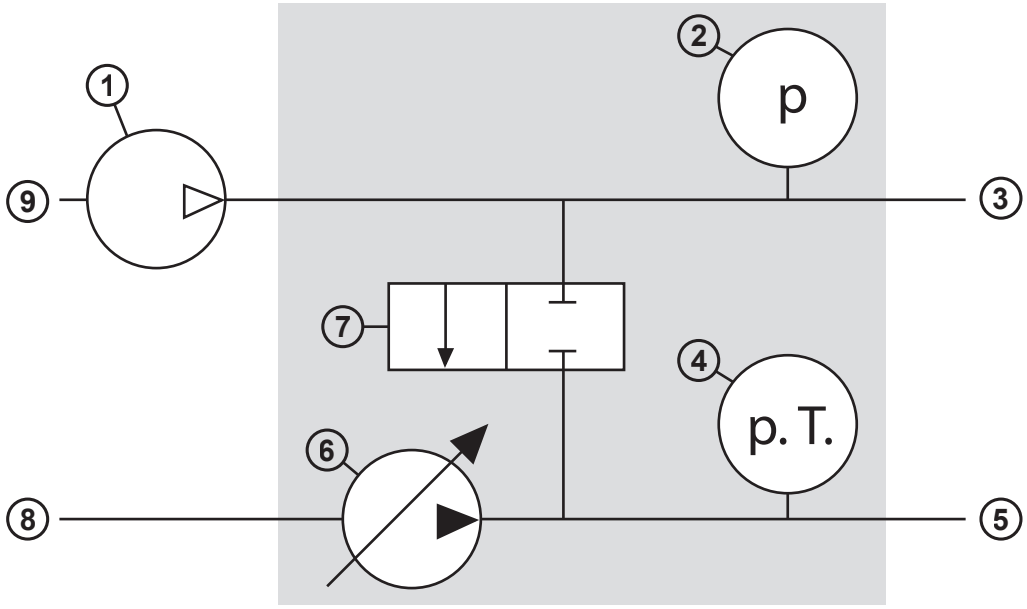

Fig. 25: Reduction agent pump functional diagram

1 Air supply system
2 Compressed air sensor
3 Compressed air line to reduction agent injector
4 Reduction agent pressure & temperature sensor
5 Reduction agent line to reduction agent injector
6 Reduction agent pump module
7 Switchover valve
8 Reduction agent line from reduction agent tank
9 Air inlet connection

Reduction agent pump function

The operating pressure of the air pressure sensor in phase 8 is between 300 mbar and 1500 mbar:
– If the air pressure is lower than 300 mbar: Compressed air fault, check lines for leaks.
– If the air pressure is higher than 1500 mbar: Check reduction agent injector for blockages and deposits.

The operating pressure for the reduction agent pressure sensor is between 0 mbar and 2000 mbar:
– If the reduction agent pressure is higher than 2000 mbar: Check reduction agent injector for blockages and deposits.

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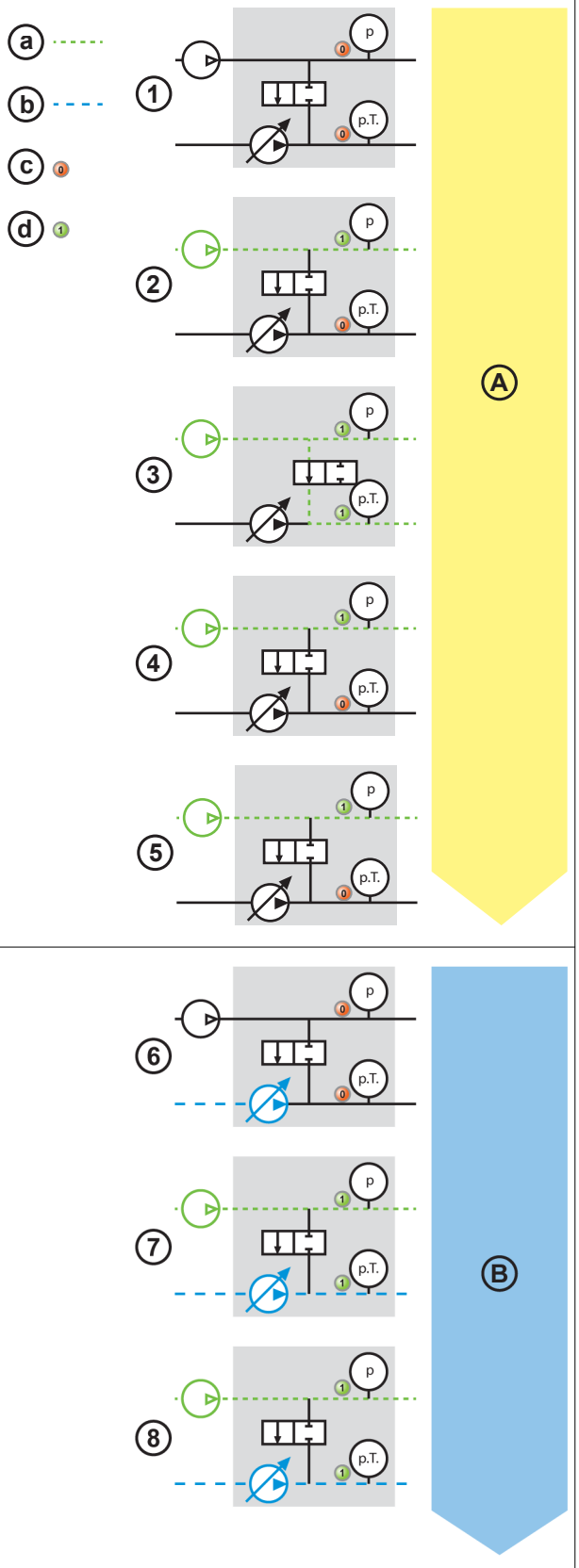
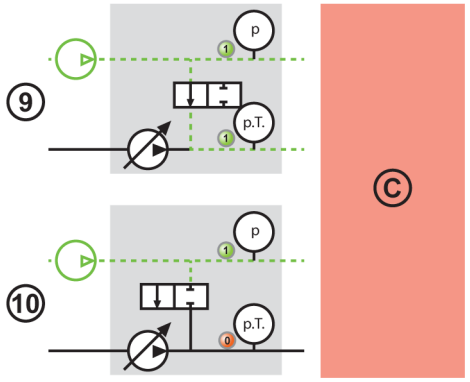
A	Ignition on
a	Compressed air
b	Reduction agent
c	Sensor reports no pressure.
d	Sensor reports pressure.
1	**Sensor check / check of the sensors** System checks if the pressure sensors report back a plausible actual value.
2	**System check 1 / check of the compressor** Air pressure is built up until pressure sensor (p) reports back an air pressure.
3	**System check 2 / check of the switchover valve** Switchover valve is actuated. It is necessary that both pressure sensors report back an air pressure.
4	**System check 3 / check if switchover valve closes.** Switchover valve closes. It is necessary that the pressure on sensor (p.T.) drops.
5	**Wait phase / wait after system check 3.** If the SCR temperature is too low to fill the reduction agent line, the system will not activate the air supply until the engine is running.
B	Engine running and SCR at operating temperature
6	**Reduction agent line filling 1 / filling of the suction side reduction agent pump** Intake of reduction agent until reduction agent pump has reduction agent.
7	**Reduction agent line filling 2 / filling of the pressure side reduction agent pump** Air supply is active. The reduction agent pump is activated until the reduction agent pressure sensor reports back pressure pulsations.
8	**Normal operation / reduction agent dosing active** Air supply is continuously active to maintain injection of the reduction agent. Reduction agent pump is activated according to the requested quantity.



C	Engine off
9	**Reduction agent line ventilation 1 / blowing the reduction agent out of the lines** System has an electrical power supply independent of the ignition starter switch. Switchover valve is first actuated intermittently and then continuously. Air supply is always switched on. Reduction agent residues in reduction agent line are blown out. Blowing out is slightly audible when the engine is at a standstill. It is possible that blowing out will take several minutes. Make sure that the electrical power supply (battery voltage) is not interrupted during the blowing out.
10	**Reduction agent line ventilation 2 / blowing the reduction agent out of the lines** Switchover valve closes. Air supply remains active for a few seconds to remove reduction agent residues on injector tip.



Tab. 7

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2 Safety

2.1 Labeling of warnings

	This is the warning sign. It warns of a potential risk of injury. Follow all measures that are indicated with this warning sign in order to prevent injuries or death.

Tab. 8

The warning sign always appears in connection with the signal words.

DANGER
WARNING
CAUTION

	**DANGER**	Identifies an immediately dangerous situation that will result in death or serious bodily injuries if it is not avoided.
	**WARNING**	Identifies a dangerous situation that could result in death or serious bodily injuries if it is not avoided.
	**CAUTION**	Identifies a dangerous situation that could result in minor or moderate bodily injuries if it is not avoided.
	ATTENTION	Identifies a dangerous situation that could result in property damage if it is not avoided.

Tab. 9

2.1.1 Additional labels

	**Note** Identifies useful information and tips.

Tab. 10

2.2 Target group

This repair manual is aimed at technicians and workshop personnel.

All other persons, including operators, supervisors and trainees, are classified as “unauthorized personnel” for repair and maintenance tasks.

Unauthorized personnel is prohibited from maintaining or repairing the engine or accessing the engine compartment or engine cowling.

2.3 Intended use

Do not continuously operate the engine in a load range that would be assigned to another power category with lower emission limit values.

Do not continuously operate the engine in the machine outside of the test range (NTE range) for the corresponding engine category.

– Use the engine for the intended purpose.
– Observe the following conditions from the manufacturer:
  • Operating conditions
  • Servicing conditions
  • Maintenance conditions
– Make sure that the following work is only carried out by personnel in accordance with the target audience definition:
  • Using the diesel engine.
  • Servicing the diesel engine.
  • Maintaining the diesel engine.

(For more information see: 2.2 Target group, page 42.)

– Install contactors and protective devices prior to commissioning and ensure their function.
– Pay attention to the safety and operating instructions.
– Only operate the engine if it is in perfect working order.
– Operate the engine in the speed range prescribed by the manufacturer.
– Bolt the engine to the machine or the corresponding place of use by the fitted engine mounts and the corresponding tensioning instructions.
– Have engine brackets that were not installed by the manufacturer approved by the manufacturer.
– Only operate the engine in areas that are not publicly accessible.
– Only operate the engine with an enclosure or engine compartment cover.

2.4 Foreseeable misuse

The operating and maintenance manual has been drawn up in accordance with applicable standards and regulations in accordance with state-of-the-art technology.

Liebherr assumes no liability for:
– Failure to observe these instructions
– Incorrect use
– The employment of personnel who do not satisfy the target audience requirements.

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– Alterations and conversions of the diesel engine that have been carried out without the consent of Liebherr.
– Operating and auxiliary materials that have not been approved by Liebherr.
– The use of non- Liebherr spare parts that have not been officially approved by Liebherr, including the resulting consequential damages.
– Circumvention of and non-compliance with the safety regulations
– Failure to observe international and national regulations on occupational health and safety
– Failure to observe international and national regulations on environmental protection
– Unauthorized modifications to the diesel engine
– Manipulation to the injection system and control system
– Emergency operation with limited safety function is deemed improper use. The manufacturer is not liable for damages due to improper use.

EU type approval expires for:
– Manipulation to the diesel engine
– Manipulation to the injection system and control system
– Manipulation to the exhaust aftertreatment system

The actual scope of delivery of the engine can differ from the relevant information in these instructions due to situational adaptations to customer requirements.

2.5 General safety instructions

– Fulfill the requirements of the target groups for the work. (For more information see: 2.2 Target group, page 42.)
– In order to guarantee help in the event of an accident:
  • A second person is present.
  • Ensure that the emergency situation will be detected and help with take place.
– Ensure that the personnel is familiar with the operator's manual before installation work.
– Only allow the following personnel to work on the engine under the constant supervision and responsibility of a technician in accordance with the target group definition.
  • Personnel to be trained
  • Personnel to be taught
  • Personnel to be instructed
  • Personnel in apprenticeships
  (For more information see: 2.2 Target group, page 42.)
– Check the safety and hazard-conscious work of the personnel under the following conditions:
  • Observe the accident prevention regulations.
  • Observe the generally recognized safety and occupational health rules.
  • Observe the operator's manual.
– Make sure that the personnel wear the prescribed work clothing. (For more information see: 2.7 Personal protective equipment, page 46.)
– Do not wear the following:
  • Rings
  • Wristwatches
  • Neckties
  • Scarves
  • Open jackets
  • Loose-fitting clothing
– Make sure that the following equipment is available for the assembly, clean, complete and undamaged:
  • Basic tool kit
  • Required devices
  • Required special tools
– Replace damaged tools.

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- Keep the workplace clean and orderly.
- Make preparations for emergencies that could occur.
- Have a fire extinguisher and first aid kit ready.
- Have emergency telephone numbers ready.
- Make sure that the workplace has sufficient lighting.
- Perform installation work only when the engine is secured.
- Ensure that the engine is not started by unauthorized individuals.

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2.6 Preventing personal injuries

2.6.1 Bruises

- Do not lift heavy parts by hand.
- Fasten and secure individual parts and larger assemblies carefully with suitable lifting gear during their replacement.
- Use Liebherr lifting gear according to the operator's manual.
- Observe the regulations on the lifting points.
- Do not use any load handling devices that are damaged or that have an inadequate carrying capacity.
- Only use load handling attachments with sufficient load bearing capacity.
- Make sure that no persons stand or walk under loads.
- When the engine is running, objects can be flung back: Make sure that no objects come in contact with moving parts.

2.6.2 Burns and scalds

The diesel engine is hot at its operating temperature.
- Only work on the diesel engine after it has cooled down.
- Touch hot parts with thermal protection gloves for repair purposes.

Before work on the cooling system:
- Let the engine cool down
- Release the pressure in the cooling system on the device side.
- Avoid contact with parts carrying coolant.

The engine oil is hot when the diesel engine is at its operating temperature.
- Avoid any skin contact with hot oil or parts carrying oil.

2.6.3 Fires and explosions

- Smoking is prohibited in the immediate vicinity of the engine.
- Avoid fires, sparks and open flames when handling fuels and flammable liquids.
- Start the engine according to the provisions of the repair instructions and assembly instructions.
- Eliminate leaks and replace defective parts. Fuel and oil spurting out of leaky spots can lead to fires.
- When working on batteries: Wear safety goggles and protective gloves.
- Remove rags that are soaked with flammable liquids.
- When working on the electrical system: Disconnect the electrical power supply.

2.6.4 Poisoning

- Only allow the engine to run in closed rooms when there is sufficient ventilation.
- Never ingest operating fluids.
- Do not use beverage bottles to store operating fluids.

Escaping liquids can penetrate the skin and will lead to blood poisoning:
- Do not open any lines and hoses that are under pressure.
- Do not remove any lines and hoses that are under pressure.
- Protect hands, face and body against escaping liquids when searching for leaks on lines and hoses that are under pressure. (For more information see: 2.7 Personal protective equipment, page 46.)

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2.6.5 High-pressure injection (liquids at high pressure can squirt out)

When the Diesel engine is running the fuel lines are under a constant fuel pressure of up to 2400 bar. Escaping liquids can penetrate the skin and lead to injuries.

– Only work on the fuel and injection systems when the diesel engine has been switched off. Wait at least 20 minutes after turning the Diesel engine off until the pressure in the injection system has been released before starting work.
– Check the pressure reduction with the diagnostics software.
– Use suitable protective equipment during work on the fuel and injection system (e.g. safety gloves, safety goggles, etc.).
– Do not open any pressurized fuel lines or hoses.
– Do not disconnect any pressurized fuel lines or hoses.
– Protect hands, face and body against escaping liquids when looking for leaks in pressurized lines and hoses.

2.6.6 Electrical energy

– Persons with pacemakers have no access to the safety zones around the operational diesel engine.
– Do not touch any live parts.
– Before work on the electrical system, disconnect the electrical power supply and secure it against being switched back on.

2.6.7 Danger due to noise

Possible permanent hearing loss due to noise levels above 84dB(A). Sound levels up to 110dB possible!
– Keep all sound-insulating protective devices for the system closed when the engine is running.
– Only reside near the running engine with hearing protection matched to the noise level.
– Observe the hearing protection measures according to the repair instructions of the device manufacturer.

Access to the safety zones is prohibited for the operator and unauthorized personnel when the engine is ready for operation or in operation. However, if a technician must reside by the unprotected engine for troubleshooting, he must wear hearing protection which is designed for the noise exposure.

2.7 Personal protective equipment

– Wear protective equipment for direct access to engines.
– Make sure that:
  • Protective equipment is in good condition.
  • Protective function is guaranteed.

The following protective equipment is required to access the engine:

Protective work clothing
– Tight-fitting protective clothing that is not tear-resistant to protect against injuries and simple chemical substances

Wear protective work clothing in the immediate vicinity of the engine.

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Safety helmet
– Protection against
  • Falling or flying object
  • Bumping your head

Wear a safety helmet in the immediate vicinity of the engine.

Safety shoes
– Foot protection against
  • Falling objects
  • Pinching of the foot in heavy parts
  • Against slipping

Wear safety shoes in the immediate vicinity of the engine.

Safety gloves
– Protection against hot elements and chemicals

  Wear safety gloves when working with hot parts, for example,
  • shrinking the gear ring onto the flywheel.
  • Working with operating fluids (See manufacturer's specifications for the operating fluids and safety data sheet for the operating fluid.)

Safety goggles
– Protection against:
  • Flying fragments
  • Chemical splashes
– Wear safety goggles when:
  • Handling operating fluids (See manufacturer's specifications for the operating fluids and safety data sheet for the operating fluid.)
  • Wear during mechanical interventions, for example, using compressed air.

Hearing protection
– Protection against noise

Wear hearing protection around the diesel engine when it is running.

2.8 Operating areas and maintenance areas

2.8.1 Safety instructions

Trapping points and mechanical parts flying around when the engine is ready for operation or in operation

Serious injuries and risk of death:
– Keep away from the operational engine.
– Wear personal protective equipment.
– Technicians may reside in safety zone “A” for measurement purposes, if nothing else has been stated by the device manufacturer.

Hot parts when the engine is ready for operation or in operation.

Risk of burns:
– Keep away from the operational engine.
– Wear personal protective equipment.

– Let the engine cool down sufficiently.

High electric short-circuit currents during maintenance work

Risk of burns from electric shock:
– Access to safety zones in maintenance condition, according to target group definition
– Disconnect the electrical power supply.
– Wear personal protective equipment.

2.8.2 Operating areas

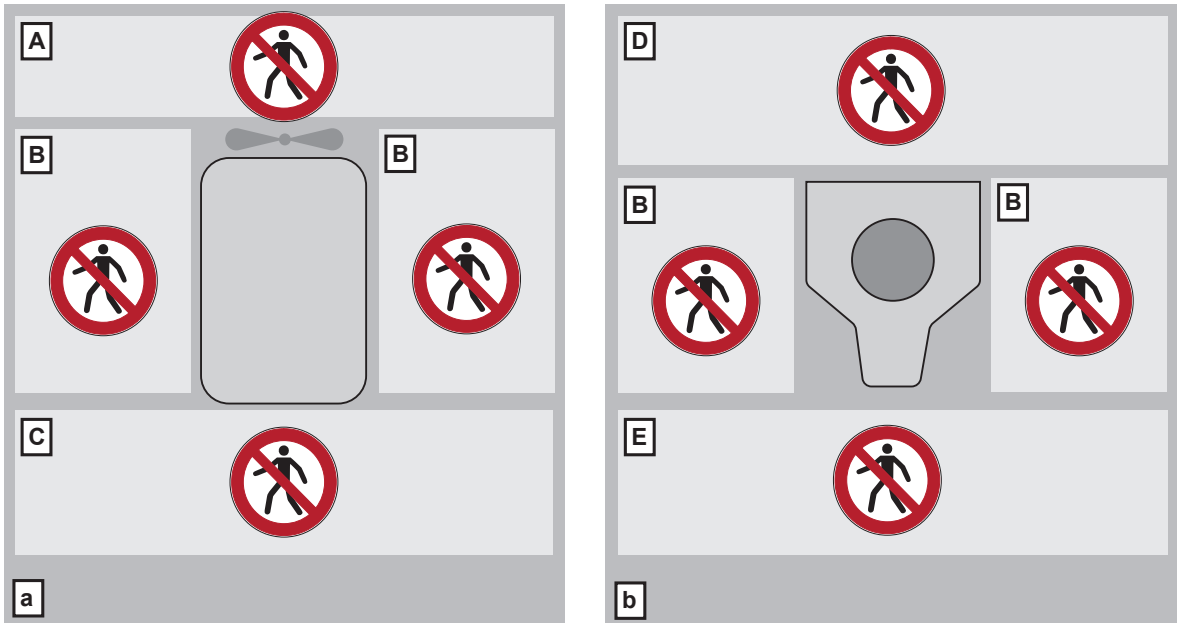

Fig. 40: Safety zones for the engine that is ready for operation or in operation

a Horizontal plan (view from above) **b** Vertical plan (view from flywheel side)

Do not enter the following zones:
– Safety zone for unit ancillary support housing side **A**
– Safety zone next to the engine **B**
– Safety zone for flywheel side **C**
– Safety zone above the engine **D**
– Safety zone below the engine **E**

2.8.3 Maintenance areas

Maintenance areas are the safety zones that are to be entered for maintenance work and trouble-shooting.

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

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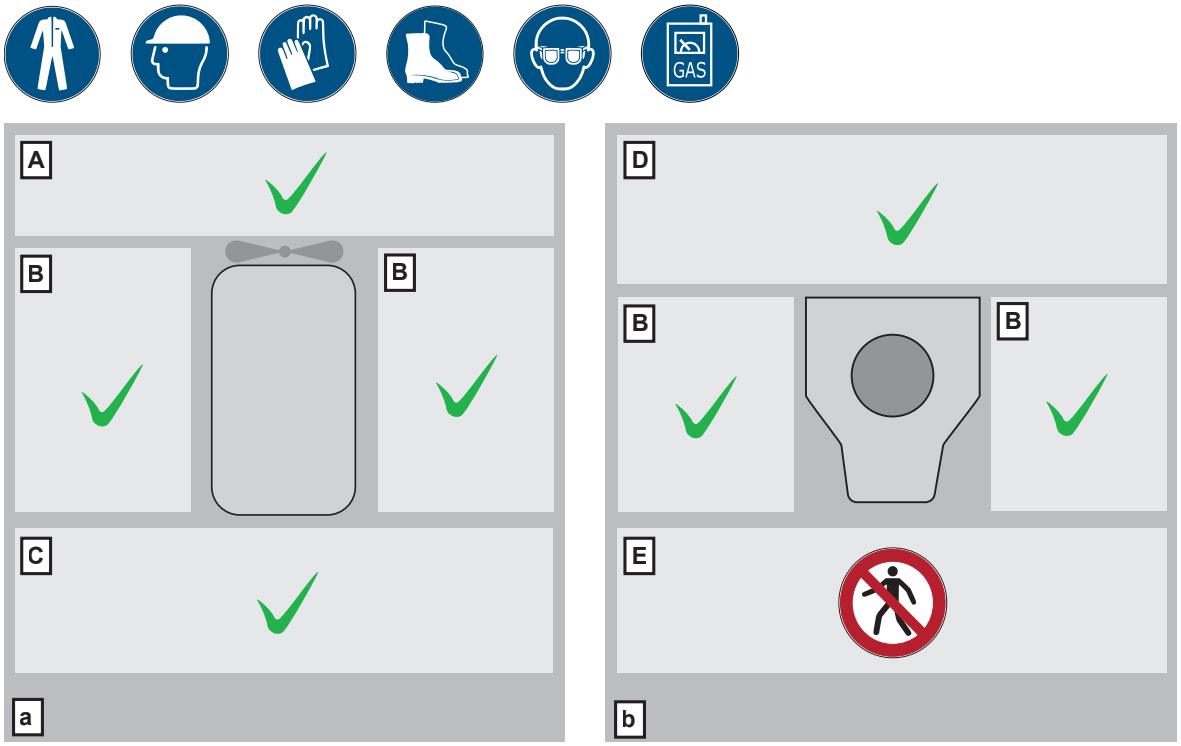

Fig. 41: Safety zones for maintenance and repairs

a Horizontal plan (view from above) **b** Vertical plan (view from flywheel side)

The following zones are accessible:
– Safety zone for unit ancillary support housing side **A**
– Safety zone next to the engine **B**
– Safety zone for flywheel side **C**
– Safety zone above the engine **D**

Do not enter the following zones:
– Safety zone below the engine **E**

2.8.4 Securing and releasing the diesel engine against accidental start-up

Access to the engine must be secured against unexpected start-up before entering the safety zones.

Procedure:

Secure the engine against unexpected start-up:
– Disconnect the diesel fuel supply.
– Label cut-off point.
– Disconnect electrical power supply and secure against reactivation.
– Label cut-off point.

Make the diesel engine ready for operation (release):
– The following work has been completed:
  • Installation activities
  • Maintenance activities
  • Repair activities
– Make sure that all foreign bodies have been removed.
– All of the protective devices are installed and are working properly.
– Make sure that no external persons stand or walk in the danger zones.
– The tags for the fuel supply are removed.

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– Fuel supply is connected.
– Remove the label from the electrical power supply.
– Establish the electrical power supply.

2.8.5 Emergency stop

An emergency stop is provided for hazardous situations that call for an immediate shutdown of the Diesel engine. The power supply to the Diesel engine is interrupted immediately. Only the engine control unit still receives current.

Examples of hazardous situations:
– Fire
– Persons having suffered an electric shock
– Diesel engine does not stop
– Diesel engine accelerates uncontrollably

Only use the emergency stop in emergencies. Triggering an emergency stop can cause permanent damage to the Diesel engine. The emergency stop may not be used to stop the Diesel engine for operational purposes.

2.9 Signage

Note

▶ The following required signs must be clearly visible and attached in the direct vicinity of the safety zones.

▶ The following required signs must be able to withstand the ambient conditions. The end user must ensure that these are kept visible and legible over the entire life cycle.

▶ Additional warnings or adaptations to product standards (ISO 8528-13) are possible.

ISO 7010 / W012 Warning against dangerous electrical voltage
– Only persons who are familiar with the risks of electricity may work within the identified area. Unauthorized persons may only enter the safety zone after the electrical power supply has been disconnected.

ISO 7010 / W017 Warning against hot surfaces
– The Diesel engine has hot surfaces that are not immediately recognizable as such.
Wait for a sufficient time until the engine has cooled down.
Only touch components that may be hot with suitable protective gloves.

ISO 7010 / W025 Warning of entanglement hazard
– There are potential trapping hazards on the engine in the area of the V-ribbed belts and alternator to charge the battery.
Attach a warning sign if traps are not secured through guards (optional).
Enter the safety zone only after the Diesel engine has been turned off.
Secure the Diesel engine against any unexpected start-up.

ISO 7010 / P007 No access for persons with pacemakers or implanted defibrillators
– Possible EMC radiation that may affect heart pacemakers and implanted defibrillators.
People with a heart pacemaker or implanted defibrillator: keep a minimum distance of 20 cm from the operational Diesel engine.

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ISO 7010 / M002 Observe instructions

– In order to ensure that all residual risks are known by the personnel, the system documentation must be read and understood.
  Make sure that all residual risks according to the risk assessment of the system manufacturer are reflected in the system documentation.
  Provide documentation to the personnel according to the “target audience” definitions without restrictions.

2.10 Preventing property damage

– Replace sealing material, for example, o-rings and seals.
– Check removed, reusable parts for reusability, see corresponding information in the repair instruction.
– Replace removed, not reusable parts.
– If no specific torques and tightening instructions are specified: Tighten screwed assemblies according to the standard torques. For further information, see “Standard torques” chapter.
– Replace self-locking screwed assemblies.
– Thoroughly clean the engine, connections and screwed assemblies of oil, combustion residues or care products before installation.
– Use lint-free cleaning cloths.
– Do not touch electrical contacts. Connection will be affected by contamination or components will be destroyed by electrostatic discharge.
– Before cleaning the engine: Cover or seal openings into which no water, steam or cleaning agents may enter due to safety or functional reasons.
– Remove covers or adhesives after cleaning.
– Check gas-conveying lines, engine oil lines and hydraulic lines for the following defects:
  • Leaks
  • Loose connections
  • Abrasion points
  • Damage
– Make sure that the electrical power supply is securely connected when starting.
– Before disconnecting the electrical power supply: Turn off engine.
– Use suitable test leads for measurements on plug connections.
– If no mating connector is attached: Protect the engine control unit against dust and water.
– When working on the electrical system: Disconnect the battery (if present).
– Disconnect the negative pole first and connect it last.
– During electric welding on the machine, remove the plug from the control unit.

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3 Repair work

3.1 Removing and installing the cover plate

3.1.1 Removing the cover plate

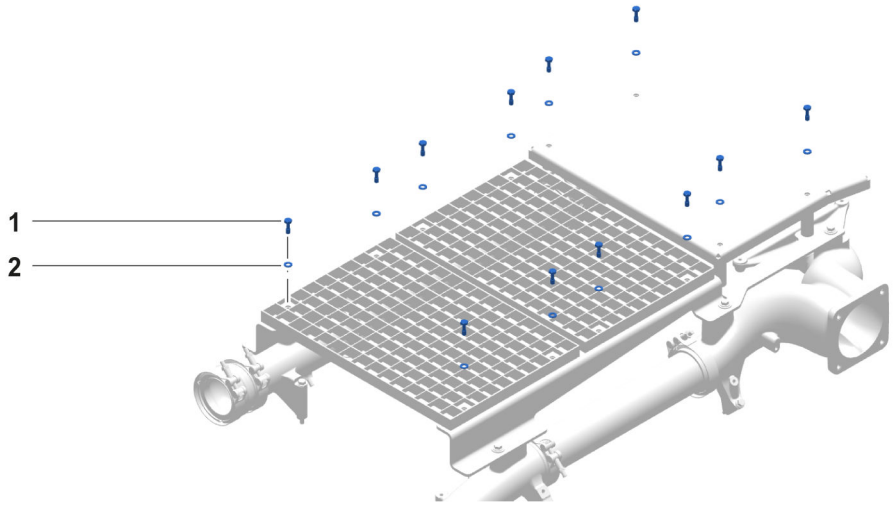

Fig. 47: Cover plate

1 Combination screw (12x)

2 Washer (12x)

▶ Unscrew combination screws **1**.

▶ Remove washers **2**.

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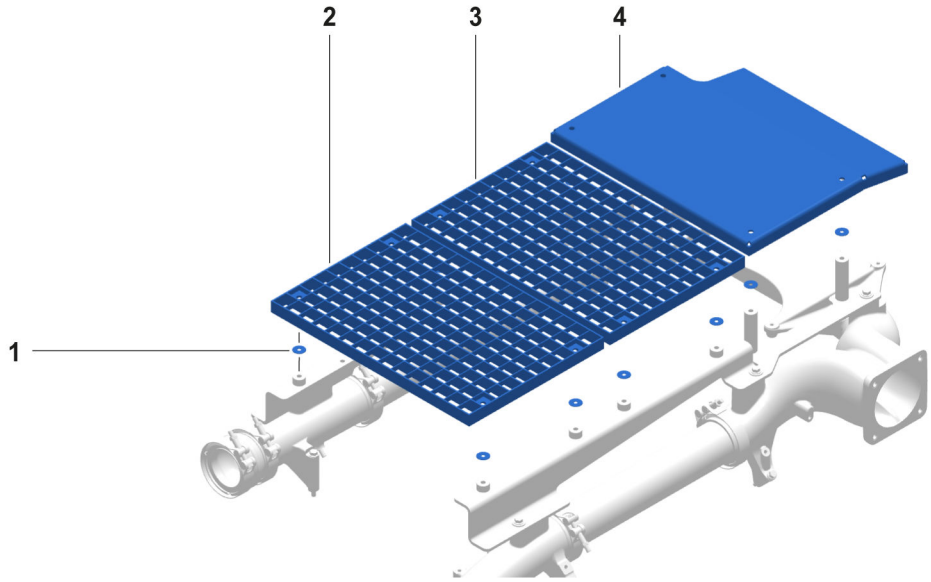

Fig. 48: Cover plate

1 Washer (12x)
2 Grating
3 Grating
4 Cover plate

▶ Remove grating **2**.

▶ Remove grating **3**.

▶ Remove cover plate **4**.

▶ Remove washers **1**.

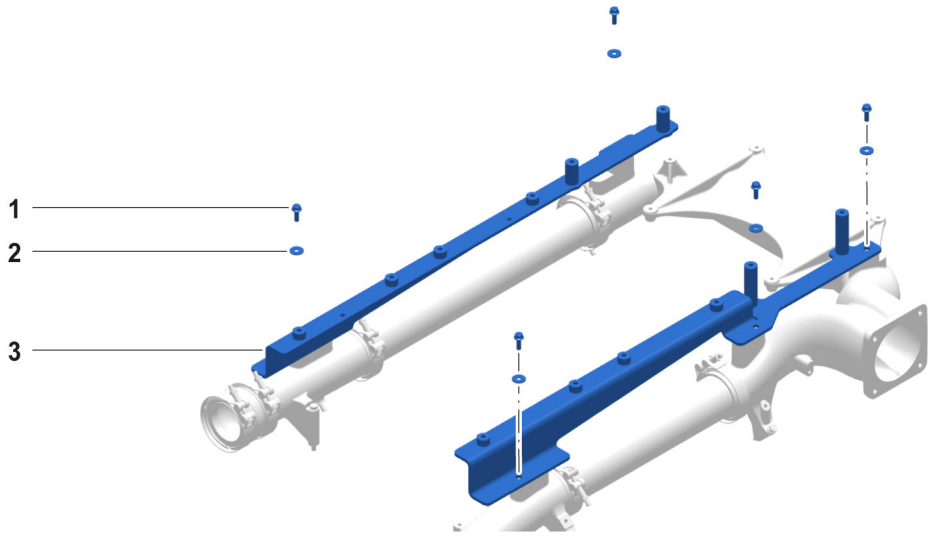

Fig. 49: Cover plate

1 Hex head screw (5x)
2 Washer (5x)
3 Bracket (2x)

▶ Unscrew hex head screws **1**.

▶ Remove washers **2**.

▶ Remove bracket **3**.

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3.1.2 Installing the cover plate

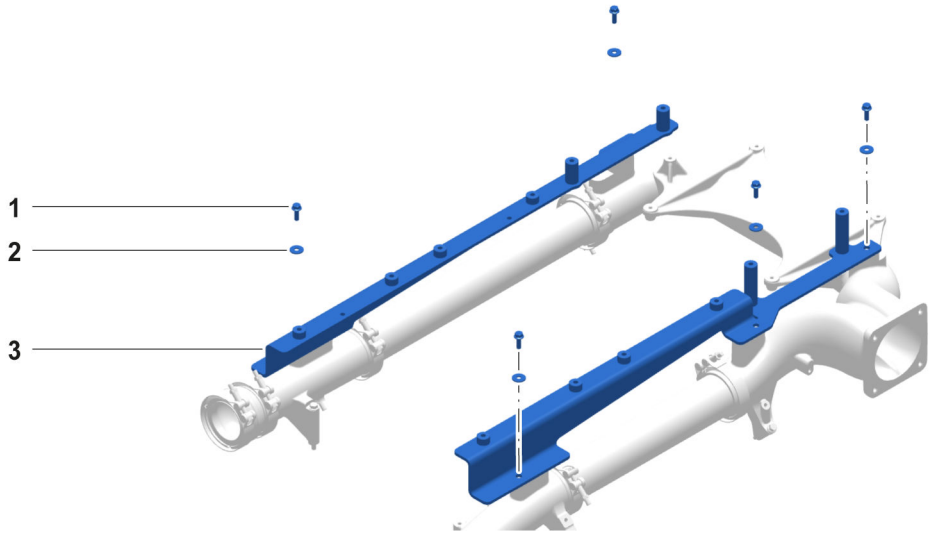

Fig. 50: Cover plate

1 Hex head screw (5x)
2 Washer (5x)
3 Bracket (2x)

▶ Install bracket **3**.

▶ Align washers **2**.

▶ Tighten hex head screws **1**.

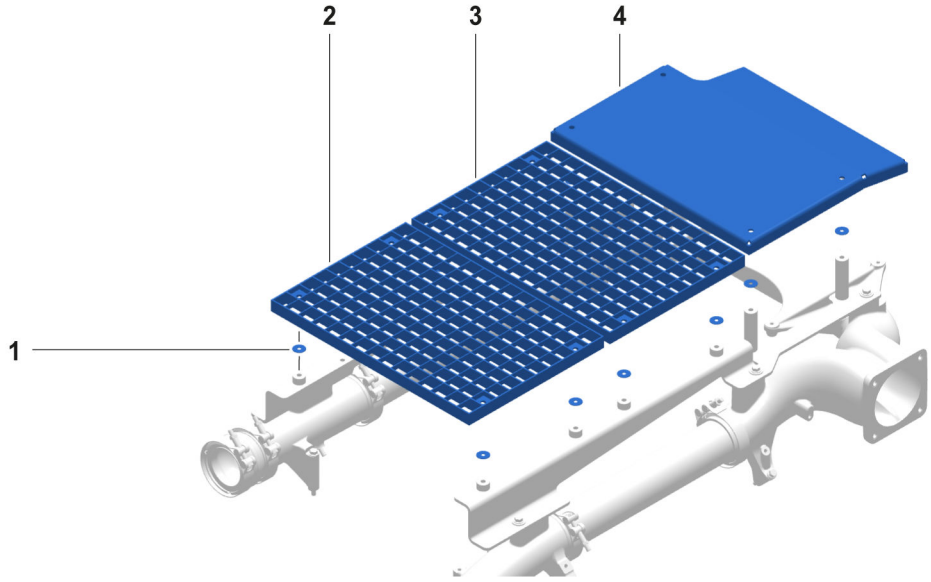

Fig. 51: Cover plate

1 Washer (12x)
2 Grating
3 Grating
4 Cover plate

▶ Align washers **1**.

▶ Install cover plate **4**.

▶ Install grating **3**.

▶ Install grating **2**.

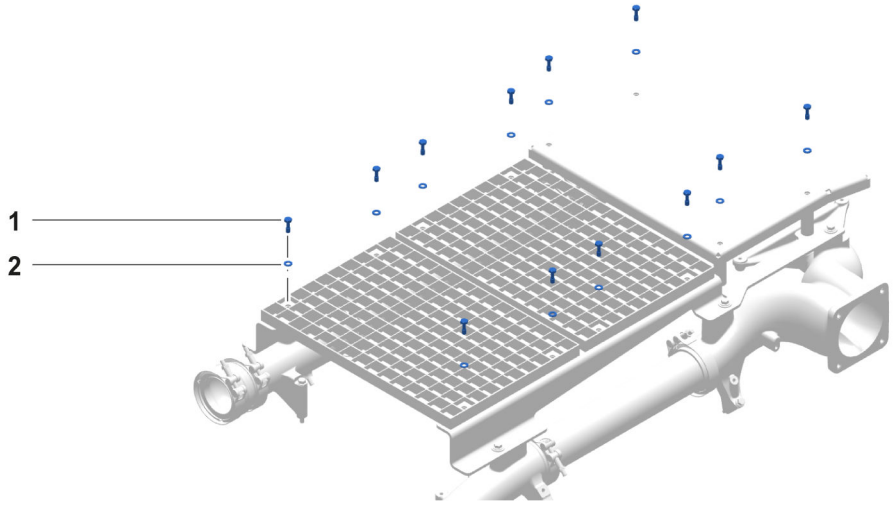

Fig. 52: Cover plate

1 Combination screw (12x) **2** Washer (12x)

▶ Align washers **2**.

▶ Tighten combination screws **1**.

3.2 Cylinder head cover

3.2.1 Removing and installing the cylinder head cover

Removing the cylinder head cover

Make sure that the following prerequisites are met:

- ❑ For cylinder 1 to 4, the pipeline from the cylinder head cover to the oil mist separator on the right is removed. (For more information see: Removing the cylinder head cover pipeline to the right oil mist separator, page 363.)
- ❑ For cylinder 1 and 3, the right brackets are removed. (For more information see: Removing the right bracket, page 372.)
- ❑ For cylinder 7 to 9, the pipeline from the cylinder head cover to the oil mist separator on the left is removed. (For more information see: Removing the cylinder head cover pipeline to the left oil mist separator, page 359.)
- ❑ For cylinder 7, the left bracket is removed. (For more information see: Removing the left bracket, page 371.)

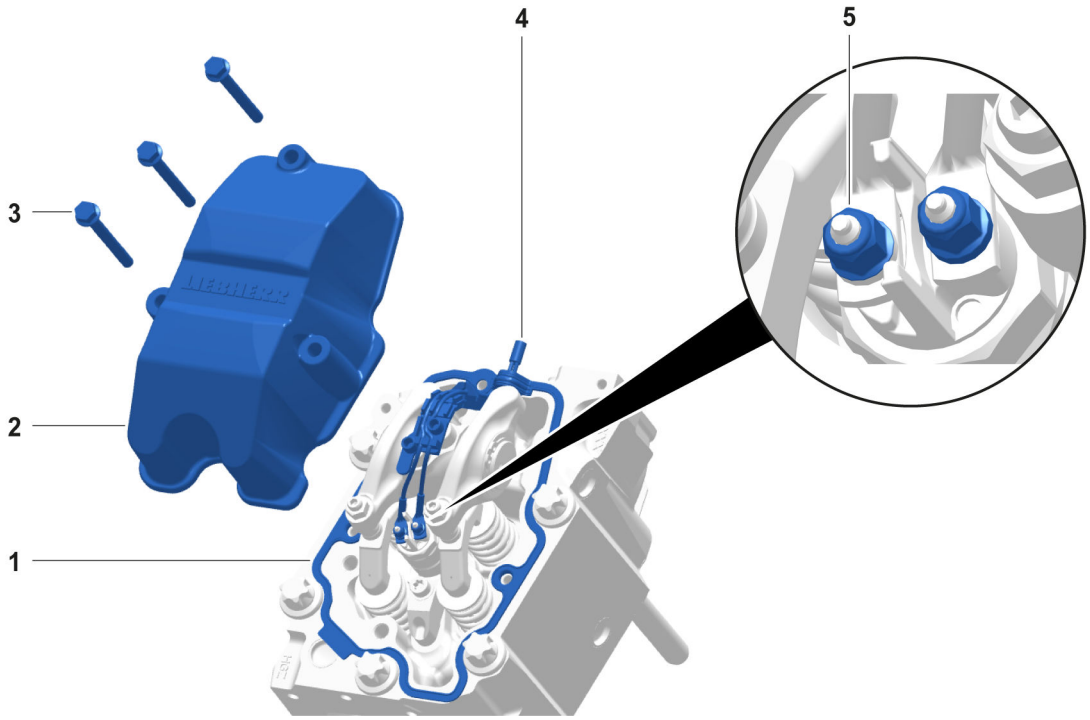

Fig. 53: Cylinder head cover

1 Cylinder head cover seal
2 Cylinder head cover
3 Hex head screws (3x)
4 Cable harness
5 Hex nut (2x)

▶ Unscrew hex head screws **3**.

▶ Remove cylinder head cover **2**.

▶ Unscrew hex nuts **5**.

▶ Remove cable harness **4** from feed-through.

▶ Remove cylinder head cover seal **1**.

Checking and cleaning the cylinder head cover

▶ Check cylinder head cover seal **1** for damage and replace if necessary.

If cylinder head cover seal **1** is being reused:

▶ Degrease cylinder head cover seal **1**.

▶ Degrease cylinder head sealing surface.

▶ Degrease cylinder head cover **2** sealing surface.

Installing the cylinder head cover

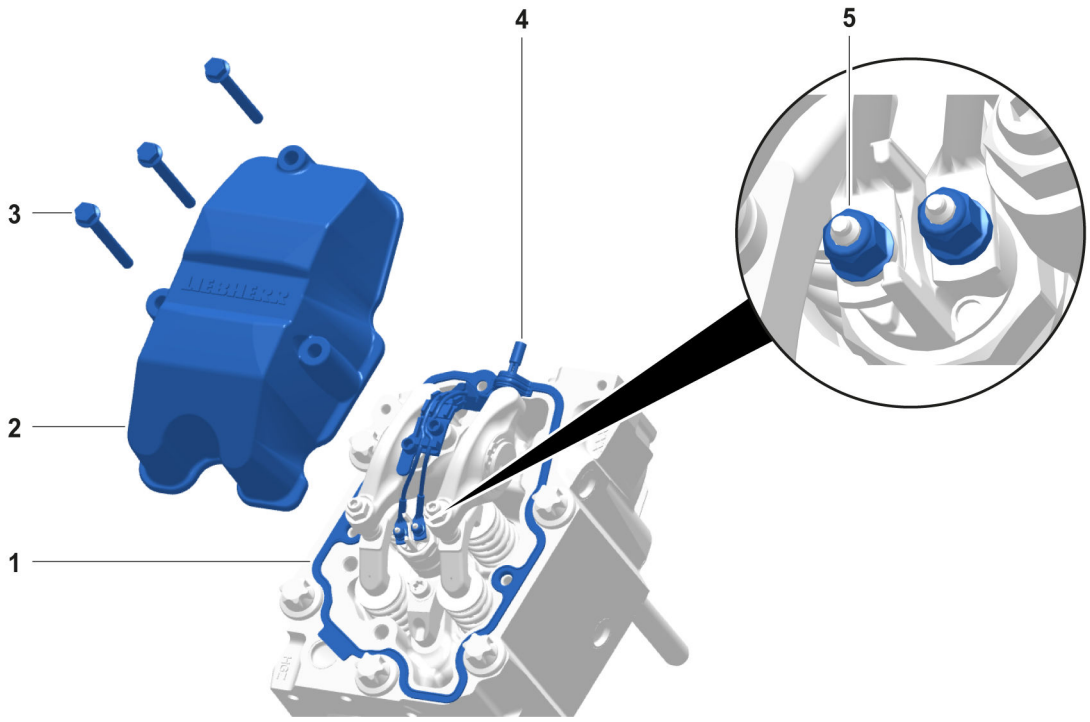

Fig. 54: Cylinder head cover

1 Cylinder head cover seal
2 Cylinder head cover
3 Hex head screws (3x)
4 Cable harness
5 Hex nut (2x)

▶ Install cylinder head cover seal **1**. (For more information see: Installing the cylinder head cover seal, page 59.)

▶ Install cylinder head cover **2**.

▶ Tighten hex head screws **3**.

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3.2.2 Installing the cylinder head cover seal

Installing the cylinder head cover seal

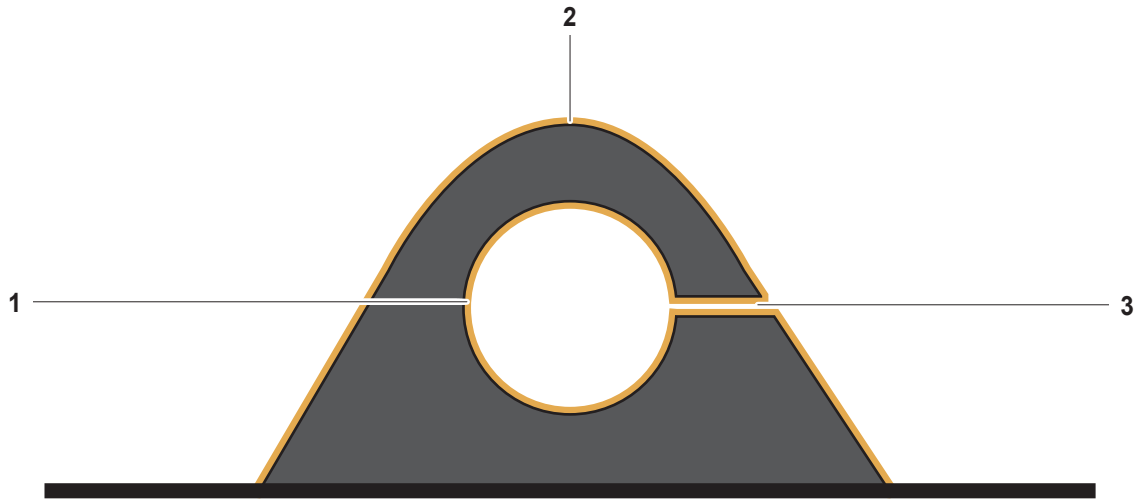

Fig. 55: Feed-through lubricating points

1 Cable harness feed-through
2 Cylinder head cover contact surface
3 Closing area

- ▶ Degrease cable harness feed-through **1**.
- ▶ Degrease cylinder head cover contact surface **2**.
- ▶ Degrease closing area **3**.
- ▶ Lubricate cable harness feed-through **1** with Weicon® Black-Seal sealant.
- ▶ Lubricate cylinder head cover contact surface **2** with Weicon® Black-Seal sealant.
- ▶ Lubricate closing area **3** with Weicon® Black-Seal sealant.

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Fig. 56: Sealing the closing area

1 Cable feed-through **2** Closing area

▶ Open cable feed-through **1** by hand.

Note

Weicon® Black-Seal sealant white for presentation purposes.

Complete assembly, taking into account the drying time of the Weicon® Black-Seal sealant.

▶ Lubricate closing area **2** with Weicon® Black-Seal sealant.

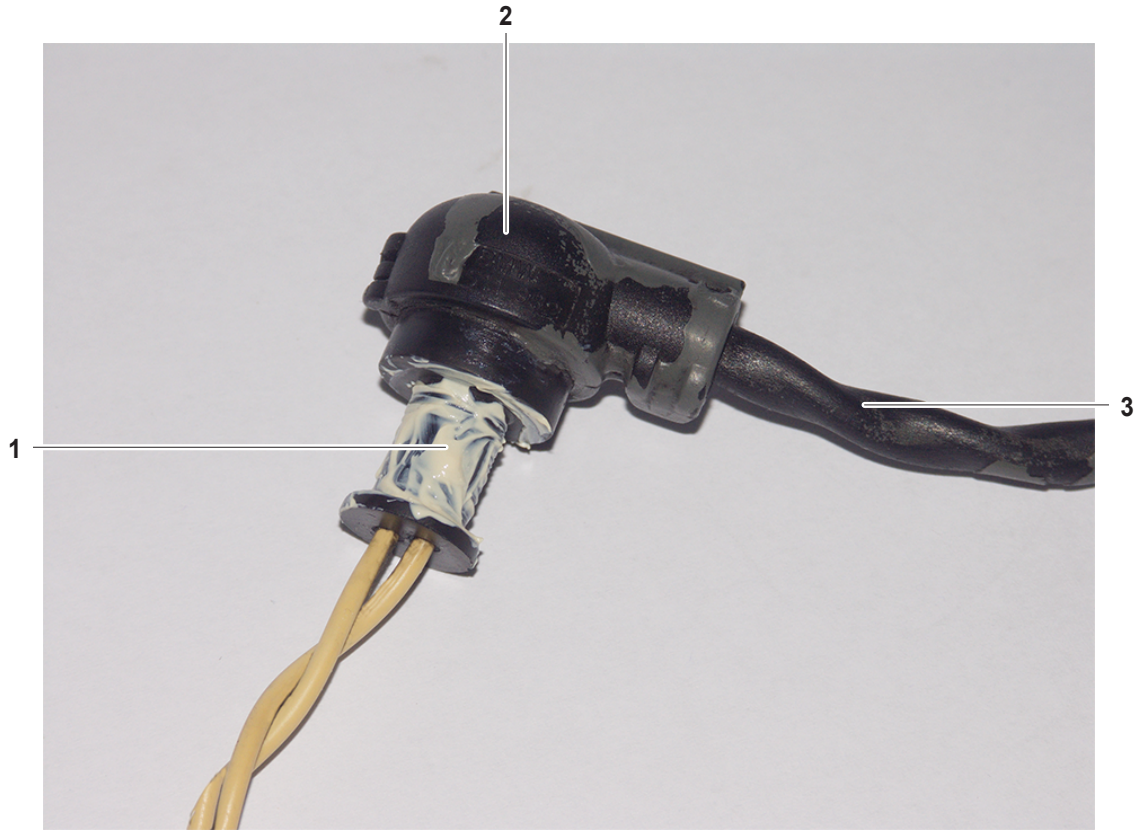


Fig. 57: Sealing the cable harness

1 Cable harness feed-through
2 Plug
3 Cable harness

▶ Lubricate cable harness feed-through **1** area with Weicon® Black-Seal sealant.

▶ Insert plug **2** in feed-through.

Fig. 58: Sealing the feed-through

1 Cylinder head cover feed-through contact surface

▶ Lubricate cylinder head cover feed-through contact surface **1** area with Weicon® Black-Seal sealant.

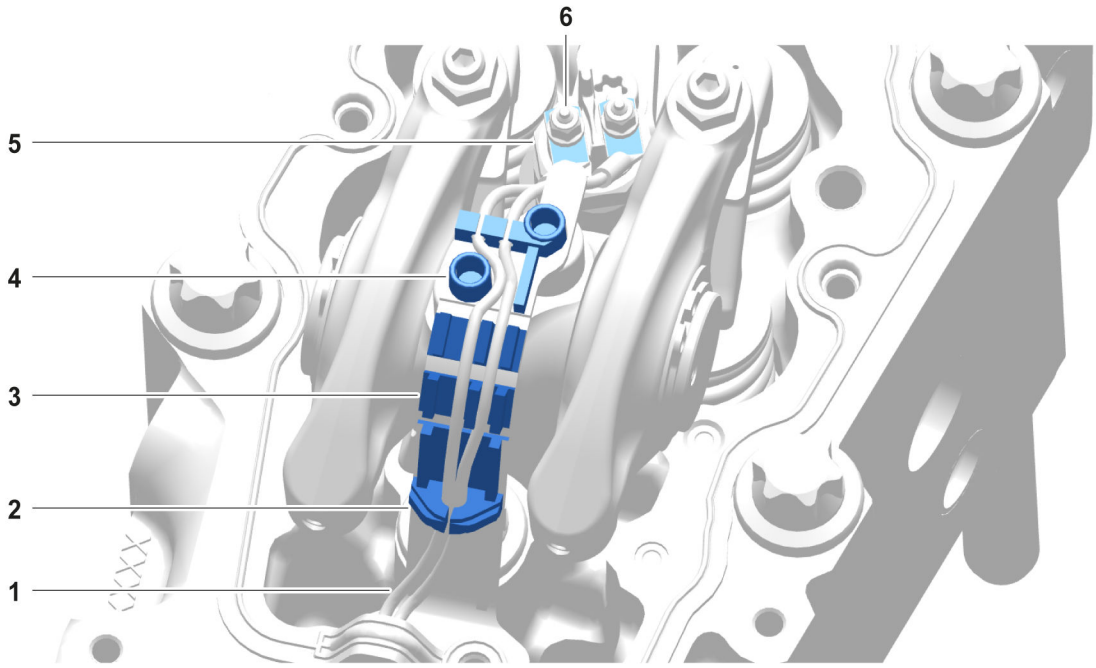


Fig. 59: Installing the valve cover seal

1 Cable harness
2 Feed-through
3 Cable harness guide
4 Fastening nubs
5 Injector
6 Hex nut (2x)

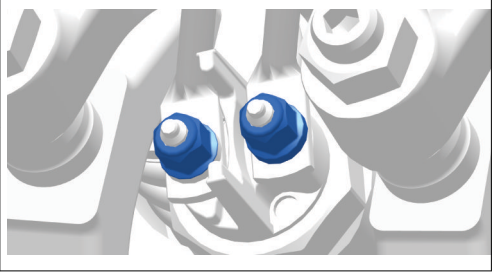
▶ Align cylinder head cover seal.

▶ Insert cable harness **1** in feed-through **2**.

▶ Insert cable harness **1** in cable harness guide **3**.

▶ Press fastening nubs **4** into socket head screws.

▶ Connect cable harness **1** to injector **5**.

Tightening instruction for hex nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	1.8 $^{+0.2}$ Nm	

Tab. 11: Tightening instruction 12977315-001

▶ Tighten hex nuts **6** according to tightening instruction.

3.2.3 Removing and installing the crankcase ventilation of the cylinder head cover

Removing the crankcase ventilation of the cylinder head cover

Make sure that the following prerequisite is met:

❑ Corresponding cylinder head cover is removed. (For more information see: Removing the cylinder head cover, page 57.)

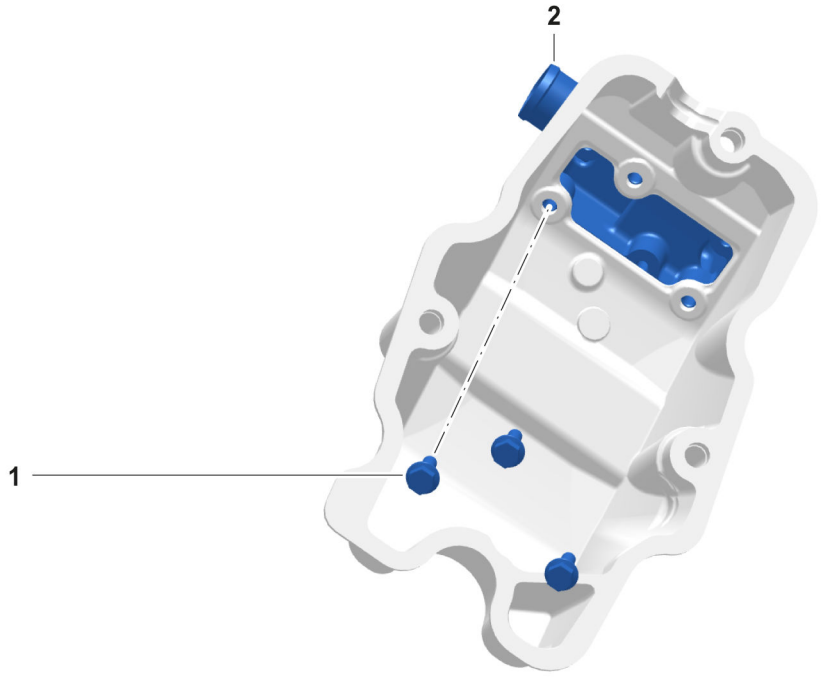


Fig. 61: Crankcase ventilation of cylinder head cover

1 Hex head screw (3x)

2 Connection piece

▶ Unscrew hex head screws **1**.

▶ Remove connection piece **2**.

Cleaning

▶ Clean sealing surface of cylinder head cover.

▶ Clean sealing surface of connection piece.

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Installing the crankcase ventilation of the cylinder head cover

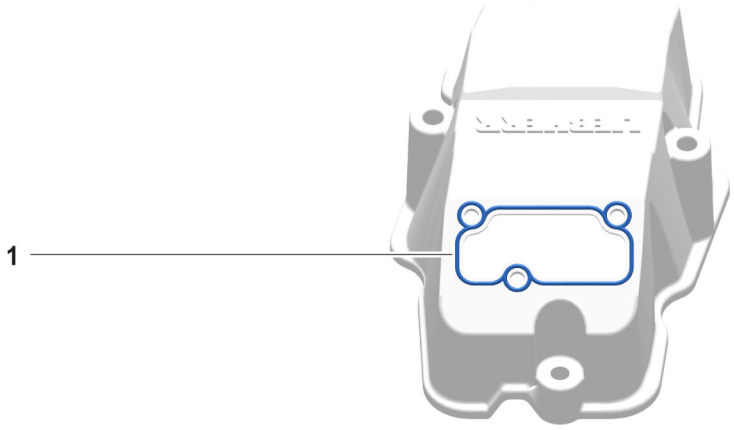

Fig. 62: Surface seal

1 Surface seal

▶ Apply Loctite® 5910 surface seal **1**.

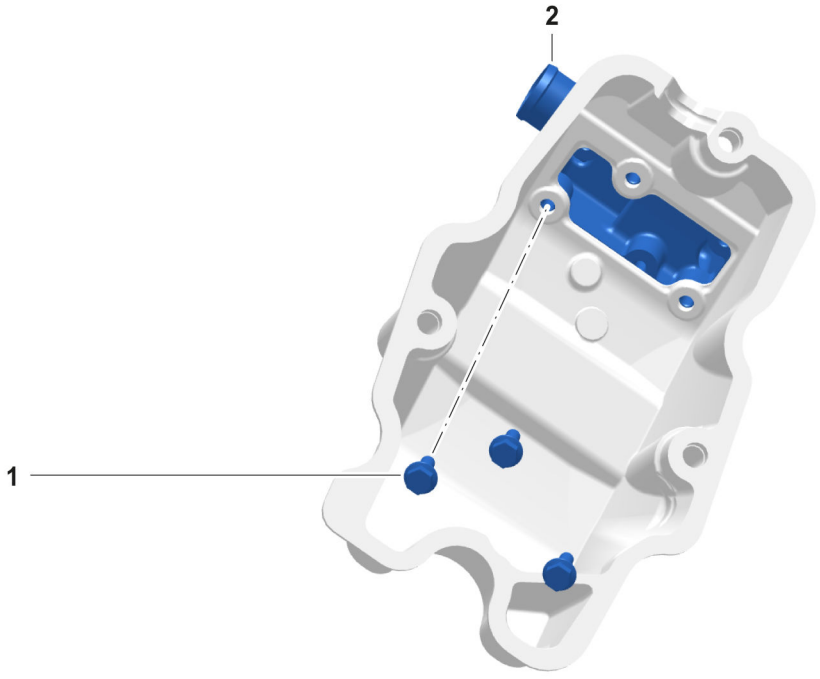

Fig. 63: Crankcase ventilation of cylinder head cover

1 Hex head screw (3x) **2** Connection piece

▶ Align connection piece **2**.

▶ Lubricate hex head screws **1** with Loctite® 243.

▶ Tighten hex head screws **1**.

3.3 Cylinder head

3.3.1 Checking and setting the valve clearance

Removing the flywheel housing cover

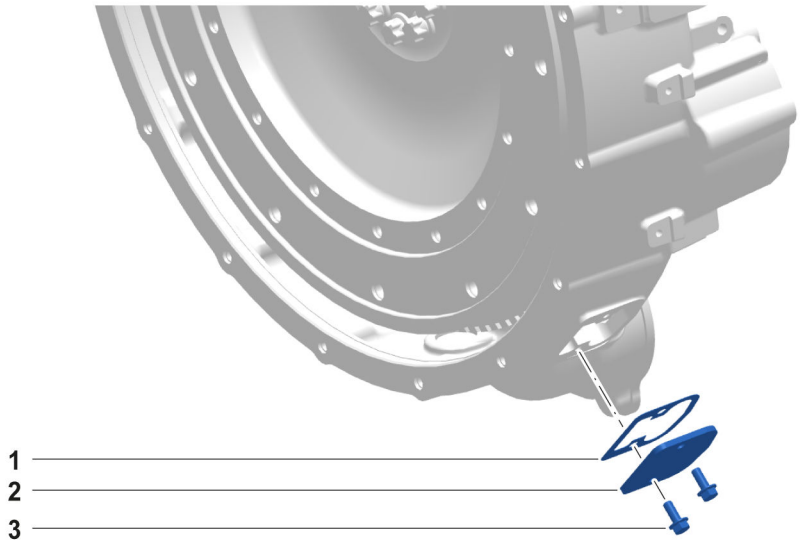

Fig. 64: Flywheel housing cover

1 Seal
2 Cover
3 Hex head screw (2x)

▶ Unscrew hex head screws **3**.

▶ Remove cover **2**.

▶ Remove seal **1**.

Cleaning the flywheel housing cover

▶ Clean cover **2**.

▶ Clean sealing surface on flywheel housing.

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Installing the turning device

Graphic representation	Description	Required number	Part number
	Turning device	1	10123791

Tab. 12: Special tool

Make sure that the following prerequisite is met:
❑ Starter motor is removed. (For more information see: Removing the starter motor, page 465.)

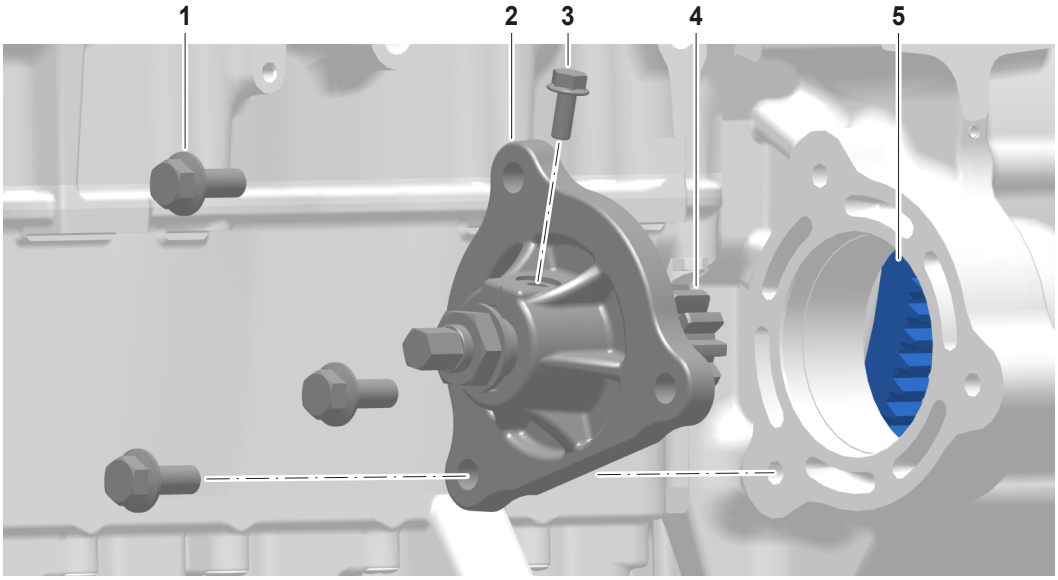

Fig. 66: Installing the turning device

1 Hex head screw (3x)
2 Turning device
3 Hex head screw
4 Gearing of turning device
5 Gearing of flywheel

▶ Install turning device **2**.

▶ Screw in hex head screws **1**.

▶ Unscrew hex head screw **3**.

▶ Slide gearing of turning device **4** into gearing of flywheel **5**.

▶ Make sure that gearing of turning device **4** engages in gearing of flywheel **5**.

▶ Tighten hex head screws **1**.

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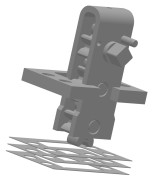
Installing the turning device (optional)

Graphic representation	Description	Required number	Part number
	Turning device	1	9078688

Tab. 13: Special tool

Make sure that the following prerequisite is met:
❑ Flywheel housing cover is removed. (For more information see: Removing the flywheel housing cover, page 66.)

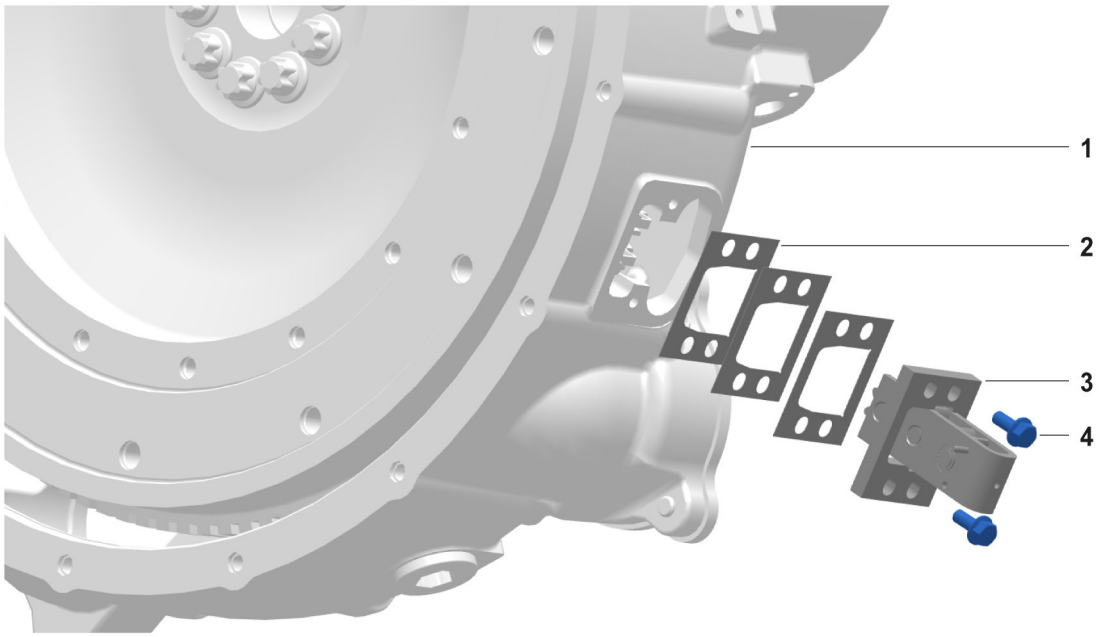


Fig. 68: Turning device

1 Flywheel
2 Spacer (3x)
3 Turning device
4 Hex head screw (2x)

▶ Install turning device **3** with spacers **2**.

▶ Make sure that gearing of turning device **3** engages in gearing of flywheel.

▶ Tighten hex head screws **4**.

Setting the cylinder to top dead center (TDC)

There is always one cylinder in ignition TDC position and one cylinder in scavenging TDC position at the same time. (For more information see: Setting table, page 69.)

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TDC type	Ignition TDC	Overlapping TDC
Position of the piston	Between “compressing” and “working” cycles	Between “ejection” and “intake” cycles
Position of the valves	closed	overlapping
Rocker arms	do not press on the valve bridges	press on the valve bridges
Rocker arm movable by hand	Yes	No
Setting valve clearance possible	Yes	No

Tab. 14: Differences between ignition TDC and overlapping TDC

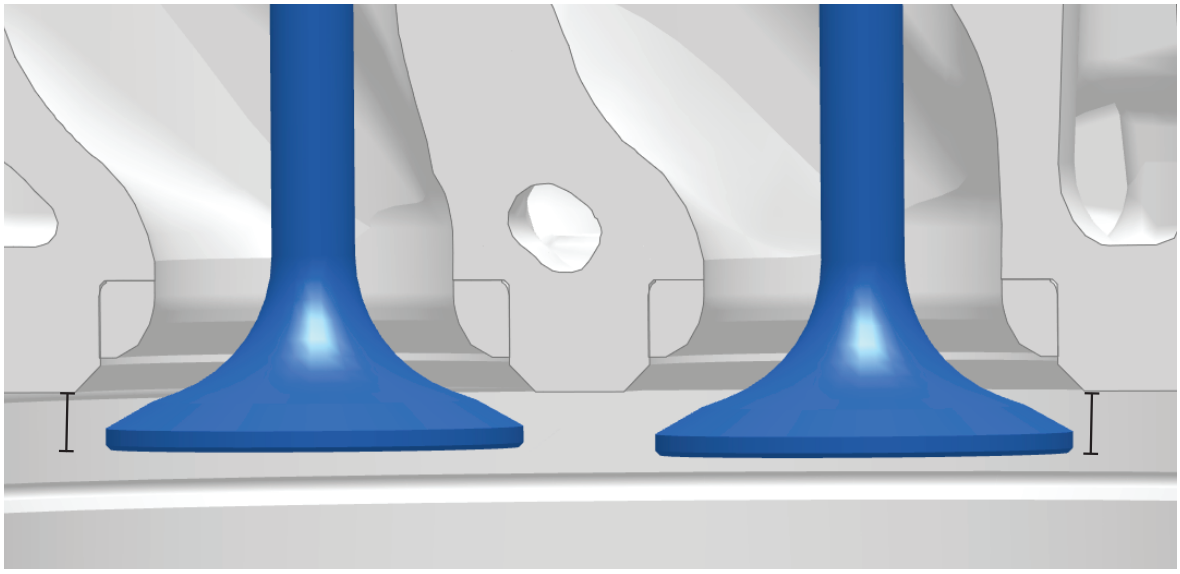

Fig. 69: Valve overlap

Make sure that the following prerequisites are met:
- ❑ Corresponding cylinder head covers are removed. (For more information see: Removing the cylinder head cover, page 57.)
- ❑ Turning device is installed. (For more information see: Installing the turning device, page 67.)

▶ Turn turning device counterclockwise until cylinder is in corresponding TDC position. (see: tab. 14, page 69)

Setting table

Valves of the cylinder												
set (ignition TDC)	1	12	2	11	3	10	6	7	5	8	4	9
overlap (overlapping TDC)	6	7	5	8	4	9	1	12	2	11	3	10

Tab. 15: Valves of the cylinder

Setting cylinder 1 to ignition TDC

Make sure that the following prerequisites are met:
- ❑ Turning device is installed. (For more information see: Installing the turning device, page 67.)

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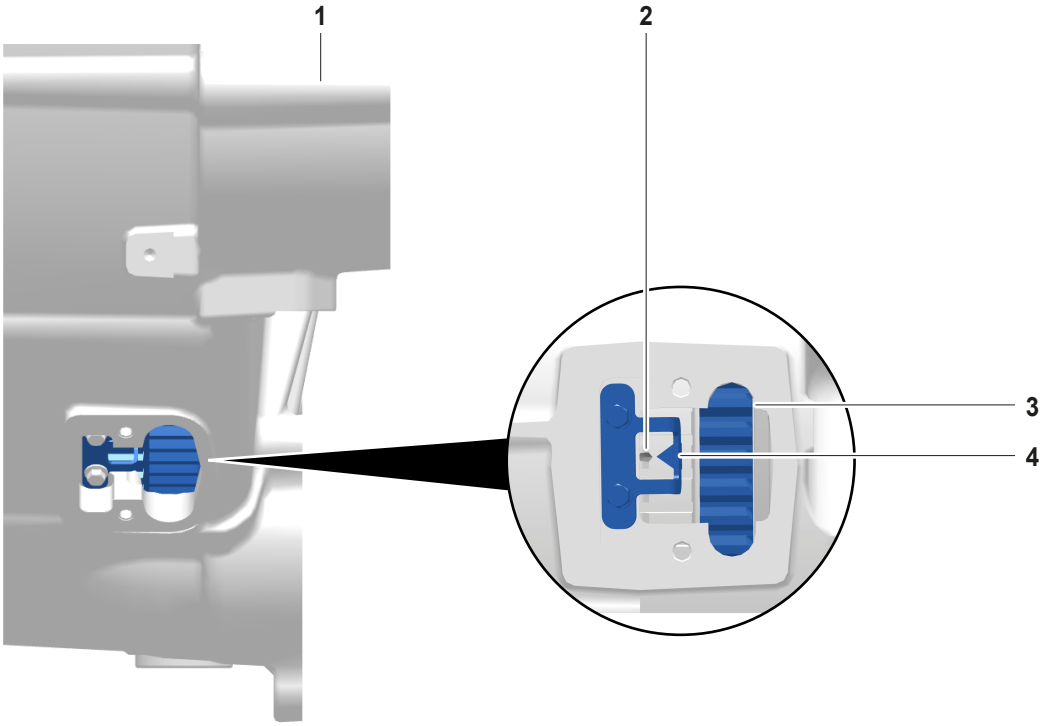

Fig. 70: TDC mark

1	Flywheel housing	**3**	Flywheel
2	TDC mark	**4**	Adjusting plate

▶ Turn turning device counterclockwise.
▷ The TDC marking **2** on the flywheel **3** and adjusting plate **4** align.

▶ Check if the cylinder 1 rocker arm can be moved by hand.
▷ Cylinder 1 is in ignition TDC position.
▷ The valve clearance of cylinder 1 is ready to be checked.

Setting cylinder 2 to 12 to ignition TDC

Make sure that the following prerequisites are met:
❑ Corresponding cylinder head covers are removed. (For more information see: Removing the cylinder head cover, page 57.)
❑ Turning device is installed. (For more information see: Installing the turning device, page 67.)

▶ Turn crankshaft with turning device counterclockwise.

▶ Check if the cylinder rocker arm can be moved by hand. (For more information see: Setting table, page 69.)
▷ The cylinder rocker arm can be moved by hand.
▷ Cylinder is in ignition TDC position.
▷ The valve clearance of the cylinder is ready to be checked.

Checking and setting the valve clearance

Make sure that the following prerequisites are met:
❑ Engine is in maintenance position, see operator's manual.
❑ Cylinder head covers are removed. (For more information see: Removing the cylinder head cover, page 57.)
❑ The cylinder to be checked is at ignition TDC. (For more information see: Setting cylinder 1 to ignition TDC, page 69.) (For more information see: Setting cylinder 2 to 12 to ignition TDC, page 70.)

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Name	Value
Valve clearance, inlet, cold	0.5 mm
Valve clearance, outlet, cold	0.6 mm

Tab. 16: Settings for valve clearance

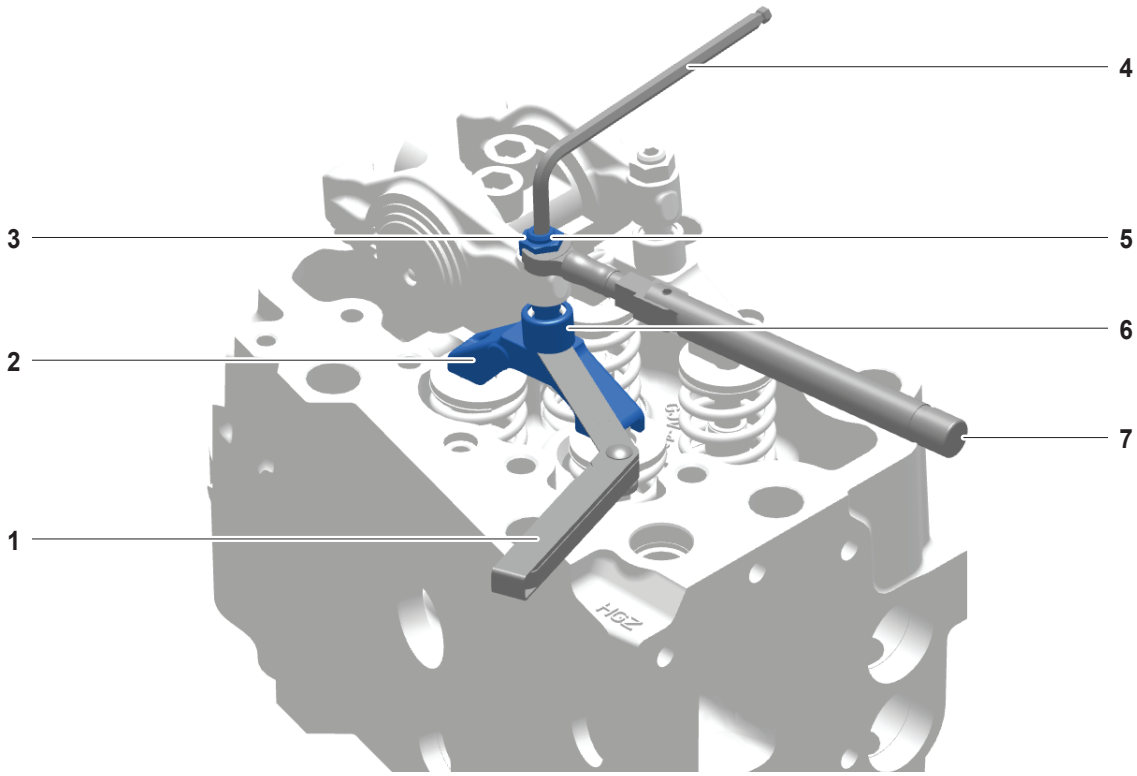

Fig. 71: Checking and setting the valve clearance

1 Feeler gauge
2 Valve bridge
3 Lock nut
4 Allen wrench
5 Adjusting screw
6 Tappet
7 Torque wrench

▶ Slide feeler gauge **1** between the valve bridge **2** and tappet **6**.

▶ Check valve clearance.

If the valve clearance does not correspond to the settings (see: tab. 16, page 71):

▶ Release lock nut **3** on adjusting screw **5** of tappet **6**.

▶ Set valve clearance by turning the adjusting screw **5**.

▶ Hold onto adjusting screw **5**.

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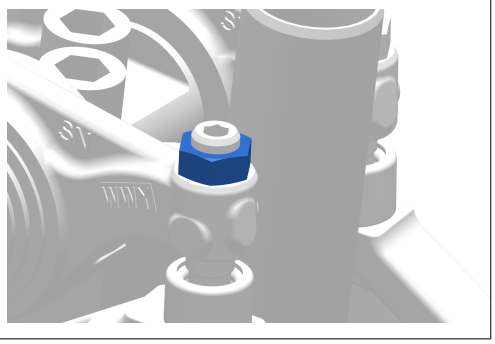
Tightening instruction for lock nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	45 Nm	

Tab. 17: Tightening instruction 10146199-000

- ▶ Tighten lock nut **3** according to tightening instruction.
- ▶ Check setting again.
- ▶ Repeat process for all cylinders.

When valves have been checked and set:

- ▶ Install cylinder head cover. (For more information see: Installing the cylinder head cover, page 58.)

Removing the turning device

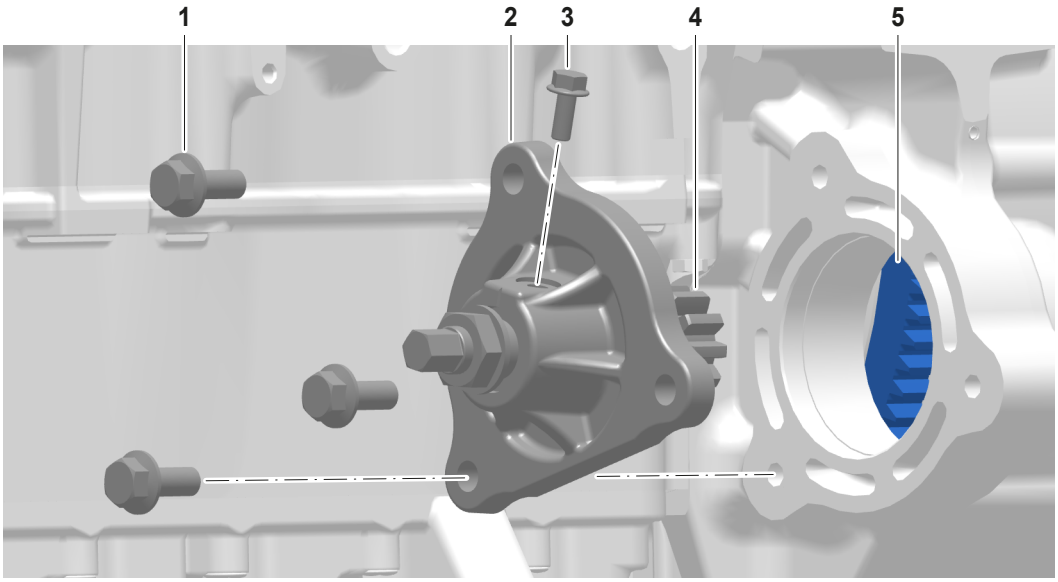


Fig. 73: Installing the turning device

1 Hex head screw (3x)
2 Turning device
3 Hex head screw
4 Gearing of turning device
5 Gearing of flywheel

- ▶ Pull gearing of turning device **4** out of gearing of flywheel **5**.
- ▶ Tighten hex head screw **3**.
- ▶ Unscrew hex head screws **1**.
- ▶ Remove turning device **2**.

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Removing the turning device (optional)

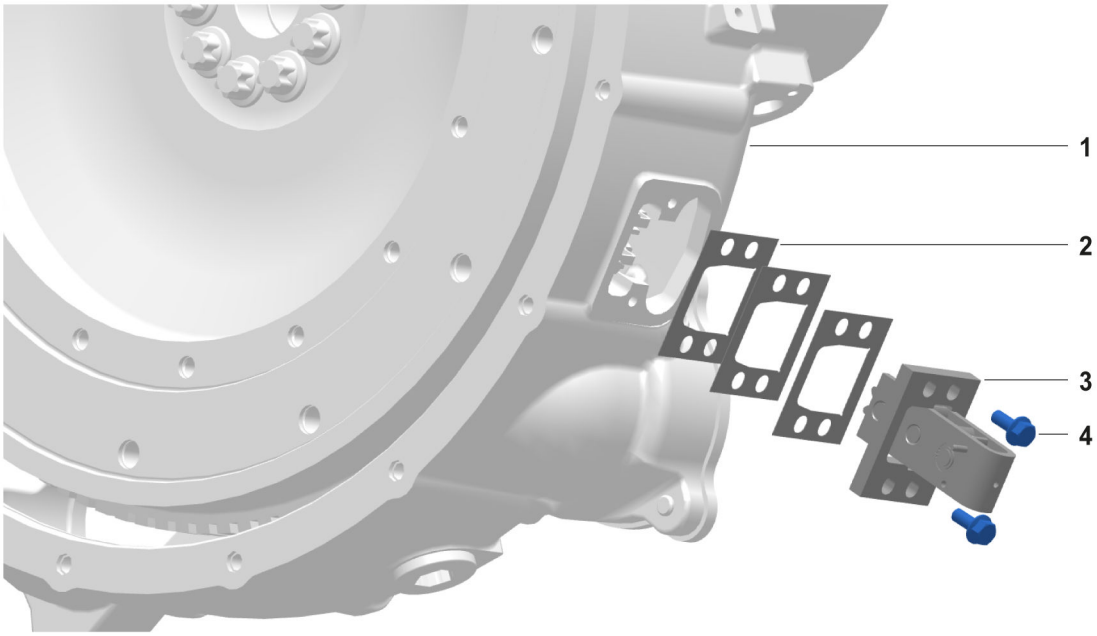


Fig. 74: Turning device

1 Flywheel
2 Spacer (3x)
3 Turning device
4 Hex head screw (2x)

▶ Unscrew hex head screws **4**.

▶ Remove turning device **3** and spacers **2**.

Installing the flywheel housing cover

Fig. 75: Flywheel housing cover

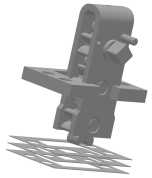
1 Seal
2 Cover
3 Hex head screw (2x)

- ▶ Align new seal **1**.
- ▶ Install cover **2**.
- ▶ Tighten hex head screws **3**.

3.3.2 Rocker arm bracket and push rods

Removing and installing the rocker arm bracket and push rods

Removing the rocker arm bracket and push rods

Graphic representation	Description	Required number	Part number
	Turning device	1	10123791
	Turning device	1	9078688

Tab. 18: Special tool

Make sure that the following prerequisites are met:
- ❑ Cylinder head cover is removed. (For more information see: Removing the cylinder head cover, page 57.)
- ❑ Turning device is installed. (For more information see: Installing the turning device, page 67.) (For more information see: Installing the turning device (optional), page 68.)

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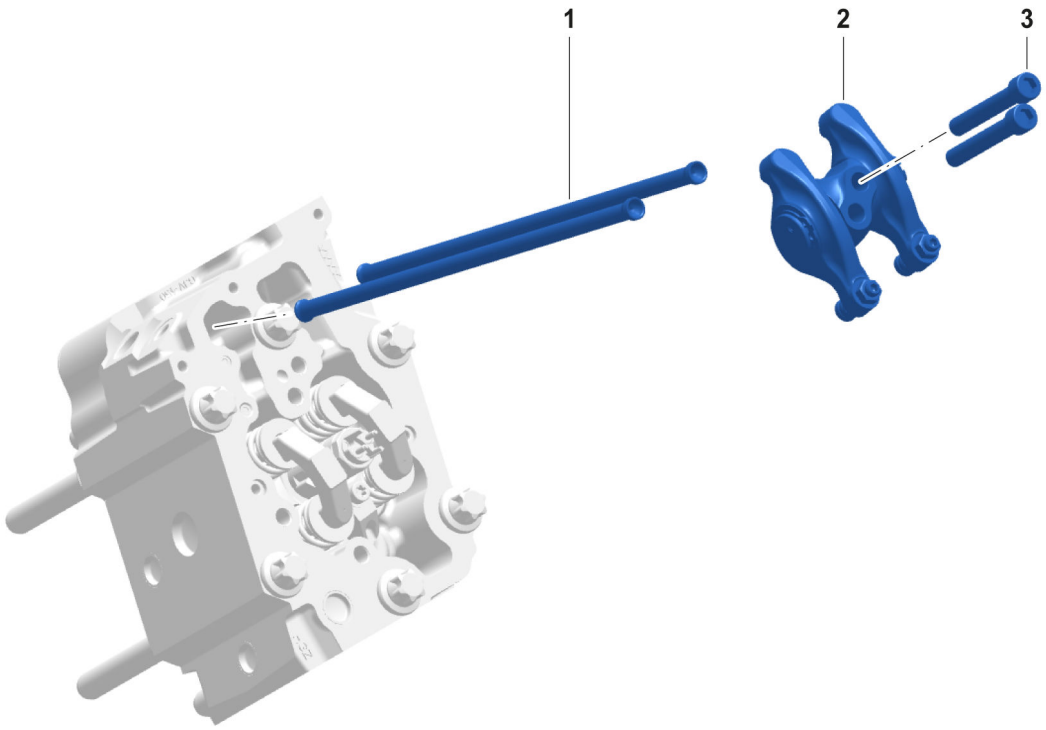


Fig. 78: Rocker arm bracket and push rods

1 Push rod (2x)
2 Rocker arm bracket
3 Socket head screw (2x)

▶ Turn crankshaft until corresponding valves are relieved.

▶ Unscrew hex socket screws **3**.

▶ Remove rocker arm bracket **2**.

▶ Remove push rods **1**.

Installing the rocker arm bracket and push rods

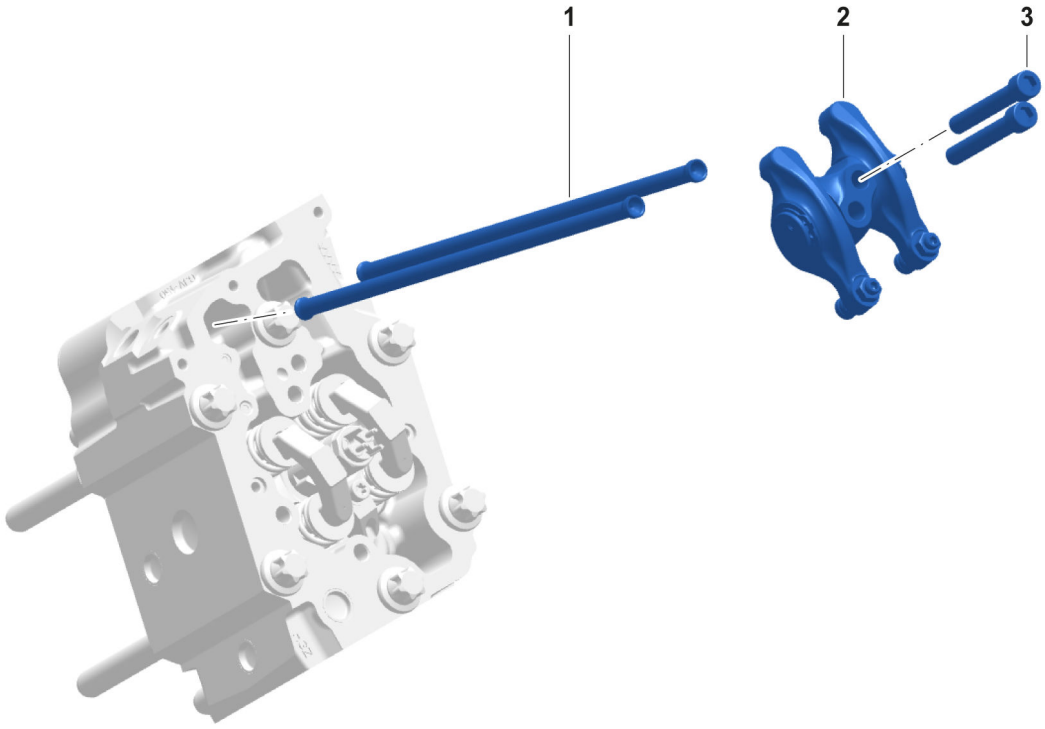
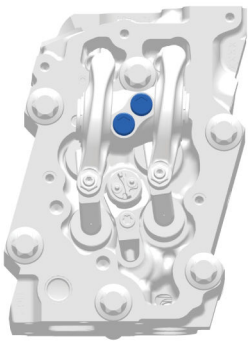


Fig. 79: Rocker arm bracket and push rods

1 Push rod (2x)
2 Rocker arm bracket
3 Socket head screw (2x)

▶ Install push rods **1**.

▶ Install rocker arm bracket **2**.

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	Engine oil	
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	19 Nm	
2.	50 Nm	
Stage	**Angle of rotation**	
3.	75°	

Tab. 19: Tightening instruction 10122891-006

▶ Lubricate socket head screws **3** according to tightening instruction.

▶ Tighten socket head screws **3** according to tightening instruction.

▶ Remove turning device. (For more information see: Removing the turning device, page 72.) (For more information see: Removing the turning device (optional), page 73.)

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Dismantling and assembling the rocker arm bracket

Dismantling the rocker arm bracket

Make sure that the following prerequisites are met:

❑ Rocker arm bracket is removed. (For more information see: Removing the rocker arm bracket and push rods, page 74.)

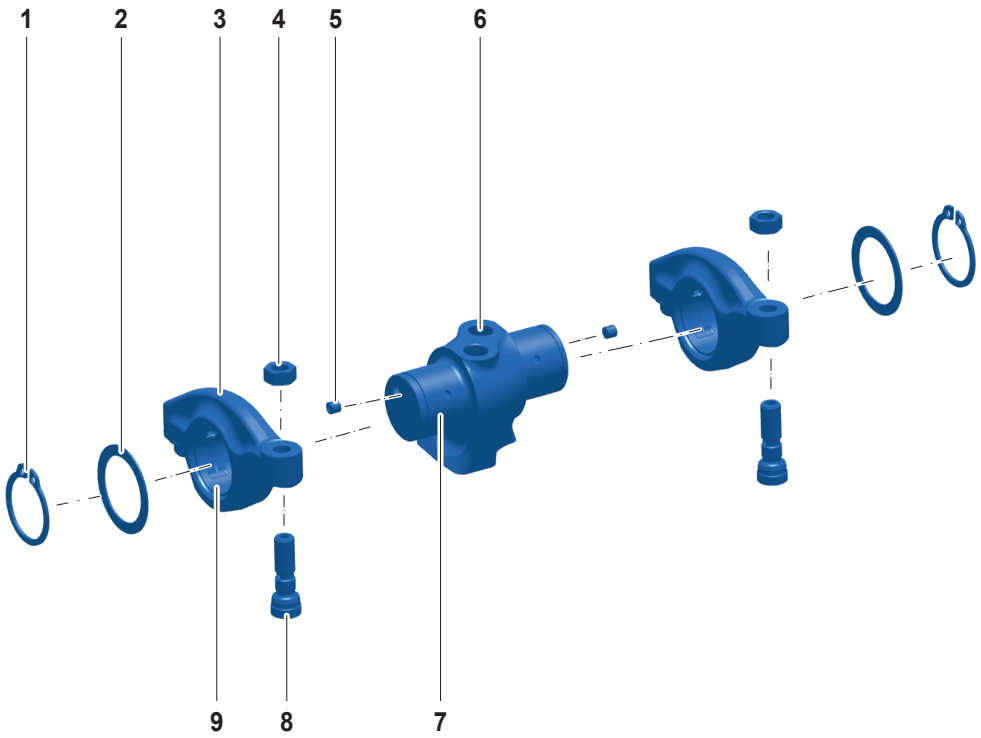

Fig. 81: Dismantling the rocker arm bracket

1 Locking ring (2x)
2 Washer (2x)
3 Rocker arm (2x)
4 Hex nut (2x)
5 Sealing plug (2x)
6 Rocker arm bracket
7 Rocker arm bracket bearing bush (2x)
8 Adjusting screw (2x)
9 Rocker arm bearing bush (2x)

▶ Remove locking rings **1** from rocker arm bracket **6** using standard circlip pliers.

▶ Remove washers **2**.

▶ Pull rocker arm **3** out of rocker arm bracket **6**.

▶ Unscrew hex nuts **4**.

▶ Unscrew adjusting screws **8** from rocker arm **3**.

▶ Remove sealing plug **5** from rocker arm bracket **6**.

Checking the rocker arm bracket

▶ Check components for damage and replace if necessary.

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Assembling the rocker arm bracket

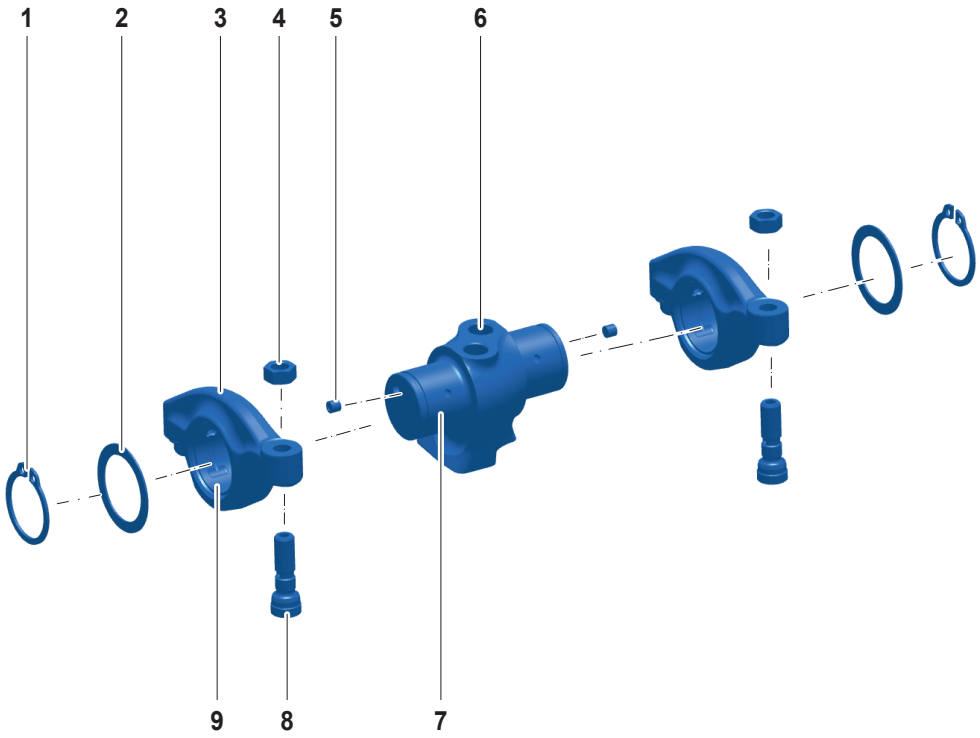

Fig. 82: Assembling the rocker arm bracket

1 Locking ring (2x)
2 Washer (2x)
3 Rocker arm (2x)
4 Hex nut (2x)
5 Sealing plug (2x)
6 Rocker arm bracket
7 Rocker arm bracket bearing bush (2x)
8 Adjusting screw (2x)
9 Rocker arm bearing bush (2x)

- ▶ Install adjusting screws **8** with hex nuts **4** on rocker arm **3**.
- ▶ Install sealing plug **5** in rocker arm bracket **6**.
- ▶ Lubricate rocker arm bracket bearing bushes **7** with engine oil.
- ▶ Lubricate rocker arm bearing bushes **9** with engine oil.
- ▶ Install rocker arm **3** on rocker arm bracket **6**.
- ▶ Slide washers **2** on rocker arm bracket bearing bushes **7**.
- ▶ Install locking rings **1** on rocker arm **3** using standard circlip pliers.

3.3.3 Removing and installing the valve bridges

Removing the valve bridges

Make sure that the following prerequisites are met:
- ❑ Rocker arm bracket is removed. (For more information see: Removing the rocker arm bracket and push rods, page 74.)

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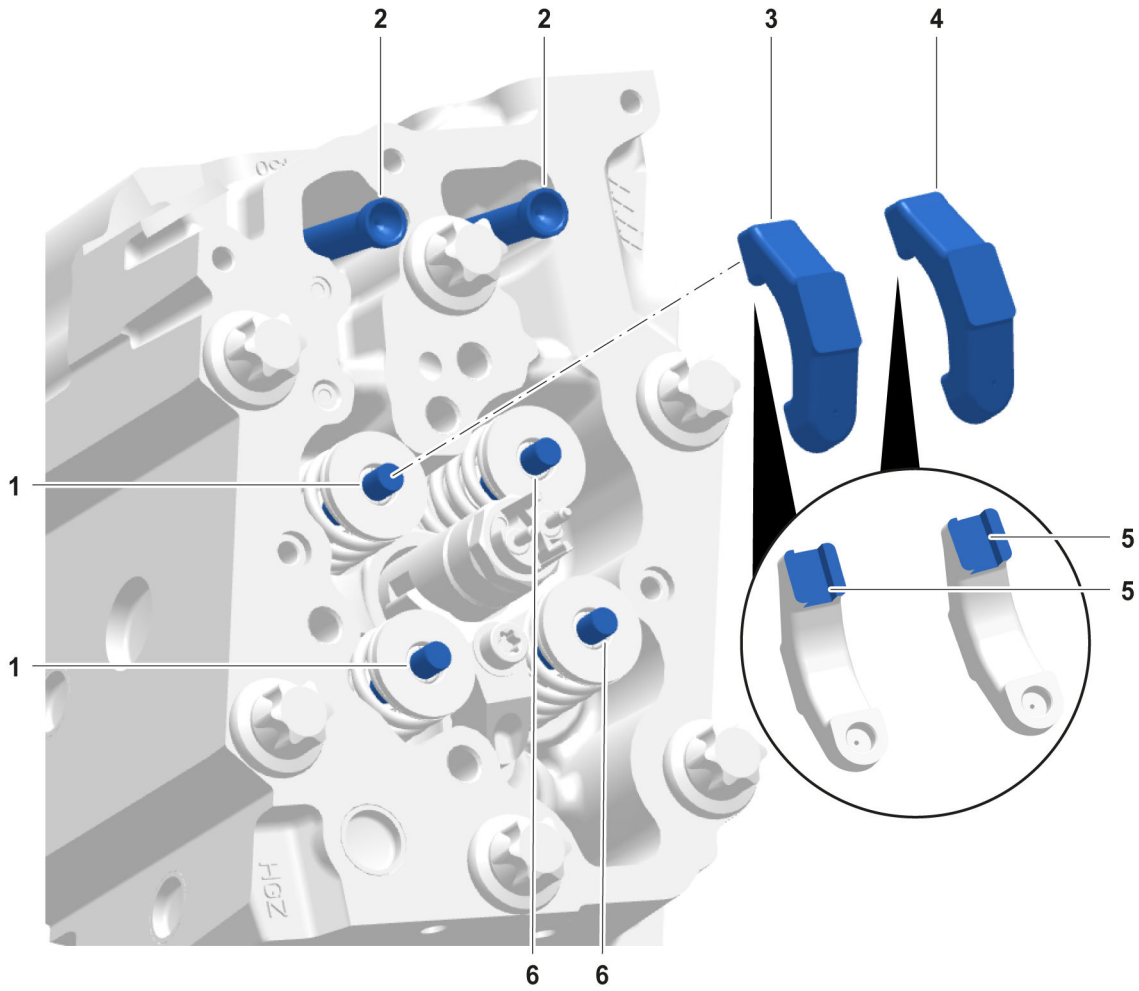

Fig. 83: Installing the valve bridges

1 Valve stem of the outlet valves
2 Push rod
3 Valve bridge of the outlet valves
4 Valve bridge of the inlet valves
5 Milling
6 Valve stem of the inlet valves

▶ Remove the valve bridge of the outlet valves **3**.

▶ Remove the valve bridge of the inlet valves **4**.

Cleaning the valve bridges

▶ Clean the valve stem of the outlet valves **1**.

▶ Clean the valve stem of the inlet valves **6**.

▶ Clean the contact surfaces of the valve stem of the outlet valves **3**.

▶ Clean the contact surfaces of the valve stem of the inlet valves **4**.

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Installing the valve bridges

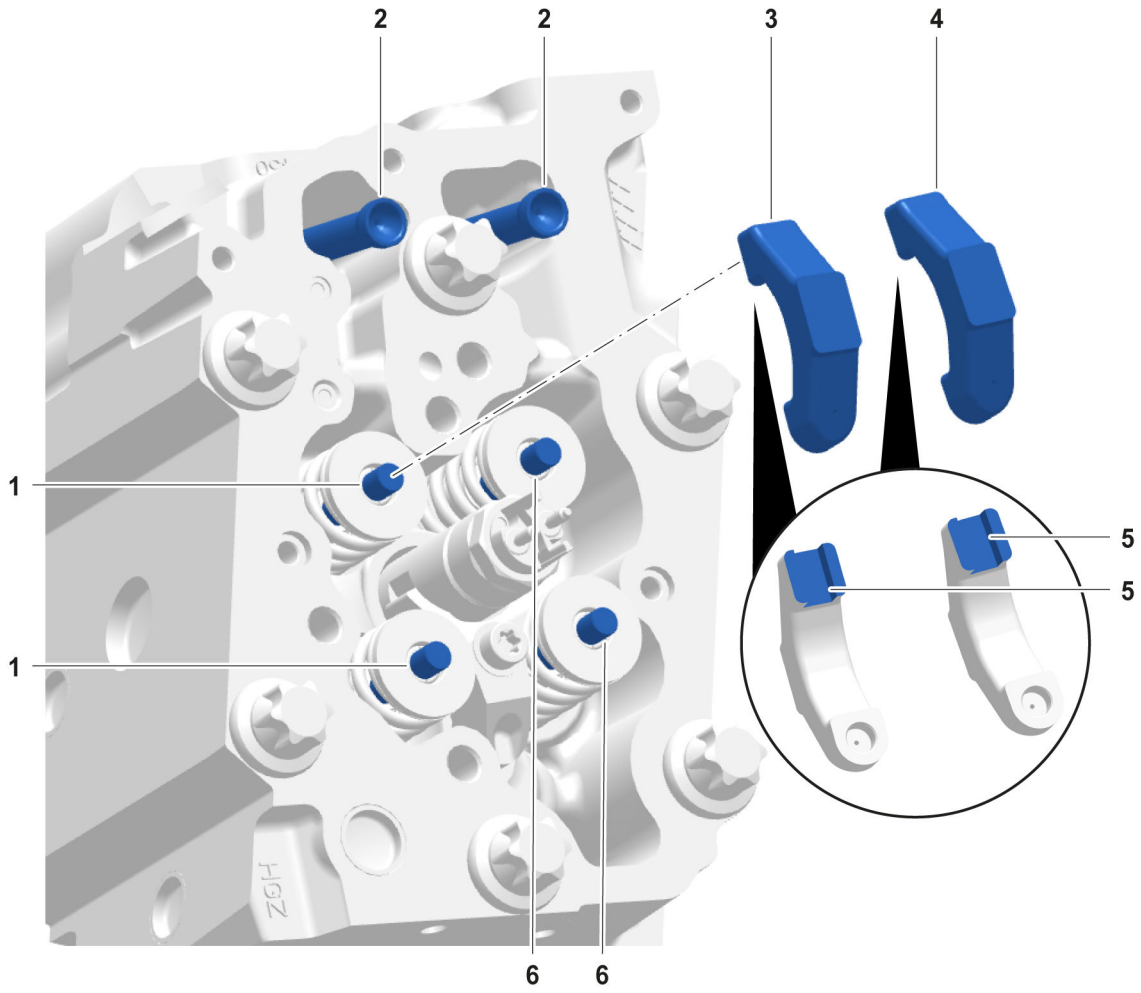

Fig. 84: Installing the valve bridges

1	Valve stem of the outlet valves	**4**	Valve bridge of the inlet valves
2	Push rod	**5**	Milling
3	Valve bridge of the outlet valves	**6**	Valve stem of the inlet valves

▶ Align the valve bridge of the inlet valves **4** with the milling **5** in the direction of the push rod **2**.

▶ Install the valve bridge of the inlet valves **4** on the valve stem of the inlet valves **6**.

▶ Align the valve bridge of the outlet valves **3** with the milling **5** in the direction of the push rod **2**.

▶ Install the valve bridge of the outlet valves **3** on the valve stem of the outlet valves **1**.

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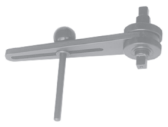
3.3.4 Removing and installing the cylinder head

Removing the cylinder head

Graphic representation	Description	Required number	Part number
	Angle of rotation device for 1/2” drive	1	0524062
	Angle of rotation device for 3/4” drive	1	10023839

Tab. 20: Special tool (optional)

Make sure that the following prerequisites are met:
- ❑ Valve bridges are removed. (For more information see: Removing the valve bridges, page 78.)
- ❑ For left cylinder head removal, the left air intake manifold is removed. (For more information see: Removing the left air intake manifold, page 275.)
- ❑ For right cylinder head removal, the right air intake manifold is removed. (For more information see: Removing the right air intake manifold, page 278.)
- ❑ For left cylinder head removal, the left exhaust manifold is removed. (For more information see: Removing the left exhaust manifold, page 341.)
- ❑ For right cylinder head removal, the right exhaust manifold is removed. (For more information see: Removing the right exhaust manifold, page 344.)
- ❑ Ventilation line is removed from corresponding cylinder head. (For more information see: Removing the ventilation lines from the cylinder banks, page 413.)
- ❑ For left cylinder head removal, the left fuel return lines from injectors to distributor block are removed. (For more information see: Removing the left fuel return lines from the injectors to the distributor block, page 194.)
- ❑ For right cylinder head removal, the right fuel return lines from injectors to distributor block are removed. (For more information see: Removing the right fuel return lines from the injectors to the distributor block, page 196.)
- ❑ Injection pipe is removed from the pressure pipe socket. (For more information see: Removing the injection pipes, page 213.)

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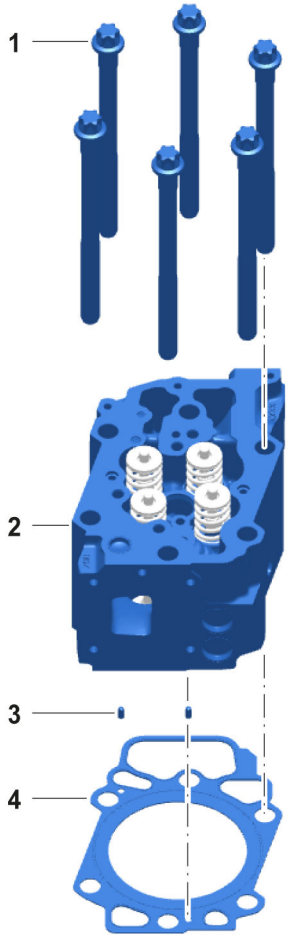

Fig. 87: Cylinder head

1	Hexalobular flange head screw (6x)	**3**	Parallel pin (2x)
2	Cylinder head	**4**	Cylinder head gasket

▶ Unscrew hexalobular flange head screws **1**.

Note
The injector projects over the sealing surface!
Damage to injector.

▶ Put cylinder head down on its side.

▶ If necessary, remove pressure pipe socket and injector. (For more information see: Removing the pressure pipe socket and injector, page 220.)

▶ Remove cylinder head **2**.

▶ Remove cylinder head gasket **4**.

▶ If necessary, remove parallel pins **3**.

Cleaning and checking the cylinder head

▶ Clean sealing surface of crankcase.

▶ Clean sealing surface of cylinder head.

▶ Clean threaded holes.

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- ▶ Check sealing surface of cylinder head with a straightedge for flatness.
- ▶ Check sealing surface of crankcase with a straightedge for flatness.

Installing the cylinder head

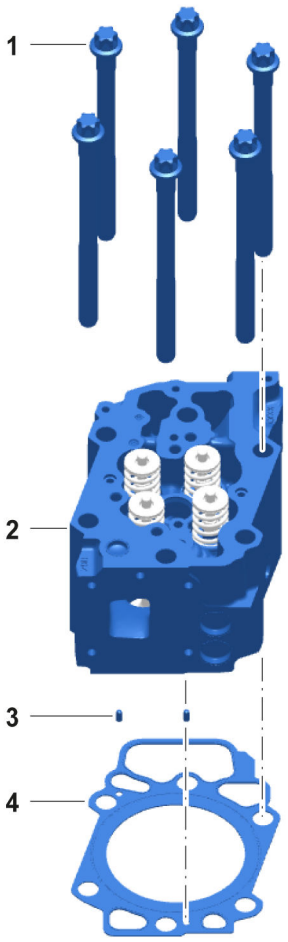

Fig. 88: Cylinder head

1 Hexalobular flange head screw (6x)
2 Cylinder head
3 Parallel pin (2x)
4 Cylinder head gasket

- ▶ Install parallel pins **3**.
- ▶ Install pressure pipe socket and injector. (For more information see: Installing the pressure pipe socket and injector, page 226.)
- ▶ Align new cylinder head gasket **4**.
- ▶ Install cylinder head gasket **4** on crankcase.
- ▶ Install cylinder head **2**.

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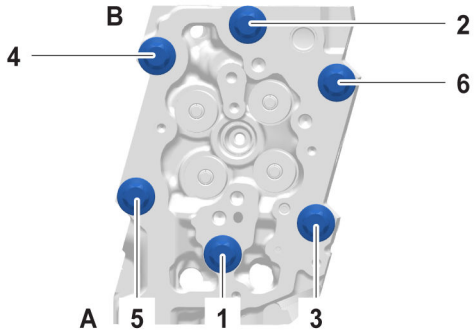
Tightening instruction for hexalobular flange head screw		
Lubricant (thread and head contact surface)	Engine oil	**Tightening sequence**  **A** Intake side **B** Exhaust gas side
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	30 Nm	
2.	100 Nm	
3.	200 Nm	
4.	300 Nm	
Stage	**Angle of rotation**	
5.	90°	
6.	60°	

Tab. 21: Tightening instruction 12935033-001

▶ Tighten new hexalobular flange head screws **1** according to tightening instruction.

3.3.5 Valves and valve stem seal

Removing the valves

Graphic representation	Description	Required number	Part number
	Valve jack	1	10354008

Tab. 22: Special tool

Make sure that the following prerequisite is met:
❑ Cylinder head is removed. (For more information see: Removing the cylinder head, page 81.)

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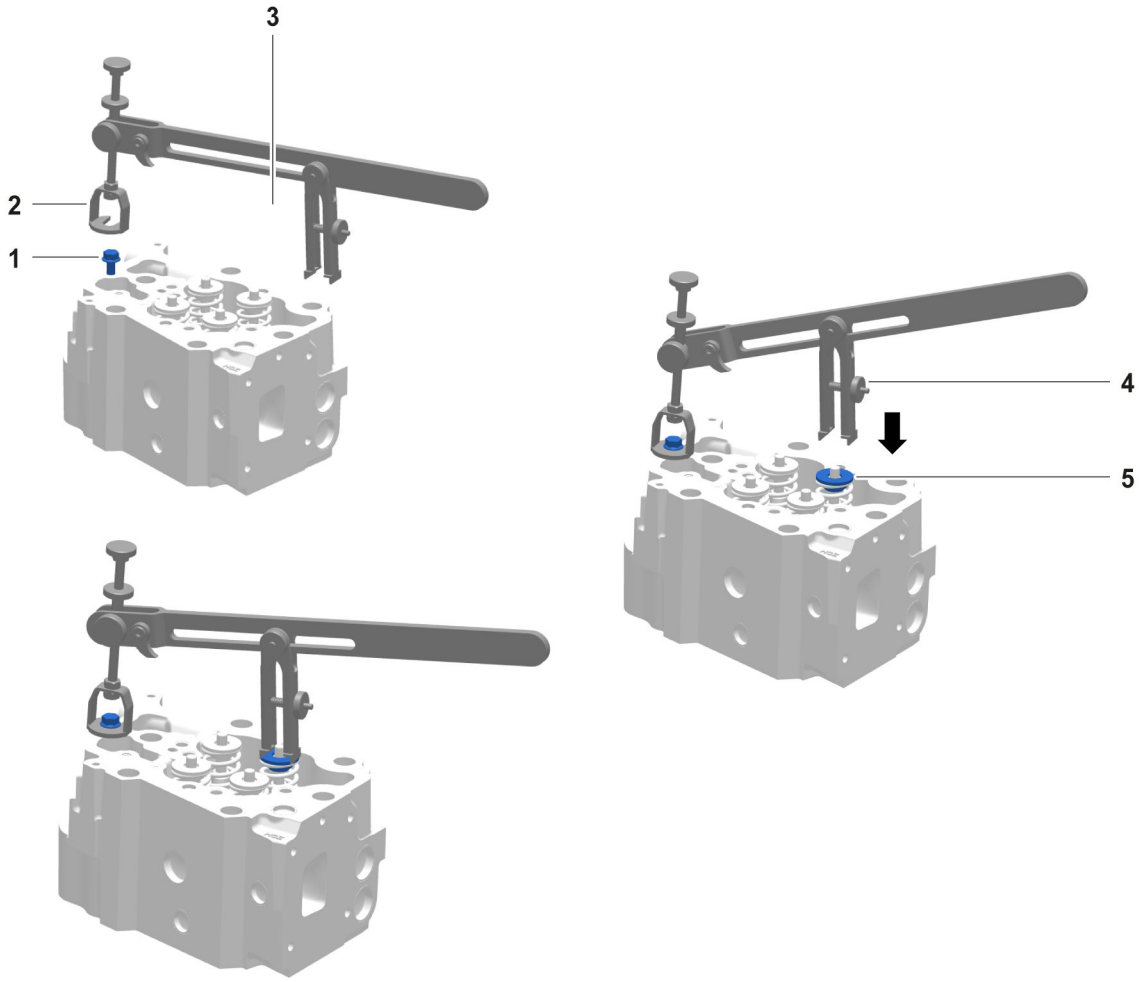

Fig. 91: Installing the valve jack

1 Hex head screw
2 Front mount
3 Valve jack lever
4 Rear mount
5 Spring cup

- ▶ Screw a suitable external hex bolt **1** into cylinder head.
- ▶ Attach front mount **2** of the valve jack to external hex bolt **1**.
- ▶ If necessary, set height of the front mount **2**.
- ▶ Attach rear mount **4** with valve jack lever **3** to spring cup **5**.
- ▶ If necessary, align rear mount **4**.
- ▶ Tighten hex head screw **1**.

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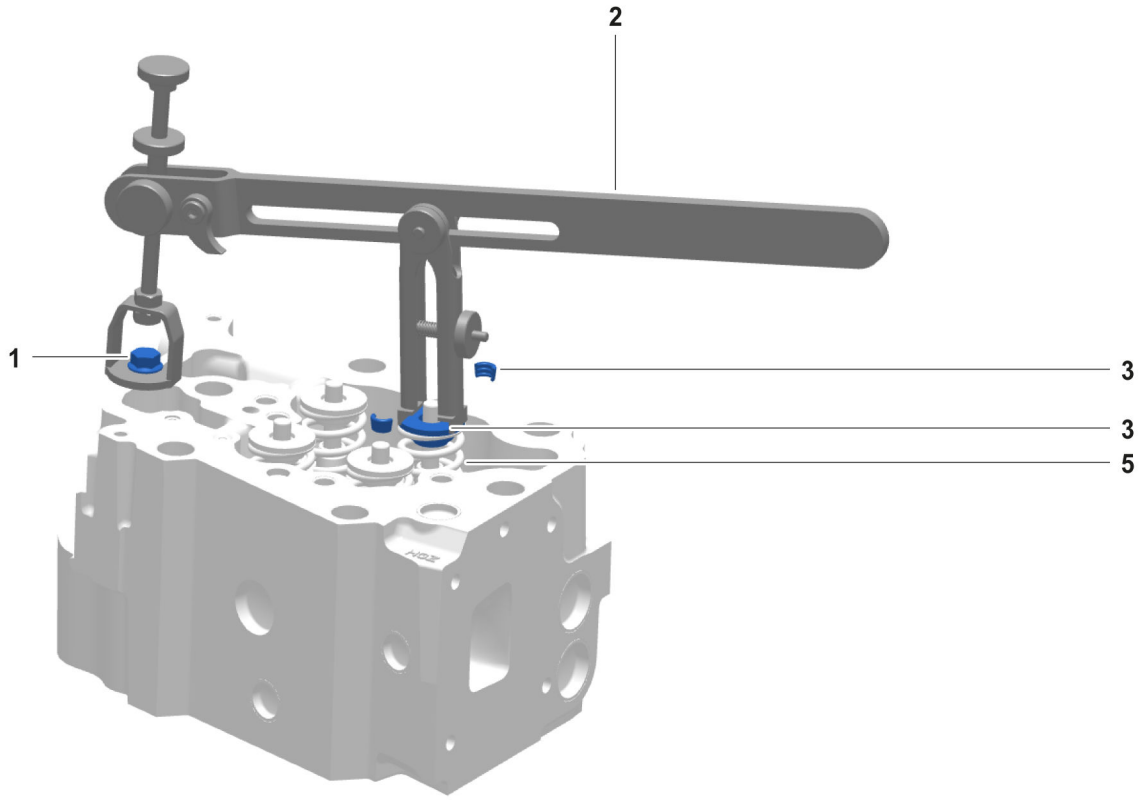

Fig. 92: Removing the valve collets

1 Hex head screw
2 Valve jack
3 Valve collet (2x)
4 Spring cup
5 Valve spring

Note

If necessary, extend valve jack lever using a suitable tool.

- ▶ Press down spring cup **4** and valve spring **5** with valve jack **2**.
- ▶ Remove both valve collets **3** with standard magnets.
- ▶ Release valve jack **2**.
- ▶ Remove valve jack **2**.
- ▶ Unscrew hex head screw **1**.

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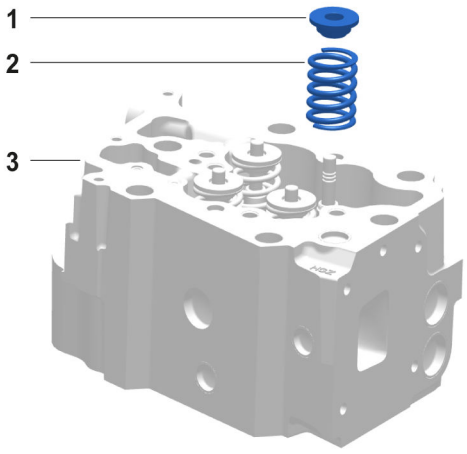

Fig. 93: Installing the valve train

1 Spring cup
2 Valve spring
3 Cylinder head

▶ Remove spring cup **1**.

▶ Remove valve spring **2**.

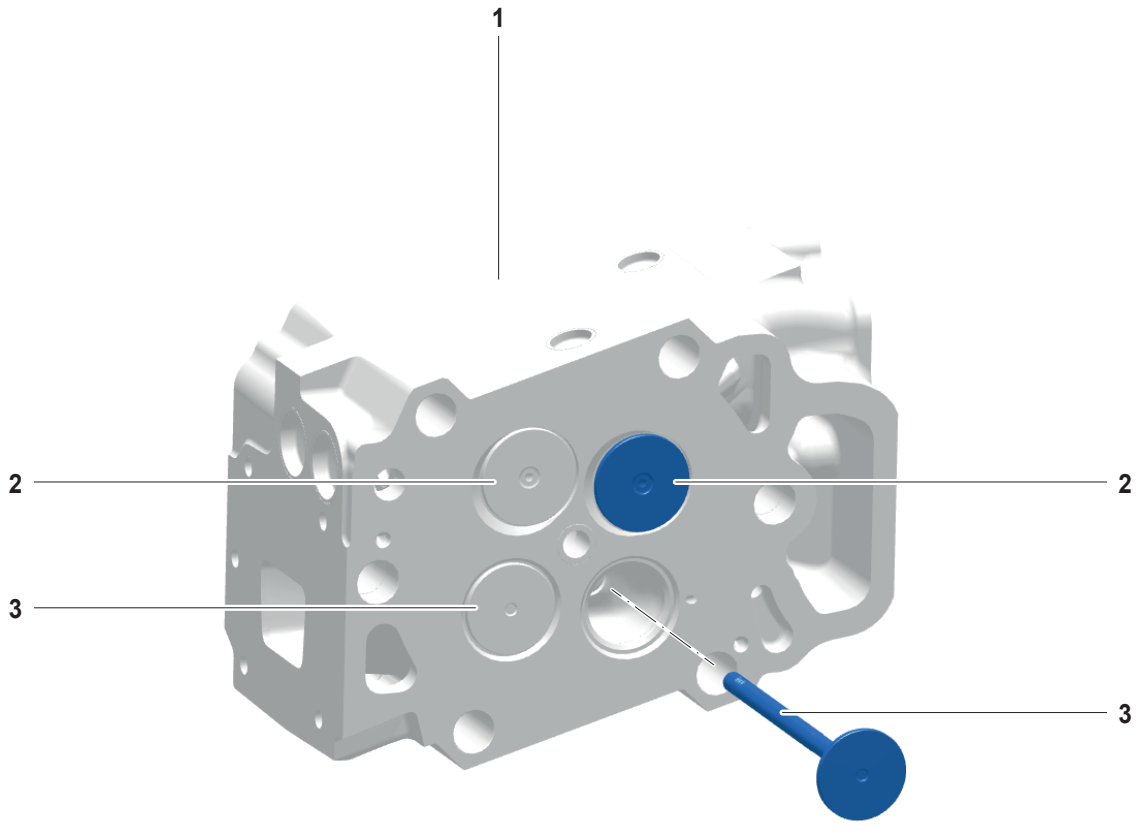

Fig. 94: Removing the valve

1 Cylinder head
2 Inlet valve
3 Outlet valve

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NOTICE
Cylinder head is sharp-edged!
Injuries.

▶ Put on safety gloves.

▶ Carefully lay cylinder head **1** on its side.

▶ Remove inlet valves **2** from cylinder head **1**.

▶ Remove outlet valves **3** from cylinder head **1**.

Installing the valves

Graphic representation	Description	Required number	Part number
	Valve jack	1	10354008

Tab. 23: Special tool

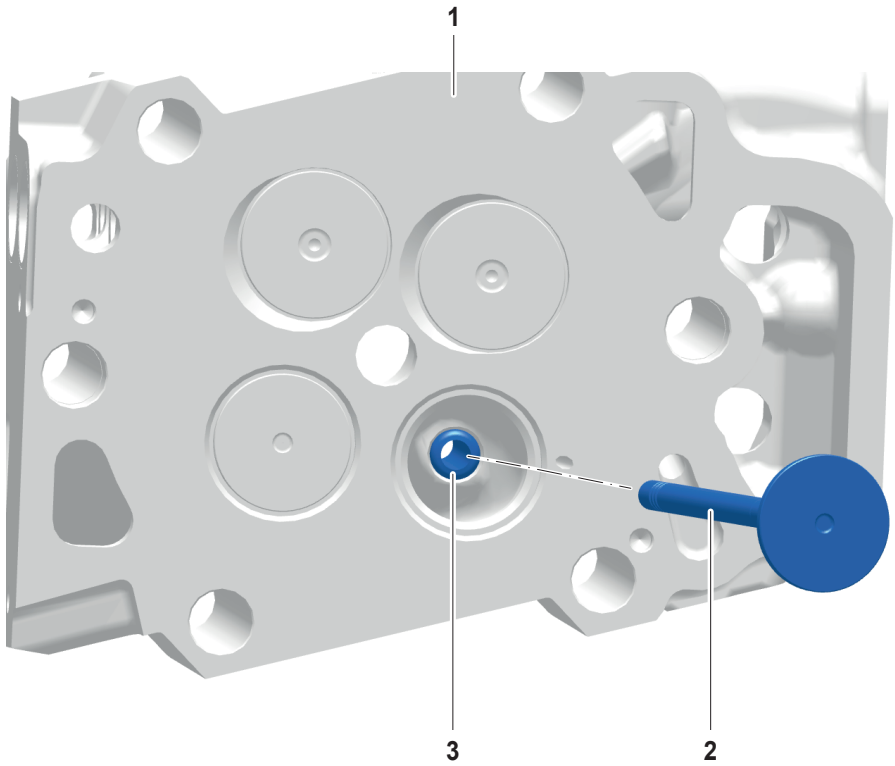

Fig. 96: Installing the valve

1 Cylinder head
2 Valve stem
3 Valve guide

▶ Lubricate valve stem **2** with new engine oil.

▶ Install valve in valve guide **3** of cylinder head **1**.

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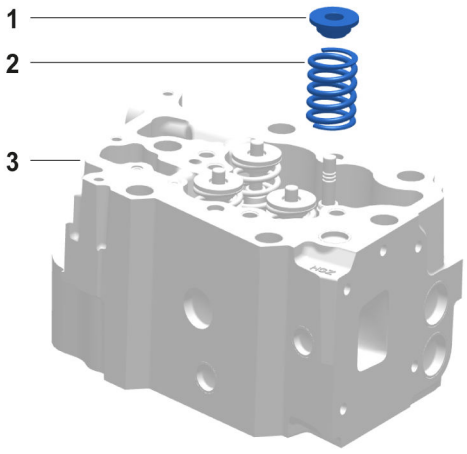

Fig. 97: Installing the valve train

1 Spring cup
2 Valve spring
3 Cylinder head

▶ Install valve spring **2** in cylinder head **3**.

▶ Install spring cup **1** on valve spring **2**.

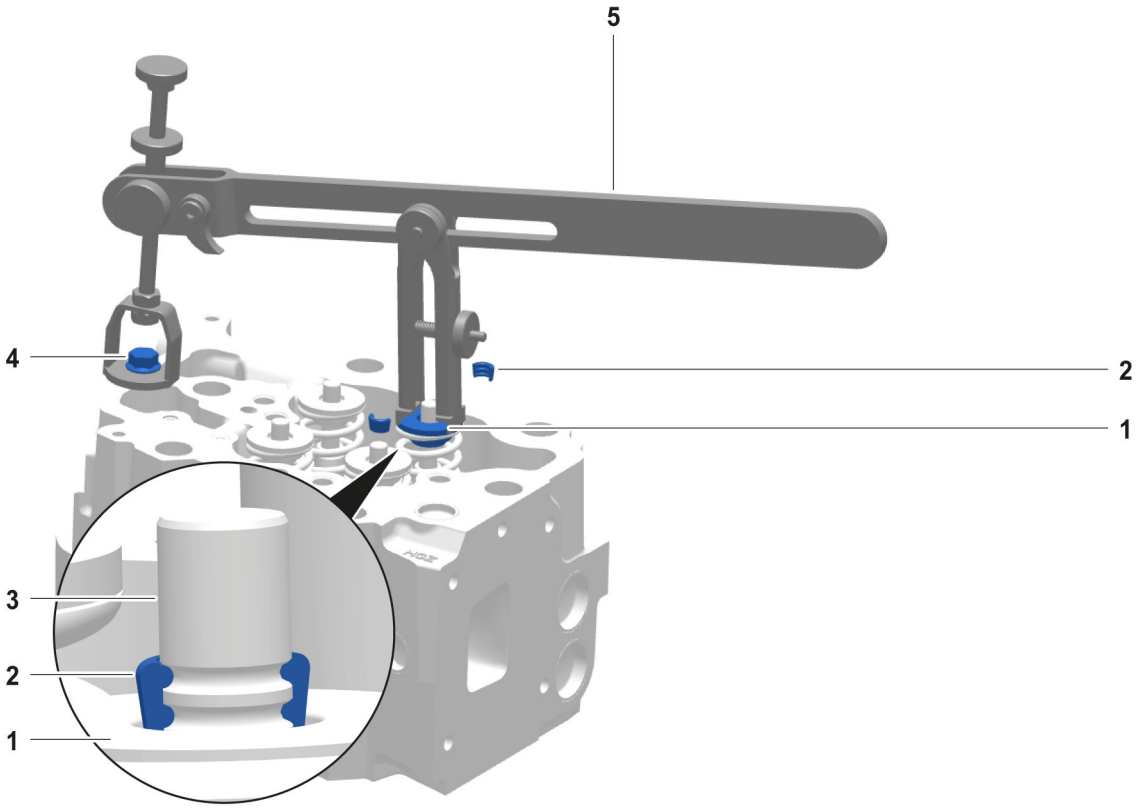

Fig. 98: Installing the valve collet

1 Spring cup
2 Valve collet (2x)
3 Valve stem
4 Hex head screw
5 Valve jack

▶ Attach valve jack **5** to spring cup **1**.

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DANGER
The valve springs are installed with a high preload and can be ejected in the event of a mechanical defect!
Injuries.

- ▶ Use special tool.
- ▶ Observe repair instruction.

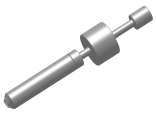
Note

If necessary, extend valve jack lever using a suitable tool.

- ▶ Press down spring cup **1** with valve jack **5**.
- ▶ Install valve collets **2** in grooves of valve stem **3**.
- ▶ Carefully release valve jack **5**.
- ▶ Unscrew hex head screw **4**.
- ▶ Remove valve jack **5**.
- ▶ Set valve clearance of the inlet valves and outlet valves. (For more information see: Checking and setting the valve clearance, page 70.)

Removing and installing the valve stem seals

Removing the valve stem seals

Graphic representation	Description	Required number	Part number
	Assembly device	1	10023928

Tab. 24: Special tool

Make sure that the following prerequisite is met:
❑ Valve spring is removed. (For more information see: Removing the valves, page 84.)

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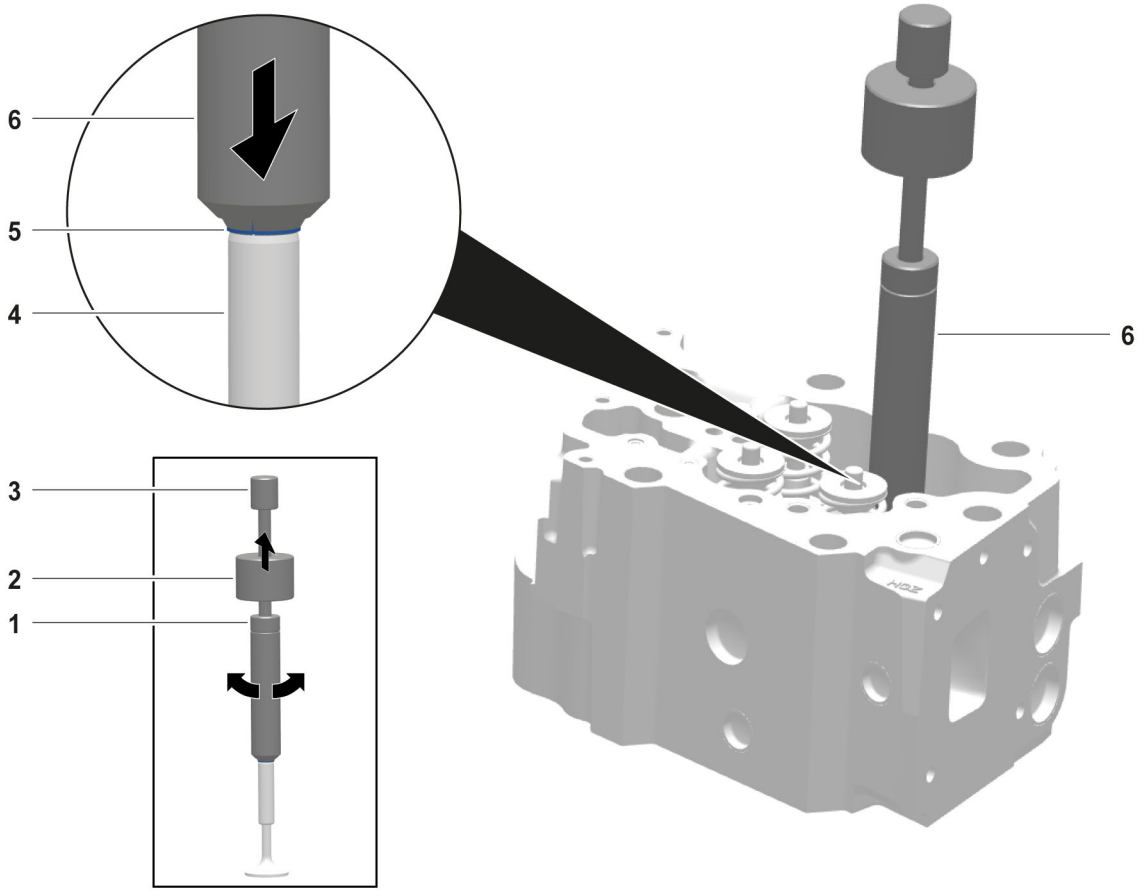


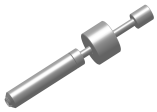
Fig. 100: Removing the valve stem seal with assembly device

1 Adjustment unit
2 Impact extractor
3 End stop
4 Valve guide
5 Valve stem seal
6 Assembly device

- ▶ Turn adjustment unit **1** of the assembly device **6** counterclockwise to limit stop.
- ▶ Install assembly device **6** over valve stem seal **5**.
- ▶ Turn adjustment unit **1** clockwise until the valve stem seal **5** clamps.
- ▶ Strike impact extractor **2** against the end stop **3** until the valve stem seal **5** releases.
- ▶ Remove valve stem seal **5**.

Installing the valve stem seals

Graphic representation	Description	Required number	Part number
	Mounting sleeve	1	10023909

Graphic representation	Description	Required number	Part number
	Assembly device	1	10023928

Tab. 25: Special tool

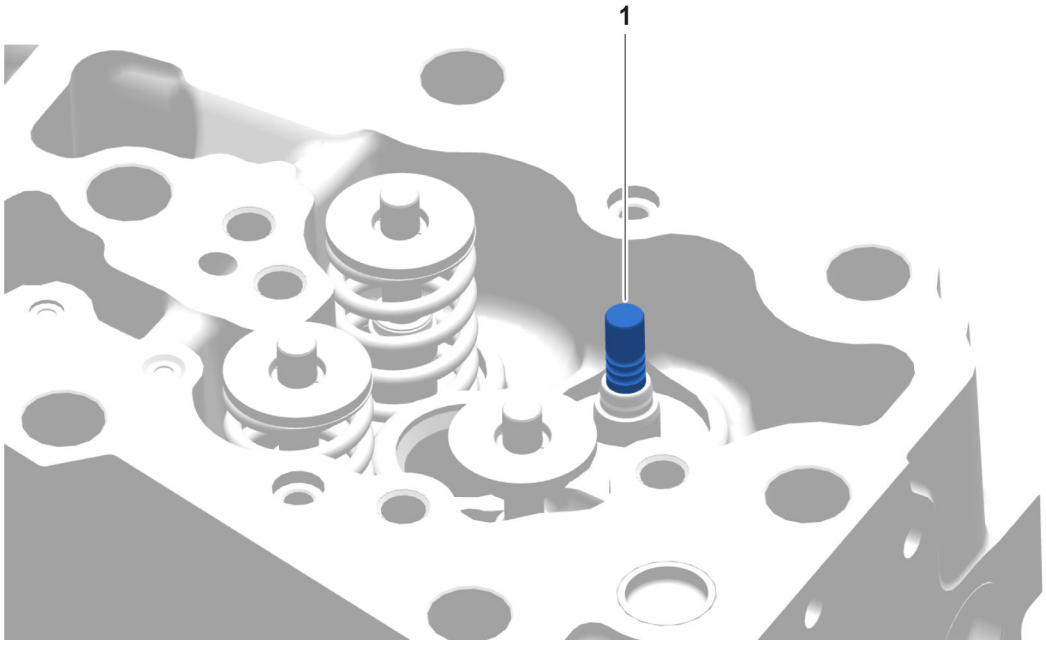


Fig. 103: Aligning the valve for the assembly device

1 Valve stem

▶ Push valve stem **1** down by hand until the position shown is reached.

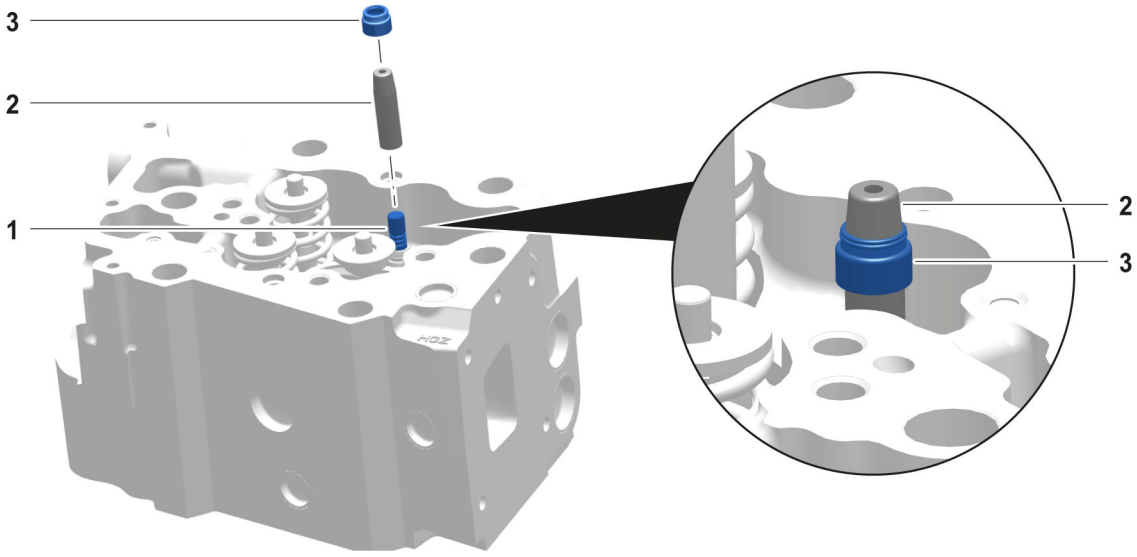


Fig. 104: Valve stem seal

1 Valve stem
2 Mounting sleeve
3 Valve stem seal

▶ Install mounting sleeve **2** on valve stem **1**.

▶ Install new valve stem seal **3** over mounting sleeve **2** and valve stem **1**.

▶ Remove mounting sleeve **2**.

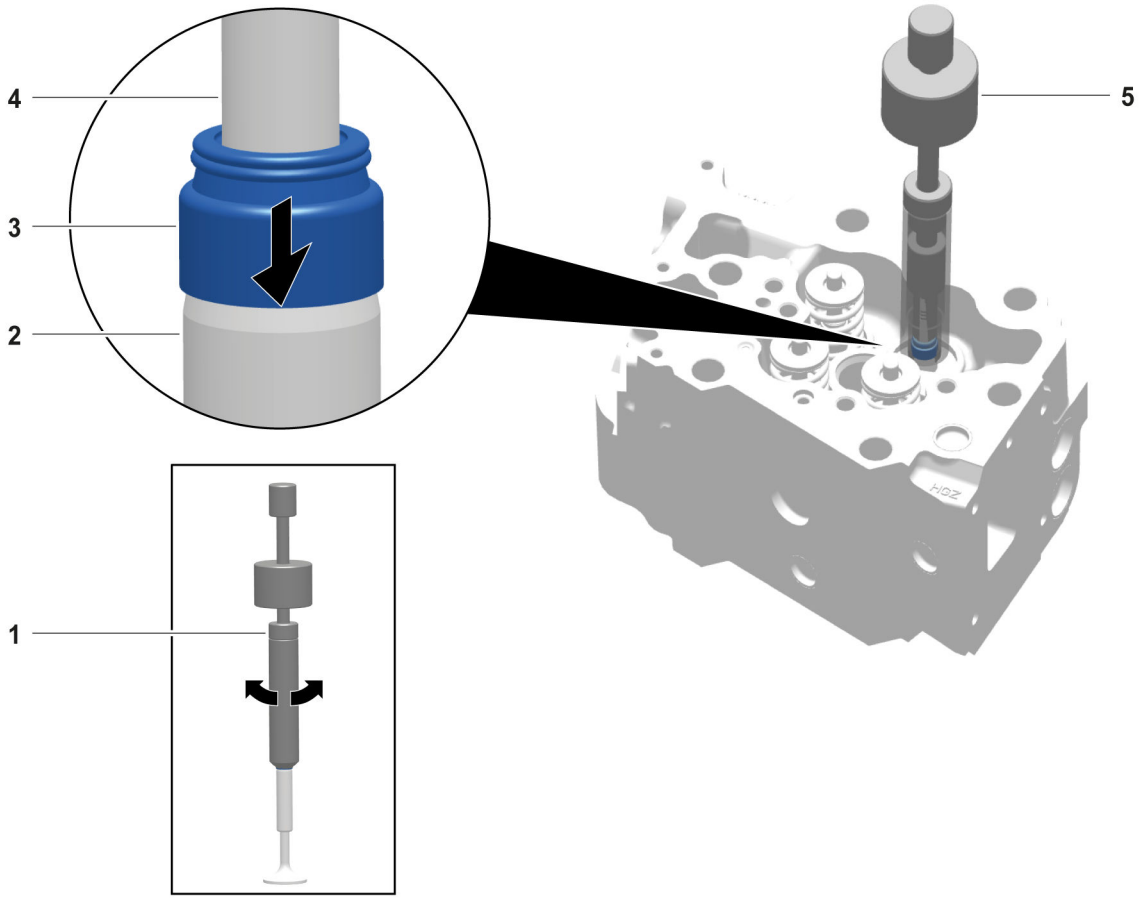


Fig. 105: Installing the valve stem seal with assembly device

1 Adjustment unit
2 Valve guide
3 Valve stem seal
4 Valve stem
5 Assembly device

▶ Turn adjustment unit **1** of the assembly device **5** counterclockwise to limit stop.

▶ Install assembly device **5** over valve stem **4** and valve stem seal **3**.

▶ Turn adjustment unit **1** clockwise until valve stem seal **3** is firmly seated in assembly device **5**.

▶ Carefully press down valve stem seal **3** with assembly device **5**.
▷ The valve stem seal **3** is firmly seated on the valve guide **2**.

▶ Turn adjustment unit **1** of the assembly device **5** counterclockwise to limit stop.

▶ Remove assembly device **5**.

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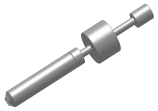
Removing and installing the valve stem seal (without cylinder head removal)

Removing the valve stem seal (without cylinder head removal)

Graphic representation	Description	Required number	Part number
	Valve jack	1	10354008
	Assembly device	1	10023928

Tab. 26: Special tool

Make sure that the following prerequisite is met:

- ❑ Rocker arm bracket and push rods are removed. (For more information see: Removing the rocker arm bracket and push rods, page 74.)

- ▶ Turn crankshaft until corresponding cylinder is in ignition TDC position. (For more information see: Setting cylinder 1 to ignition TDC, page 69.) (For more information see: Setting cylinder 2 to 12 to ignition TDC, page 70.)

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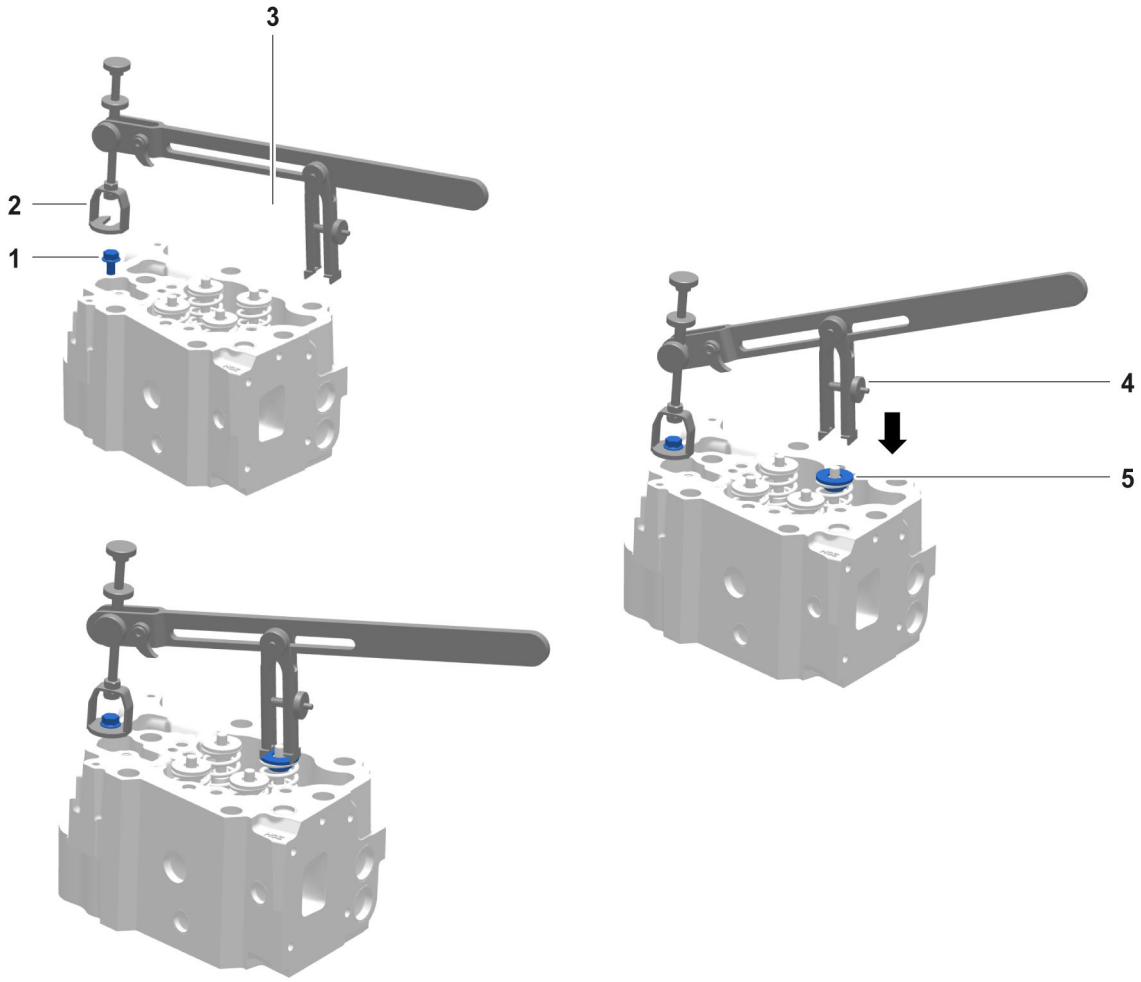

Fig. 108: Installing the valve jack

1 Hex head screw
2 Front mount
3 Valve jack lever
4 Rear mount
5 Spring cup

- ▶ Screw a suitable external hex bolt **1** into cylinder head.
- ▶ Attach front mount **2** of the valve jack to external hex bolt **1**.
- ▶ If necessary, set height of the front mount **2**.
- ▶ Attach rear mount **4** with valve jack lever **3** to spring cup **5**.
- ▶ If necessary, align rear mount **4**.
- ▶ Tighten hex head screw **1**.

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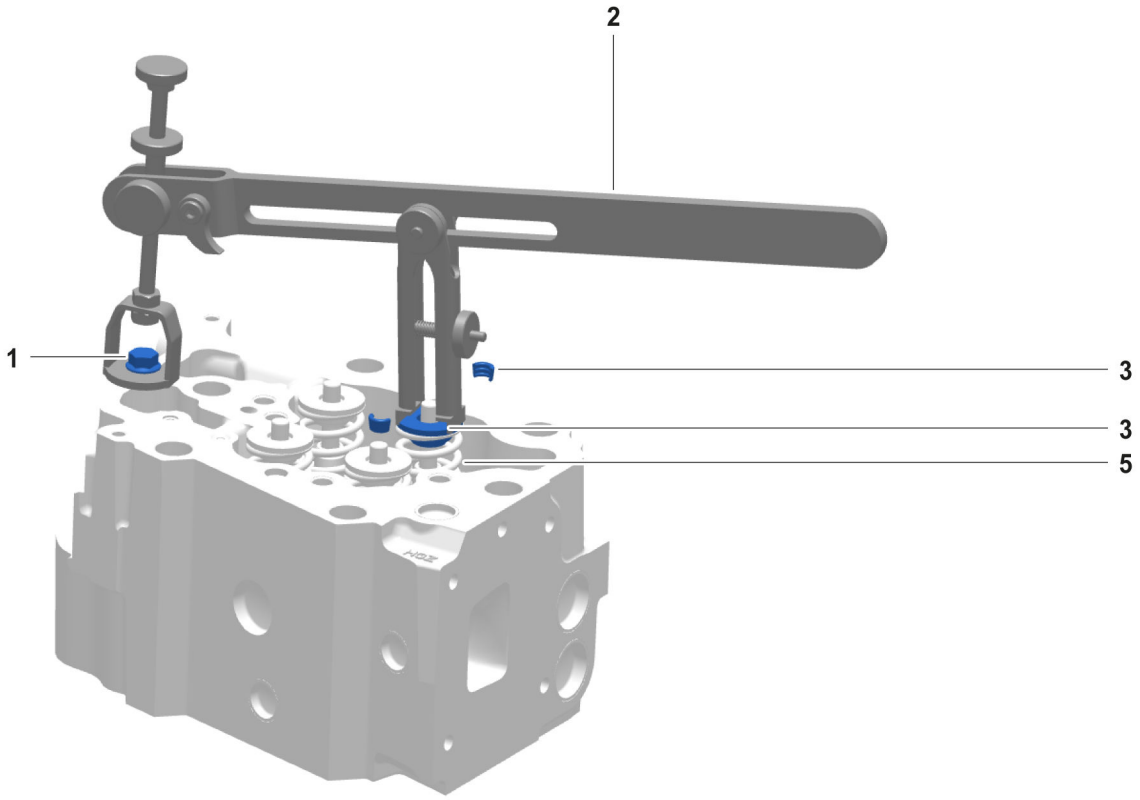

Fig. 109: Removing the valve collets

1 Hex head screw
2 Valve jack
3 Valve collet (2x)
4 Spring cup
5 Valve spring

WARNING
Ejection of valve springs due to a high preload!
Serious injuries possible.

- ▶ Only remove valve springs with special tool.
- ▶ Observe repair instruction.

NOTICE
Valve falls out of valve guide onto piston head!
Damage to engine.

- ▶ Do not continue to turn the engine.

Note

If necessary, extend valve jack lever using a suitable tool.

- ▶ Press down spring cup **4** and valve spring **5** with valve jack **2**.
- ▶ Remove both valve collets **3** with standard magnets.
- ▶ Release valve jack **2**.
- ▶ Remove valve jack **2**.
- ▶ Unscrew hex head screw **1**.

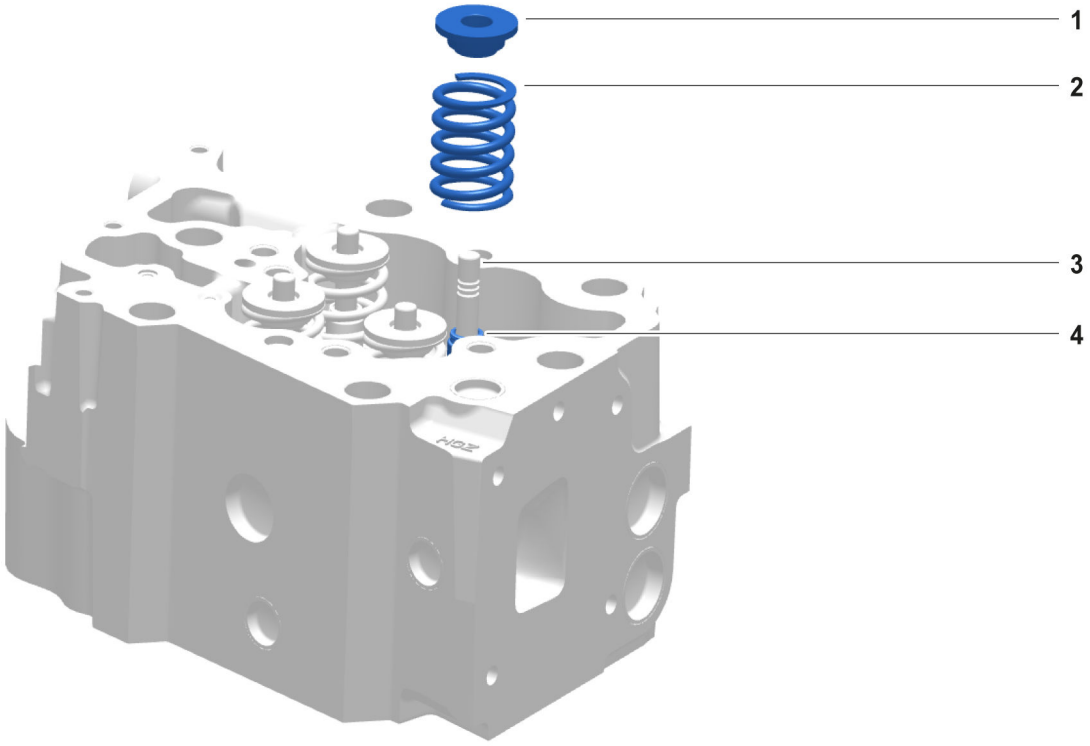

Fig. 110: Removing the valve train

1 Spring cup
2 Valve spring
3 Valve stem
4 Valve stem seal

▶ Remove spring cup **1**.

▶ Remove valve spring **2**.

▶ Turn crankshaft and simultaneously press valve stem **3** down by hand until the upper area of the valve stem **3** is at the height of the valve stem seal **4**.

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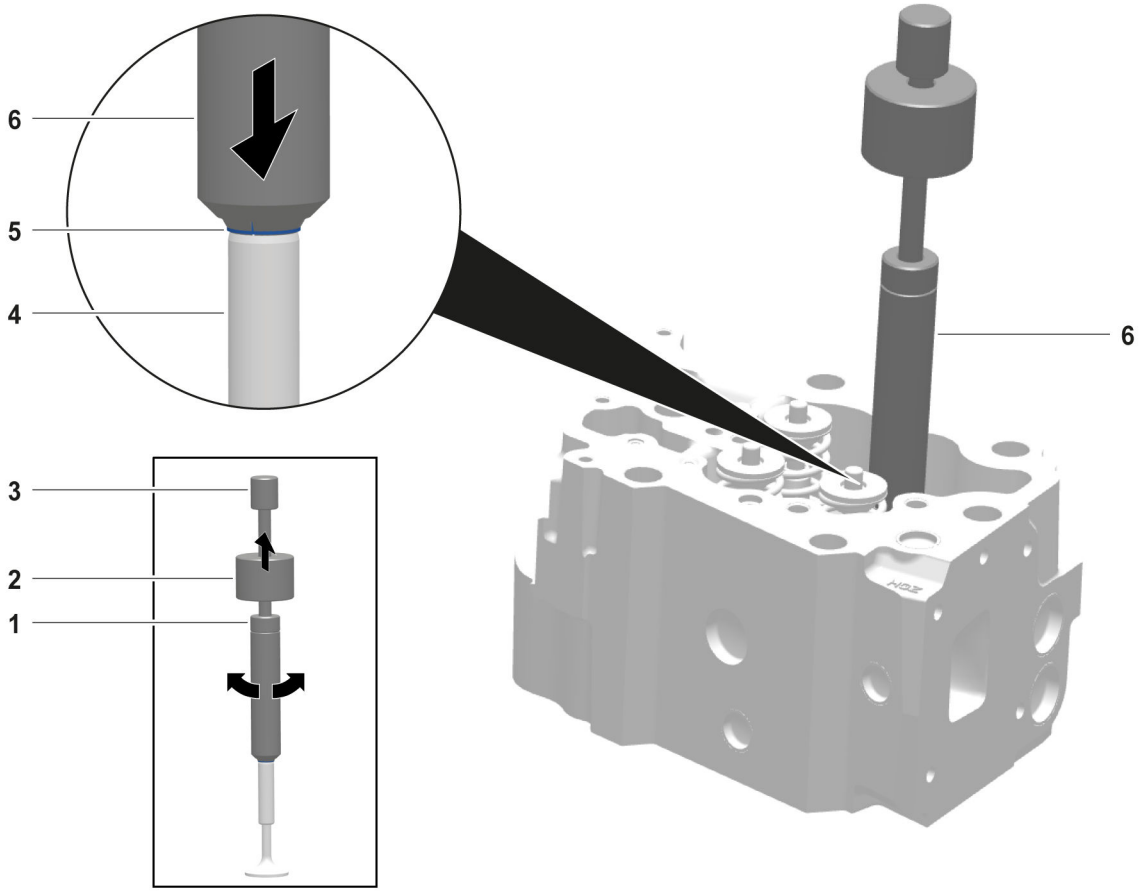

Fig. 111: Removing the valve stem seal with assembly device

1 Adjustment unit
2 Impact extractor
3 End stop
4 Valve guide
5 Valve stem seal
6 Assembly device

- ▶ Turn adjustment unit **1** of the assembly device **6** counterclockwise to limit stop.
- ▶ Install assembly device **6** over valve stem seal **5**.
- ▶ Turn adjustment unit **1** clockwise until the valve stem seal **5** clamps.
- ▶ Strike impact extractor **2** against the end stop **3** until the valve stem seal **5** releases.
- ▶ Remove valve stem seal **5**.

Cleaning

- ▶ If necessary, remove residues from the valve stem seal that was removed.

Installing the valve stem seal (without cylinder head removal)

Graphic representation	Description	Required number	Part number
	Valve jack	1	10354008

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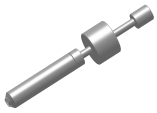
Graphic representation	Description	Required number	Part number
	Assembly device	1	10023928
	Mounting sleeve	1	10023909

Tab. 27: Special tool

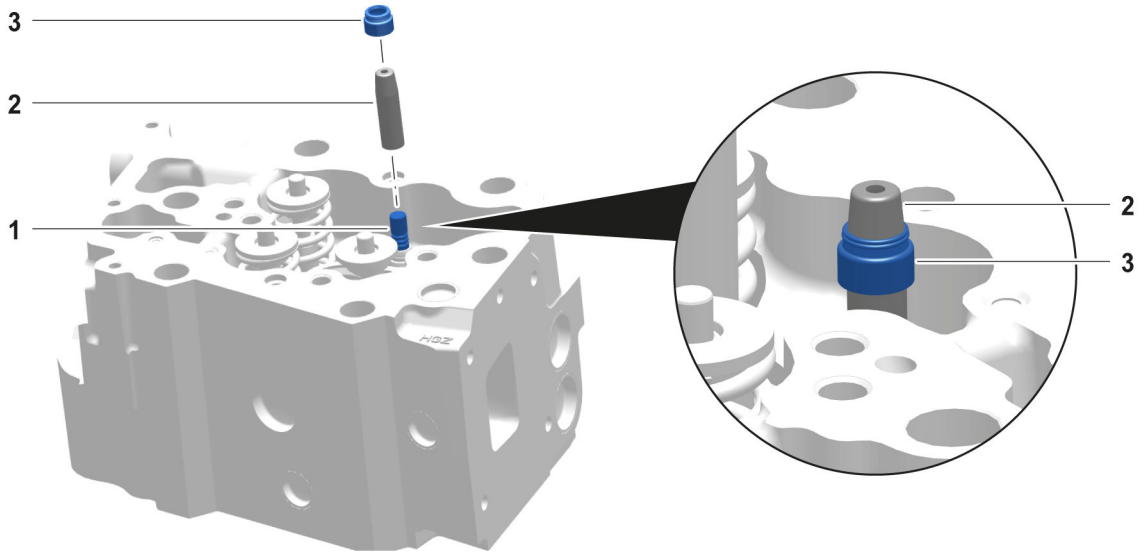


Fig. 115: Valve stem seal

1 Valve stem
2 Mounting sleeve
3 Valve stem seal

▶ Install mounting sleeve **2** on valve stem **1**.

▶ Install new valve stem seal **3** over mounting sleeve **2** and valve stem **1**.

▶ Remove mounting sleeve **2**.

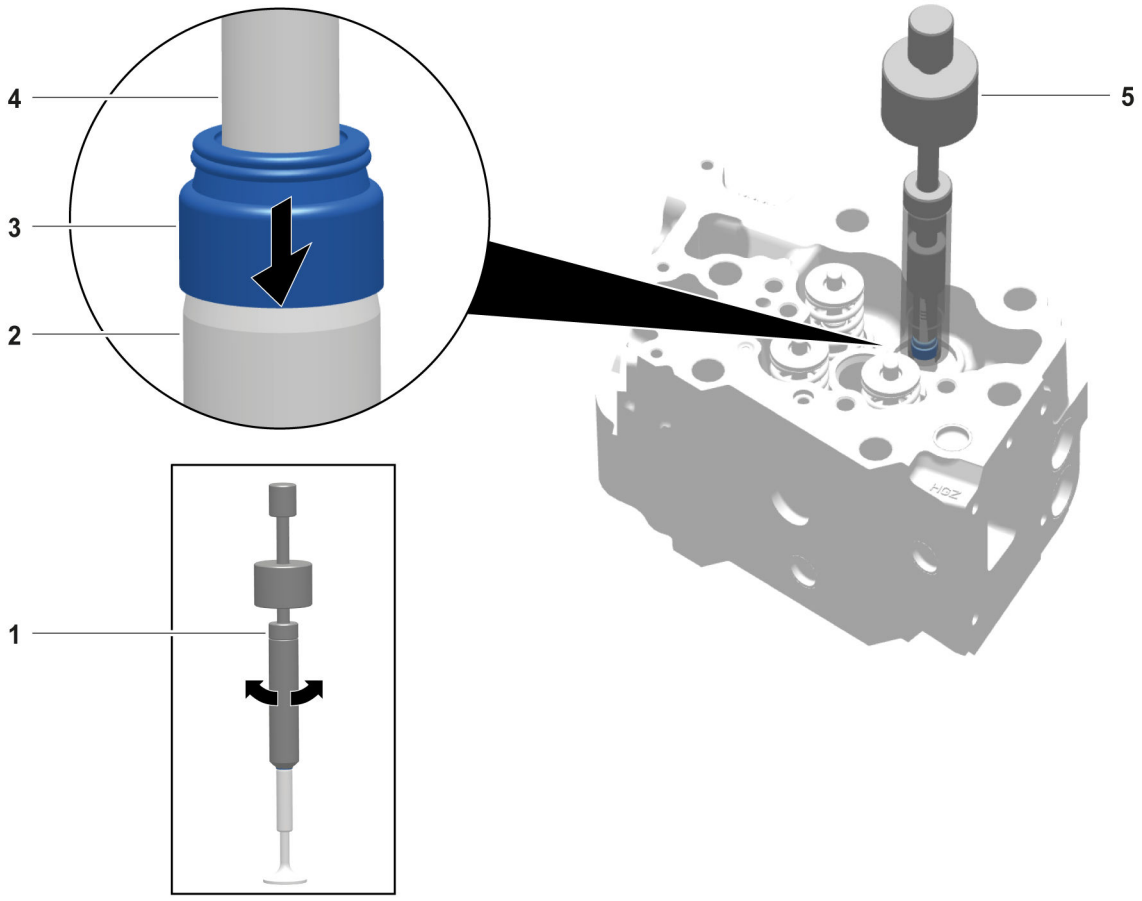


Fig. 116: Installing the valve stem seal with assembly device

1 Adjustment unit
2 Valve guide
3 Valve stem seal
4 Valve stem
5 Assembly device

- ▶ Turn adjustment unit **1** of the assembly device **5** counterclockwise to limit stop.
- ▶ Install assembly device **5** over valve stem **4** and valve stem seal **3**.
- ▶ Turn adjustment unit **1** clockwise until valve stem seal **3** is firmly seated in assembly device **5**.
- ▶ Carefully press down valve stem seal **3** with assembly device **5**.
  ▷ The valve stem seal **3** is firmly seated on the valve guide **2**.
- ▶ Turn adjustment unit **1** of the assembly device **5** counterclockwise to limit stop.
- ▶ Remove assembly device **5**.

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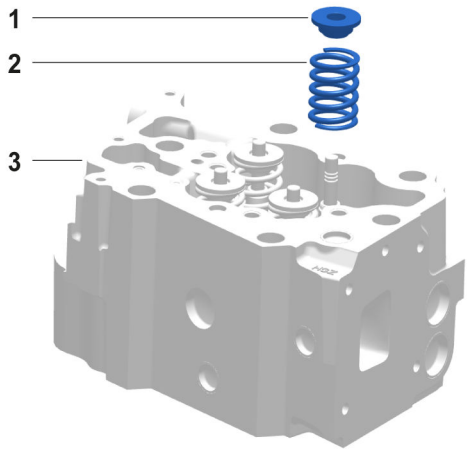

Fig. 117: Installing the valve train

1 Spring cup
2 Valve spring
3 Cylinder head

▶ Install valve spring **2** in cylinder head **3**.

▶ Install spring cup **1** on valve spring **2**.

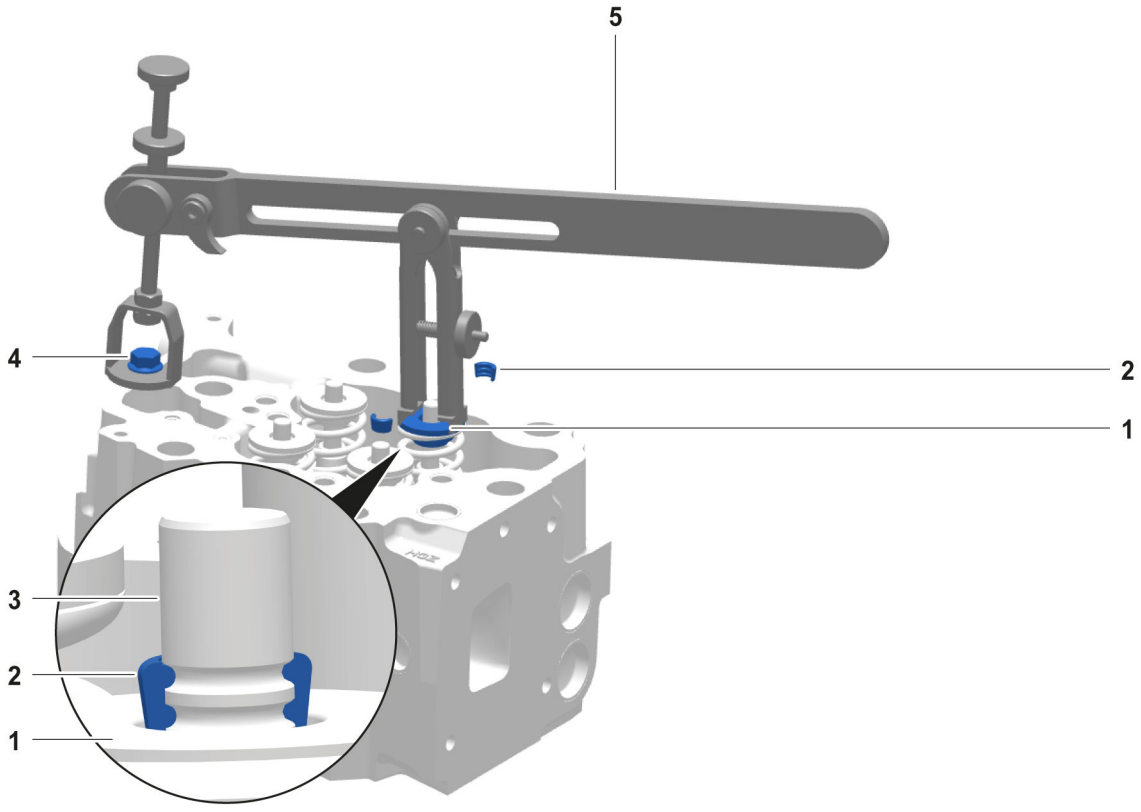

Fig. 118: Installing the valve collet

1 Spring cup
2 Valve collet (2x)
3 Valve stem
4 Hex head screw
5 Valve jack

▶ Attach valve jack **5** to spring cup **1**.

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WARNING
Ejection of valve springs due to a high preload!
Serious injuries possible.

- ▶ Only remove valve springs with special tool.
- ▶ Observe repair instruction.

Note

If necessary, extend valve jack lever using a suitable tool.

- ▶ Press down spring cup **1** with valve jack **5**.
- ▶ Install valve collets **2** in grooves of valve stem **3**.
- ▶ Carefully release valve jack **5**.
- ▶ Unscrew hex head screw **4**.
- ▶ Remove valve jack **5**.
- ▶ Set valve clearance of the inlet valves and outlet valves. (For more information see: Checking and setting the valve clearance, page 70.)

3.3.6 Removing and installing the roller plunger

Removing the roller plunger

Make sure that the following prerequisites are met:
- ❑ Cylinder head is removed. (For more information see: Removing the cylinder head, page 81.)
- ❑ Piston cooling nozzle is removed. (For more information see: Removing the piston cooling nozzle, page 409.)

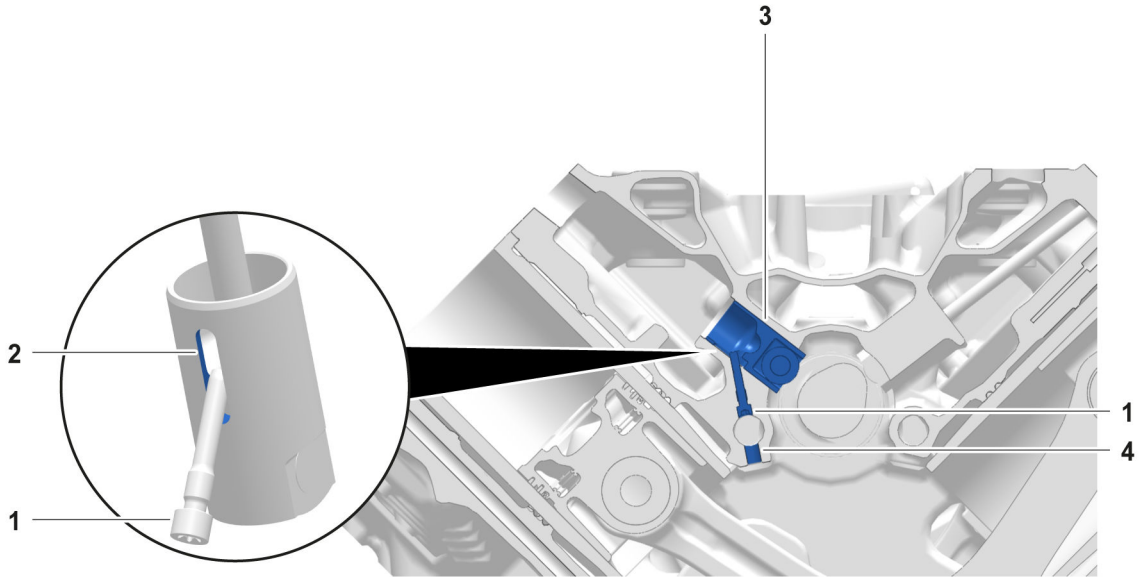


Fig. 119: Roller plunger

1 Self-locking screw
2 Groove
3 Roller plunger
4 Access hole

- ▶ Unscrew self-locking screw **1**.
- ▶ Remove roller plunger **3**.

Checking the roller plunger

- ▶ Check roller plunger **3** for damage and replace if necessary.
- ▶ Check ease of operation of the roller plunger **3**.
- ▶ Check anti-twist protection of the roller plunger **3**.

Installing the roller plunger

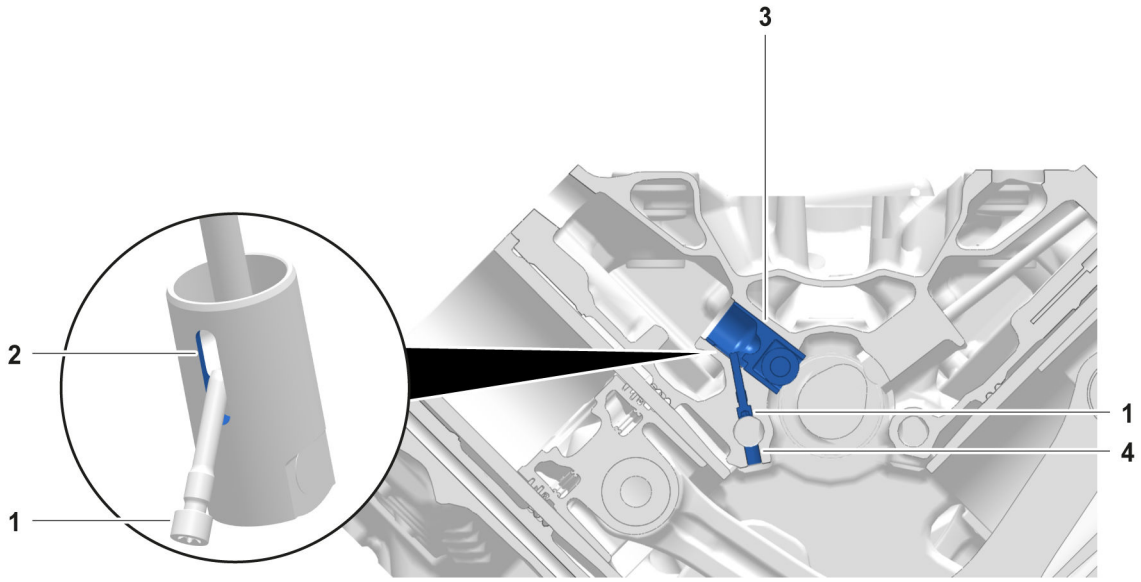
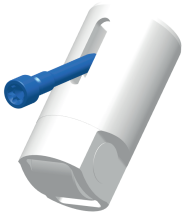


Fig. 120: Roller plunger

1 Self-locking screw
2 Groove
3 Roller plunger
4 Access hole

- ▶ Lubricate roller plunger **3** with fresh engine oil.
- ▶ Align roller plunger **3** with groove **2** in direction of access hole **4**.
- ▶ Install roller plunger **3**.
- ▶ Screw in self-locking screw **1** through access hole **4**.

Tightening instruction for self-locking screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	12.5 Nm	

Tab. 28: Tightening instruction 10120082-003

- ▶ Tighten self-locking screw **1** according to tightening instruction.

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3.3.7 Removing and installing the camshaft

Removing the camshaft

Graphic representation	Description	Required number	Part number
	Assembly tool	1	11211940

Tab. 29: Special tool

Make sure that the following prerequisites are met:
- ❑ Roller plungers are removed. (For more information see: Removing the roller plunger, page 103.)
- ❑ Flywheel housing is removed. (For more information see: Removing the flywheel housing, page 162.)

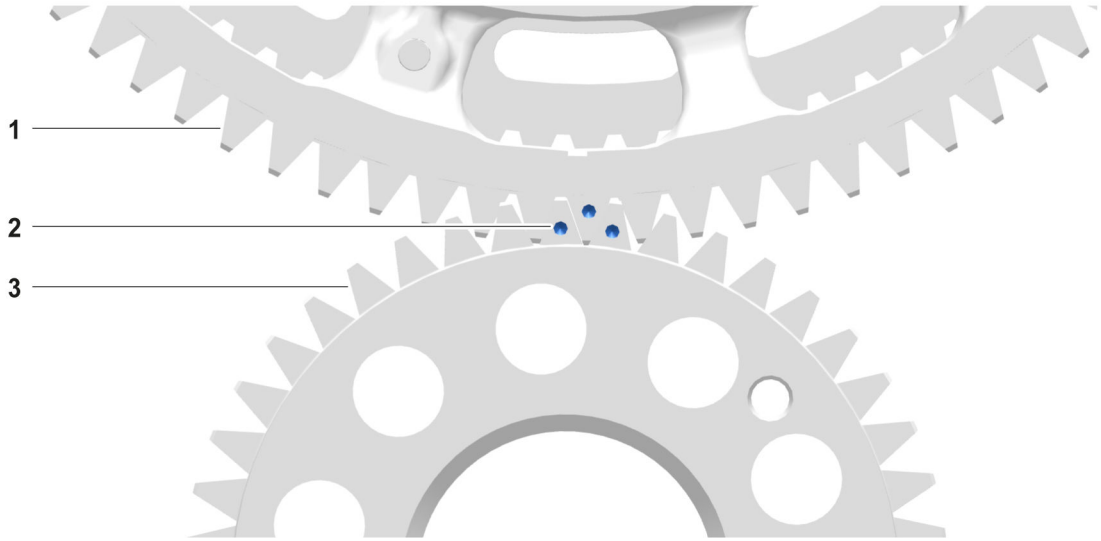

Fig. 123: Ignition TDC mark

1 Camshaft gear wheel
2 Ignition TDC mark (3x)
3 Crankshaft gear wheel

▶ Turn crankshaft gear wheel **3** and camshaft gear wheel **1** to ignition TDC marks **2**.

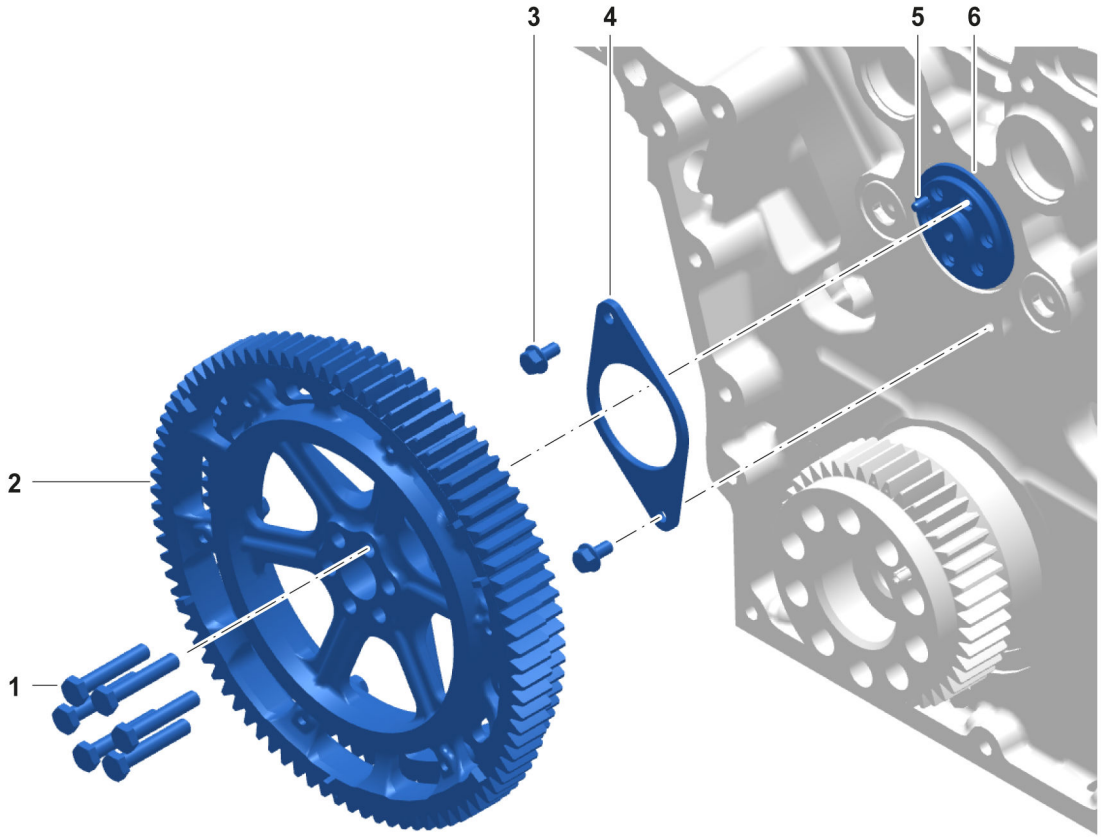

Fig. 124: Camshaft gear wheel and bearing flange

1 Hex head screw (6x)
2 Camshaft drive gear wheel
3 Hex head screw (2x)
4 Bearing flange
5 Dowel
6 Camshaft

▶ Unscrew hex head screws **1**.

▶ Remove camshaft drive gear wheel **2**.

▶ Unscrew hex head screws **3**.

▶ Remove bearing flange **4**.

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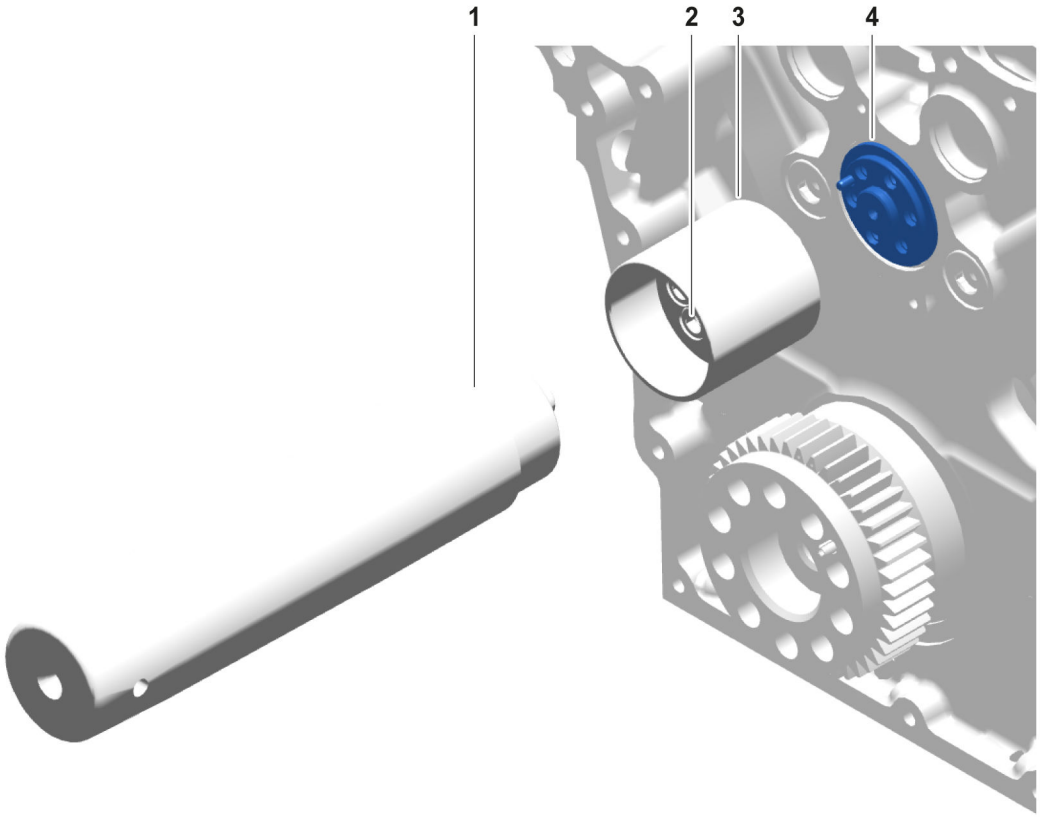

Fig. 125: Camshaft

1 Assembly tool
2 Socket head screw (6x)
3 Adapter
4 Camshaft

- ▶ Install adapter **3** on camshaft **4**.
- ▶ Tighten socket head screws **2**.
- ▶ Screw assembly tool **1** into adapter **3**.
- ▶ Remove camshaft **4** in direction of ancillary support housing.
  ▷ Assembly tool guides camshaft **4** through bearing points.
- ▶ Remove assembly tool **1** and adapter **3** from camshaft **4**.

Checking and cleaning the camshaft

- ▶ Clean crankcase in outer area of camshaft **4**.
- ▶ Clean camshaft **4** with a lint-free cloth.
- ▶ Check camshaft **4** for damage and replace if necessary.
- ▶ Check camshaft **4** bearings and cams for wear.

If camshaft **4** is worn:
- ▶ Contact Liebherr customer service.
- ▶ Check camshaft **4** for cracks.

If camshaft **4** has cracks:
- ▶ Contact Liebherr customer service.

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Installing the camshaft

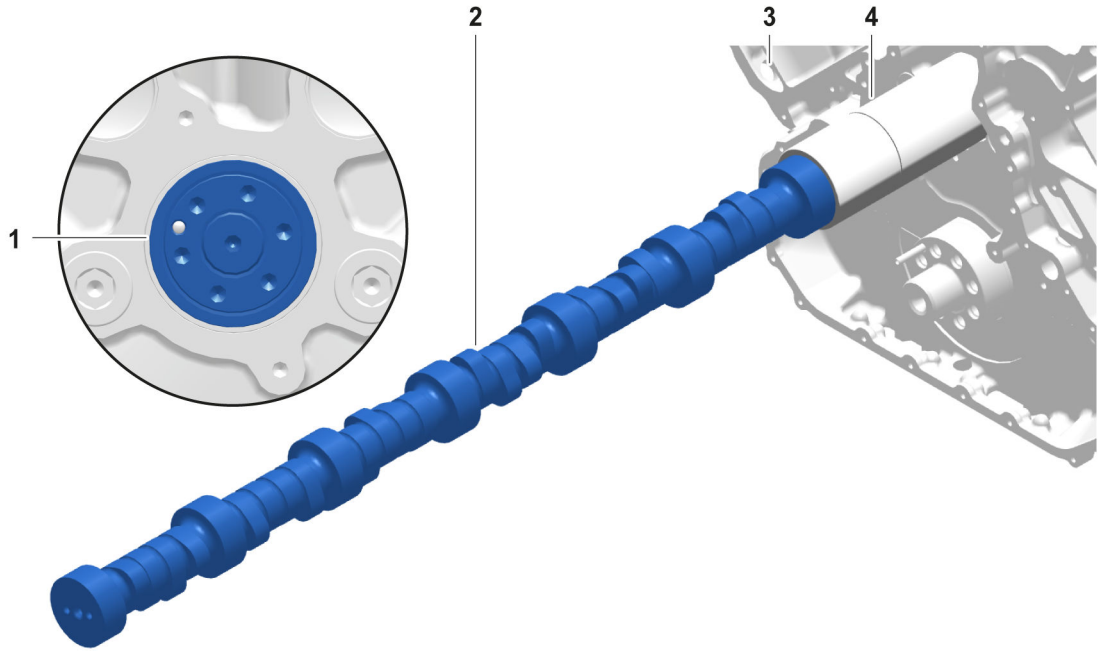

Fig. 126: Camshaft

1	Installation position	**3**	Ancillary support housing side
2	Camshaft	**4**	Assembly tool

- ▶ Install assembly tool **4** on camshaft **2**. (see: fig. 125, page 107)
- ▶ Lubricate bearing points of camshaft **2** with new engine oil.
- ▶ Carefully install camshaft **2** from direction of ancillary support housing side **3**.
- ▶ Turn camshaft **2** to correct installation position **1**.
- ▶ Remove assembly tool **4** from camshaft **2**.

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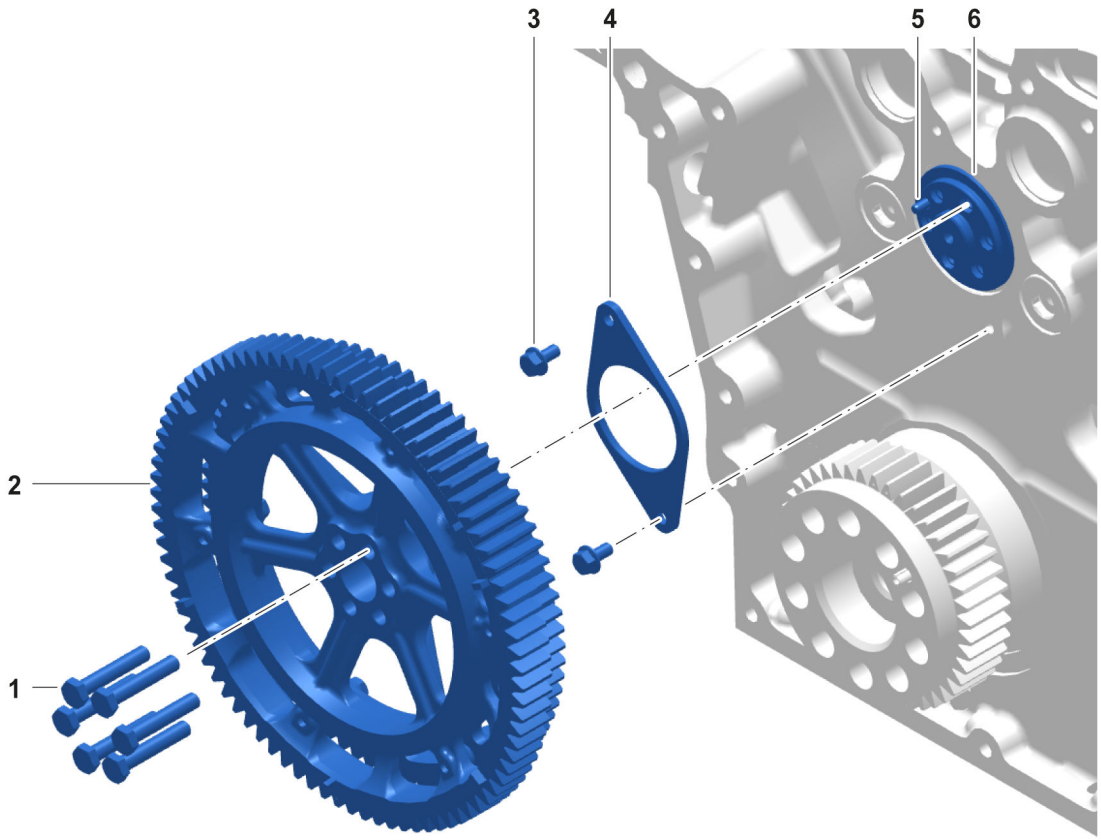

Fig. 127: Camshaft gear wheel and bearing flange

1	Hex head screw (6x)	**4**	Bearing flange
2	Camshaft drive gear wheel	**5**	Dowel
3	Hex head screw (2x)	**6**	Camshaft

- ▶ Replace bearing flange **4**.
- ▶ Align bearing flange **4** to camshaft **6**.
- ▶ Tighten hex head screws **3**.
- ▶ Degrease contact surfaces of camshaft **6** and camshaft drive gear wheel **2**.
- ▶ Align camshaft drive gear wheel **2** with dowel hole on dowel **5**.
- ▶ Install camshaft drive gear wheel **2** on camshaft **6**.

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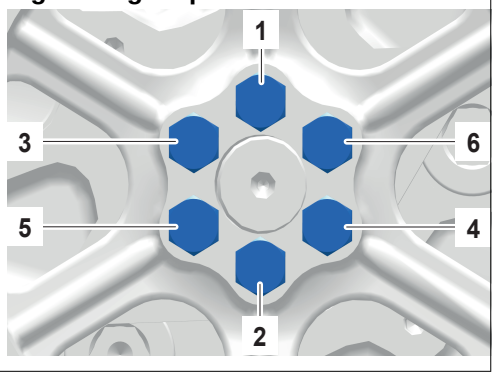
Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	Engine oil	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	25 Nm	
Stage	**Angle of rotation**	
2.	60°	

Tab. 30: Tightening instruction 9080478-002

▶ Tighten hex head screws **1** according to tightening instruction.

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3.4 Driving gear

3.4.1 Piston with connecting rod

Removing the piston with connecting rod

Graphic representation	Description	Required number	Part number
	Holding device	1	10118850

Tab. 31: Special tool

Make sure that the following prerequisites are met:
- ❑ Turning device is installed. (For more information see: Installing the turning device (optional), page 68.)
- ❑ Cylinder head is removed. (For more information see: Removing the cylinder head, page 81.)
- ❑ Piston cooling nozzle is removed. (For more information see: Removing the piston cooling nozzle, page 409.)

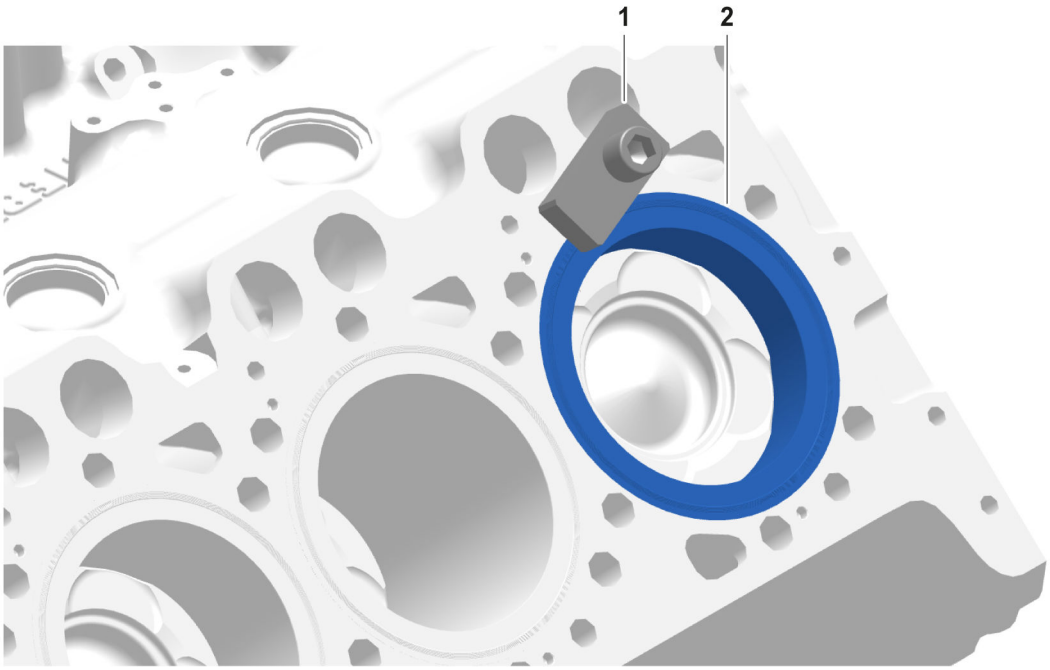
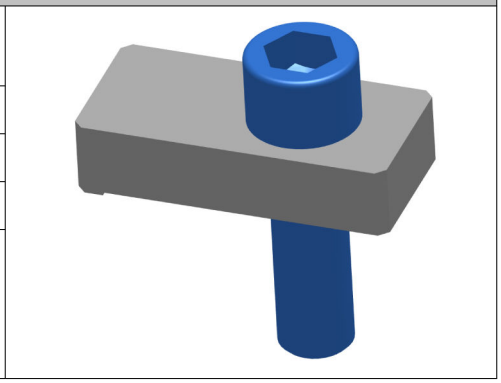


Fig. 130: Cylinder liner

1 Holding device

2 Cylinder liner

▶ Align holding device **1**.

Tightening instruction for holding device		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	30 Nm	

Tab. 32: Tightening instruction

- ▶ Tighten holding device **1** according to tightening instruction.
- ▶ Turn crankshaft until piston is just before ignition TDC.
- ▶ Clean upper area of cylinder liner **2**.
- ▶ Remove combustion residues.

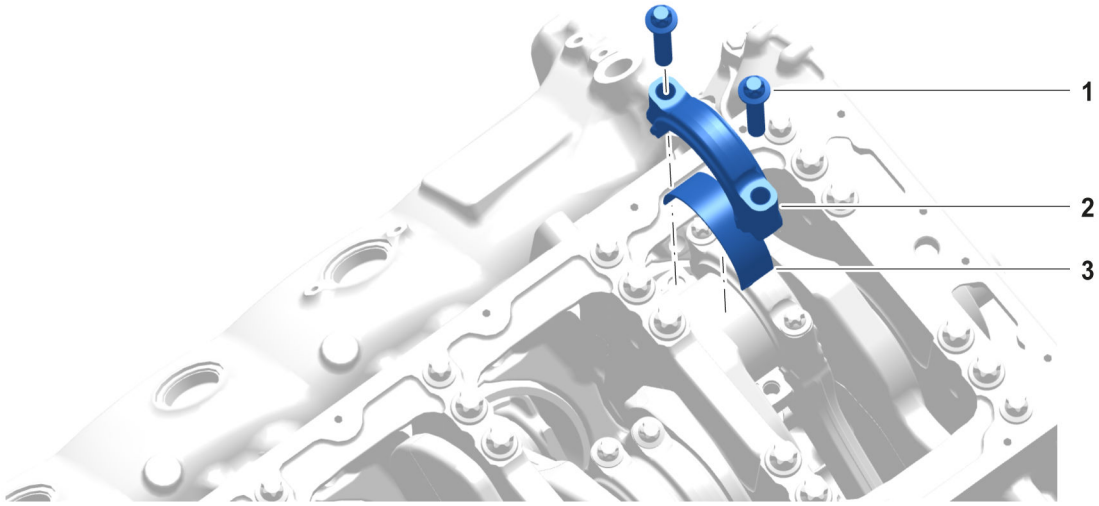


Fig. 132: Connecting rod lower part

1 Hexalobular flange head screw (2x)
2 Connecting rod bearing cover
3 Lower connecting rod bearing shell

- ▶ Turn crankshaft until hexalobular flange head screws **1** are accessible.
- ▶ Unscrew hexalobular flange head screws **1**.

NOTICE
Improper handling!
Damage to connecting rod and connecting rod bearing cover.

- ▶ Do not clean the connecting surfaces of the connecting rod and connecting rod bearing cover with a wire brush or other tools.
- ▶ Do not put the connecting rod and connecting rod bearing cover down on the connecting surfaces.

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▶ Remove connecting rod bearing cover **2** and lower connecting rod bearing shell **3** and put them down according to cylinder designation.

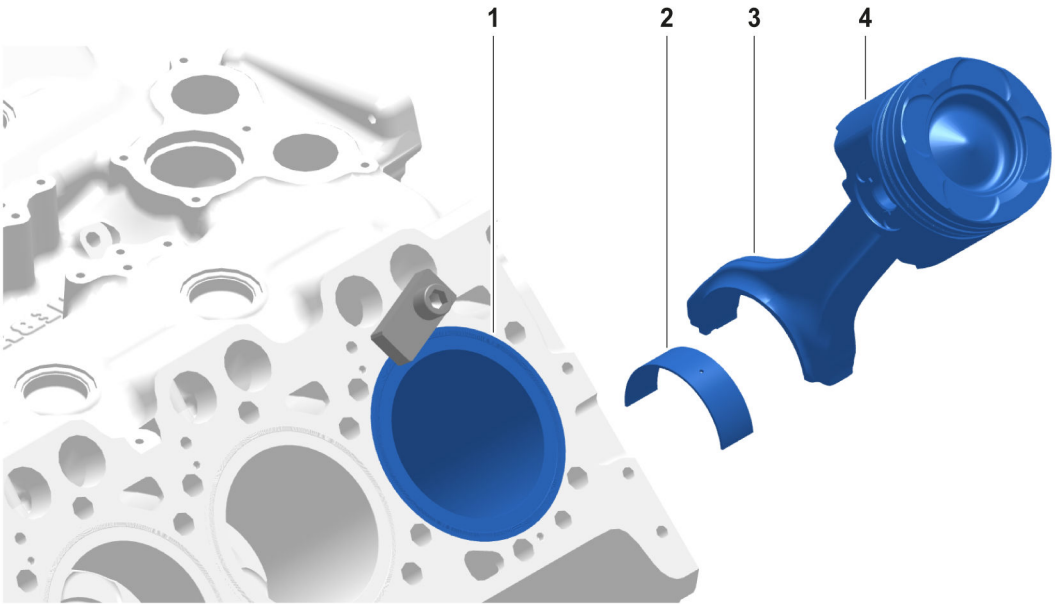

Fig. 133: Connecting rod lower part

1	Cylinder liner	**3**	Connecting rod
2	Upper connecting rod bearing shell	**4**	Piston

NOTICE
Improper removal!
Damage to the connecting rod bearing shell.

▶ Make sure that the upper connecting rod bearing shell installed in the connecting rod is not damaged during removal.

▶ Press piston **4** with connecting rod **3** and upper connecting rod bearing shell **2** out of cylinder liner **1** from below.

▶ Put piston **4**, connecting rod **3** and upper connecting rod bearing shell **2** down according to cylinder designation.

▶ Remove upper connecting rod bearing shell **2** from connecting rod **3**.

Dismantling the piston

Make sure that the following prerequisite is met:
❑ Piston with connecting rod is removed. (For more information see: Removing the piston with connecting rod, page 111.)

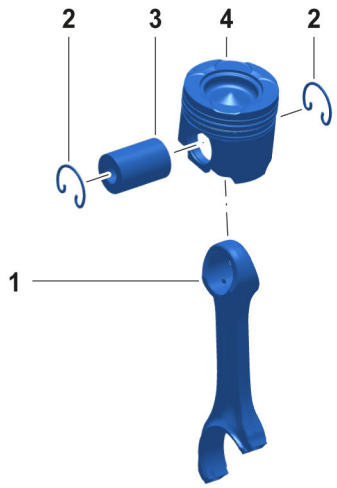

Fig. 134: Piston with connecting rod

1 Connecting rod
2 Locking ring
3 Piston pin
4 Piston

▶ Mark piston **4** and connecting rod **1**.

▶ Remove locking rings **2** with standard circlip pliers.

▶ Remove piston pin **3** using a suitable tool.

▶ Remove piston **4** from connecting rod **1**.

Assembling the piston

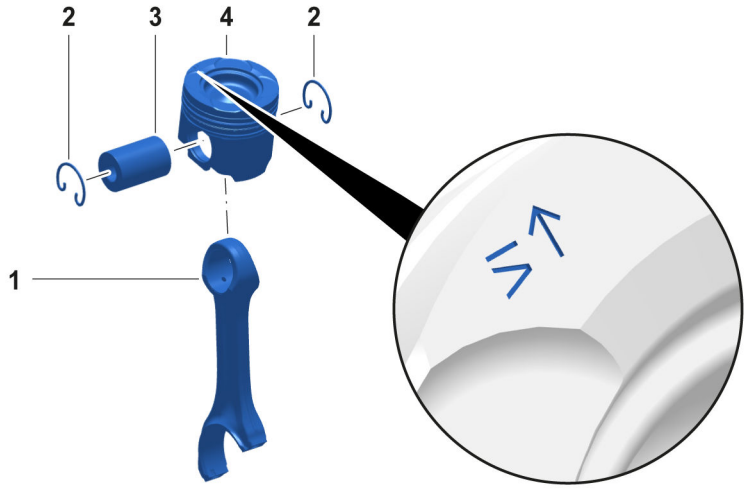

Fig. 135: Piston with connecting rod

1 Connecting rod
2 Locking ring
3 Piston pin
4 Piston

▶ Align piston **4** with mark on long side of connecting rod **1**.

▶ Install piston **4** on connecting rod **1**.

▶ Observe marking of piston **4** and connecting rod **1**.

▶ Lubricate piston pin **3** with new engine oil.

▶ Install piston pin **3** in piston **4**.

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- ▶ Install locking rings **2**.
- ▶ Make sure that locking rings **2** sit correctly in groove.

Installing the piston with connecting rod

Graphic representation	Description	Required number	Part number
	Holding device	1	10118850
	Piston strap	1	8000592
	Rotation angle plate	1	0524062
	Rotation angle attachment	1	10023839

Tab. 33: Special tool

Make sure that the following prerequisite is met:
- ❑ Turning device is installed. (For more information see: Installing the turning device (optional), page 68.)

Note

- ▶ Only install piston with connecting rod and connecting rod bearing shells in original cylinder.

Note

The connecting rod and connecting rod bearing cover are produced by cracking (fracturing)!

- ▶ Install the connecting rod and connecting rod bearing cover only in the original manufactured pairing.

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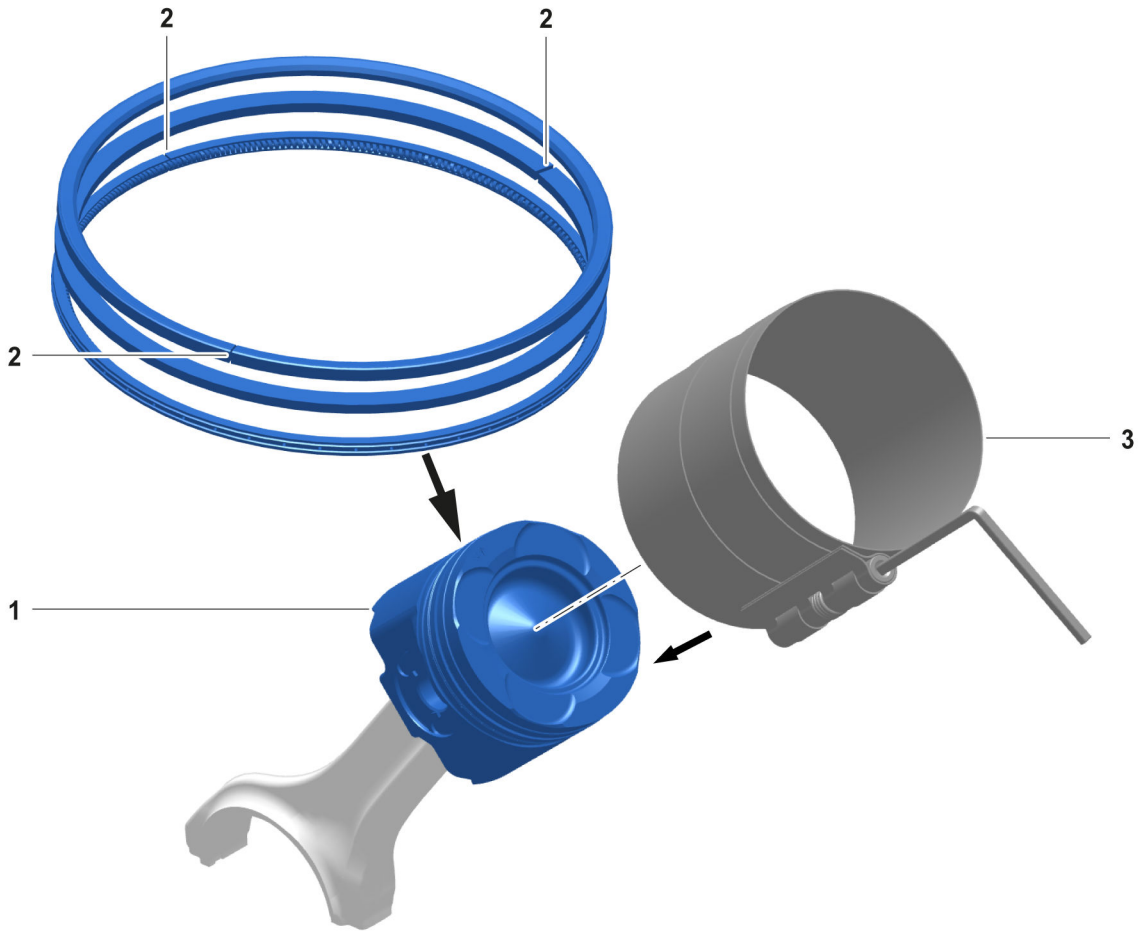

Fig. 140: Piston rings and piston strap

1 Piston
2 Piston ring joint
3 Piston strap

▶ Turn piston rings in piston **1** until piston ring joints **2** are offset by approx. 120°.

▶ Carefully slide piston strap **3** over piston **1** and piston rings.

▶ Tension piston rings with piston strap **3**.

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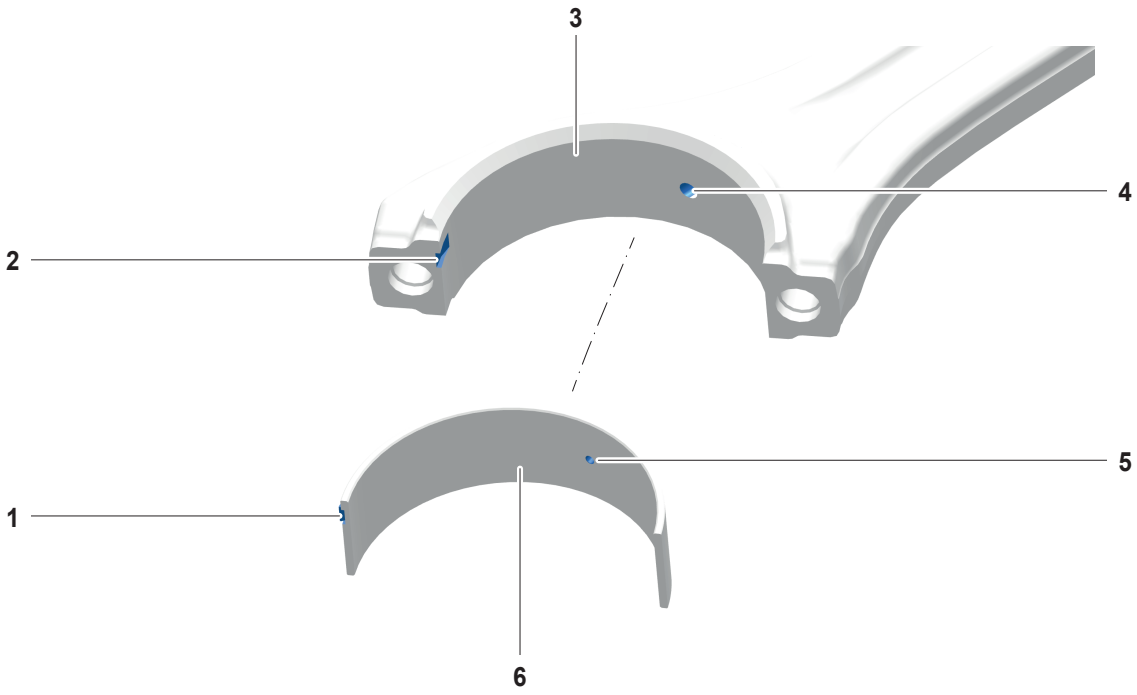

Fig. 141: Upper connecting rod bearing shell

1	Upper connecting rod bearing shell guide	**4**	Connecting rod oil hole
2	Connecting rod guide	**5**	Upper connecting rod bearing shell oil hole
3	Connecting rod	**6**	Upper connecting rod bearing shell

- ▶ Insert upper connecting rod bearing shell **6** in connecting rod **3**.
- ▶ Make sure that the upper connecting rod bearing shell guide **1** sits in the connecting rod guide **2**.
- ▶ Make sure that the upper connecting rod bearing shell oil hole **5** and the connecting rod oil hole **4** are aligned.
- ▶ Lubricate running surface of upper connecting rod bearing shell **6** with new engine oil.
- ▶ Lubricate crankshaft journal of corresponding cylinder with new engine oil.

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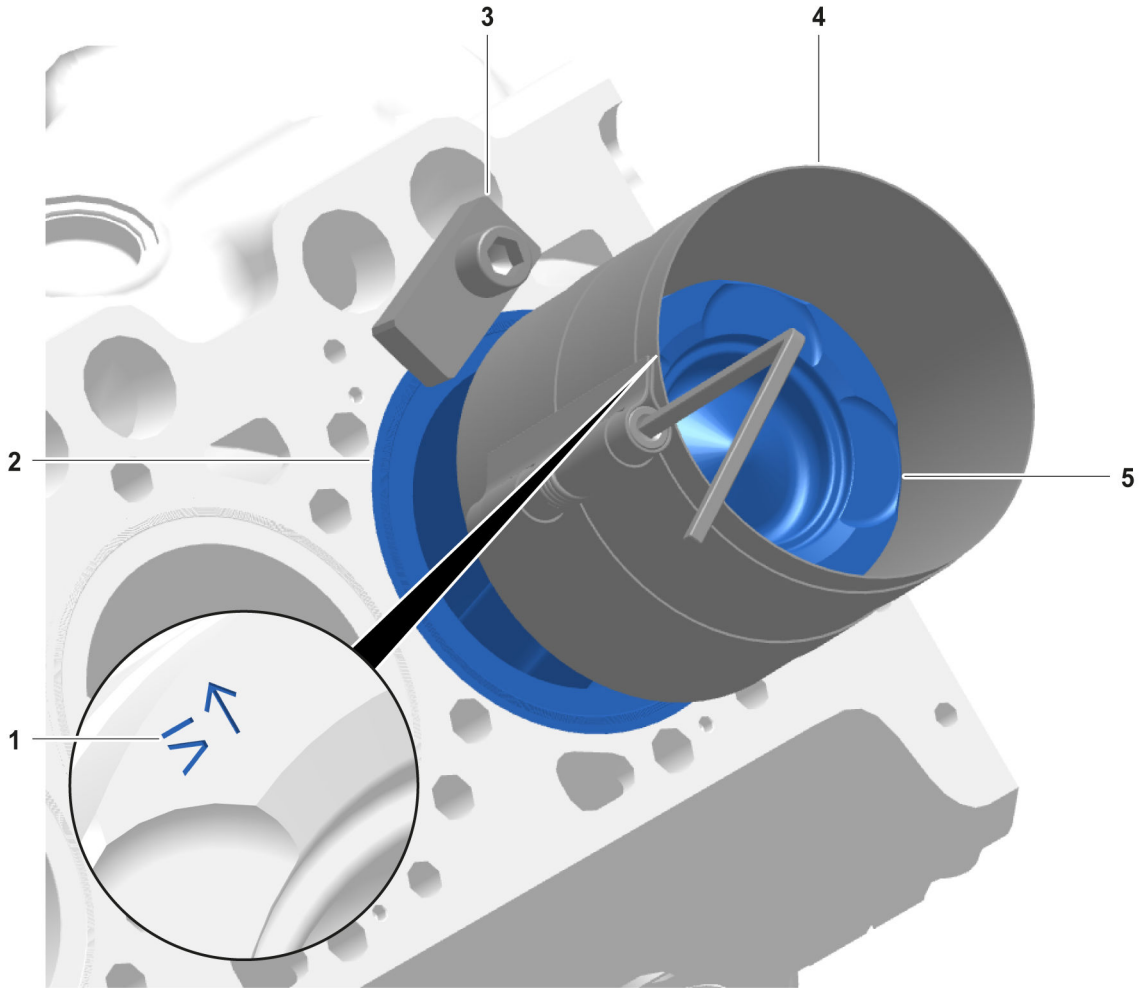
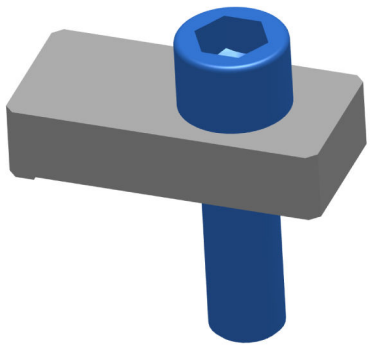


Fig. 142: Piston with connecting rod

1 Mark
2 Cylinder liner
3 Holding device
4 Piston strap
5 Piston

▶ Align holding device **3**.

Tightening instruction for holding device		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	30 Nm	

Tab. 34: Tightening instruction

▶ Tighten holding device **3** according to tightening instruction.

▶ Clean running surface of cylinder liner **2**.

- ▶ Lubricate running surface of cylinder liner **2** with new engine oil.
- ▶ Attach piston **5** with piston strap **4** on crankcase.
- ▶ Align mark **1** in direction of engine center.
- ▶ Carefully slide piston **5** with connecting rod and connecting rod bearing shell into cylinder liner **2** using a suitable tool.
- ▶ Remove piston strap **4**.
- ▶ Carefully slide piston **5** with connecting rod and connecting rod bearing shell into cylinder liner **2** using a suitable tool until connecting rod bearing fits against crankshaft journal.

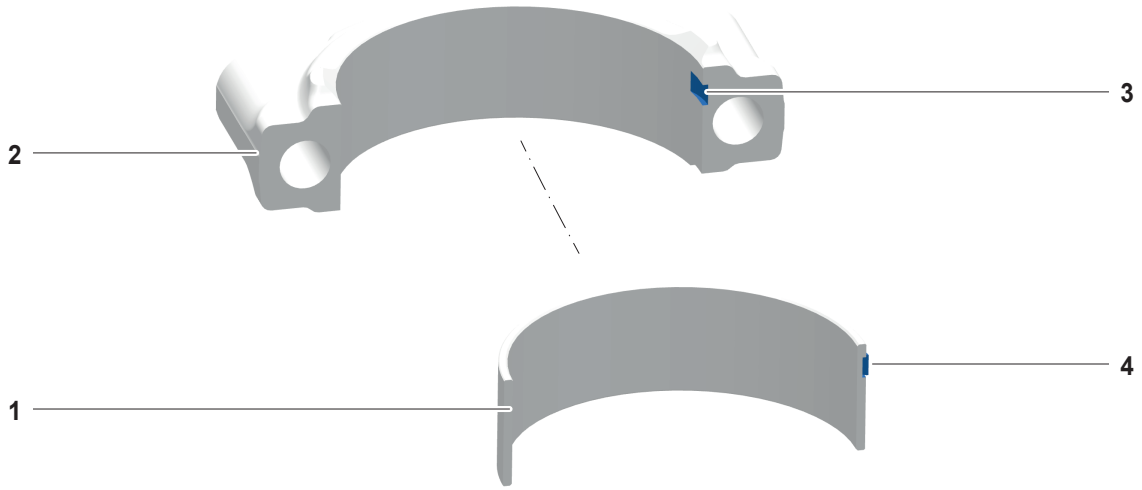


Fig. 144: Lower connecting rod bearing shell

1	Lower connecting rod bearing shell	**3**	Guide groove
2	Connecting rod bearing cover	**4**	Guide pin

- ▶ Install lower connecting rod bearing shell **1** in connecting rod bearing cover **2**.
- ▶ Make sure that the guide pin **4** sits in the guide groove **3**.
- ▶ Lubricate running surface of lower connecting rod bearing shell **1** with new engine oil.
- ▶ Lubricate crankshaft journal of corresponding cylinder with new engine oil.

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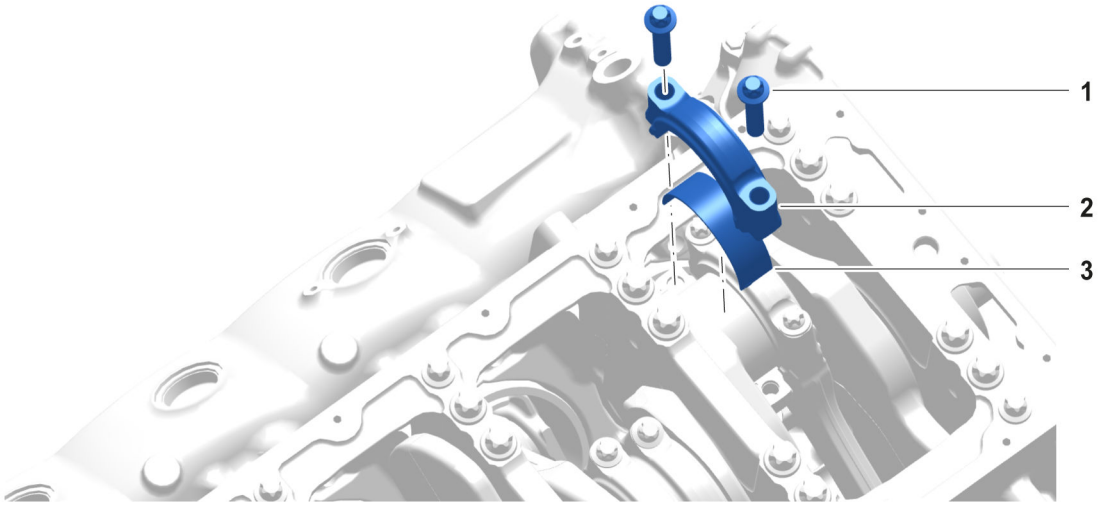


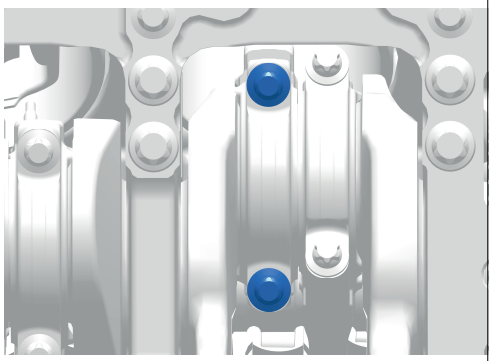
Fig. 145: Connecting rod lower part

1 Hexalobular flange head screw (2x)
2 Connecting rod bearing cover
3 Lower connecting rod bearing shell

NOTICE
Improper installation!
Damage to connecting rod bearing shells and crankshaft journal.

- ▶ Install connecting rod bearing cover on connecting rod correctly.
- ▶ Do not turn crankshaft until connecting rod bearing cover is screwed tight according the tightening instruction.

- ▶ Carefully install connecting rod bearing cover **2** with lower connecting rod bearing shell **3** on the connecting rod.
- ▶ Lubricate hexalobular flange head screws **1** with new engine oil.

Hexalobular flange head screw tightening instruction		
Lubricant (thread and head contact surface)	Engine oil	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	5 Nm	
2.	30 Nm	
3.	110 Nm	
Stage	**Angle of rotation**	
4.	45°	
5.	45°	

Tab. 35: Tightening instruction 9077201-004

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- ▶ Tighten hexalobular flange head screws **1** according to tightening instruction.
- ▶ Turn crankshaft with turning device one more revolution.
- ▶ Check connecting rod for ease of operation.
- ▶ Remove holding devices. (see: fig. 142, page 118)

3.4.2 Piston rings

Removing the piston rings

Graphic representation	Description	Required number	Part number
	Piston ring pliers	1	7009319

Tab. 36: Special tool

Make sure that the following prerequisite is met:
- ❑ Piston with connecting rod is removed. (For more information see: Removing the piston with connecting rod, page 111.)

NOTICE
Improper removal!
Damage to piston rings.

- ▶ Only remove piston rings with piston ring pliers.
- ▶ Spread piston rings as little as possible.

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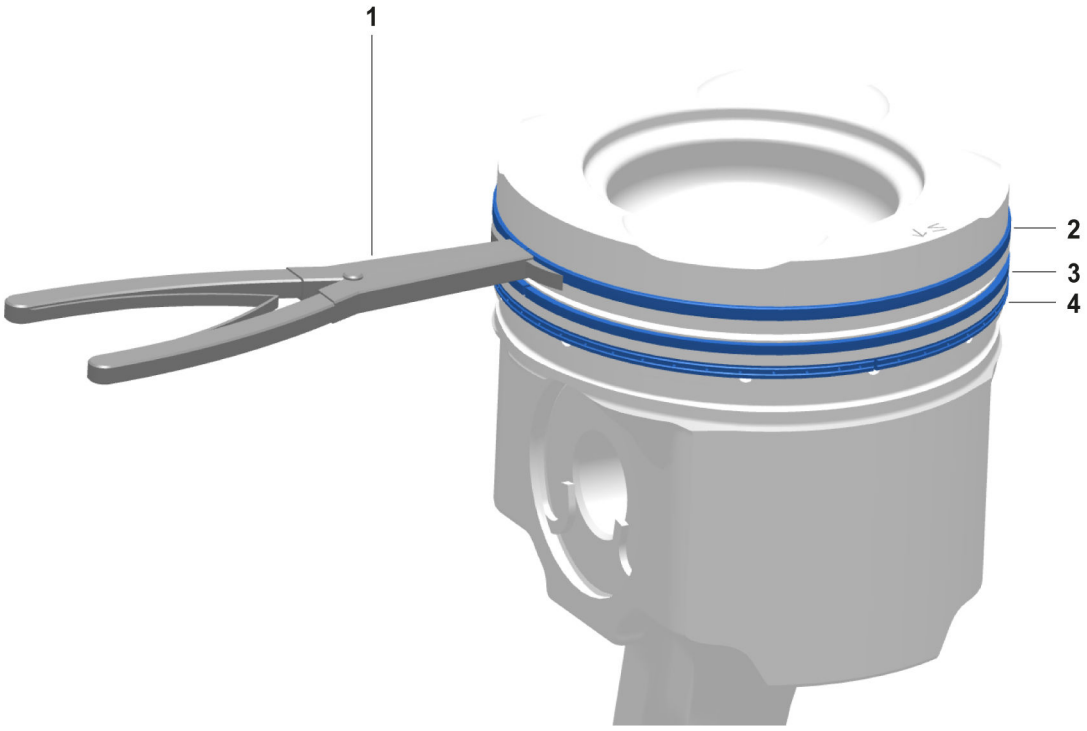

Fig. 148: Piston rings

1 Piston ring pliers
2 KBA ring (double trapezoidal ring)
3 M ring (minute ring)
4 DSF ring (beveled hose spring ring)

▶ Mark piston rings according to their affiliation.

▶ Carefully remove piston rings with piston ring pliers **1**.

Checking and cleaning the piston rings

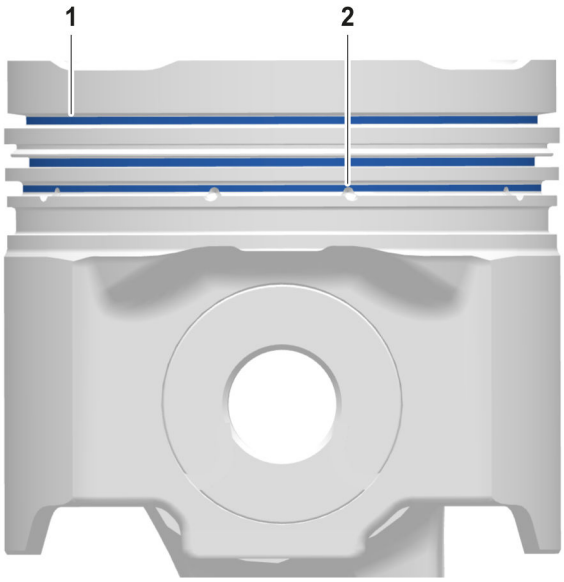

Fig. 149: Piston ring grooves

1 Piston ring groove (3x)
2 Oil drain hole (10x)

▶ Check piston rings for damage and replace if necessary.

If piston rings are damaged:
▶ Replace piston rings.

If piston rings are replaced:
▶ Install new cylinder liner. (For more information see: Removing the cylinder liner, page 127.)

▶ Clean piston rings.

▶ Clean piston ring grooves **1**.

▶ Clean oil drain holes **2**.

Installing the piston rings (checking the end gap and backlash)

Checking the end gap

Piston rings	Permissible end gap (a)
KBA ring (double trapezoidal ring)	0.35 $^{+0.10}$ mm
M ring (minute ring)	1.10 $^{+0.20}$ mm
DSF ring (beveled hose spring ring)	0.25 $^{+0.25}$ mm

Tab. 37: Permissible end gap

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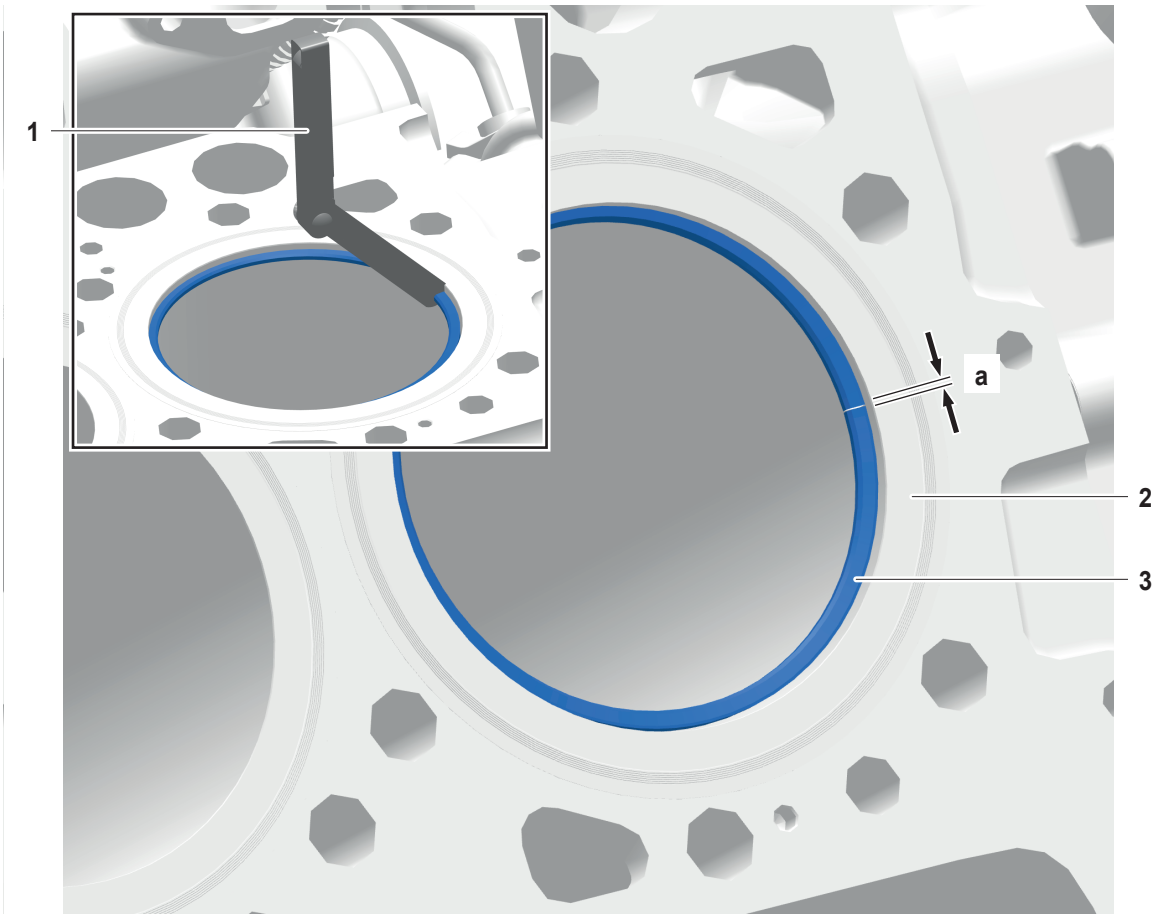

Fig. 150: Checking the end gap

a	End gap	**2**	Cylinder liner
1	Feeler gauge	**3**	Piston ring

▶ Make sure that the cylinder liner **2** has been cleaned.

▶ Insert piston ring **3** in upper area of cylinder liner **3**.

▶ Measure end gap **a** with standard feeler gauge **2**. (see: tab. 37, page 123)

If the end gap is outside of the tolerance:

▶ Contact Liebherr customer service.

▶ Perform measurement with all piston rings.

Installing the piston rings

Graphic representation	Description	Required number	Part number
	Piston ring pliers	1	7009319

Tab. 38: Special tool

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NOTICE
Improper assembly!
Engine damage.

▶ When installing new piston rings, install new cylinder liner.

NOTICE
Improper installation!
Damage to piston rings.

▶ Only install piston rings with piston ring pliers.

▶ Spread piston rings as little as possible.

Note

▶ Make sure that the “TOP” mark on the piston rings points upward in the direction of the piston head.

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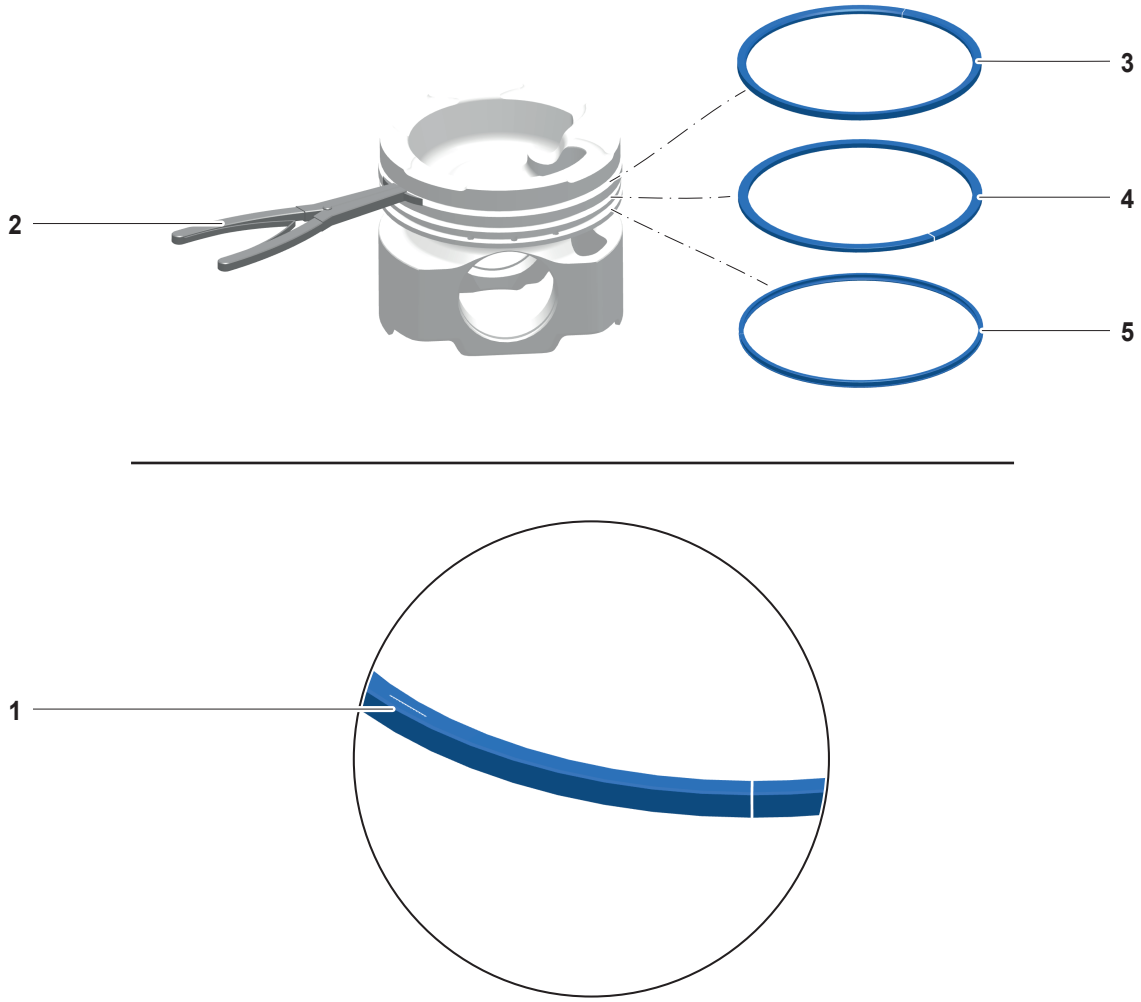

Fig. 152: Piston ring installation instructions

1 TOP mark
2 Piston ring pliers
3 KBA piston ring (double trapezoidal ring)
4 M piston ring (minute ring)
5 DSF ring (beveled hose spring ring)

▶ Check piston rings for damage and replace if necessary.

▶ Carefully install DSF ring **5** in the bottom piston ring groove.

▶ Carefully install M piston ring **4** in the middle piston ring groove.

▶ Carefully install KBA piston ring **3** in the top piston ring groove.

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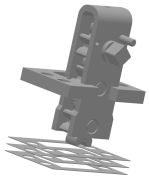
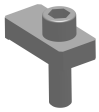
3.4.3 Removing and installing the cylinder liner

Removing the cylinder liner

Graphic representation	Description	Required number	Part number
	Turning device	1	9078688
	Extraction device	1	0528462
	Holding device	2	10118850

Tab. 39: Special tool

Make sure that the following prerequisite is met:
- ❑ Piston with connecting rod is removed. (For more information see: Removing the piston with connecting rod, page 111.)

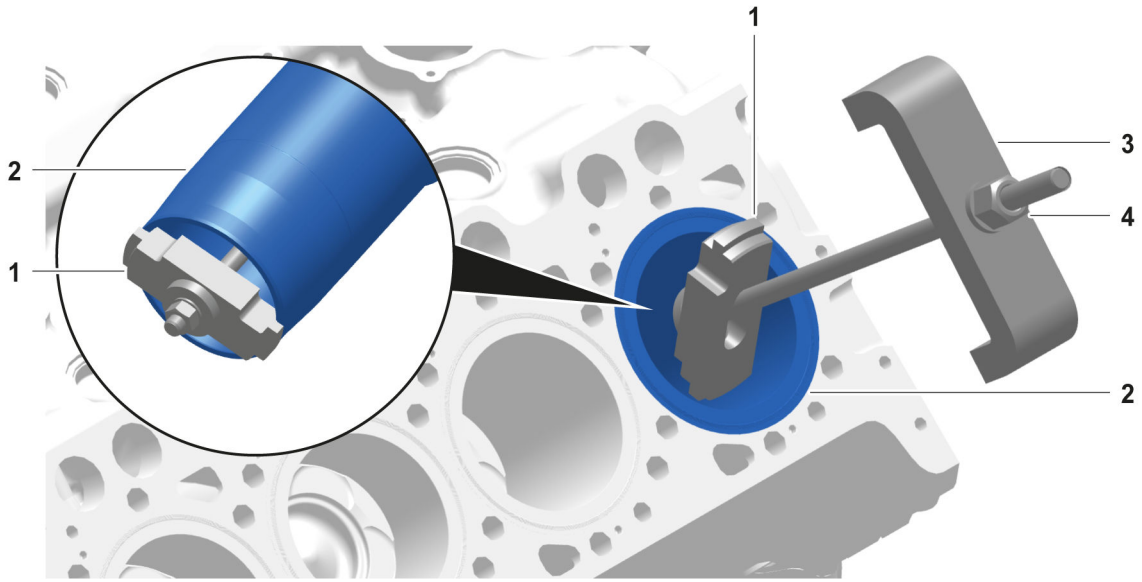


Fig. 156: Installing the extraction device on the cylinder liner

1 Mount
2 Cylinder liner
3 Bracket
4 Hex nut

▶ Turn crankshaft of the respective cylinder to BDC position with turning device.

NOTICE
Contact of cylinder liner with extraction device!
Damage to cylinder liner.

▶ Insert extraction device in cylinder liner carefully.

▶ Insert extraction device with mount **1** at an angle into cylinder liner **2**.

▶ Align mount **1** to end of cylinder liner **2**.

▶ Tighten hex nut **4**.
▷ The bracket **3** rests against the crankcase.

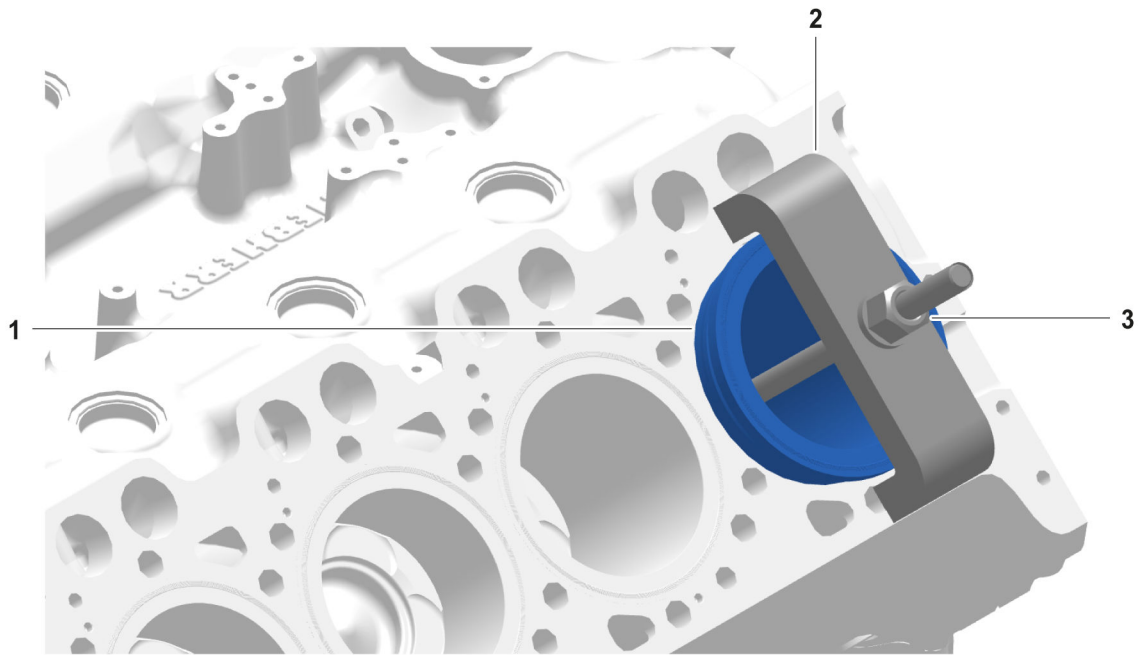


Fig. 157: Cylinder liner

1 Cylinder liner
2 Extraction tool
3 Hex nut

▶ Mark installation location and installation position for the cylinder liner **1**.

▶ Turn hex nut **3** clockwise until cylinder liner **1** releases from crankcase.

NOTICE
Improper storage!
Damage to cylinder liners.

▶ Only store cylinder liners vertically.

▶ Remove extraction tool **2** together with cylinder liner **1** from crankcase.

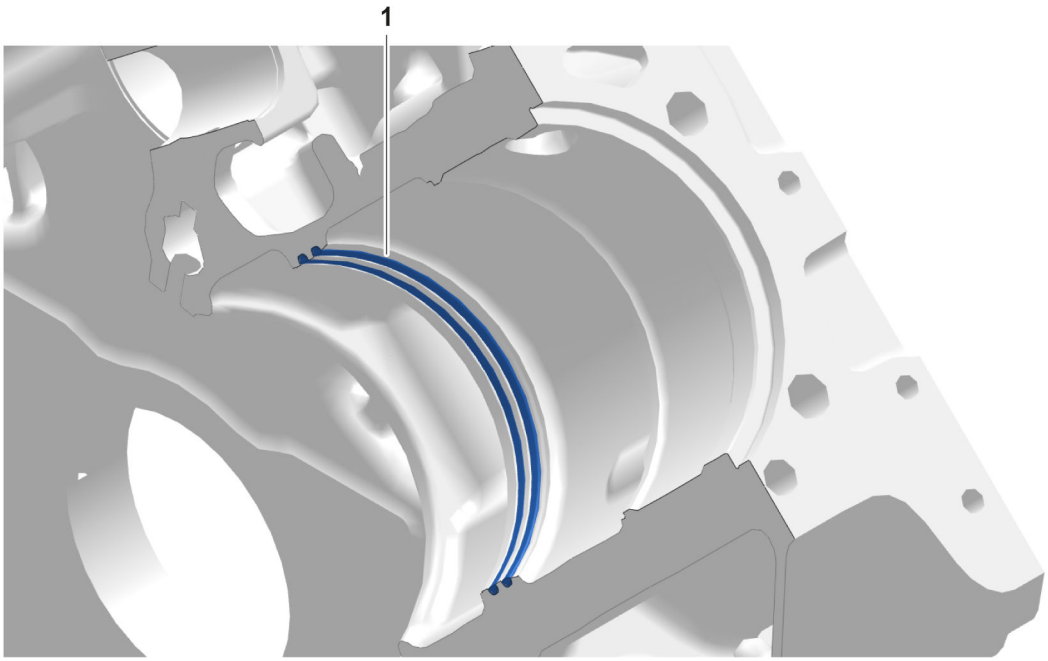


Fig. 158: Cylinder liner o-rings

1 O-ring (2x)

▶ Remove o-ring **1**.

Checking and cleaning

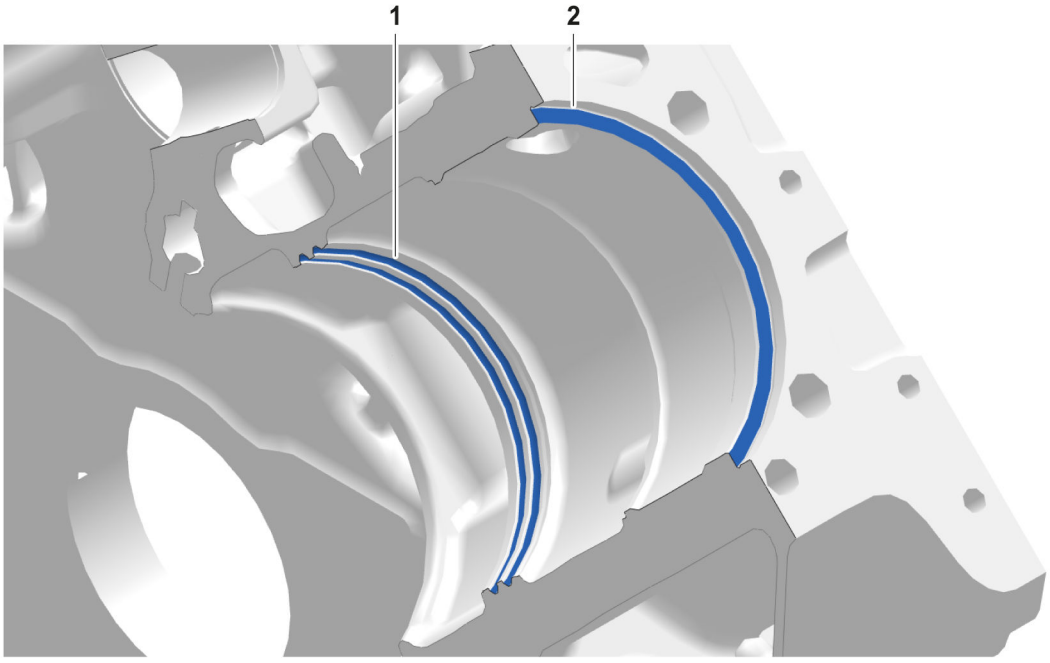


Fig. 159: Cylinder

1 Grooves of o-rings

2 Upper seat of the cylinder liner

▶ Clean upper seat of the cylinder liner **2**.

▶ Check upper seat of the cylinder liner **2** for damage.

If the upper seat of the cylinder liner **2** is damaged:
▶ Replace cylinder liner.

▶ Clean grooves of o-rings **1**.

▶ Clean cylinder.

▶ Check cylinder for damage.

If the cylinder is damaged:
▶ Contact Liebherr customer service.

Installing the cylinder liner

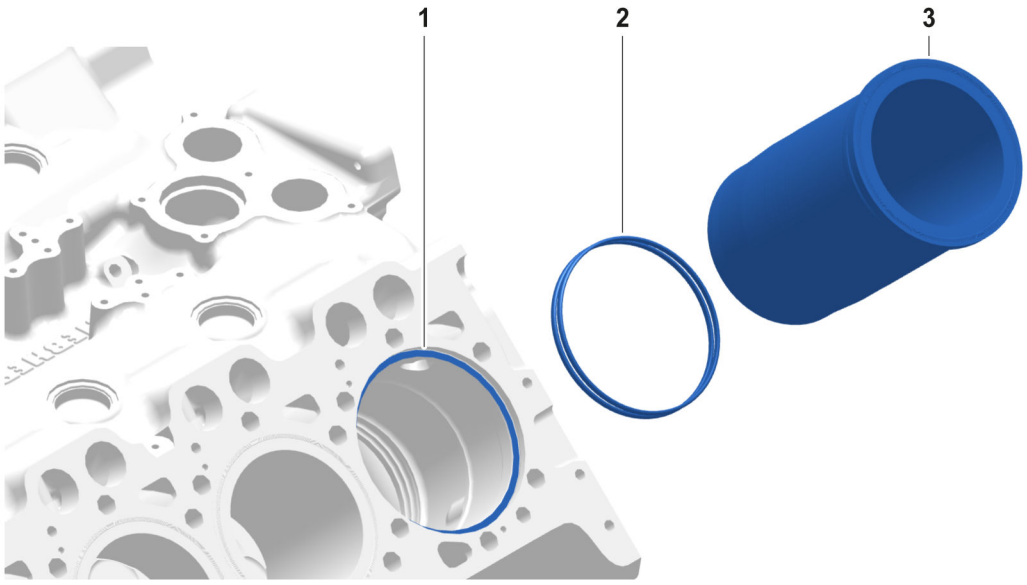


Fig. 160: Cylinder liner

1 Upper seat of the cylinder liner
2 O-ring (2x)
3 Cylinder liner

▶ Lubricate new o-rings **2** with NBU 30 grease.

▶ Install o-rings **2** in grooves in crankcase.

▶ Make sure that o-rings **2** sit correctly in grooves in crankcase.

NOTICE
Improper assembly!
Engine damage.

▶ When installing a new cylinder liner, install new piston rings.

Note

▶ Only install cylinder liners in the original cylinder and in the original installation position if being reused.

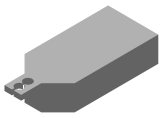
Note

If repair work is interrupted after cylinder liners have been completely installed:
▶ Fix cylinder liners in position with holding devices.

▶ Install cylinder liner **3** up to limit stop in crankcase.
▷ Cylinder liner **3** lies on upper seat of the cylinder liner **1**.

▶ Check cylinder liner projection. (For more information see: 3.4.4 Checking the projection of the cylinder liners, page 131.)

3.4.4 Checking the projection of the cylinder liners

Graphic representation	Description	Required number	Part number
	Holding device	2	10118850
	Dial gauge (universal)	1	11127327
	Dial gauge holder (universal)	1	10023385

Tab. 40: Special tool

Make sure that the following prerequisite is met:
❑ Cylinder head is removed. (For more information see: Removing the cylinder head, page 81.)

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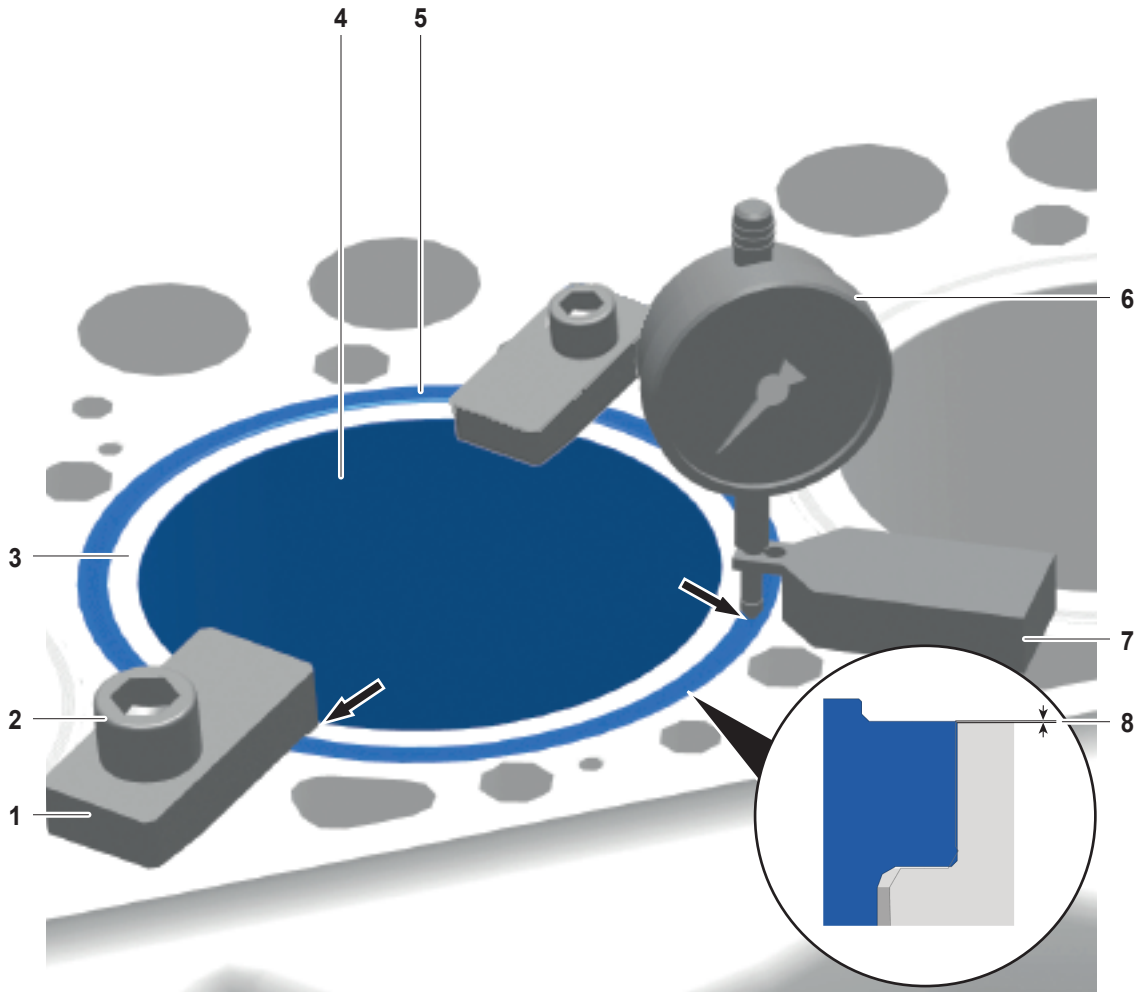

Fig. 164: Checking the projection of the cylinder liners

1 Holding device (2x)
2 Socket head screw (2x)
3 Contact surface
4 Cylinder liner
5 Projection
6 Dial gauge
7 Dial gauge holder
8 Set point for cylinder liner projection to crankcase joint face

▶ Install holding devices **1**.
▷ Holding devices **1** are resting against contact surface **3** (see arrow).

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	30 Nm	

Tab. 41: Tightening instruction

▶ Tighten socket head screws **2** of the holding devices **1** according to tightening instruction.

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▶ Install dial gauge **6**.

Set point for cylinder liner projection	Specification
0.070 $^{+0.030/\ -0.045}$ mm	9078049-005

Tab. 42: Set point for cylinder liner projection

▶ Check projection **5** with dial gauge **6**.

Note

▶ Repeat measurement at three points with an offset of 120°.

If the measurement result is outside of the tolerance:
▶ Correct projection. (For more information see: Removing the cylinder liner, page 127.)
or

Contact Liebherr customer service.

▶ Remove holding devices **1**.

3.4.5 Removing and installing the crankshaft attachments

Removing the crankshaft attachments

Graphic representation	Description	Required number	Part number
	Assembly pin (M16)	2	0528470

Tab. 43: Special tool

Make sure that the following prerequisite is met:
❑ Belt pulley is removed. (For more information see: Removing the belt pulley, page 273.)

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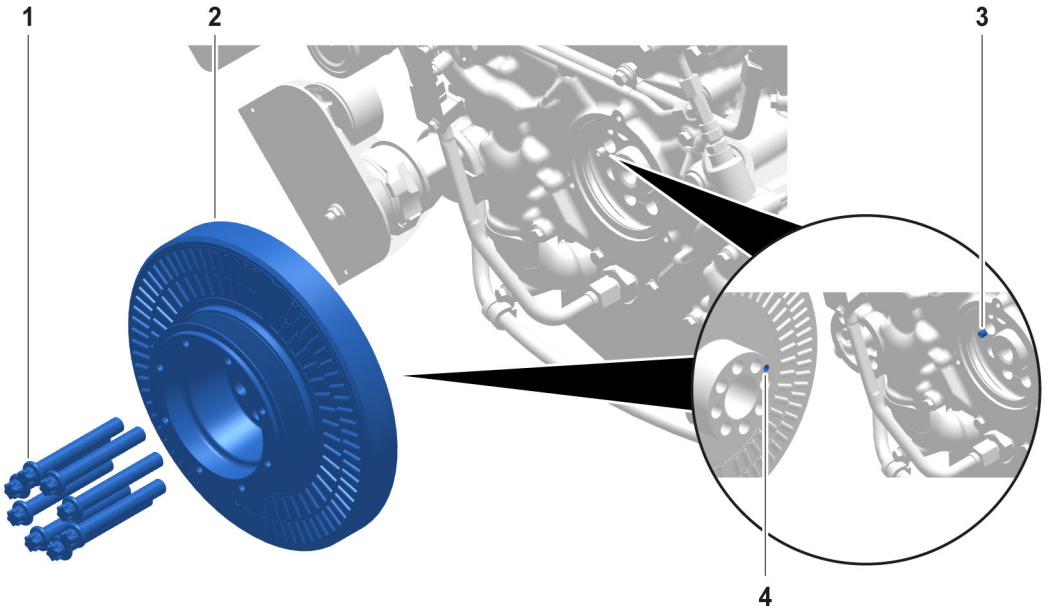


Fig. 167: Crankshaft attachments

1 Hexalobular flange head screw (8x)
2 Viscous damper
3 Guide pin
4 Guide hole

▶ Unscrew two opposing hexalobular flange head screws **1**.

▶ Tighten two assembly pins. (see: tab. 43, page 133)

▶ Unscrew hexalobular flange head screws **1**.

▶ Remove viscous damper **2**.

Installing the crankshaft attachments

Graphic representation	Description	Required number	Part number
	Assembly pin (M16)	2	0528470

Tab. 44: Special tool

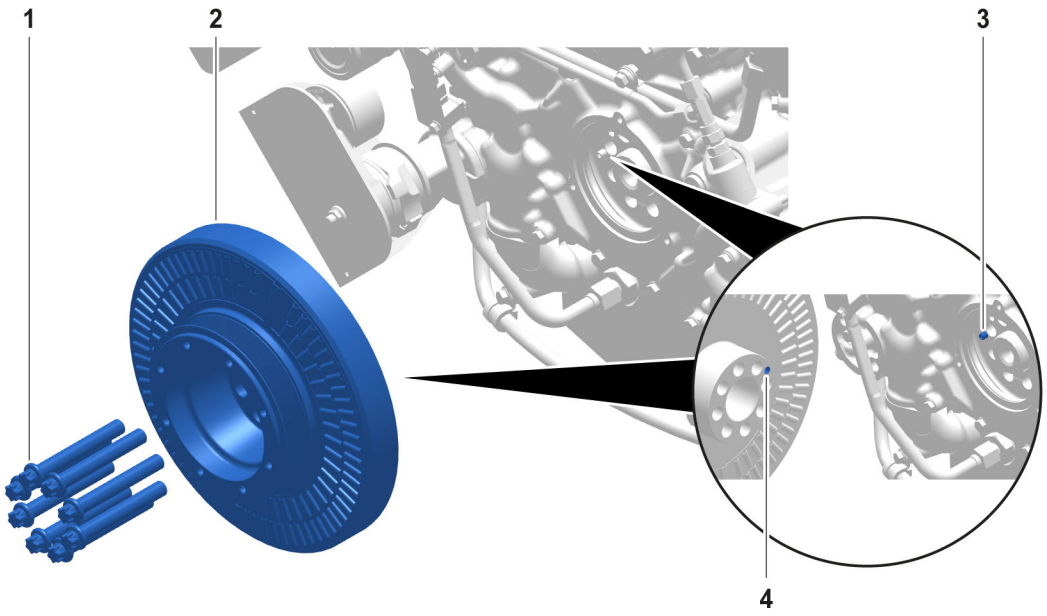
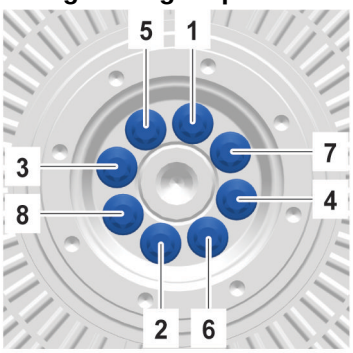


Fig. 169: Crankshaft attachments

1 Hexalobular flange head screw (8x)
2 Viscous damper
3 Guide pin
4 Guide hole

- ▶ If necessary, tighten assembly pins.
- ▶ Degrease contact surfaces of viscous damper **2** and crankshaft gear wheel.
- ▶ Align guide hole **4** to guide pin **3**.
- ▶ Install viscous damper **2**.
- ▶ Lubricate hexalobular flange head screws **1** with engine oil and screw them in evenly.
- ▶ Unscrew assembly pins.
- ▶ Lubricate remaining hexalobular flange head screws **1** with engine oil and screw them in.

Tightening instruction for hexalobular flange head screw		
Lubricant (thread and head contact surface)	Engine oil	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	30 Nm	
2.	90 Nm	
Stage	**Angle of rotation**	
3.	90°	
4.	90°	

Tab. 45: Tightening instruction 9077284-004

- ▶ Tighten hexalobular flange head screws **1** according to tightening instruction.

3.4.6 Ancillary support housing side radial shaft sealing ring

Removing the radial shaft sealing ring on the ancillary support housing side

Graphic representation	Description	Required number	Part number
	Extractor for radial shaft sealing ring	1	7019858

Tab. 46: Special tool

Make sure that the following prerequisite is met:
❑ Viscous damper is removed. (For more information see: Removing the crankshaft attachments, page 133.)

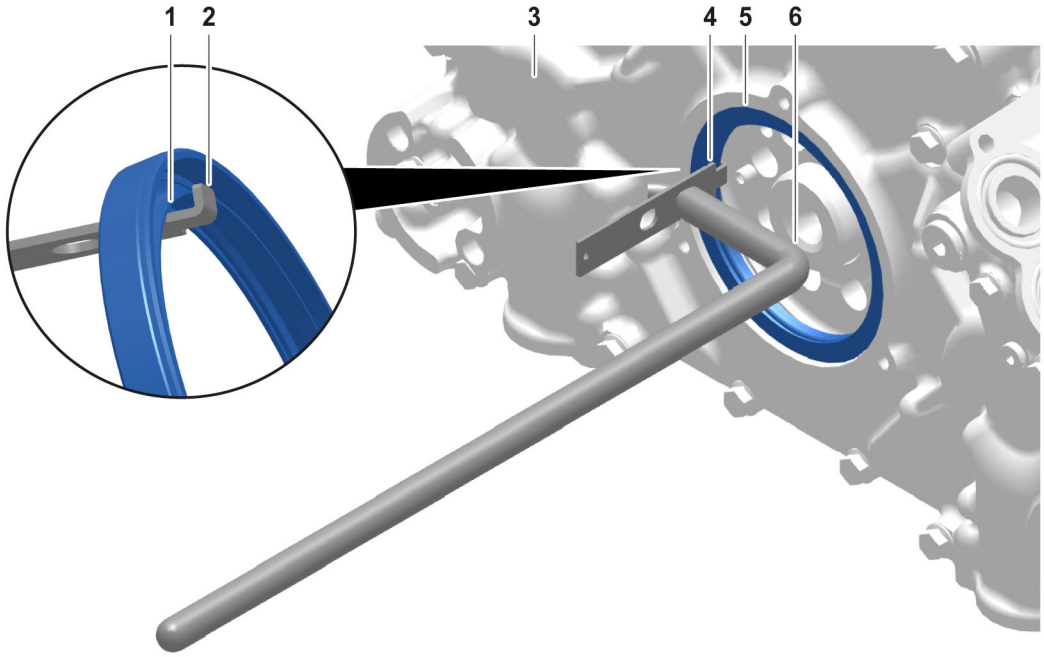


Fig. 172: Radial shaft sealing ring

1 Sealing lip
2 Nose
3 Ancillary support housing
4 Plate
5 Radial shaft sealing ring
6 Lever

▶ Align nose **2** of plate **4** under sealing lip **1** of radial shaft sealing ring **5**.

▶ Put lever **6** in hole of plate **4**.

▶ Align Teflon block between lever **6** and crankshaft.

▶ Remove radial shaft sealing ring **5** with lever **6** and plate **4**.

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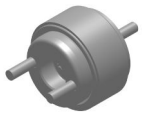
Installing the radial shaft sealing ring on the ancillary support housing side

Graphic representation	Description	Required number	Part number
	Press-in tool	1	10118887

Tab. 47: Special tool

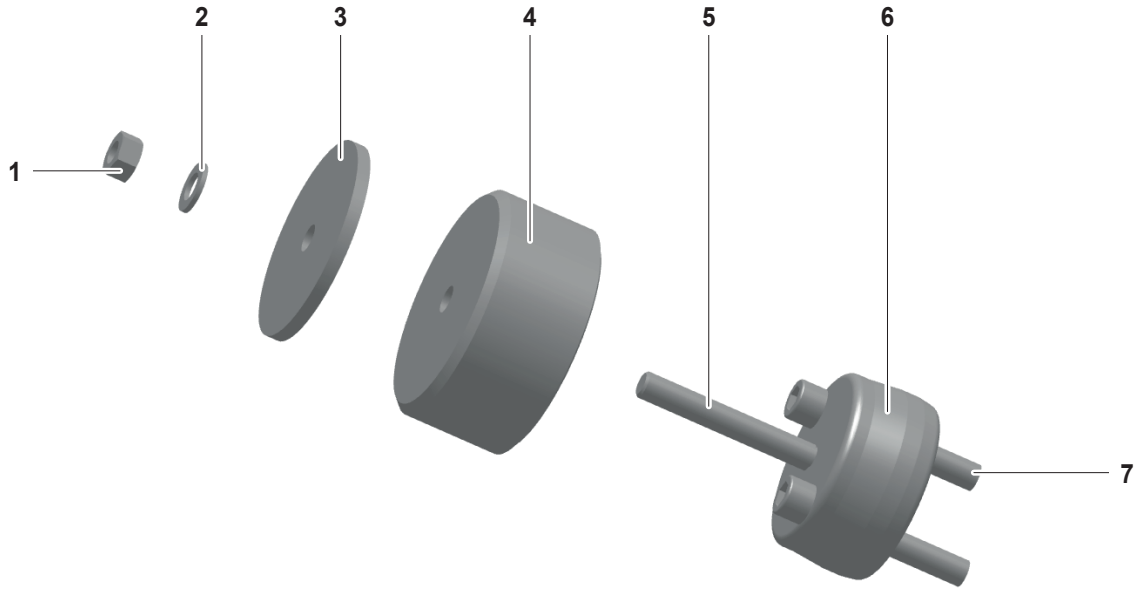


Fig. 174: Dismantling the press-in tool

1 Hex nut
2 Washer
3 Thrust washer
4 Sleeve
5 Threaded rod
6 Adapter
7 Socket head screw (2x)

▶ Unscrew hex nut **1**.

▶ Remove washer **2**, thrust washer **3** and sleeve **4**.

▶ Remove socket head screws **7**.

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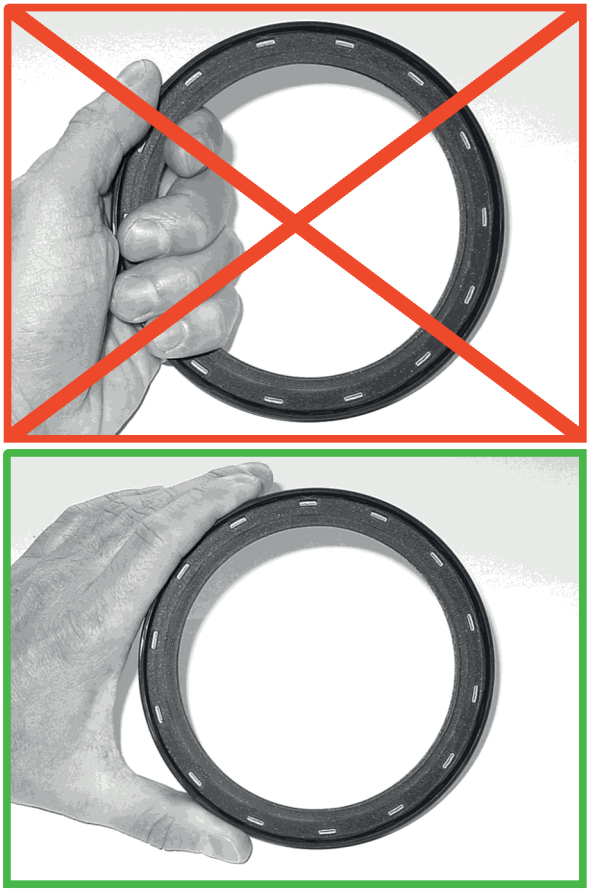

Fig. 175: Do not touch radial shaft sealing ring

- ▶ Remove new radial shaft sealing ring from the original packing immediately before installation.
- ▶ Carefully open original packing.
- ▶ Do not touch sealing lip of radial shaft sealing ring.
- ▶ Only grasp the radial shaft sealing ring on the outer periphery.

If the original packing is damaged:

- ▶ Check condition of the radial shaft sealing ring.
- ▶ In case of doubt, use a new radial shaft sealing ring.

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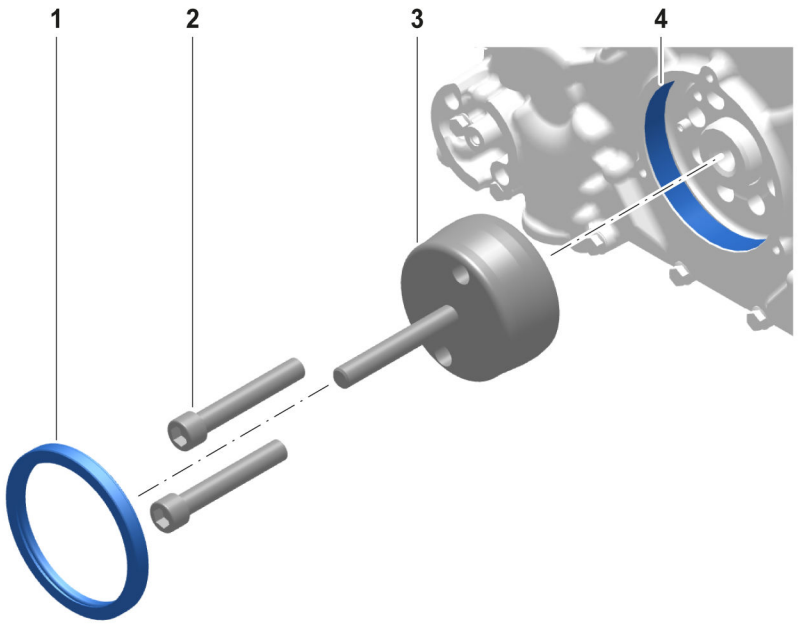

Fig. 176: Sliding the radial shaft sealing ring on the adapter

1 Radial shaft sealing ring
2 Socket head screw (2x)
3 Adapter
4 Ancillary support housing sealing surface

- ▶ Clean and degrease ancillary support housing sealing surface **4**.
- ▶ Lubricate ancillary support housing sealing surface **4** with Klüberplus S 06-100.
- ▶ Make sure that the adapter **3** is clean.
- ▶ Align adapter **3**.
- ▶ Tighten socket head screws **2** with 10 Nm.
- ▶ Install radial shaft sealing ring **1** on adapter **3**.

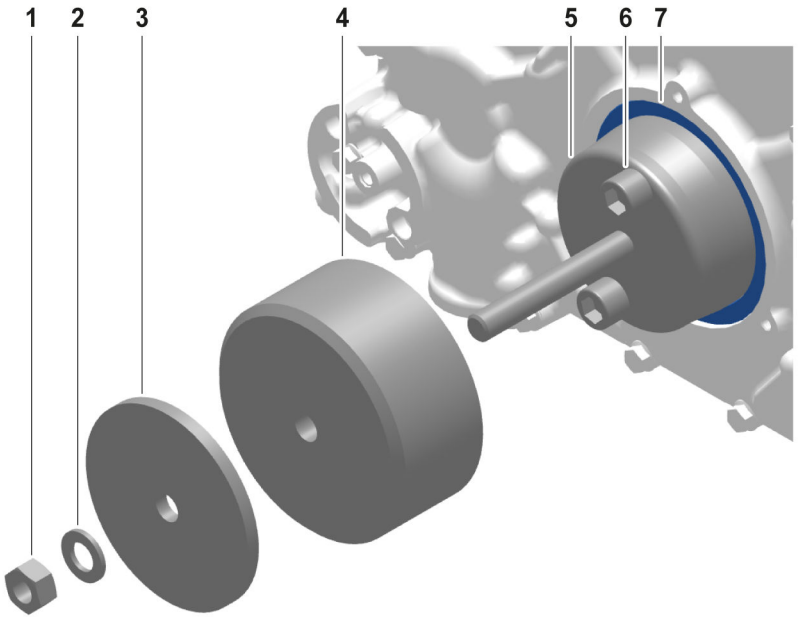

Fig. 177: Radial shaft sealing ring

1 Hex nut
5 Adapter

See next page for continuation of the image legend

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2 Washer
3 Thrust washer
4 Sleeve
6 Socket head screw (2x)
7 Radial shaft sealing ring

▶ Make sure that the sleeve **4** is clean.

▶ Install sleeve **4** on adapter.

▶ Install thrust washer **3** and washer **2** on adapter **5**.

NOTICE
Overtightening of the hex nut!
Damage to press-in tool.

▶ Screw on hex nut of press-in tool carefully.

▶ Screw on hex nut **1** until outer edge of sleeve **4** fits against ancillary support housing.
▷ The sleeve **4** presses the radial shaft sealing ring **7** into position.

▶ Unscrew hex nut **1**.

▶ Remove washer **2** and thrust washer **3**.

▶ Remove sleeve **4**.

▶ Unscrew hex socket screws **6**.

▶ Remove adapter **5**.

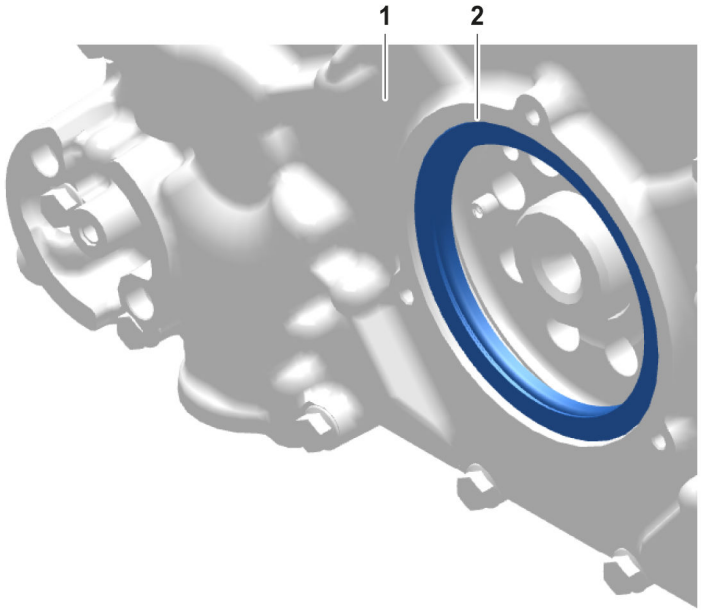

Fig. 178: Radial shaft sealing ring

1 Ancillary support housing
2 Radial shaft sealing ring

▶ Check radial shaft sealing ring **2** for correct seat.
▷ The radial shaft sealing ring **2** rests evenly against the ancillary support housing **1**. Max. deviation 0.5 mm.

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3.4.7 Removing and installing the ancillary support housing

Removing the ancillary support housing

Graphic representation	Description	Required number	Part number
	Assembly pin (M10)	2	12214084

Tab. 48: Special tool

Make sure that the following prerequisites are met:
- ❑ Radial shaft sealing ring on ancillary support housing side is removed. (For more information see: Removing the radial shaft sealing ring on the ancillary support housing side, page 136.)
- ❑ Coolant pump is removed. (For more information see: Removing the coolant pump, page 429.)
- ❑ Left oil module is removed. (For more information see: Removing the left oil module, page 376.)
- ❑ Right oil module is removed. (For more information see: Removing the right oil module, page 379.)
- ❑ Oil return line is removed. (For more information see: Removing the oil return line, page 366.)
- ❑ Elbows of oil pan are removed from ancillary support housing. (For more information see: Removing the oil pan, page 395.)
- ❑ Bracket and holding clamps for cable harness are removed from ancillary support housing. (For more information see: Removing the cable harness, page 475.)
- ❑ Intermediate section of tension pulley (self-tensioning) is removed. (For more information see: Removing the right oil module, page 379.)

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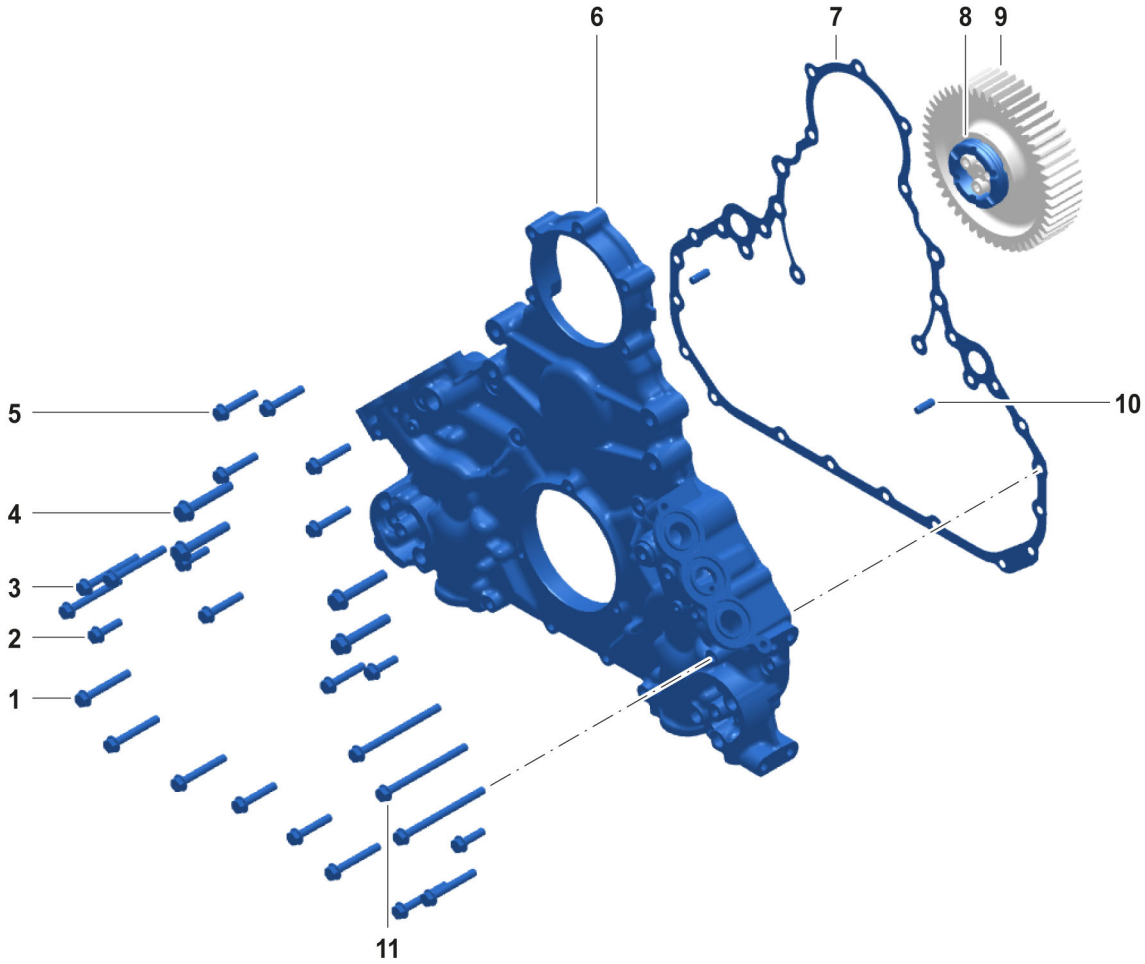

Fig. 180: Ancillary support housing

1 Hex head screw (6x)
2 Hex head screw (4x)
3 Hex head screw (3x)
4 Hex head screw (4x)
5 Hex head screw (9x)
6 Ancillary support housing
7 Seal
8 Damping element
9 Intermediate wheel
10 Parallel pin (2x)
11 Hex head screw (3x)

- ▶ Unscrew hex head screws **4**.
- ▶ Tighten two opposing assembly pins.
- ▶ Unscrew hex head screws **1**.
- ▶ Unscrew hex head screws **2**.
- ▶ Unscrew hex head screws **3**.
- ▶ Unscrew hex head screws **5**.
- ▶ Unscrew hex head screws **11**.
- ▶ Remove ancillary support housing **6**.
- ▶ If necessary, remove left oil pump. (For more information see: Removing the left oil pump, page 405.)
- ▶ If necessary, remove right oil pump. (For more information see: Removing the right oil pump, page 407.)
- ▶ Remove seal **7**.

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- ▶ Remove damping element **8** from intermediate wheel **9**.
- ▶ If necessary, remove parallel pins **10**.

Checking and cleaning the ancillary support housing

- ▶ Check damping element **8** for damage and replace if necessary.
- ▶ Clean contact surface of ancillary support housing **6**.
- ▶ Clean contact surface of crankcase.

Installing the ancillary support housing

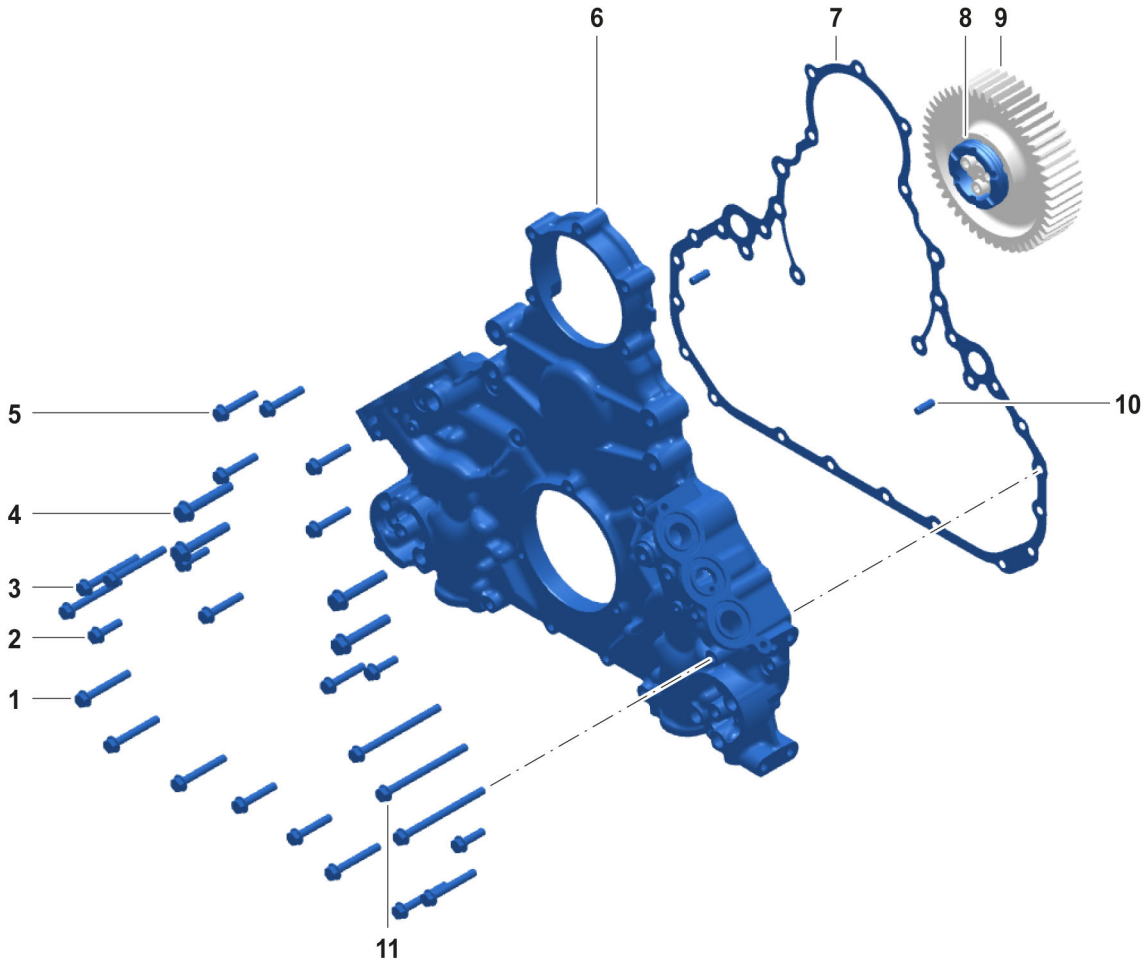

Fig. 181: Ancillary support housing

1 Hex head screw (6x)
2 Hex head screw (4x)
3 Hex head screw (3x)
4 Hex head screw (4x)
5 Hex head screw (9x)
6 Ancillary support housing
7 Seal
8 Damping element
9 Intermediate wheel
10 Parallel pin (2x)
11 Hex head screw (3x)

- ▶ Install new parallel pins **10**.
- ▶ Install right oil pump. (For more information see: Installing the right oil pump, page 409.)
- ▶ Install left oil pump. (For more information see: Installing the left oil pump, page 407.)
- ▶ Install damping element **8** on intermediate wheel **9**.

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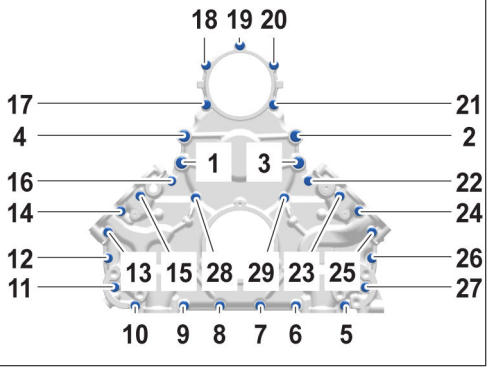
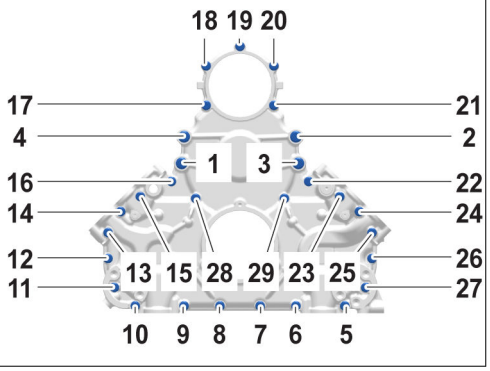
- ▶ Align new seal **7**.
- ▶ Install ancillary support housing **6**.
- ▶ Screw in hex head screws **11**.
- ▶ Screw in hex head screws **5**.
- ▶ Screw in hex head screws **3**.
- ▶ Screw in hex head screws **2**.
- ▶ Screw in hex head screws **1**.
- ▶ Unscrew assembly pins.
- ▶ Screw in hex head screws **4**.

Tightening instruction for hex head screw (M10)		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	40 Nm	
2.	55 Nm	

Tab. 49: Tightening instruction 12927642-001

Tightening instruction for hex head screw (M8)		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	20 Nm	
2.	28 Nm	

Tab. 50: Tightening instruction 12927642-001

- ▶ Tighten hex head screws **4**, hex head screws **11**, hex head screws **5**, hex head screws **3**, hex head screws **2** and hex head screws **1** according to tightening instruction.

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3.4.8 Removing and installing the intermediate wheel

Removing the intermediate wheel

Make sure that the following prerequisite is met:
❑ Ancillary support housing is removed. (For more information see: Removing the ancillary support housing, page 141.)

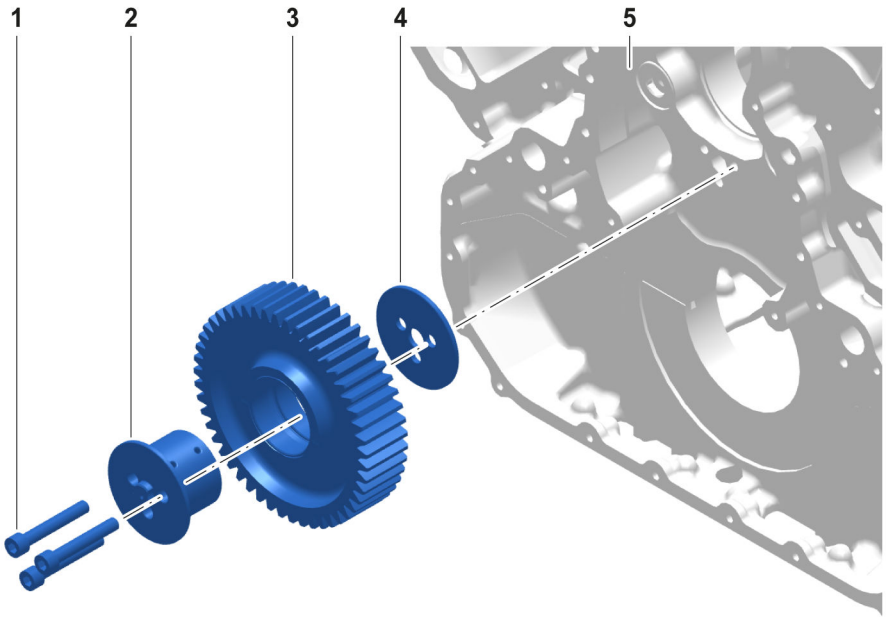

Fig. 184: Intermediate wheel

1 Socket head screw (3x)
2 Intermediate wheel axle
3 Intermediate wheel
4 Thrust washer
5 Crankcase

▶ Unscrew socket head screws **1**.

▶ Remove intermediate wheel axle **2**, intermediate wheel **3** and thrust washer **4** simultaneously.

Checking and cleaning the intermediate wheel

▶ Check intermediate wheel **3** for damage and replace if necessary.

▶ Check intermediate wheel axle **2** for damage and replace if necessary.

▶ Clean intermediate wheel **3**.

▶ Clean contact surfaces of crankcase **5**.

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Installing the intermediate wheel

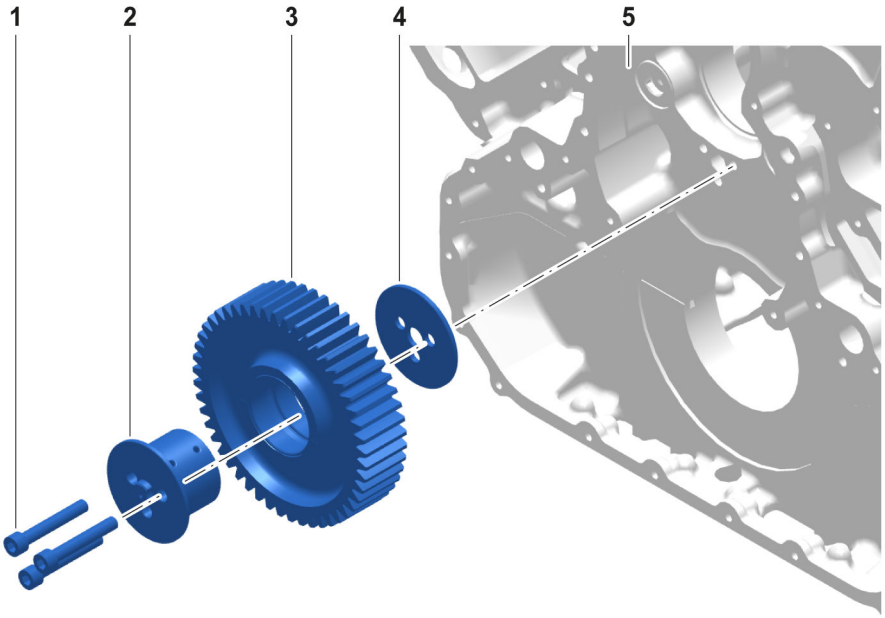

Fig. 185: Intermediate wheel

1 Socket head screw (3x)
2 Intermediate wheel axle
3 Intermediate wheel
4 Thrust washer
5 Crankcase

▶ Lubricate contact surfaces of intermediate wheel axle **2** and intermediate wheel **3** with fresh engine oil.

▶ Install intermediate wheel axle **2**, intermediate wheel **3** and thrust washer **4** simultaneously.

▶ Tighten socket head screws **1**.

3.4.9 Flywheel

Removing the flywheel

Graphic representation	Description	Required number	Part number
	Lifting device	1	11067454
	Assembly pin (M18)	2	10118882

Tab. 51: Special tool

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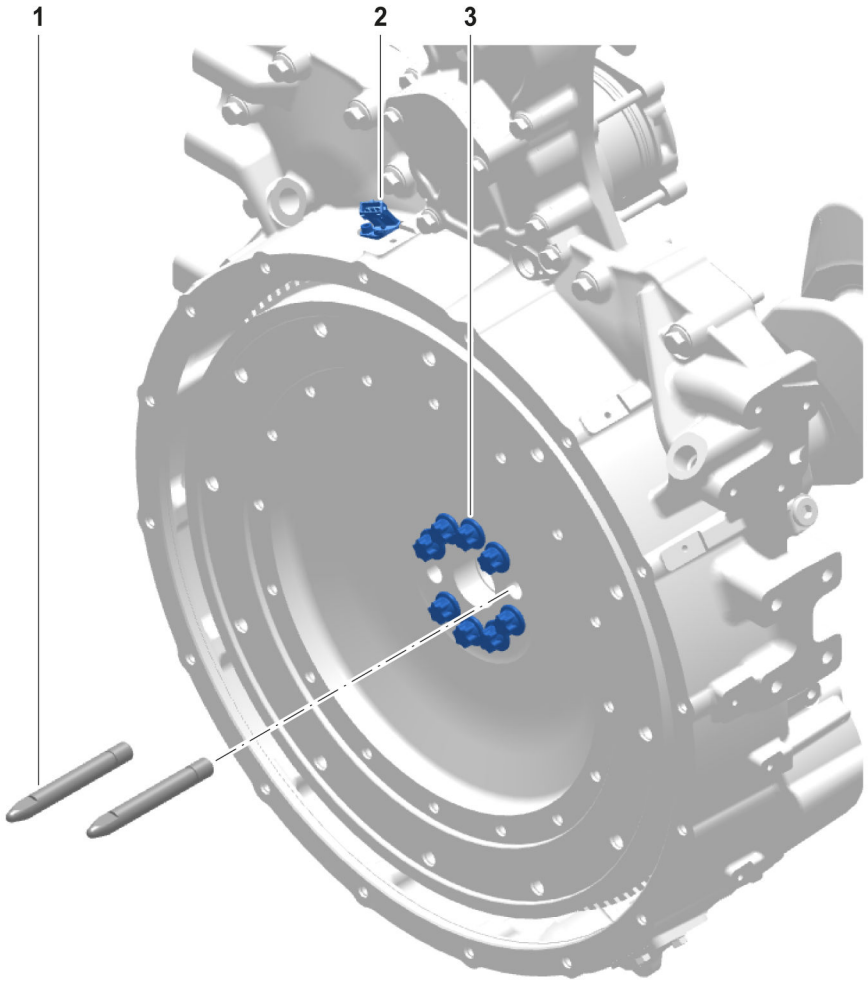

Fig. 188: Assembly pins

1 Assembly pins (2x)
2 Speed sensor
3 Hexalobular flange head screw (10x)

- ▶ Disconnect electrical plug connection from speed sensor **2**.
- ▶ Remove speed sensor **2**.
- ▶ Unscrew two opposing hexalobular flange head screws **3**.
- ▶ Tighten opposing assembly pins **1**.
- ▶ Unscrew hexalobular flange head screws **3**.

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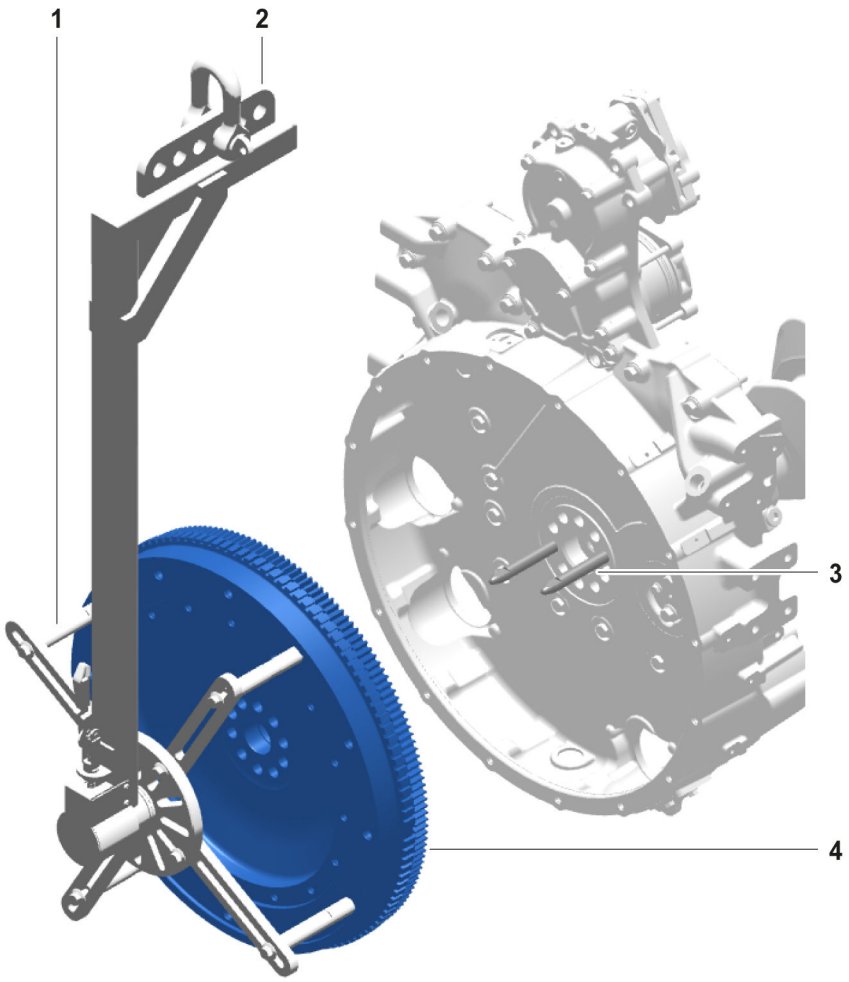

Fig. 189: Lifting device

1	Fastening bolts (4x)	**3**	Assembly pin (2x)
2	Lifting device	**4**	Flywheel

WARNING
Improper lifting of the flywheel!
Injuries.

▶ Only lift the flywheel with the lifting device.

▶ Fasten lifting device **2** to crane.

▶ Tighten fastening bolts **1** on flywheel **4**.

▶ Observe pitch diameter and thread size of threaded holes in flywheel **4**.

▶ Remove flywheel **4**.

▶ If necessary, unscrew assembly pins **3**.

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Cleaning the flywheel

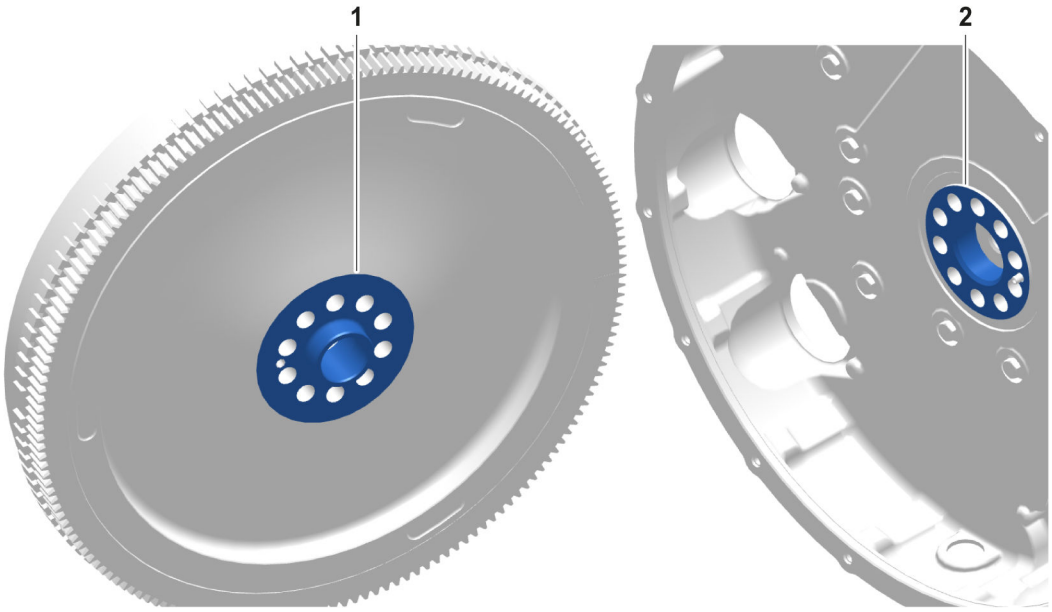

Fig. 190: Cleaning the contact surfaces

1 Contact surface on flywheel **2** Contact surface on crankshaft gear wheel

▶ Degrease contact surface on flywheel **1**.

▶ Degrease contact surface on crankshaft gear wheel **2**.

Installing the flywheel

Graphic representation	Description	Required number	Part number
	Lifting device	1	11067454
	Assembly pin (M18)	2	10118882

Tab. 52: Special tool

Make sure that the following prerequisite is met:

❑ Speed sensor is removed. (For more information see: Speed sensor on flywheel housing, page 473.)

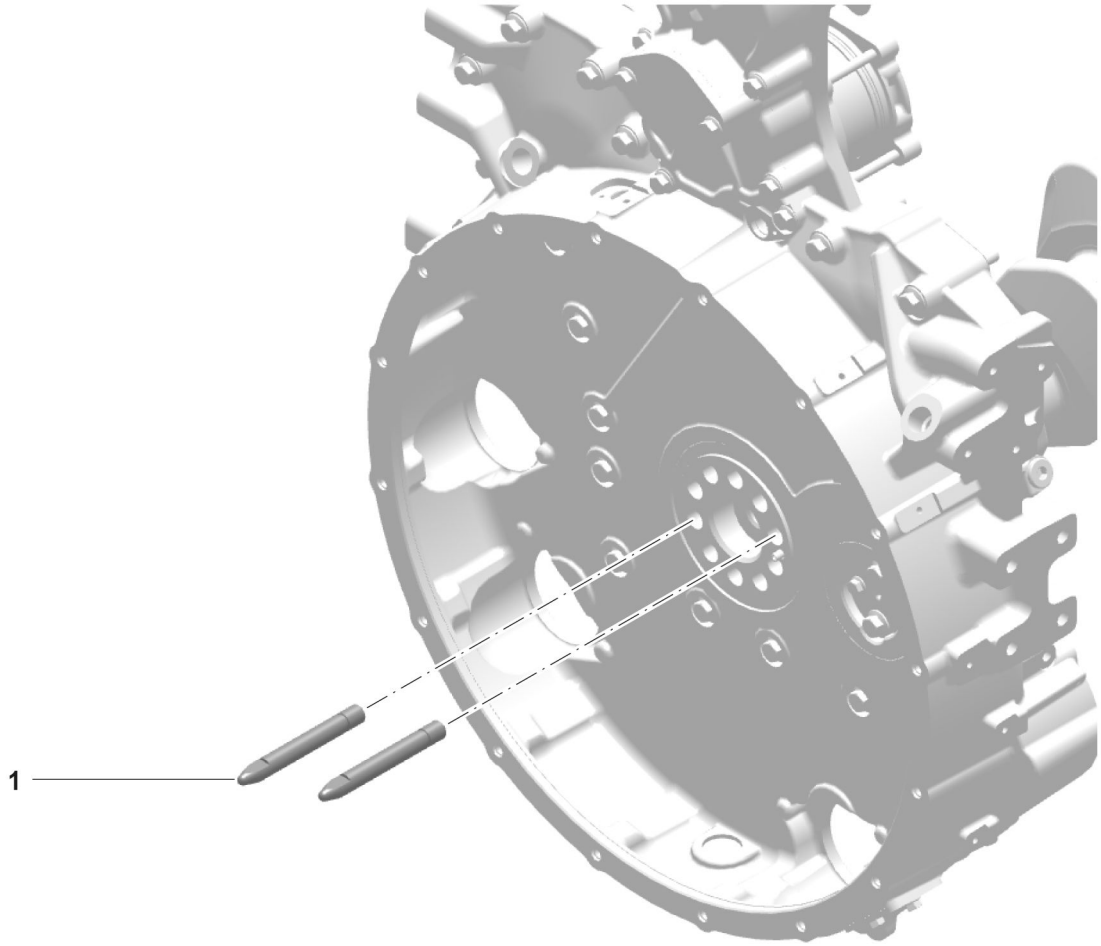

Fig. 193: Assembly pins

1 Assembly pin (2x)

▶ Check condition of radial shaft sealing ring and replace if necessary. (For more information see: Removing the radial shaft sealing ring on the flywheel side, page 154.)

▶ If necessary, tighten opposing assembly pins **1**.

WARNING
Improper lifting of the flywheel!
Injuries.

▶ Only lift the flywheel with the lifting device.

NOTICE
Improper assembly!
Damage to the flywheel gear ring.

▶ Make sure that the flywheel gear ring is not damaged.

▶ Make sure that the flywheel gear ring is free of grease.

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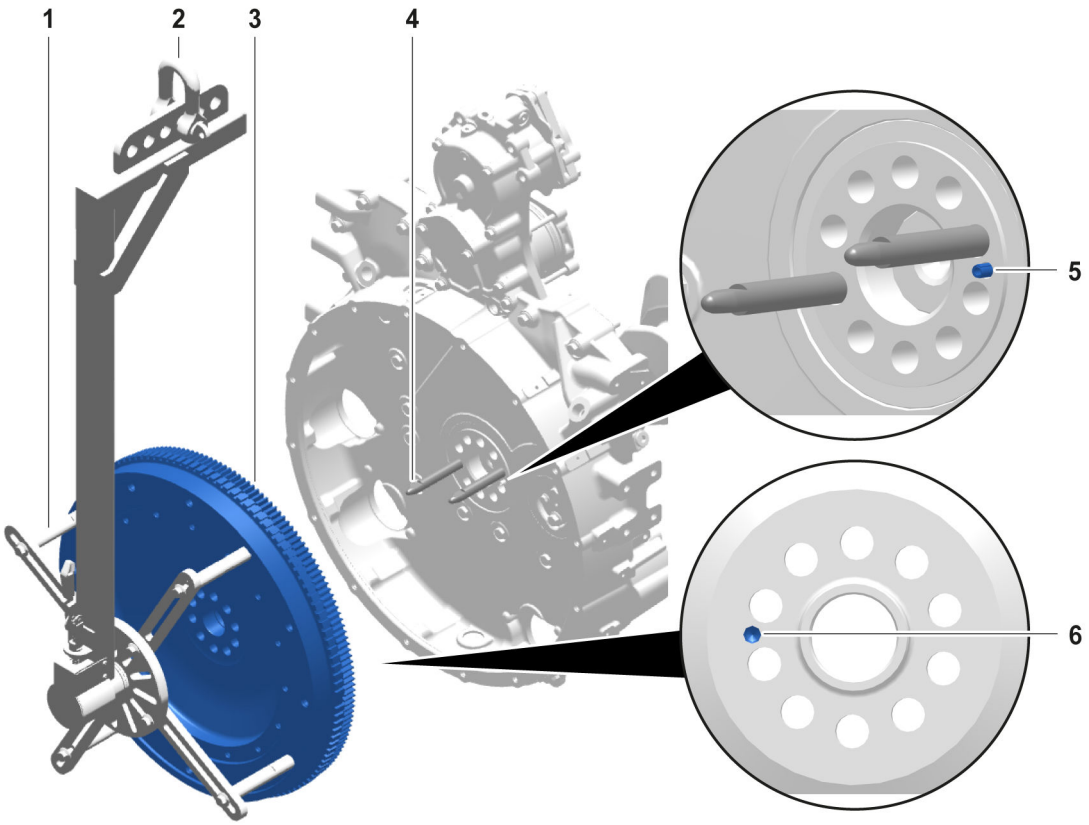

Fig. 194: Flywheel

1 Fastening bolts
2 Lifting device
3 Flywheel
4 Assembly pin (2x)
5 Guide pin
6 Guide hole

- ▶ Fasten lifting device **2** to crane.
- ▶ Tighten fastening bolts **1** on flywheel **3**.
- ▶ Observe pitch diameter and thread size of threaded holes in flywheel **3**.
- ▶ Align guide hole **6** to guide pin **5**.
- ▶ Install flywheel **3**.
- ▶ Remove lifting device **2**.

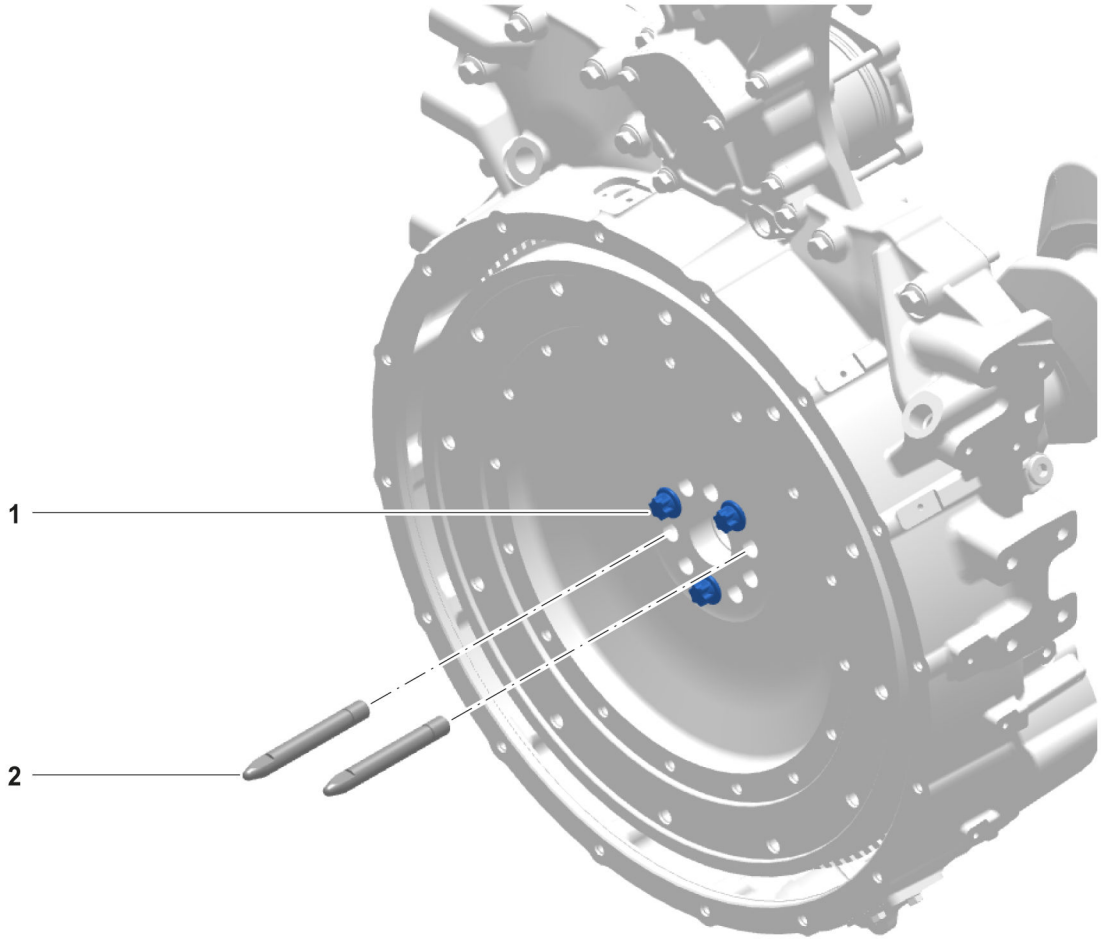

Fig. 195: Assembly pins

1 Hexalobular flange head screw (10x) **2** Assembly pin (2x)

▶ Lubricate three hexalobular flange head screws **1** with engine oil and screw them in evenly.

▶ Make sure that flywheel fits against crankshaft gear wheel.

▶ Unscrew assembly pins **2**.

▶ Lubricate remaining hexalobular flange head screws **1** with engine oil and screw them in.

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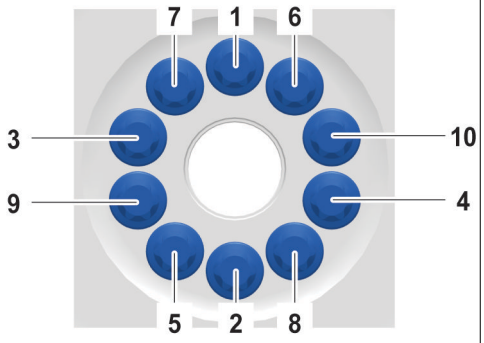
Hexalobular flange head screw tightening instruction		
Lubricant (thread and head contact surface)	Engine oil	Tightening sequence 
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque in Nm**	
1.	30	
2.	80	
Stage	**Angle of rotation in °**	
3.	23	
4.	90	
5.	90	

Tab. 53: Tightening instruction 10119803-102

▶ Tighten hexalobular flange head screws **1** according to tightening instruction.

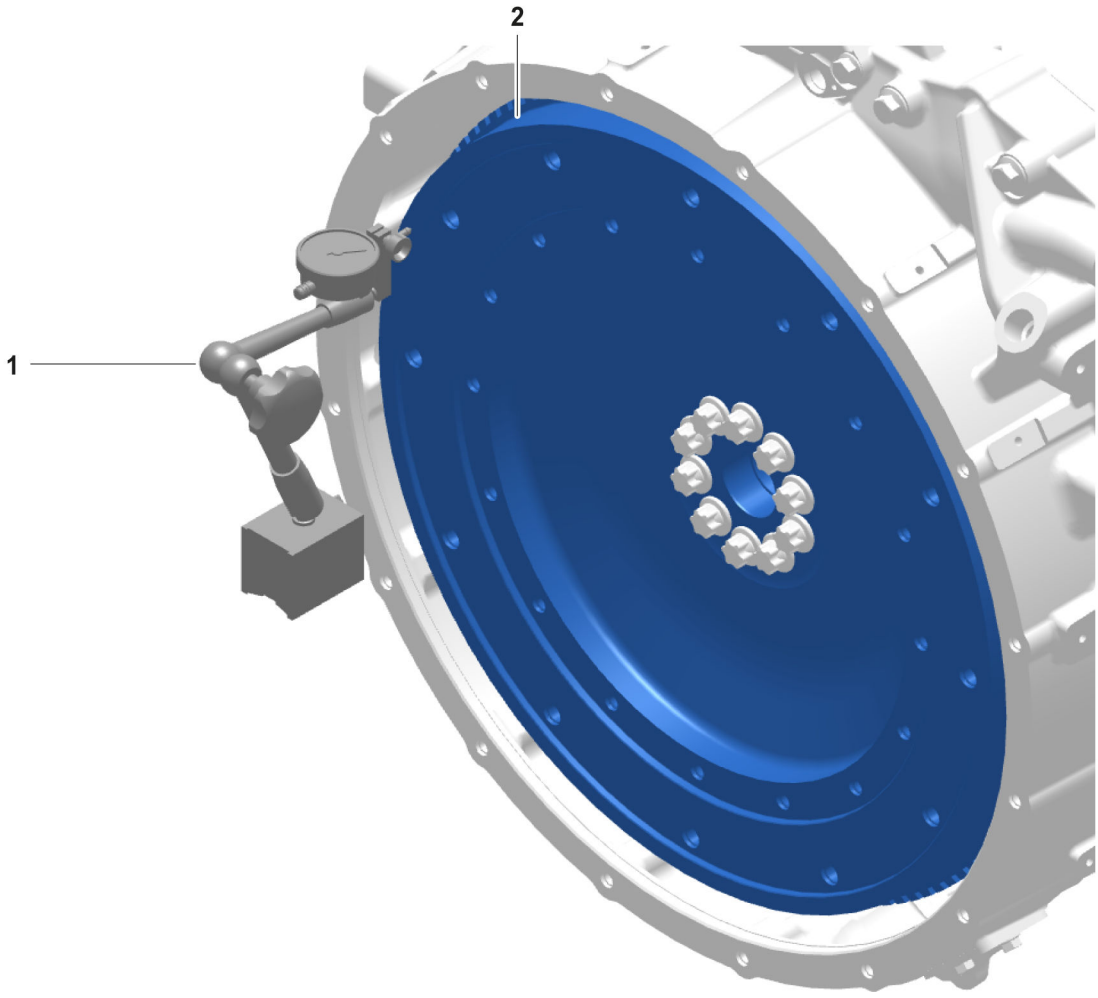


Fig. 197: Checking the axial play

1 Dial gauge **2** Flywheel

- ▶ Install turning device. (For more information see: Installing the turning device (optional), page 68.)
- ▶ Slide flywheel **2** with crankshaft to axial bearing play limit stop.
- ▶ Fasten and align dial gauge **1** for axial measurement.
- ▶ Zero dial gauge **1**.
- ▶ Rotate flywheel **2** with turning device and simultaneously check axial concentricity (tolerance 0.5 mm).

If the axial concentricity is outside of the tolerance:

- ▶ Replace complete flywheel **2**.
- ▶ Remove turning device. (For more information see: Removing the turning device (optional), page 73.)

3.4.10 Flywheel side radial shaft sealing ring

Removing the radial shaft sealing ring on the flywheel side

Graphic representation	Description	Required number	Part number
	Extractor for radial shaft sealing ring	1	7019858

Tab. 54: Special tool

Make sure that the following prerequisite is met:

- ❑ Flywheel is removed. (For more information see: Removing the flywheel, page 146.)

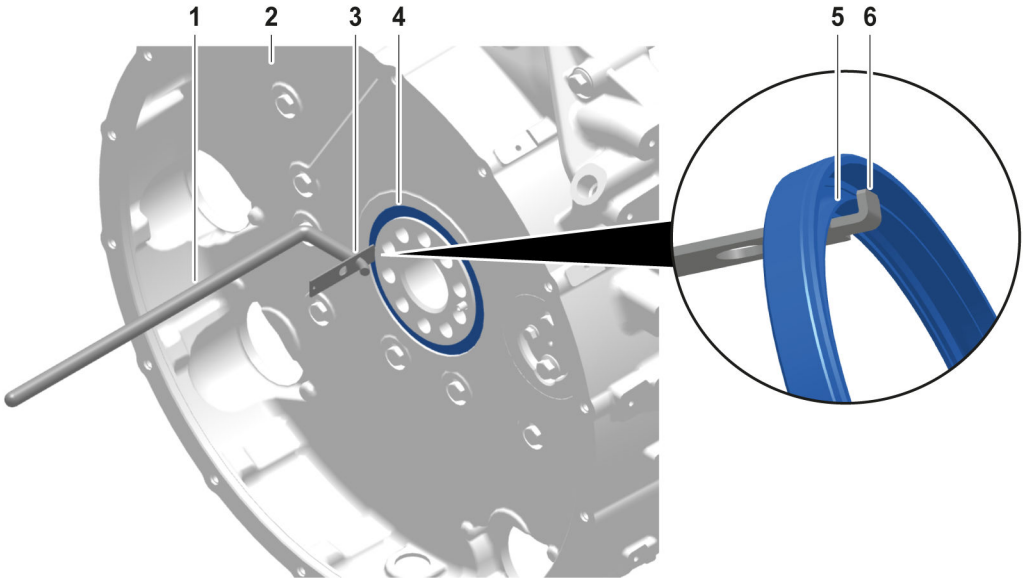


Fig. 199: Radial shaft sealing ring

1 Lever
2 Flywheel housing
3 Plate
4 Radial shaft sealing ring
5 Sealing lip
6 Nose

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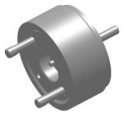
- ▶ Align nose **6** of plate **3** under sealing lip **5** of radial shaft sealing ring **4**.
- ▶ Put lever **1** in hole of plate **3**.
- ▶ Align Teflon block between lever **1** and flywheel housing **2**.
- ▶ Remove radial shaft sealing ring **4** with lever **1** and plate **3**.

Note

If the engine has only been running for a few operating hours:
- ▶ Do not replace crankshaft gear wheel.

- ▶ Replace crankshaft gear wheel. (For more information see: Removing the crankshaft gear wheel, page 161.)

Installing the radial shaft sealing ring on the flywheel side

Graphic representation	Description	Required number	Part number
	Press-in tool	1	10118886

Tab. 55: Special tool

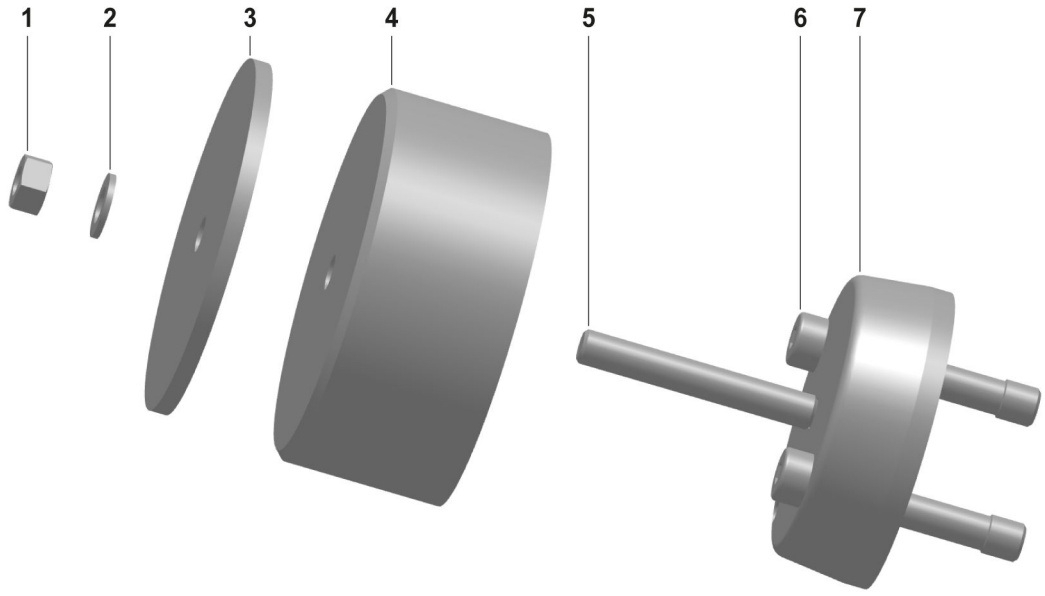


Fig. 201: Dismantling the press-in tool

1 Hex nut
2 Washer
3 Bracket
4 Sleeve
5 Grub screw
6 Socket head screw (2x)
7 Adapter

- ▶ Unscrew hex nut **1**.
- ▶ Remove washer **2**, bracket **3** and sleeve **4**.
- ▶ Remove socket head screws **6**.

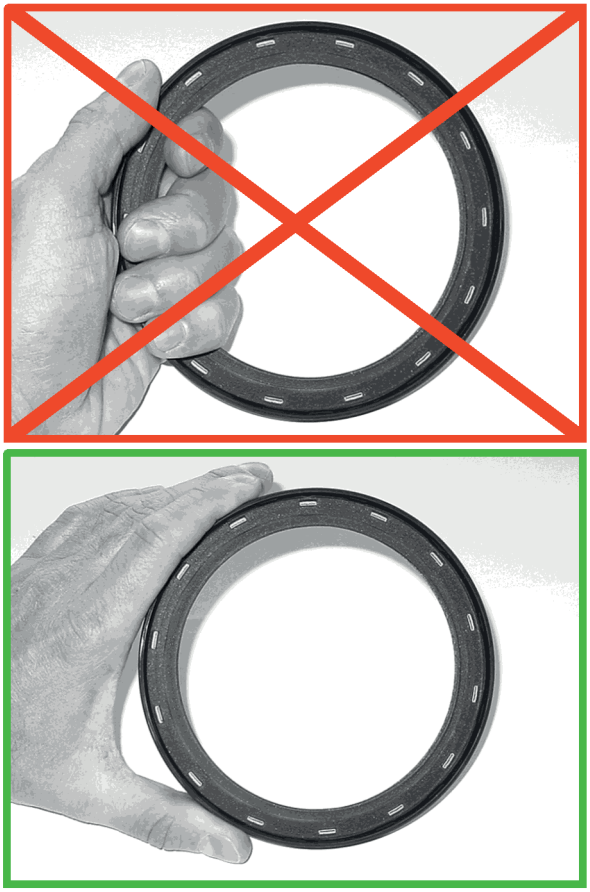


Fig. 202: Do not touch radial shaft sealing ring

- ▶ Remove new radial shaft sealing ring from the original packing immediately before installation.
- ▶ Carefully open original packing.
- ▶ Do not touch sealing lip of radial shaft sealing ring.
- ▶ Only grasp the radial shaft sealing ring on the outer periphery.

If the original packing is damaged:

- ▶ Check condition of the radial shaft sealing ring.
- ▶ In case of doubt, use a new radial shaft sealing ring.

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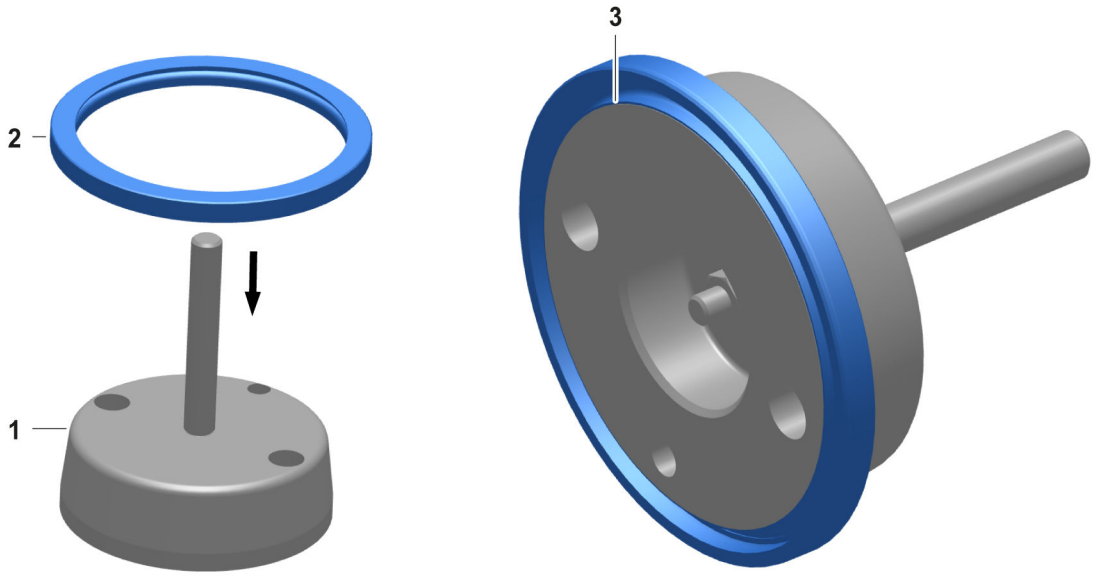

Fig. 203: Installing the radial shaft sealing ring on the adapter

1 Adapter
2 Radial shaft sealing ring
3 Periphery

▶ Make sure that the adapter **1** is clean.

▶ Set adapter **1** on a clean and level surface.

▶ Install radial shaft sealing ring **2** on adapter **1**.

▶ Make sure that the radial shaft sealing ring **2** sits correctly on the entire periphery **3** on adapter **1**.
▷ Radial shaft sealing ring **2** is flush with front surface of adapter **1**.

▶ Lubricate outer diameter of radial shaft sealing ring **2** with Klüberplus S 06-100.

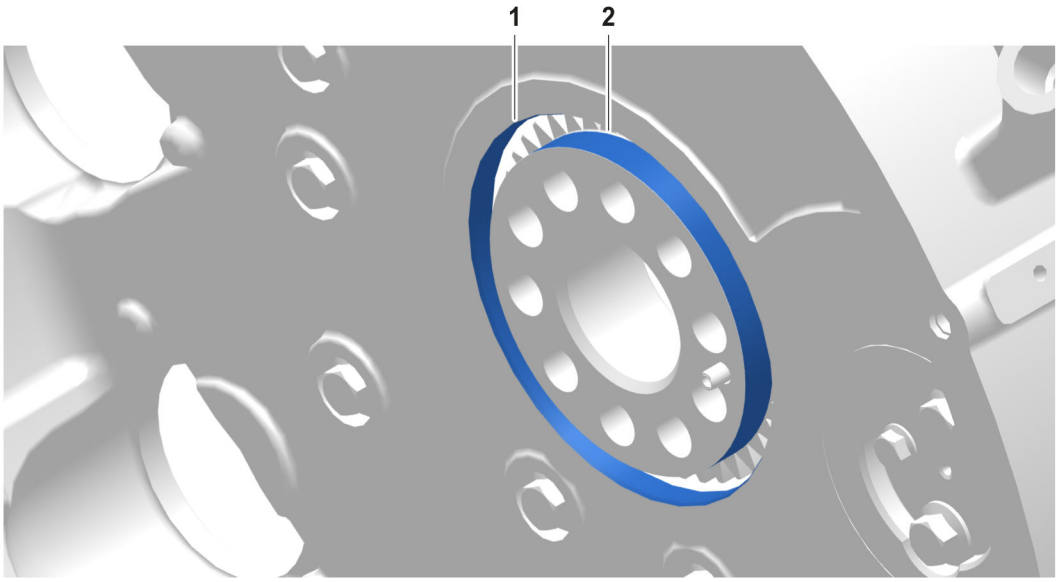

Fig. 204: Sealing surfaces

1 Flywheel housing sealing surface
2 Crankshaft sealing surface

▶ Clean and degrease flywheel housing sealing surface **1**.

▶ Clean and degrease crankshaft sealing surface **2**.

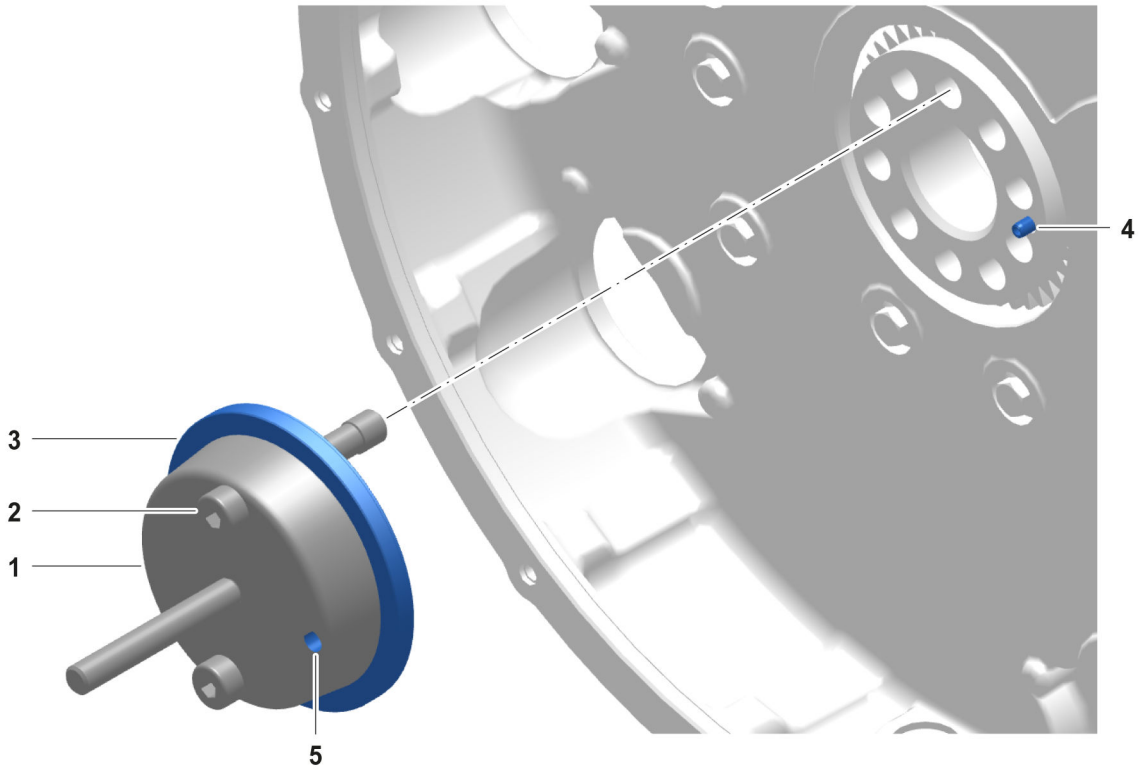

Fig. 205: Radial shaft sealing ring

1 Adapter
2 Socket head screw (2x)
3 Radial shaft sealing ring
4 Guide pin
5 Hole

▶ Align hole **5** to guide pin **4** with each other.

▶ Install adapter **1** with radial shaft sealing ring **3** on crankshaft.

▶ Tighten socket head screws **2** with max. 10 Nm.

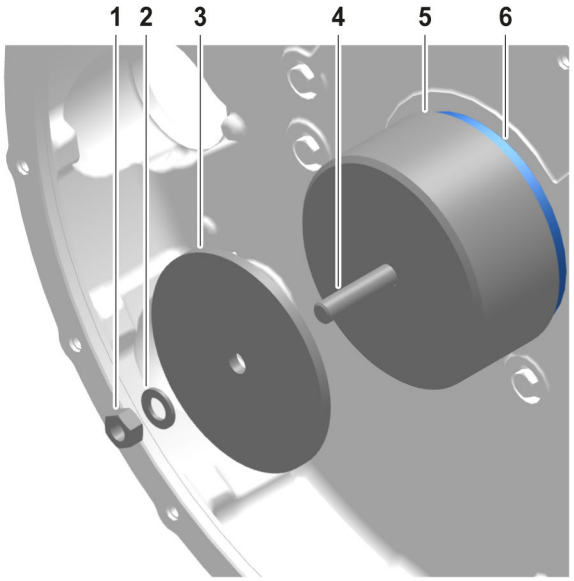

Fig. 206: Radial shaft sealing ring

1 Hex nut
2 Washer
3 Bracket
4 Grub screw
5 Sleeve
6 Radial shaft sealing ring

▶ Make sure that the sleeve **5** is clean.

▶ Install sleeve **5** on adapter.

▶ Install bracket **3** and washer **2** on grub screw **4**.

NOTICE
Overtightening of the hex nut!
Damage to press-in tool.

▶ Screw on hex nut of press-in tool carefully.

▶ Screw on hex nut **1** until outer edge of sleeve **5** fits against flywheel housing.
▷ The sleeve **5** presses the radial shaft sealing ring **6** into position.

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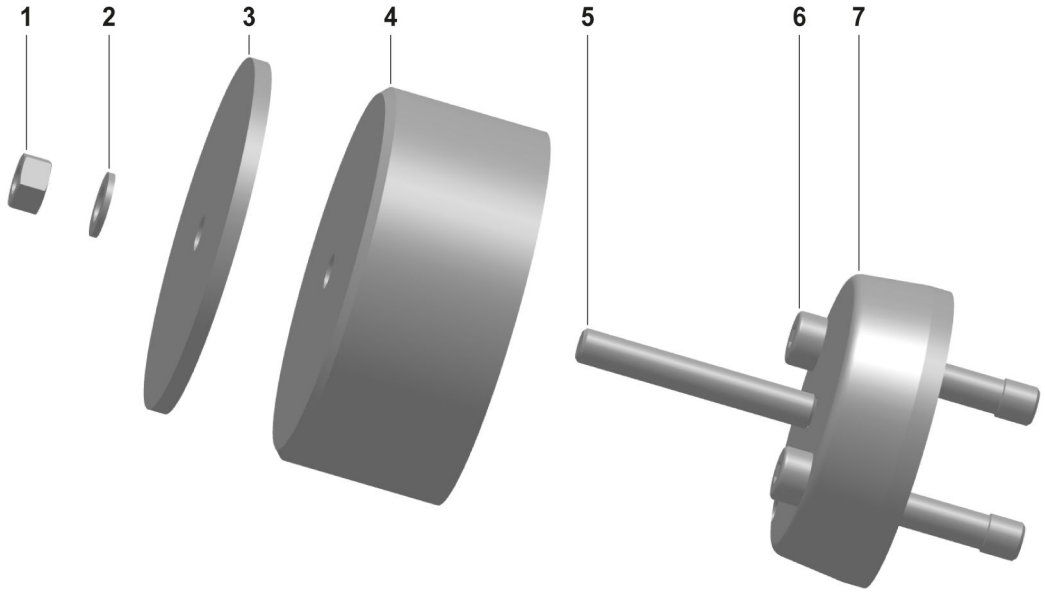

Fig. 207: Dismantling the press-in tool

1 Hex nut
2 Washer
3 Bracket
4 Sleeve
5 Grub screw
6 Socket head screw (2x)
7 Adapter

▶ Unscrew hex nut **1**.

▶ Remove washer **2** and bracket **3**.

▶ Remove sleeve **4**.

▶ Unscrew hex socket screws **6**.

▶ Remove adapter **7**.

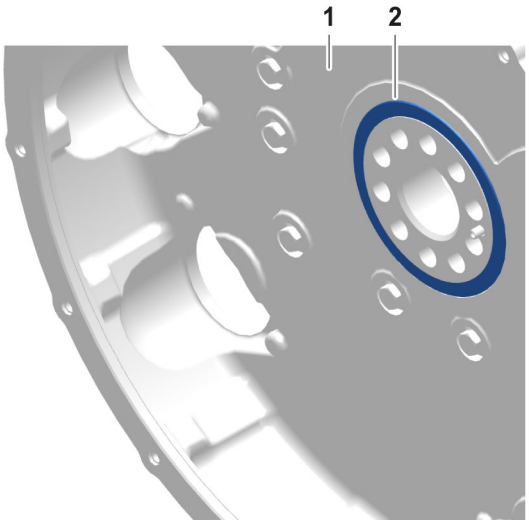

Fig. 208: Radial shaft sealing ring

1 Flywheel housing
2 Radial shaft sealing ring

▶ Check radial shaft sealing ring **2** for correct seat.
▷ The radial shaft sealing ring **2** rests evenly against the flywheel housing **1**. Max. deviation 0.5 mm

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3.4.11 Removing and installing the crankshaft gear wheel

Removing the crankshaft gear wheel

Make sure that the following prerequisites are met:
- ❑ Cylinder 1 is at ignition TDC. (For more information see: Setting cylinder 1 to ignition TDC, page 69.)
- ❑ Radial shaft sealing ring on flywheel side is removed. (For more information see: Removing the radial shaft sealing ring on the flywheel side, page 154.)

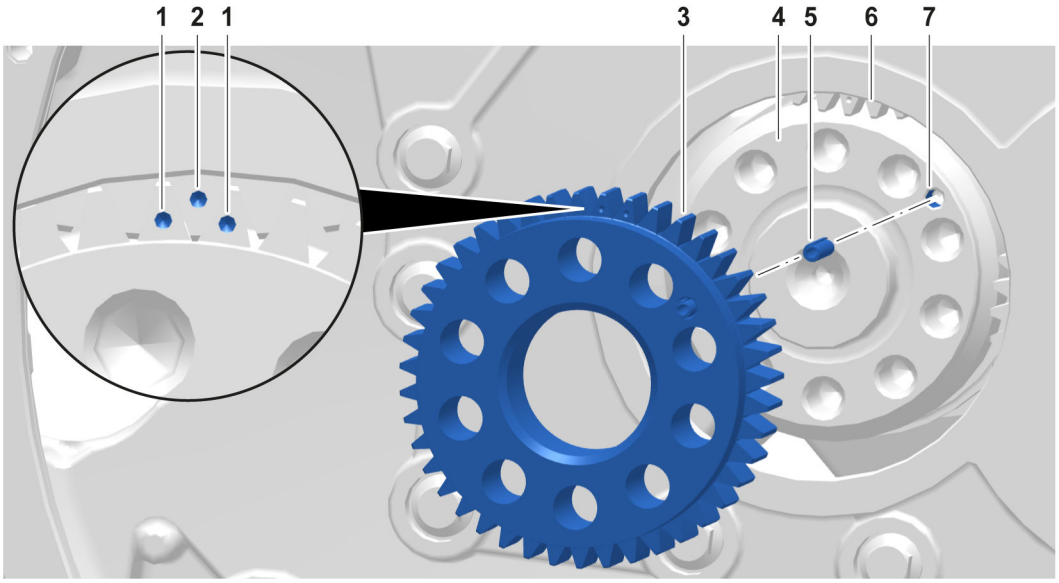

Fig. 209: Crankshaft gear wheel

1 Crankshaft gear wheel mark
2 Camshaft gear wheel mark
3 Gear wheel
4 Crankshaft
5 Heavy duty dowel pin
6 Camshaft gear wheel
7 Hole

▶ Remove gear wheel **3**.

If heavy duty dowel pin **5** is stuck in crankshaft **4**:
▶ Remove heavy duty dowel pin **5**.

Cleaning the crankshaft gear wheel

▶ Clean contact surface of crankshaft **4**.

▶ Clean hole **7**.

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Installing the crankshaft gear wheel

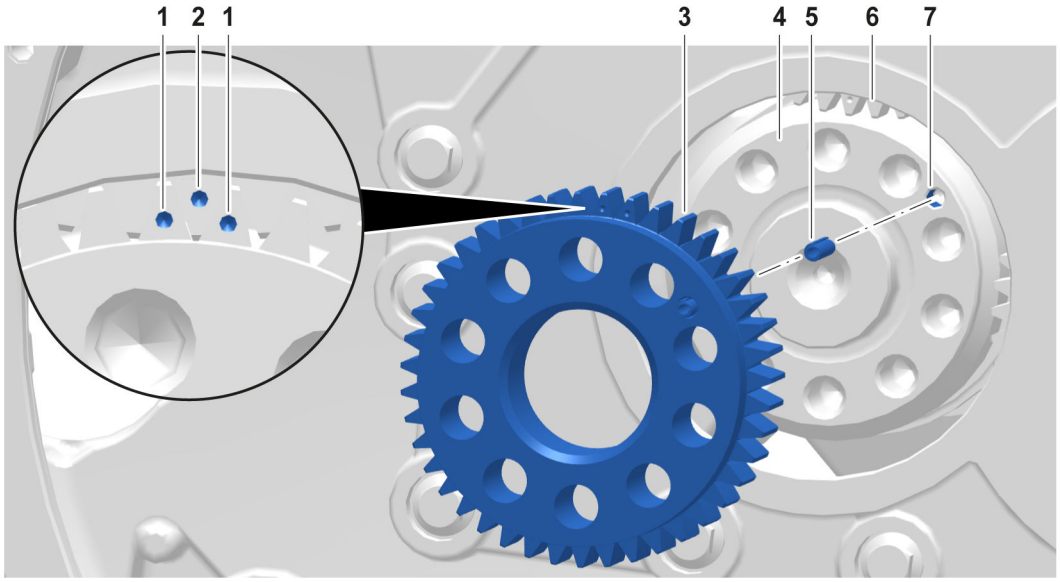

Fig. 210: Crankshaft gear wheel

1 Crankshaft gear wheel mark
2 Camshaft gear wheel mark
3 Gear wheel
4 Crankshaft
5 Heavy duty dowel pin
6 Camshaft gear wheel
7 Hole

▶ Install new heavy duty dowel pin **5** in hole **7**.

▶ Align new gear wheel **3**.

▶ Align crankshaft gear wheel mark **1** to camshaft gear wheel mark **2**.

▶ Install gear wheel **3**.

3.4.12 Removing and installing the flywheel housing

Removing the flywheel housing

Graphic representation	Description	Required number	Part number
	Assembly pin (M12)	2	0528471

Tab. 56: Special tool

Make sure that the following prerequisites are met:
❑ Engine is attached to engine assembly stand. (For more information see: 4.2.2 Engine assembly stand and adapter, page 506.)
❑ High pressure pump drive is removed. (For more information see: Removing the high pressure pump drive, page 257.)
❑ Starter motors are removed. (For more information see: Removing the starter motor, page 465.)
❑ Radial shaft sealing ring on flywheel side is removed. (For more information see: Removing the radial shaft sealing ring on the flywheel side, page 154.)

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- ❑ Left exhaust gas turbocharger is removed. (For more information see: Removing the left exhaust gas turbocharger, page 335.)
- ❑ Right exhaust gas turbocharger is removed. (For more information see: Removing the right exhaust gas turbocharger, page 337.)
- ❑ Bracket of left exhaust gas stub is removed. (For more information see: Removing the left exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger, page 307.)
- ❑ Bracket of right exhaust gas stub is removed. (For more information see: Removing the right exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger, page 312.)
- ❑ Pipeline from cycle valve to vacuum actuator is removed. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)
- ❑ Air compressor is removed. (For more information see: Removing the air compressor, page 453.)

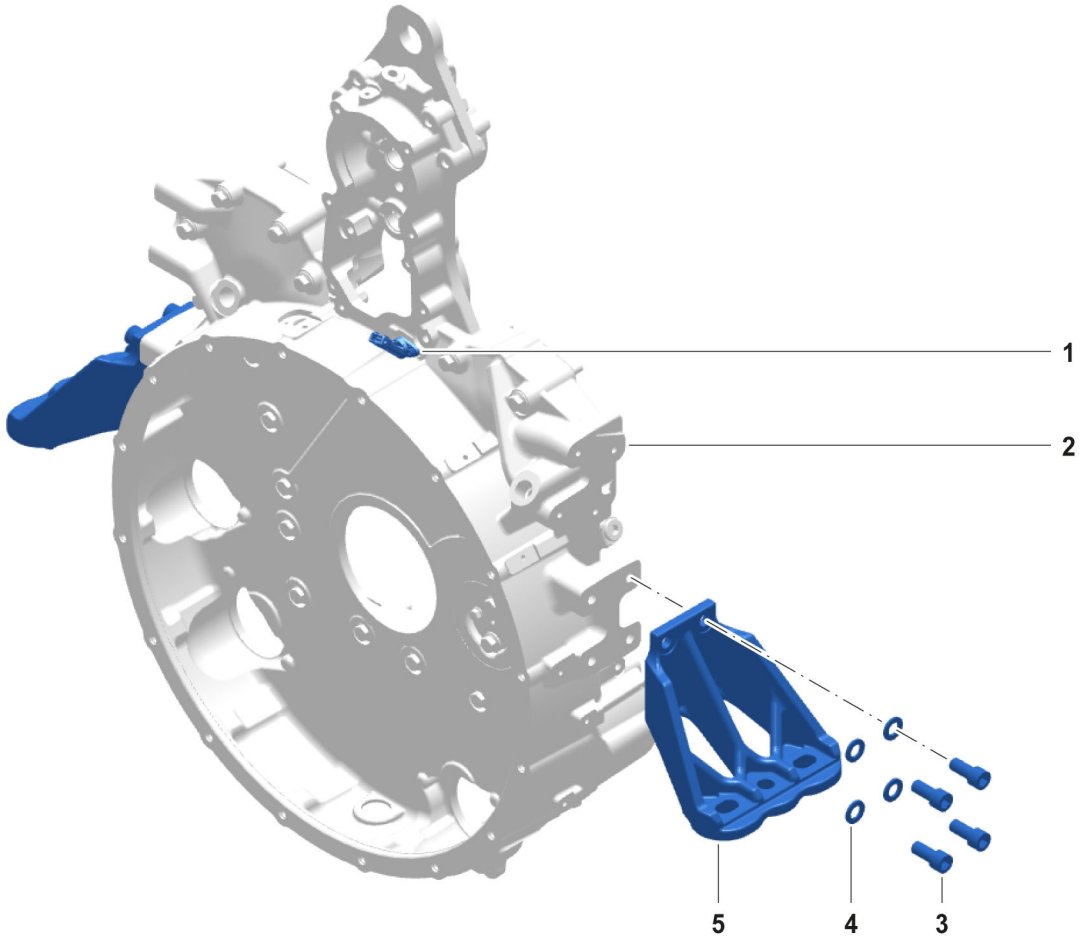

Fig. 212: Flywheel housing

1 Speed sensor
2 Socket head screw (8x)
3 Washer (8x)
4 Flywheel housing
5 Engine mount (2x)

▶ Disconnect electrical plug connections from speed sensor **1**.

▶ Remove speed sensor **1**.

▶ Remove cable harness from flywheel housing **4**.

▶ Remove bracket of cable harness from flywheel housing **4**.

▶ If necessary, unscrew socket head screws **2**.

- ▶ Remove engine mounts **5**.
- ▶ If necessary, remove cover. (For more information see: Removing the cover, page 441.)
- ▶ If necessary, remove flywheel housing cover. (For more information see: Removing the flywheel housing cover, page 66.)

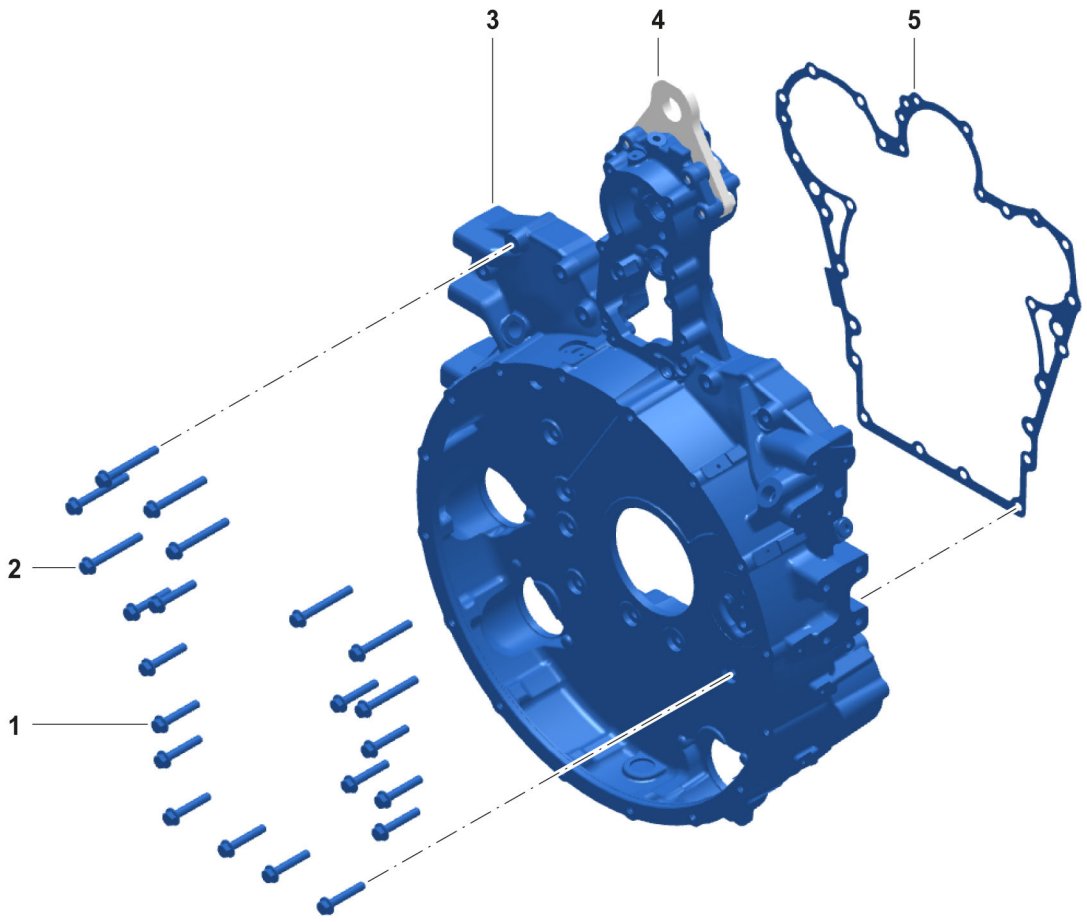

Fig. 213: Flywheel housing

1 Hex head screw (14x)
2 Hex head screw (8x)
3 Flywheel housing
4 Lifting hook
5 Seal

- ▶ Unscrew two opposing hex head screws **1**.
- ▶ Tighten two assembly pins.
- ▶ Install lifting device on lifting hook **4**.
- ▶ Unscrew hex head screws **1** and hex head screws **2**.
- ▶ Remove flywheel housing **3**.
- ▶ Remove seal **5**.
- ▶ If necessary, remove the lifting hook **4**. (For more information see: Removing the lifting hook, page 507.)
- ▶ If necessary, unscrew assembly pins.

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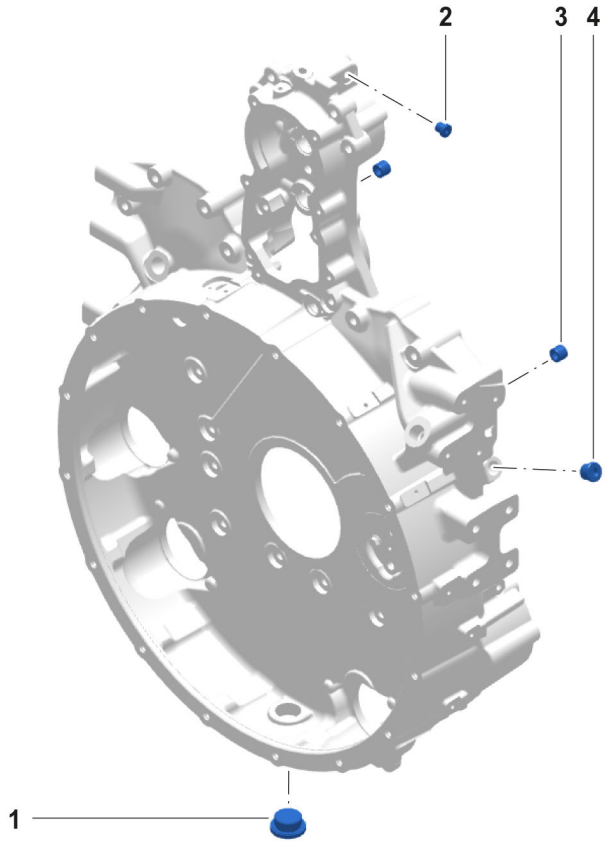

Fig. 214: Flywheel housing

1 Screw plug
2 Screw plug
3 Fitting sleeve (2x)
4 Screw plug

- ▶ If necessary, unscrew screw plug **1**.
- ▶ If necessary, unscrew screw plug **2**.
- ▶ If necessary, unscrew screw plug **4**.
- ▶ If necessary, remove fitting sleeves **3**.
- ▶ If necessary, remove intermediate wheel. (For more information see: Removing the intermediate wheel, page 145.)

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Removing the intermediate wheel

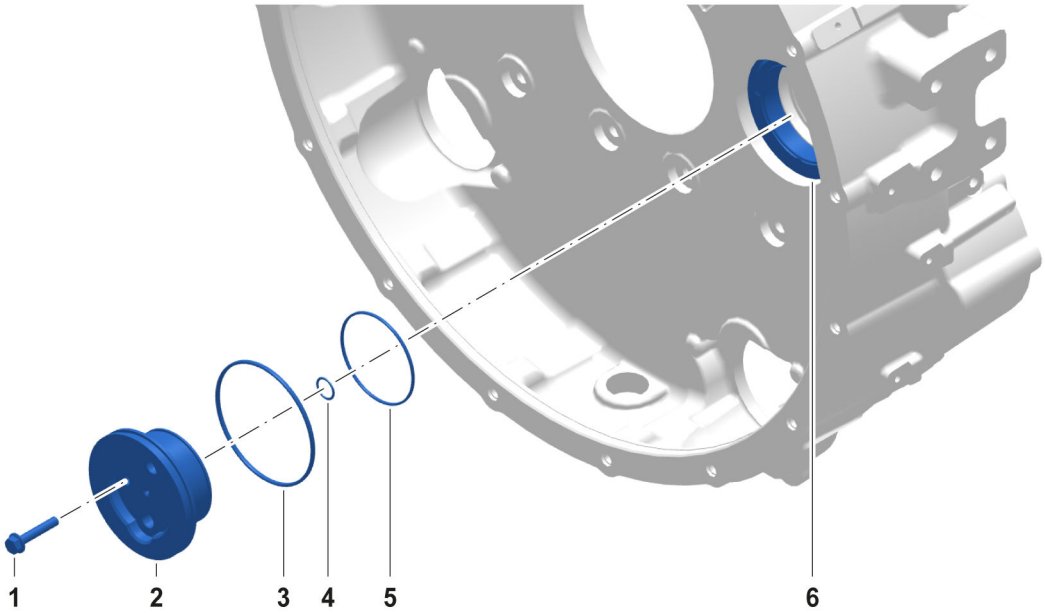

Fig. 215: Intermediate wheel

1 Hex head screw
2 Intermediate wheel axle
3 O-ring
4 O-ring
5 O-ring
6 Intermediate wheel

- ▶ Unscrew hex head screw **1**.
- ▶ Remove intermediate wheel axle **2** and intermediate wheel **6** simultaneously.
- ▶ Remove o-ring **3**.
- ▶ Remove o-ring **4**.
- ▶ Remove o-ring **5**.

Cleaning

- ▶ Clean sealing surface of flywheel housing.
- ▶ Clean sealing surface of crankcase.
- ▶ Check intermediate wheel for damage and replace if necessary.
- ▶ Clean intermediate wheel.
- ▶ Clean grooves of o-rings.
- ▶ Clean contact surfaces on intermediate wheel and flywheel housing.

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Installing the intermediate wheel

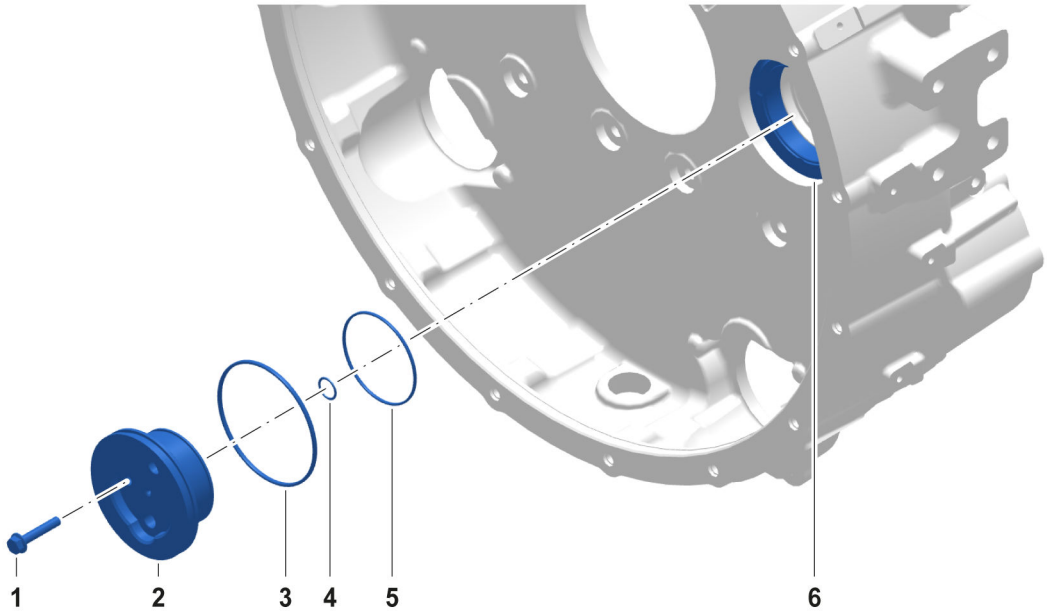

Fig. 216: Intermediate wheel

1 Hex head screw
2 Intermediate wheel axle
3 O-ring
4 O-ring
5 O-ring
6 Intermediate wheel

- ▶ Lubricate new o-ring **5** with NBU 30 grease.
- ▶ Install o-ring **5**.
- ▶ Lubricate new o-ring **4** with NBU 30 grease.
- ▶ Install o-ring **4**.
- ▶ Lubricate new o-ring **3** with NBU 30 grease.
- ▶ Install o-ring **3**.
- ▶ Lubricate contact surface of intermediate wheel axle **2** and intermediate wheel **6** with new engine oil.
- ▶ Install intermediate wheel axle **2** and intermediate wheel **6** simultaneously.
- ▶ Lubricate hex head screw **1** with Loctite® 2701.
- ▶ Tighten hex head screw **1**.

Installing the flywheel housing

Graphic representation	Description	Required number	Part number
	Assembly pin (M12)	2	0528471

Tab. 57: Special tool

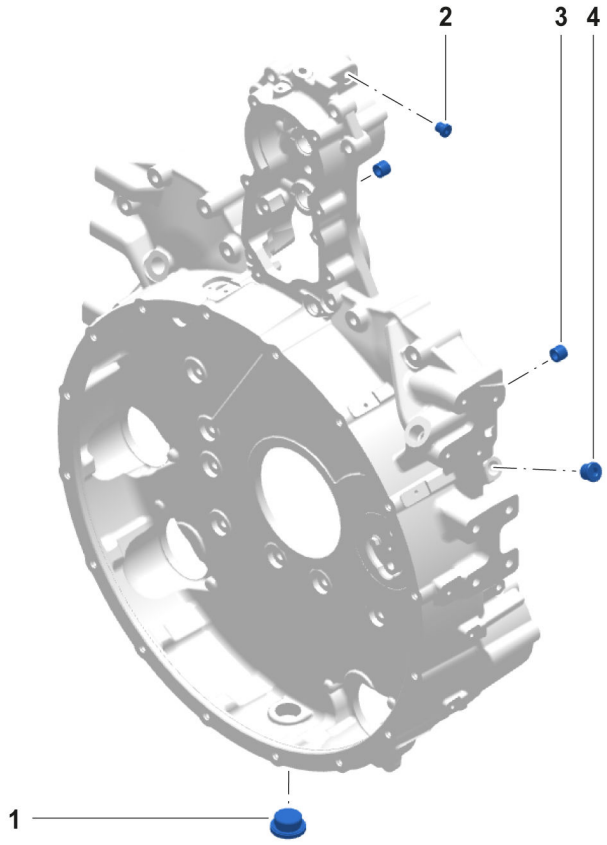

Fig. 218: Flywheel housing

1	Screw plug	**3**	Fitting sleeve (2x)
2	Screw plug	**4**	Screw plug

- ▶ Install intermediate wheel. (For more information see: Installing the intermediate wheel, page 146.)
- ▶ Install new fitting sleeves **3**.
- ▶ Tighten screw plug **4**.
- ▶ Tighten screw plug **2**.
- ▶ Tighten screw plug **1**.

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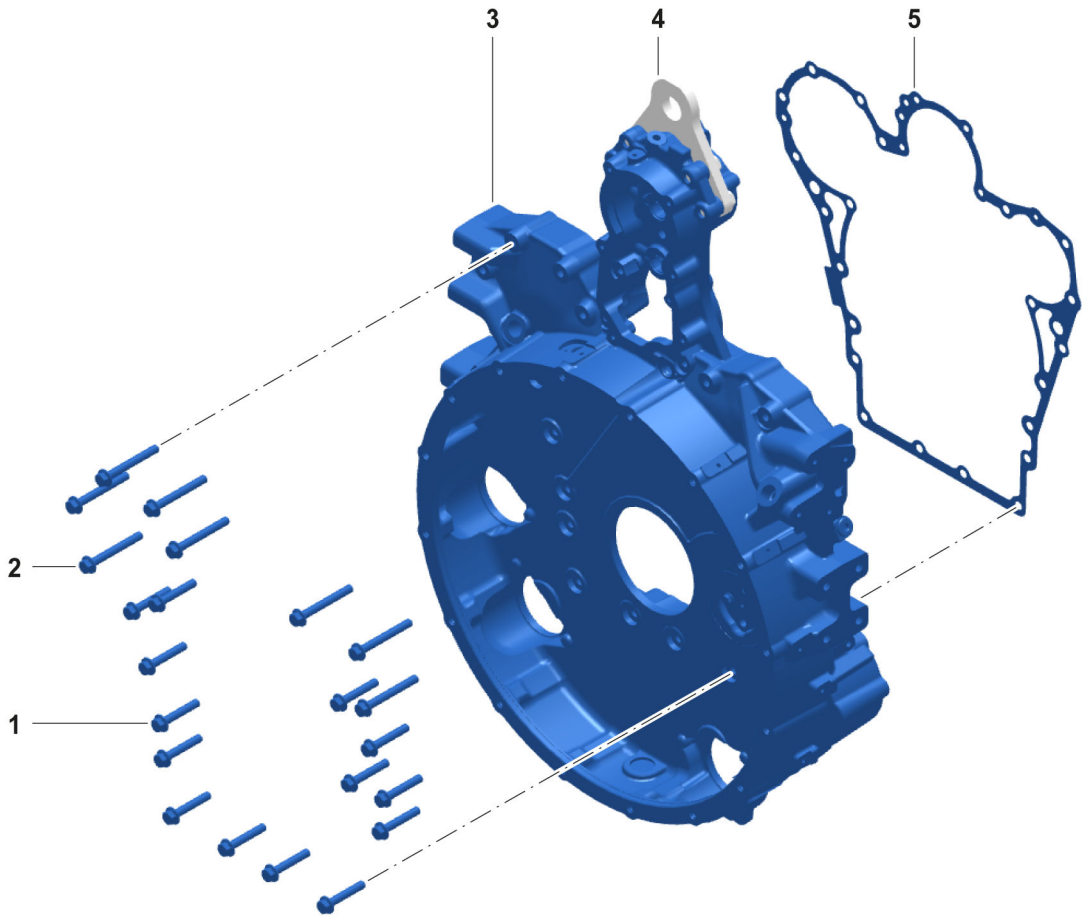

Fig. 219: Flywheel housing

1 Hex head screw (14x)
2 Hex head screw (8x)
3 Flywheel housing
4 Lifting hook
5 Seal

- ▶ Tighten two opposing assembly pins.
- ▶ Install lifting hook **4**. (For more information see: Installing the lifting hook, page 508.)
- ▶ Install lifting device on lifting hook **4**.
- ▶ Align new seal **5**.
- ▶ Align flywheel housing **3** on crankcase.
- ▶ Screw in hex head screws **1** and hex head screws **2**.
- ▶ Unscrew assembly pins.
- ▶ Screw in remaining hex head screw **1**.

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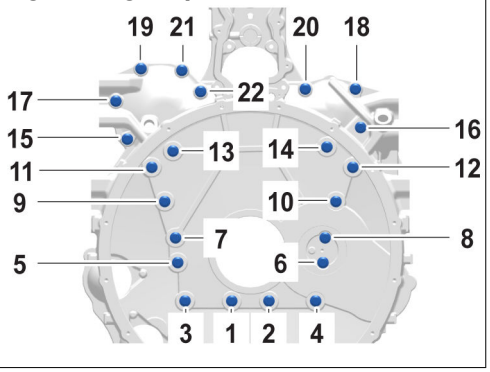
Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	35 Nm	
Stage	**Angle of rotation**	
2.	90°	

Tab. 58: Tightening instruction 9078504-002

▶ Tighten hex head screw **1** and external hex bolts **2** according to tightening instruction.

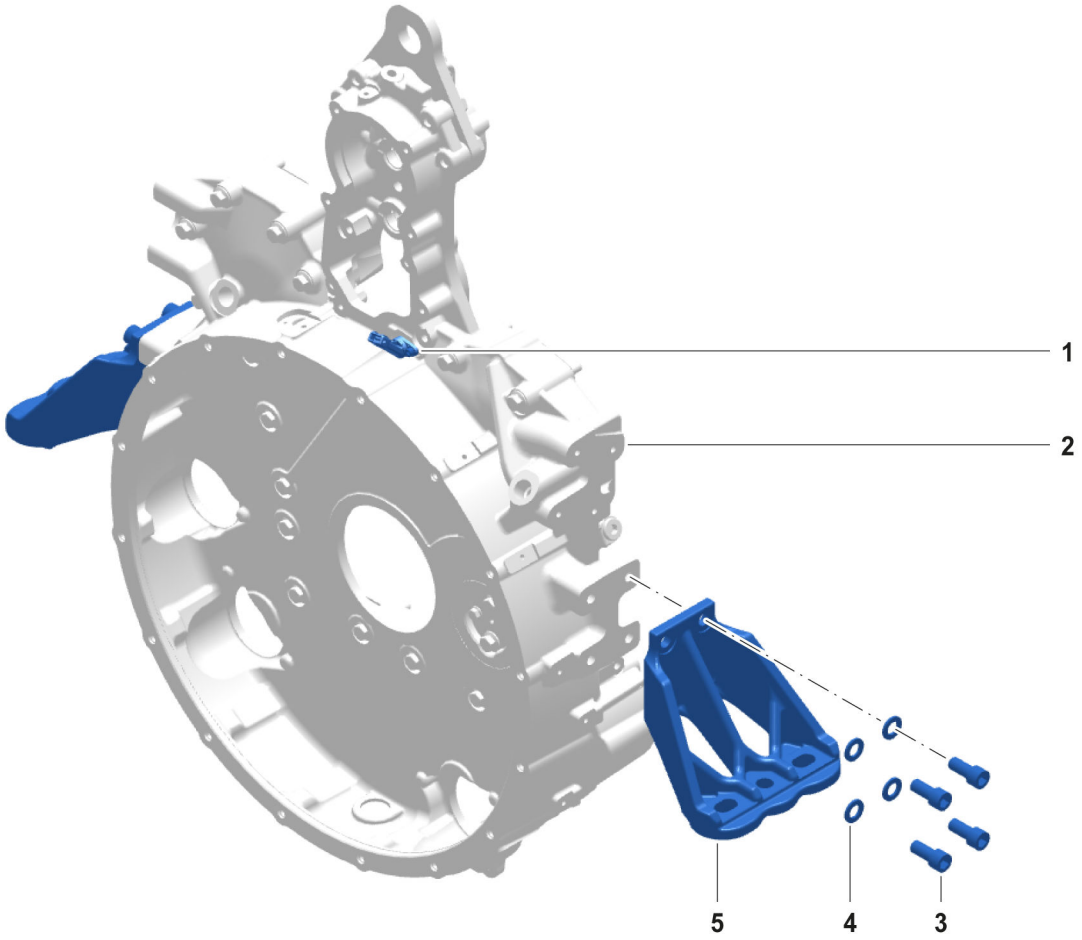


Fig. 221: Flywheel housing

1 Speed sensor
4 Flywheel housing
2 Socket head screw (8x)
3 Washer (8x)
5 Engine mount (2x)

▶ Install flywheel housing cover. (For more information see: Installing the flywheel housing cover, page 73.)

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- ▶ If necessary, install cover. (For more information see: Installing the cover, page 442.)
- ▶ Align engine mounts **5**.
- ▶ Tighten socket head screws **2**.
- ▶ Install bracket of cable harness on flywheel housing **4**.
- ▶ Install cable harness on flywheel housing **4**.
- ▶ Install speed sensor **1**.
- ▶ Connect electrical plug connections to speed sensor **1**.

3.4.13 Crankshaft

Removing the crankshaft

Graphic representation	Description	Required number	Part number
	Jacking screw (M18)	4	10129075

Tab. 59: Special tool

Make sure that the following prerequisites are met:
- ❑ Ancillary support housing is removed. (For more information see: Removing the ancillary support housing, page 141.)
- ❑ Flywheel housing is removed. (For more information see: Removing the flywheel housing, page 162.)
- ❑ Pistons with connecting rods are removed. (For more information see: Removing the piston with connecting rod, page 111.)

Note

The crankcase and bedplate are machined together and may only be installed in the original manufactured pairing. The crankcase and bedplate are marked relative to one another through a number on the ancillary support housing side.

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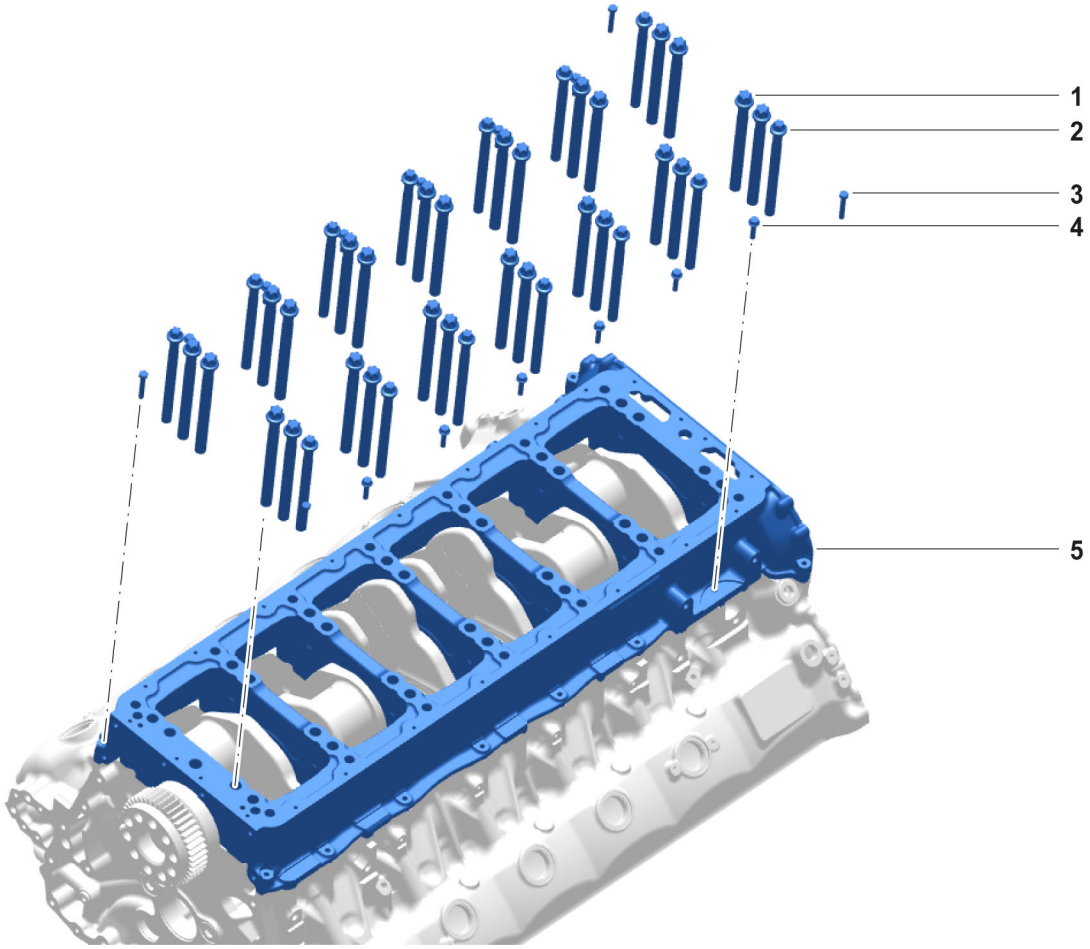

Fig. 223: Bedplate

1 Hexalobular flange head screw (28x)
2 Hexalobular flange head screw (14x)
3 Hex head screw (4x)
4 Hex head screw (12x)
5 Bedplate

▶ Unscrew hex head screws **3**.

▶ Unscrew hex head screws **4**.

▶ Unscrew hexalobular flange head screws **1**.

▶ Unscrew hexalobular flange head screws **2**.

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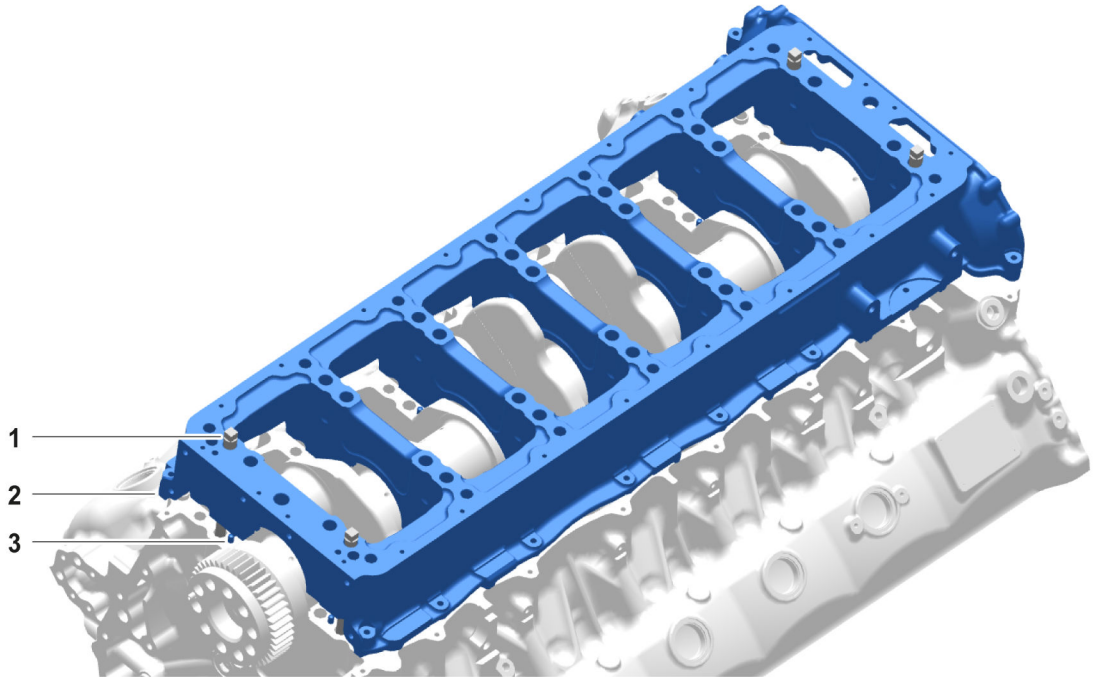

Fig. 224: Bedplate

1 Jacking screw (4x)
2 Bedplate
3 Parallel pin (14x)

▶ Screw in jacking screws **1** alternately as shown.
▷ Bedplate **2** is pressed off centering of parallel pins **3**, approx. 14 mm.

▶ Remove bedplate **2** with a suitable lifting device.

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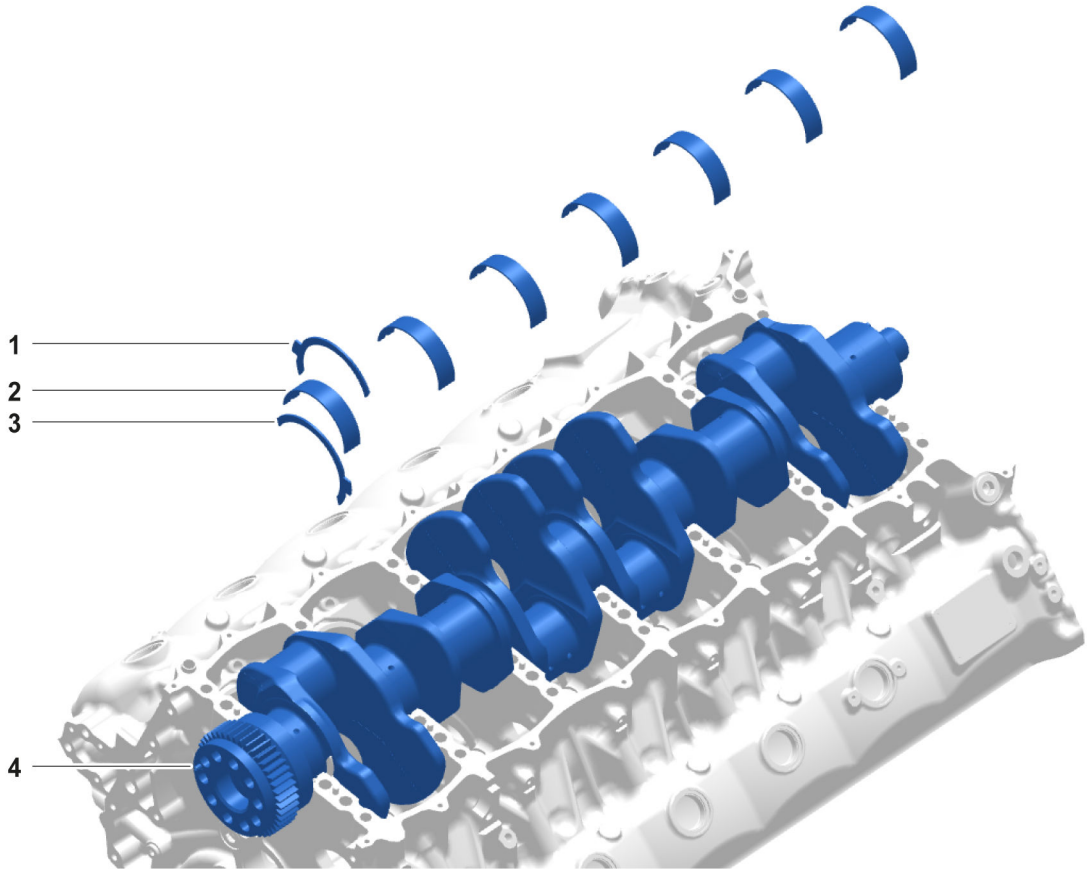

Fig. 225: Crankshaft

1 Thrust washer
2 Main bearing (7x)
3 Thrust washer
4 Crankshaft

Note

When being reused, install thrust washers at original bearing point.

- ▶ Remove thrust washer **1** and put it down according to bearing point.
- ▶ Remove thrust washer **3** and put it down according to bearing point.

Note

When being reused, install main bearing at original bearing point.

- ▶ Remove main bearings **2** and put them down according to bearing points.
- ▶ Remove crankshaft **4** with a suitable lifting device.
- ▶ Make sure that the lifting device does not damage the crankshaft **4**.

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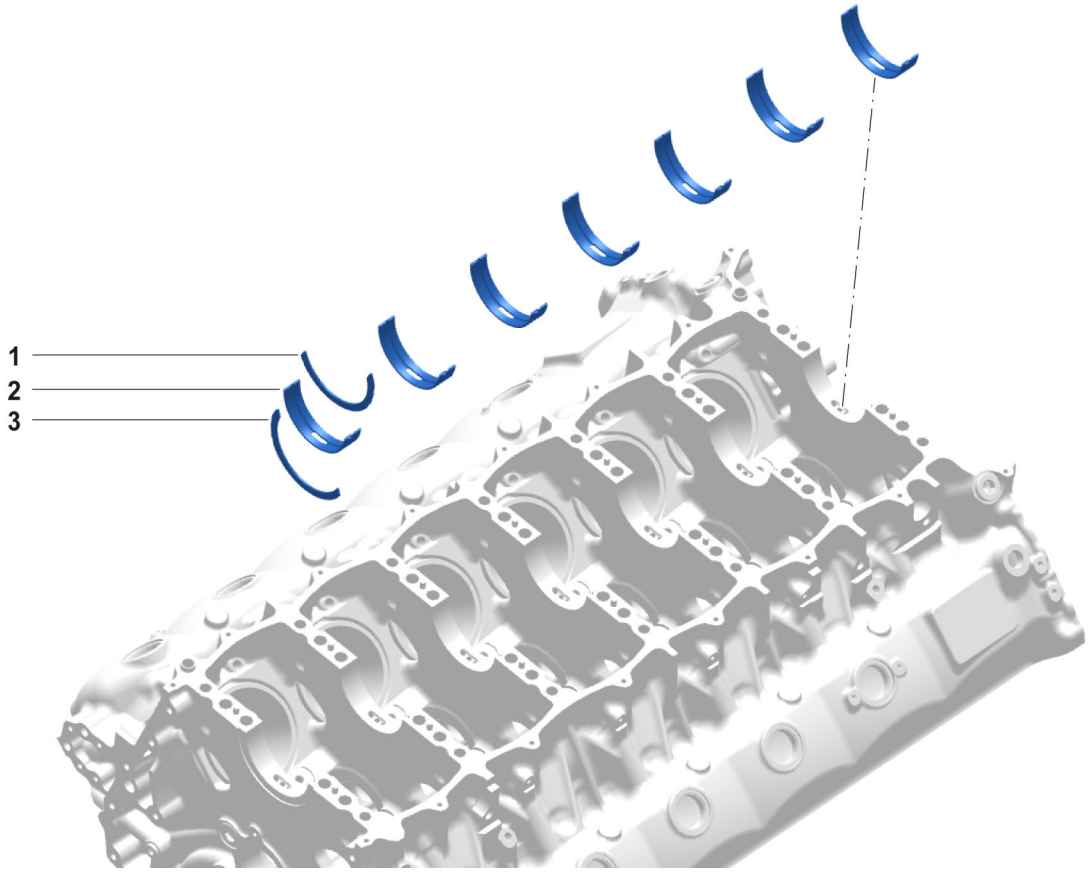

Fig. 226: Thrust washers and main bearing

1 Thrust washer
2 Main bearing (7x)
3 Thrust washer

Note

When being reused, install thrust washers at original bearing point.

- ▶ Remove thrust washer **1** and put it down according to bearing point.
- ▶ Remove thrust washer **3** and put it down according to bearing point.

Note

When being reused, install main bearing at original bearing point.

- ▶ Remove main bearings **2** and put them down according to bearing points.

Checking and cleaning the crankshaft

- ▶ Check crankshaft for damage and replace if necessary.
- ▶ Check main bearing for damage and wear and replace if necessary.
- ▶ Check thrust washers for damage and wear and replace if necessary.
- ▶ Clean sealing surface on crankcase.
- ▶ Clean sealing surface on bedplate.

Installing the crankshaft

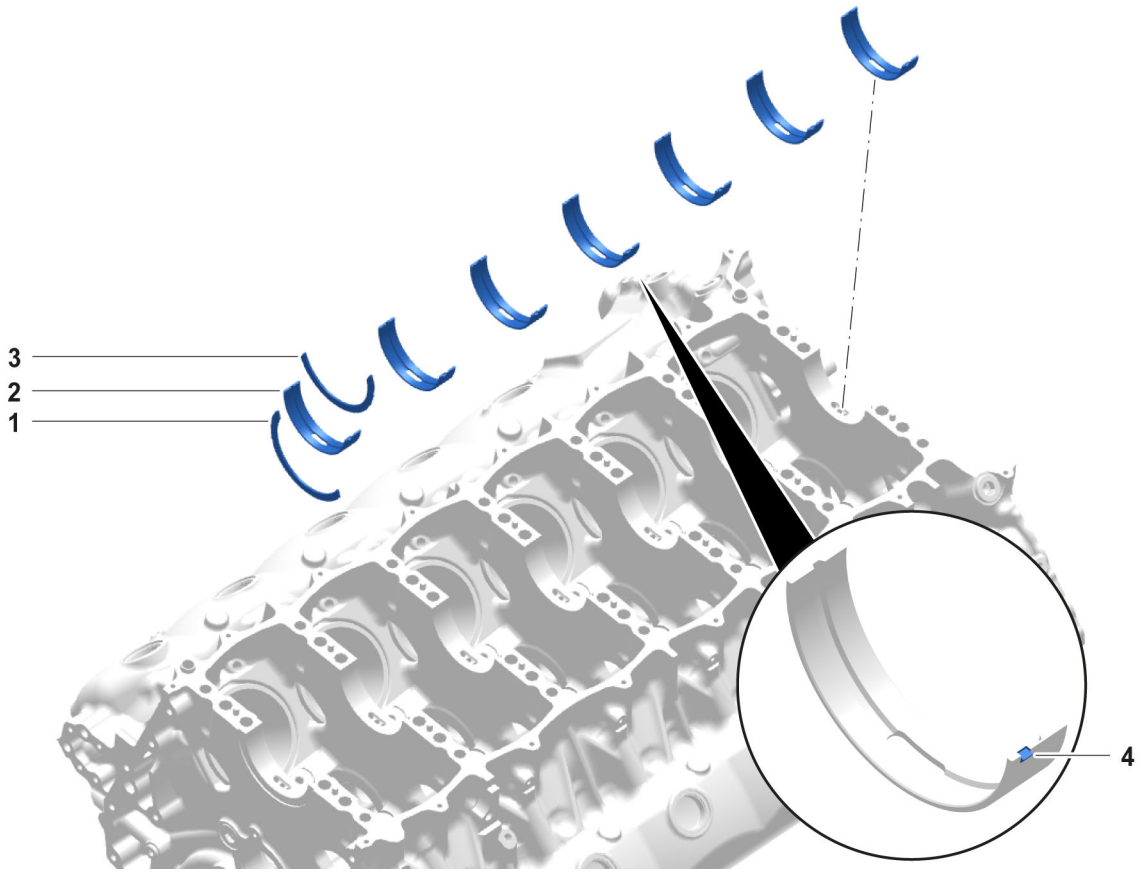

Fig. 227: Thrust washers and main bearing

1 Thrust washer
2 Main bearing (7x)
3 Thrust washer
4 Nose of main bearing (7x)

Note

When being reused, install main bearing at original bearing point.

- ▶ Degrease contact surfaces of main bearing **2** to bearing seats.
- ▶ Align noses of main bearing **4** to grooves on crankcase.
- ▶ Install main bearing **2**.
- ▶ Lubricate running surfaces of main bearing **2** with new engine oil.

Note

When being reused, install thrust washers at original bearing point.

- ▶ Lightly lubricate thrust washer **1** on side without lubrication groove with NBU 30 grease.
- ▶ Align lubrication grooves in direction of crankshaft.
- ▶ Install thrust washer **1** on crankcase bearing.
- ▶ Lightly lubricate thrust washer **3** on side without lubrication groove with NBU 30 grease.

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- ▶ Align lubrication grooves in direction of crankshaft.
- ▶ Install thrust washer **3** on crankcase bearing.

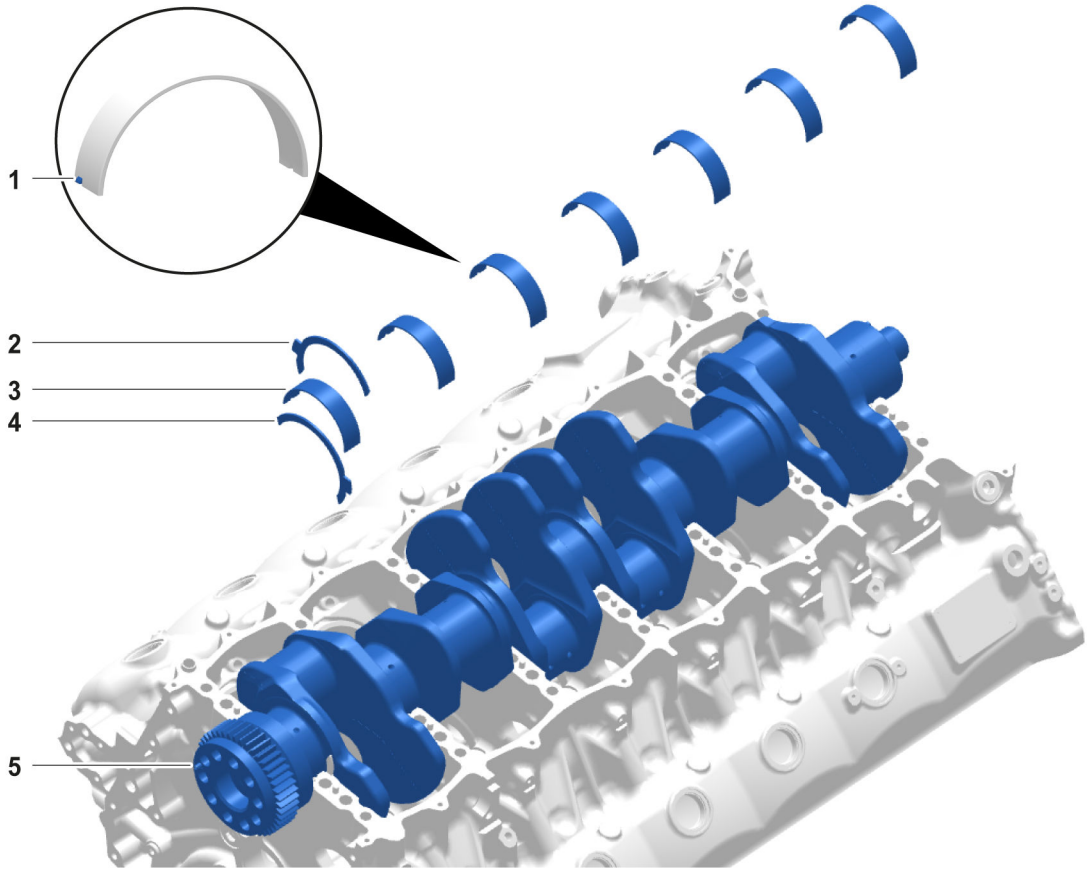

Fig. 228: Crankshaft

1 Nose of main bearing (7x)
2 Thrust washer
3 Main bearing (7x)
4 Thrust washer
5 Crankshaft

- ▶ Install crankshaft **5** with a suitable lifting device.
- ▶ Make sure that the lifting device does not damage the crankshaft **5**.

Note

When being reused, install main bearing at original bearing point.

- ▶ Degrease contact surfaces on main bearings **3** to bearing seats.
- ▶ Align noses of main bearing **3** to grooves in bedplate.
- ▶ Install main bearing **3**.
- ▶ Lubricate running surfaces of main bearing **3** with new engine oil.

Note

When being reused, install thrust washers at original bearing point.

- ▶ Lightly lubricate thrust washer **2** on side without lubrication groove with NBU 30 grease.

- ▶ Align lubrication grooves in direction of crankshaft.
- ▶ Install thrust washer **2**.
- ▶ Lightly lubricate thrust washer **4** on side without lubrication groove with NBU 30 grease.
- ▶ Align lubrication grooves in direction of crankshaft.
- ▶ Install thrust washer **4**.

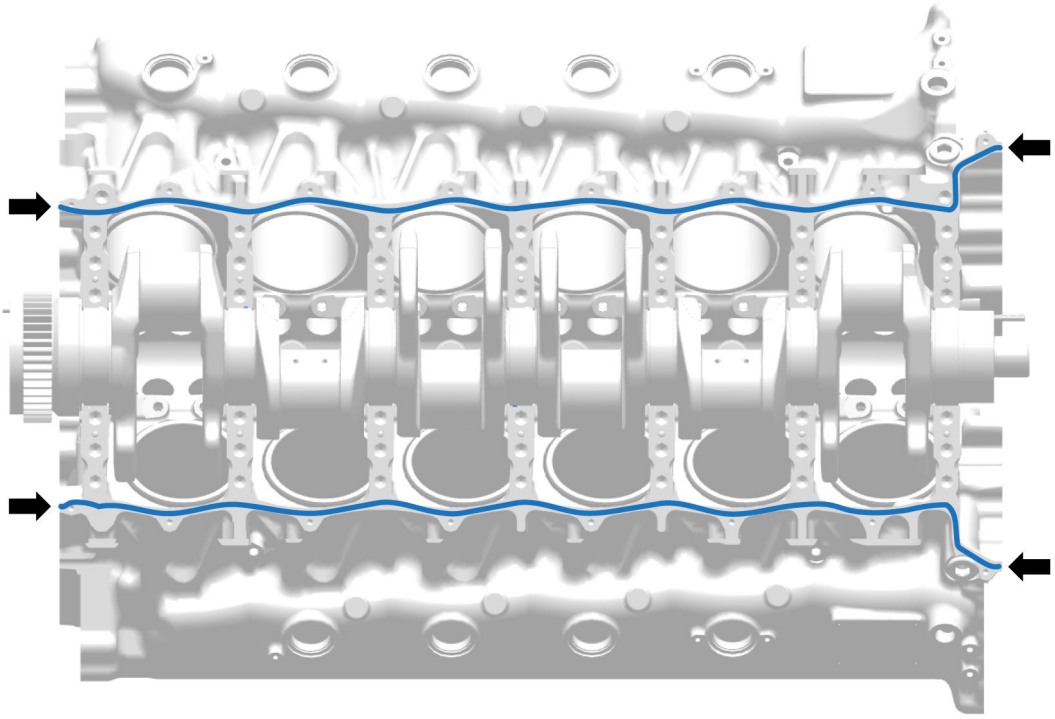

Fig. 229: Seal run

Pfeil Sealant protrusions on the joint face

Surface seal	Value
Material	Loctite® 5910

Tab. 60: Surface seal

Note

Observe processing times of surface seal, see documentation from the manufacturer.

- ▶ Make sure that contact surfaces of the crankcase are clean and free of grease.
- ▶ Apply surface seal to contact surfaces of crankcase.

Note

The crankcase and bedplate are machined together and may only be installed in the original manufactured pairing. The crankcase and bedplate are marked relative to one another through a number on the ancillary support housing side.

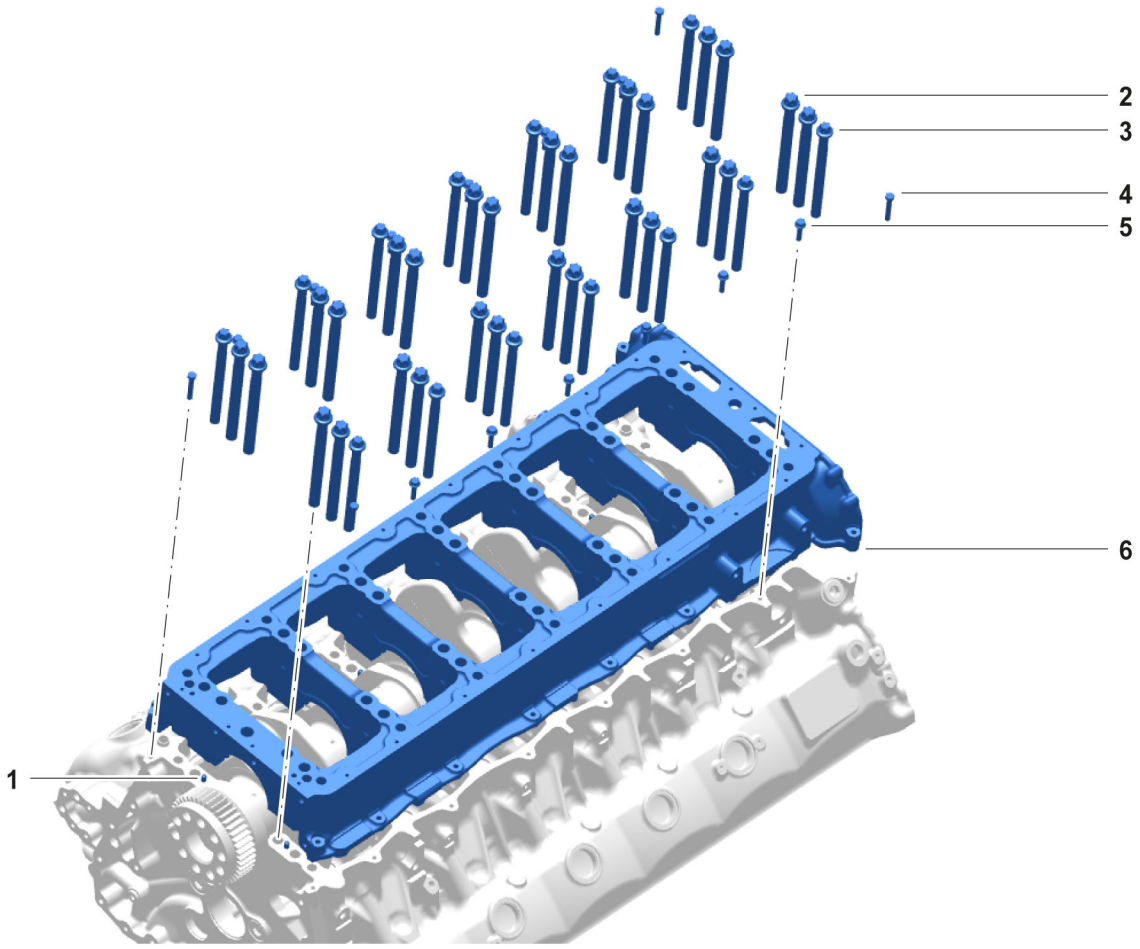

Fig. 230: Bedplate

1	Parallel pin (14x)	**4**	Hex head screw (4x)
2	Hexalobular flange head screw (28x)	**5**	Hex head screw (12x)
3	Hexalobular flange head screw (14x)	**6**	Bedplate

- ▶ Lift bedplate **6** with a suitable lifting device.
- ▶ Align bedplate **6** to crankcase and parallel pins **1**.
- ▶ Install bedplate **6**.

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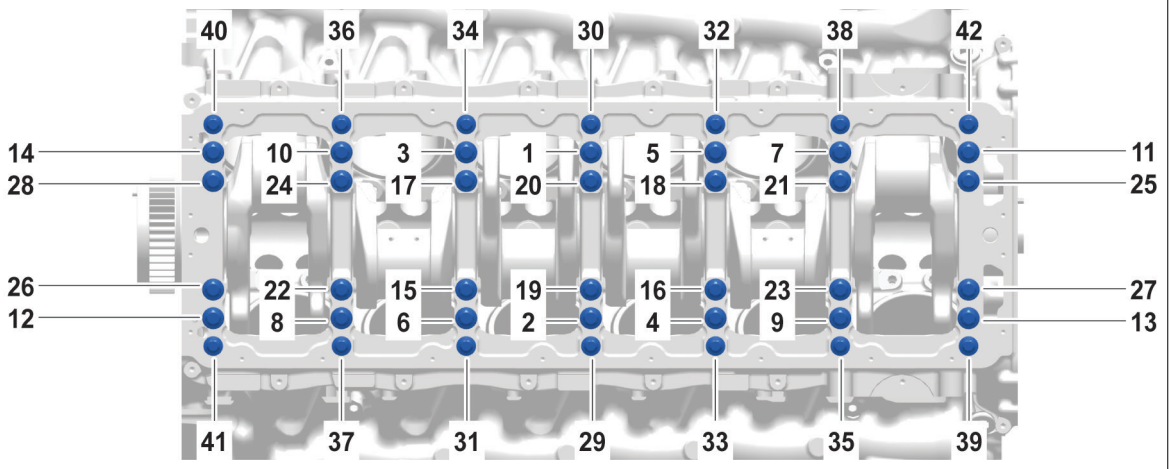
Tightening instruction for hex head screw	
	
Lubricant (thread and head contact surface)	Engine oil
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	160 Nm
Stage	**Angle of rotation**
2.	90°
3.	90°

Tab. 61: Tightening instruction 10119049-205

- ▶ Lubricate hexalobular flange head screws **2** and hexalobular flange head screws **3** according to tightening instruction.
- ▶ Tighten hexalobular flange head screws **2** and hexalobular flange head screws **3** according to tightening instruction.
- ▶ Tighten hex head screws **4**.
- ▶ Tighten hex head screws **5**.
- ▶ Remove sealant protrusions on joint face between crankcase and bedplate. (see: fig. 229, page 178)
- ▶ Turn crankshaft one revolution and check for ease of operation.

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Checking the axial play of the crankshaft

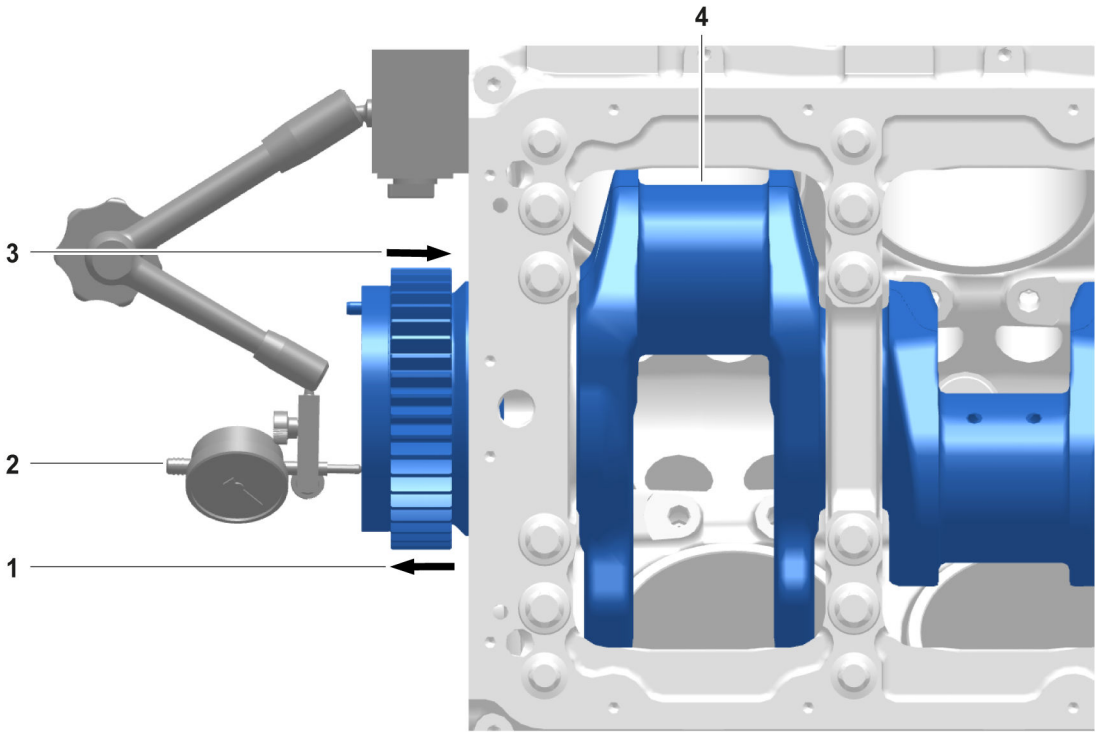

Fig. 232: Checking the axial play

1 Limit stop
2 Dial gauge
3 Opposite direction to limit stop
4 Crankshaft

▶ Slide crankshaft **4** to limit stop **1**.

▶ Set dial gauge **2** to 0.

▶ Slide crankshaft **4** in opposite direction to limit stop **3**.

Axial play	Value
Maximum axial play	0.4 $^{\pm 0.10}$ mm

Tab. 62: Axial play

▶ Read measured value.

If the measured value is outside of the tolerance:
▶ Determine cause of error and rectify.

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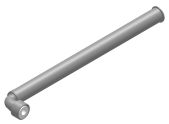
3.4.14 Removing and installing the crankcase locking pieces

Removing the crankcase locking pieces

Graphic representation	Description	Required number	Part number
	Drain hose	1	12690422
	Drain hose 90°	1	12690423

Tab. 63: Special tool

Make sure that the following prerequisite is met:
❑ Collection containers for fluids are available.

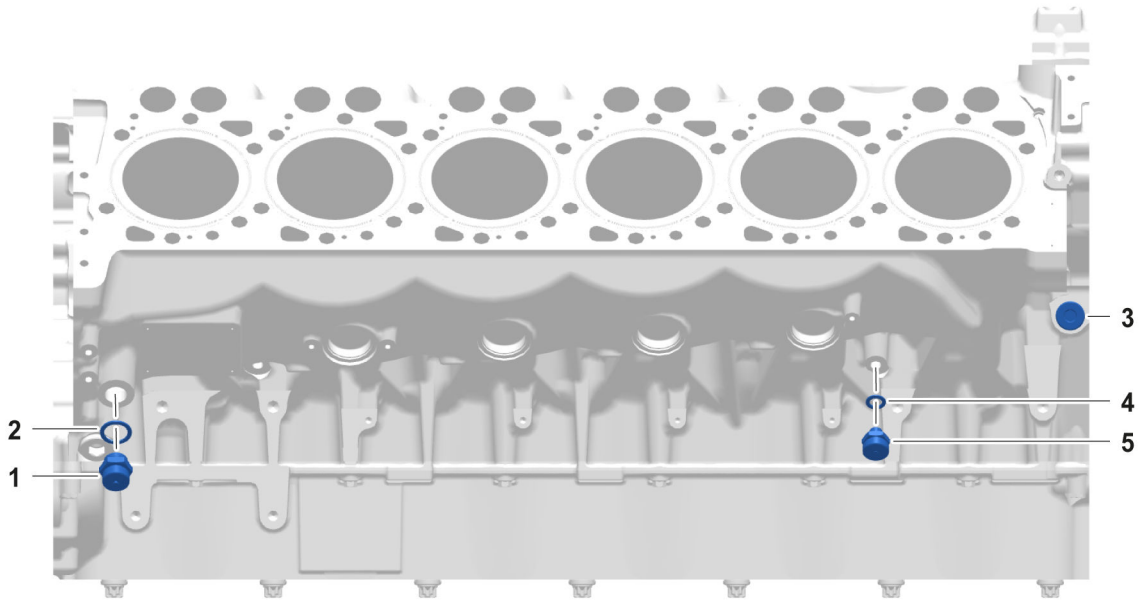


Fig. 235: Left crankcase

1 Drain valve
2 Sealing ring
3 Screw plug
4 Sealing ring
5 Drain valve

▶ Put collection container under drain valve **1**.

▶ Unscrew sealing cap of drain valve **1**.

▶ Screw drain hose onto drain valve **1**.
▷ Drain valve **1** opens.
▷ Coolant runs out.

▶ Unscrew drain hose.

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- ▶ Unscrew drain valve **1**.
- ▶ Remove sealing ring **2**.
- ▶ Put collection container under screw plug **3**.
- ▶ Unscrew screw plug **3**.
- ▶ Put collection container under drain valve **5**.
- ▶ Unscrew sealing cap of drain valve **5**.
- ▶ Screw drain hose onto drain valve **5**.
  - ▷ Drain valve **5** opens.
  - ▷ Coolant runs out.
- ▶ Unscrew drain hose.
- ▶ Unscrew drain valve **5**.
- ▶ Remove sealing ring **4**.

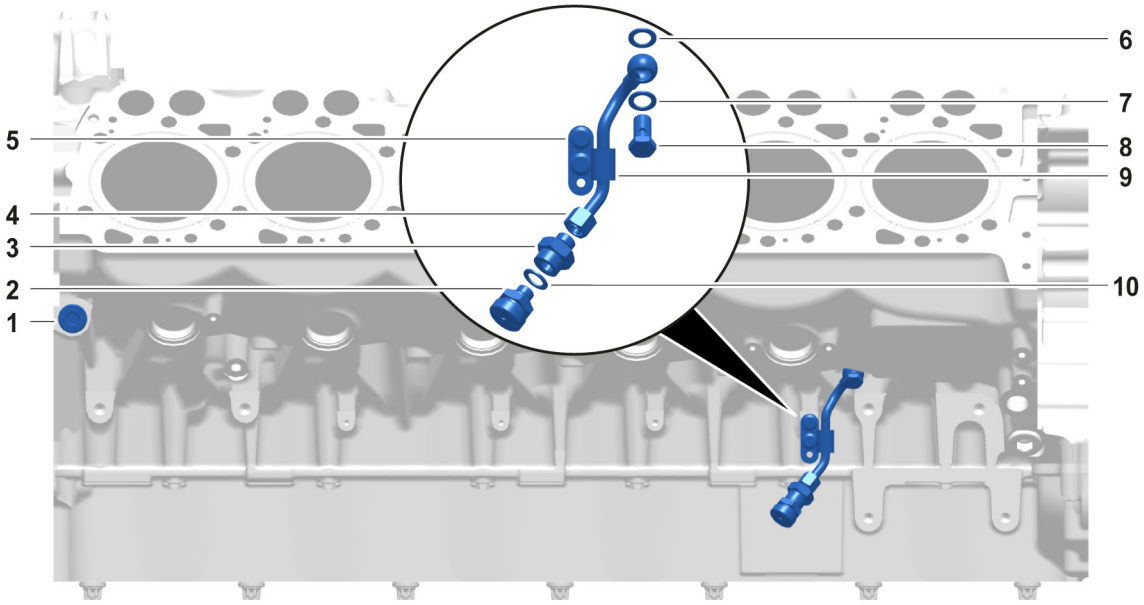

Fig. 236: Left crankcase

1	Screw plug	**6**	Sealing ring
2	Valve	**7**	Sealing ring
3	Nozzle	**8**	Banjo bolt
4	Pipeline	**9**	Holding clamp
5	Bracket	**10**	Sealing ring

- ▶ Put collection container under screw plug **1**.
- ▶ Unscrew screw plug **1**.
- ▶ Put collection container under valve **2**.
- ▶ Unscrew sealing cap of valve **2**.
- ▶ Screw drain hose onto valve **2**.
  - ▷ Valve **2** opens.
  - ▷ Coolant runs out.
- ▶ Unscrew drain hose.
- ▶ Unscrew valve **2**.

- ▶ Remove sealing ring **10**.
- ▶ Unscrew nozzle **3**.
- ▶ Unscrew banjo bolt **8**.
- ▶ Remove sealing ring **7**.
- ▶ Remove sealing ring **6**.
- ▶ Remove holding clamp **9**.
- ▶ Remove pipeline **4**.
- ▶ Remove bracket **5**.

Checking and cleaning the crankcase locking pieces

- ▶ Check pipeline **4** for damage and replace if necessary.

Installing the crankcase locking pieces

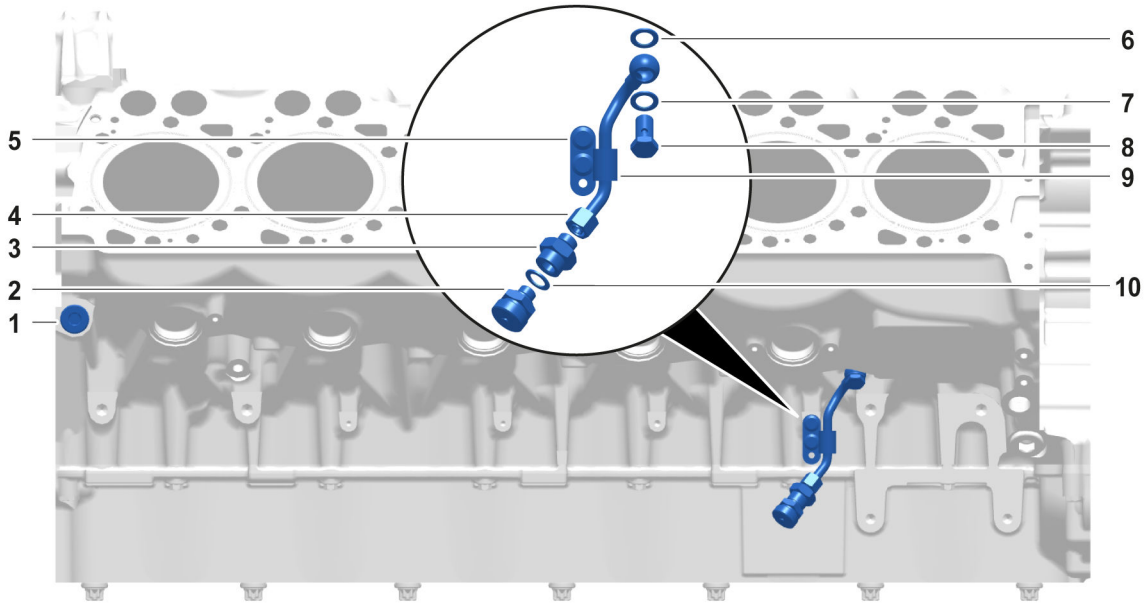

Fig. 237: Left crankcase

1	Screw plug	**6**	Sealing ring
2	Valve	**7**	Sealing ring
3	Nozzle	**8**	Banjo bolt
4	Pipeline	**9**	Holding clamp
5	Bracket	**10**	Sealing ring

- ▶ Install bracket **5**.
- ▶ Align pipeline **4**.
- ▶ Install new sealing ring **6**.
- ▶ Install new sealing ring **7**.
- ▶ Tighten banjo bolt **8**.
- ▶ Tighten nozzle **3**.
- ▶ Install new sealing ring **10**.

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- ▶ Tighten valve **2**.
- ▶ Install holding clamp **9**.
- ▶ Tighten screw plug **1**.

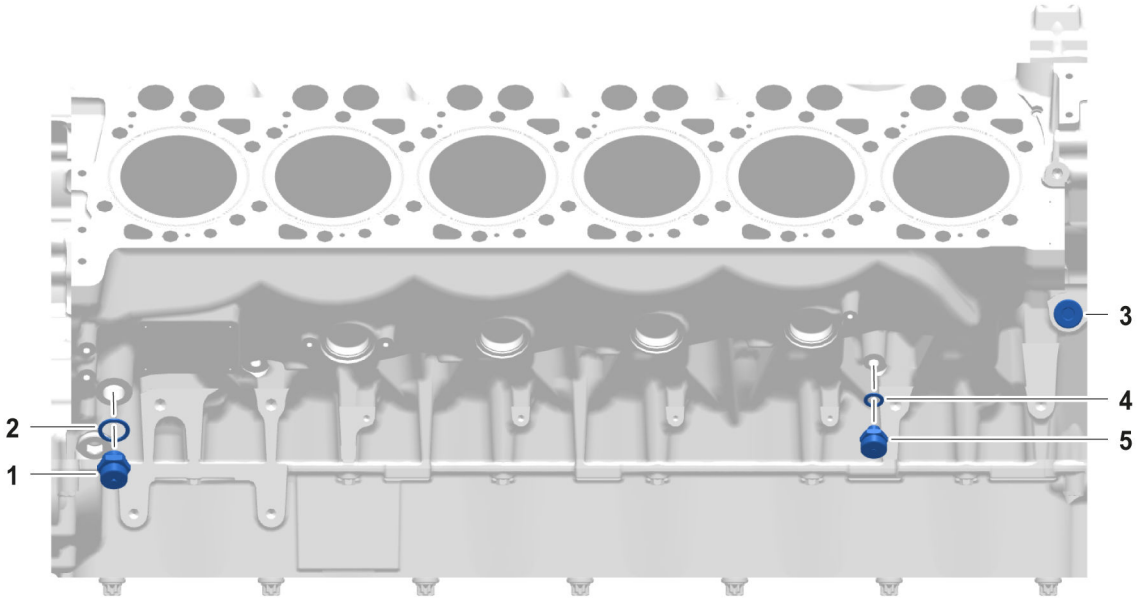

Fig. 238: Left crankcase

1 Drain valve
2 Sealing ring
3 Screw plug
4 Sealing ring
5 Drain valve

- ▶ Install new sealing ring **4**.
- ▶ Tighten drain valve **5**.
- ▶ Tighten screw plug **3**.
- ▶ Install new sealing ring **2**.
- ▶ Tighten drain valve **1**.
- ▶ Fill up fluids, see operator's manual.

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3.5 Fuel system

3.5.1 Safety instructions for working on the fuel system

Preventing personal injuries

DANGER
When the engine is running, the fuel lines are constantly under a fuel pressure of up to 2400 bar (34810 psi)!
Escaping liquids can penetrate the skin and will lead to injuries.

- ▶ Only work on the fuel and injection system when the engine is turned off.
- ▶ Reduce the pressure to below 10 bar (145 psi) with diagnostics software.
- ▶ Check the residual pressure with diagnostics software. (variables: 6996 - Fuel Pressure High 1/ 6997 - Fuel Pressure High 2)
- ▶ Use suitable protective equipment when working on the fuel and injection system. (For more information see: 2.7 Personal protective equipment, page 46.)
- ▶ Do not open any fuel lines and hoses that are under pressure.
- ▶ Do not remove any fuel lines and hoses that are under pressure.
- ▶ Protect hands, face and body against escaping liquids when searching for leaks 1-18n on lines and hoses that are under pressure. (For more information see: 2.7 Personal protective equipment, page 46.)
- ▶ Screw connections on injection system tight with prescribed tightening torques.

Preventing property damage

Components of the fuel and injection system consist of highly precise parts that are subjected to extreme loads. Even the smallest particles of dirt can lead to failure of components.
– When working on the fuel and injection system, ensure the utmost cleanliness.

Before starting work, observe the following:
– Perform work on the fuel and injection system in areas, in which no dust is stirred up and no other particles of dirt get into the work area.
– When working on the fuel and injection system, use an appropriate workshop or assembly shop.
– Hang clean covering foil around engine hoods.
– Before parts are removed: Thoroughly clean and dry the relevant parts of the engine.
– Perform a visual inspection for leaks or damage to the fuel and injection system.
– Use clean and undamaged tools.
– Replace damaged tools in a timely manner.
– Change work clothing that was previously worn during dusty work.
– Wash hands before starting work.
– Use lint-free cleaning cloths.

During the work, observe the following:
– If the clean side fuel system has been opened: Do not use compressed air.
– Remove loose dirt (e.g. paint chips) during the work.
– Seal open line connections so they are dust and moisture proof.
– Package and store removed parts so they are dust and moisture proof. Do not dismantle removed parts of the injection system (high pressure pump, pressure pipe socket, injector).
– Do not remove “new” parts from the original packing until just before installation and check their reusability.
– When working on removed components, ensure cleanliness.

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– Use unused cleaning fluids.
– If removed components are being shipped: Use the original packing of the “new” part.

3.5.2 Removing and installing the fuel lines

Removing the device fuel line to the fuel prefeeding pumps

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.
❑ Fuel supply is closed, see documentation from the device manufacturer.
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

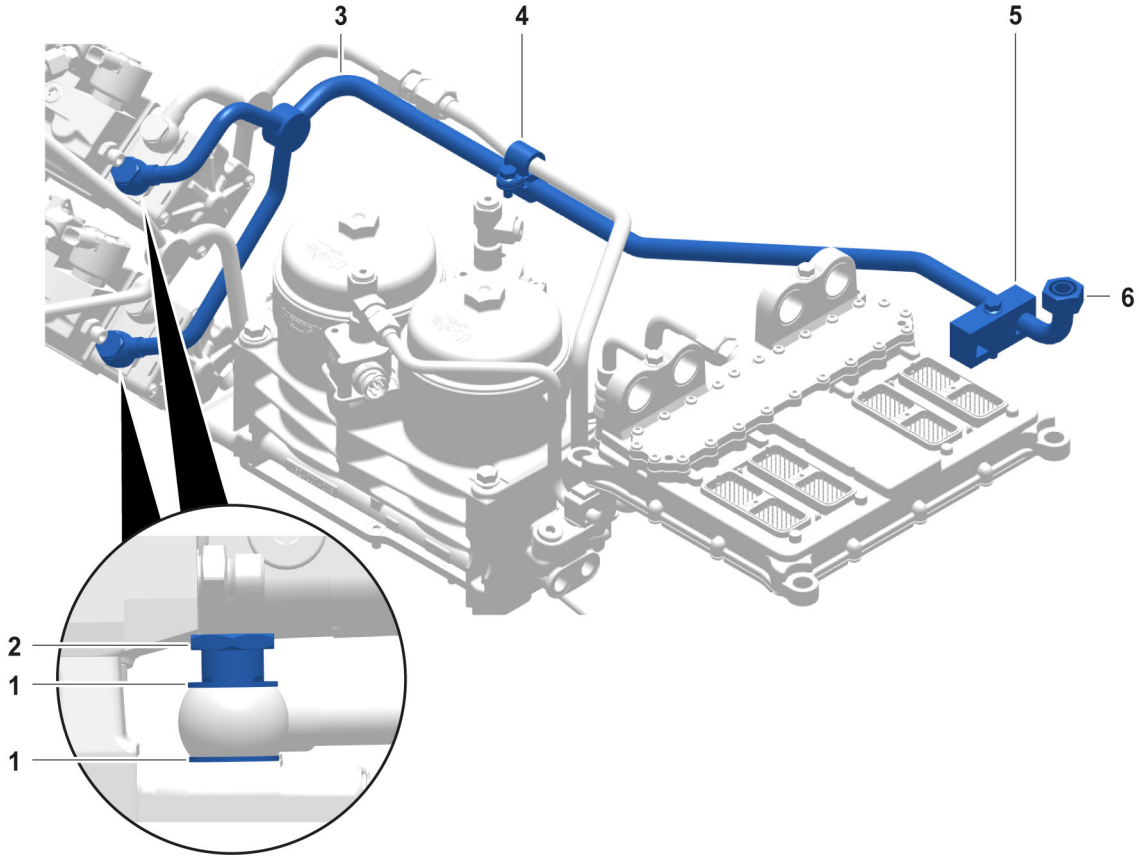

Fig. 239: Device fuel line to fuel prefeeding pumps

1 Sealing ring (4x)
2 Banjo bolt (2x)
3 Fuel line
4 Holding clamp
5 Holding clamp
6 Box nut

▶ Remove holding clamp **4**.
▶ Remove holding clamp **5**.
▶ Unscrew box nut **6**.
▶ Unscrew banjo bolts **2** and pull them out as far as possible.
▶ Remove fuel line **3** with banjo bolts **2** and sealing rings **1**.
▶ Seal openings on fuel line **3**.
▶ Seal openings on fuel prefeeding pumps and device.

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Removing the fuel prefeeding pumps fuel line to the engine control unit

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

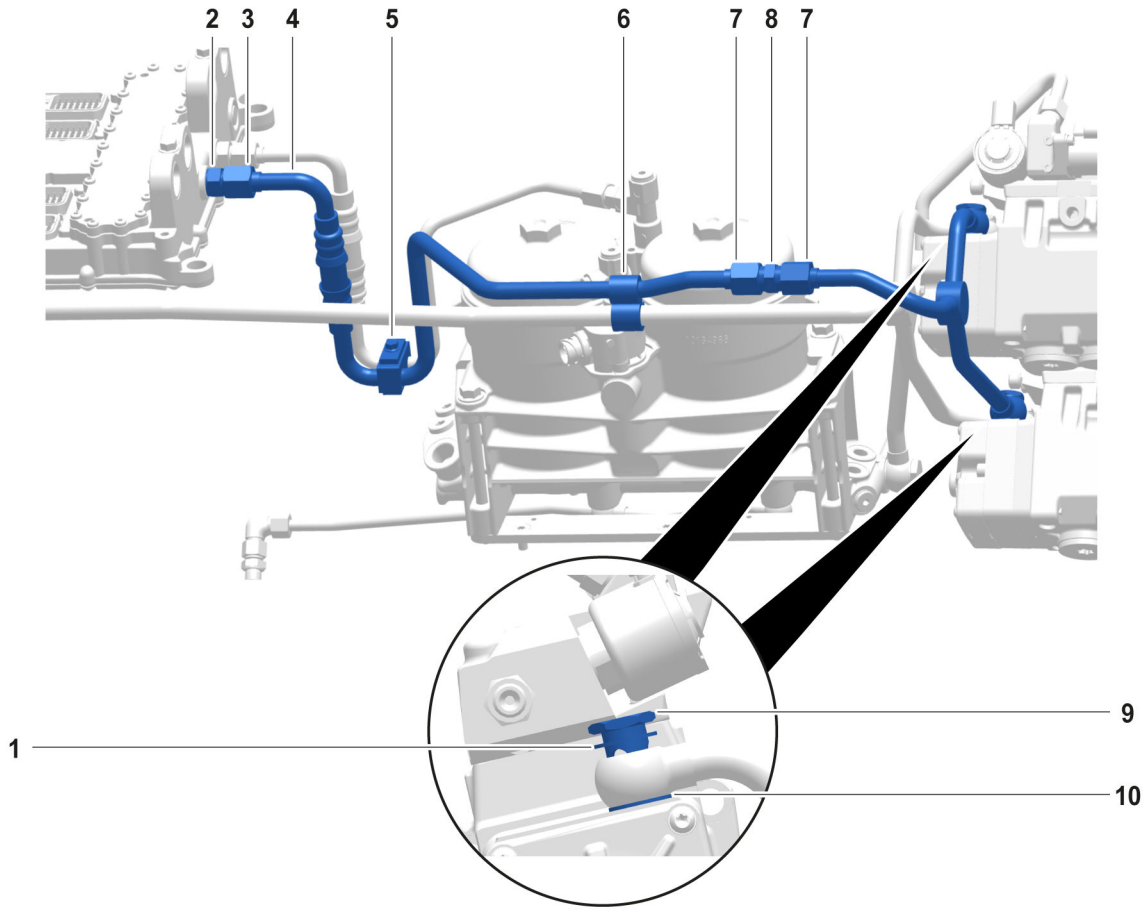

Fig. 240: Fuel prefeeding pumps fuel line to engine control unit

1	Sealing ring (2x)	**6**	Holding clamp
2	Screw fitting	**7**	Box nut
3	Box nut	**8**	Screw fitting
4	Fuel line	**9**	Banjo bolt (2x)
5	Holding clamp	**10**	Sealing ring (2x)

- ▶ Remove holding clamp **5**.
- ▶ Remove holding clamp **6**.
- ▶ Unscrew box nut **3**.
- ▶ Unscrew banjo bolts **9** and pull them out as far as possible.
- ▶ Remove sealing rings **10**.
- ▶ Remove fuel line **4** with banjo bolts **9** and sealing rings **1**.
- ▶ If necessary, unscrew box nuts **7**.
- ▶ Seal openings on fuel line **4**.

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▶ If necessary, unscrew screw fitting **2**.

▶ Seal openings on engine control unit and fuel prefeeding pumps.

Removing the engine control unit fuel line to the fuel fine filter

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.
❑ Fuel supply is closed, see documentation from the device manufacturer.
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

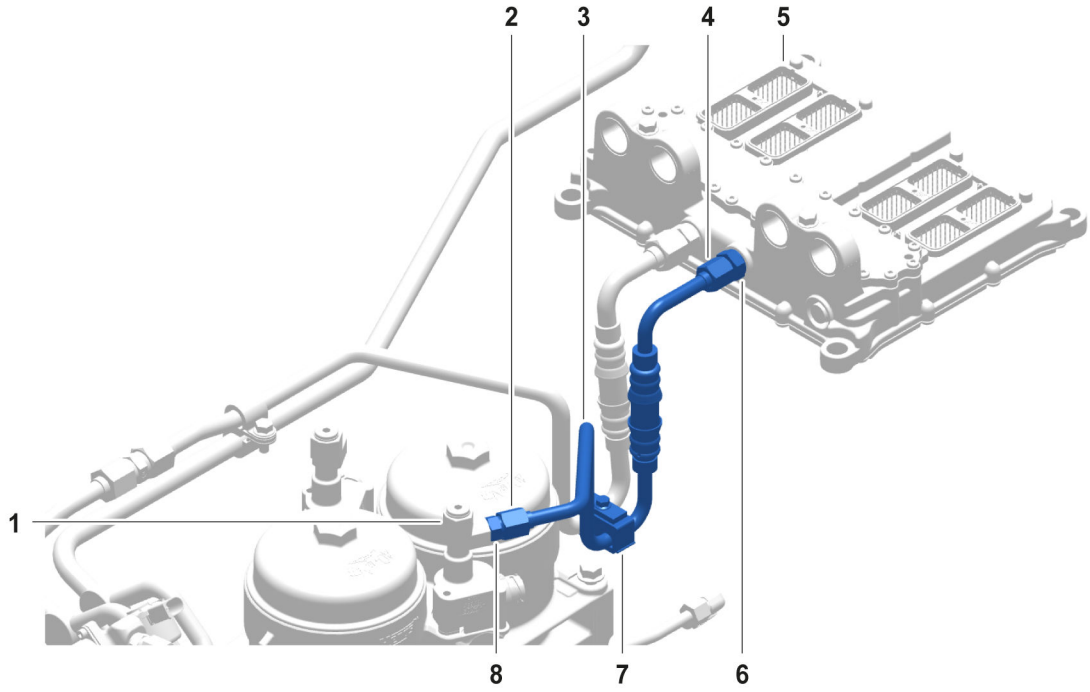

Fig. 241: Engine control unit fuel line to fuel fine filter

1 Adapter part
2 Box nut
3 Fuel line
4 Box nut
5 Engine control unit
6 Screw fitting
7 Holding clamp
8 Screw fitting

▶ Remove holding clamp **7**.

▶ Unscrew box nut **2**.

▶ Unscrew box nut **4**.

▶ Remove fuel line **3**.

▶ Seal openings on fuel line **3**.

▶ If necessary, unscrew screw fitting **6**.

▶ If necessary, unscrew screw fitting **8**.

▶ Seal openings on adapter part **1** and engine control unit **5**.

Removing the fuel fine filter fuel line to the fuel high pressure pumps

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.

- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

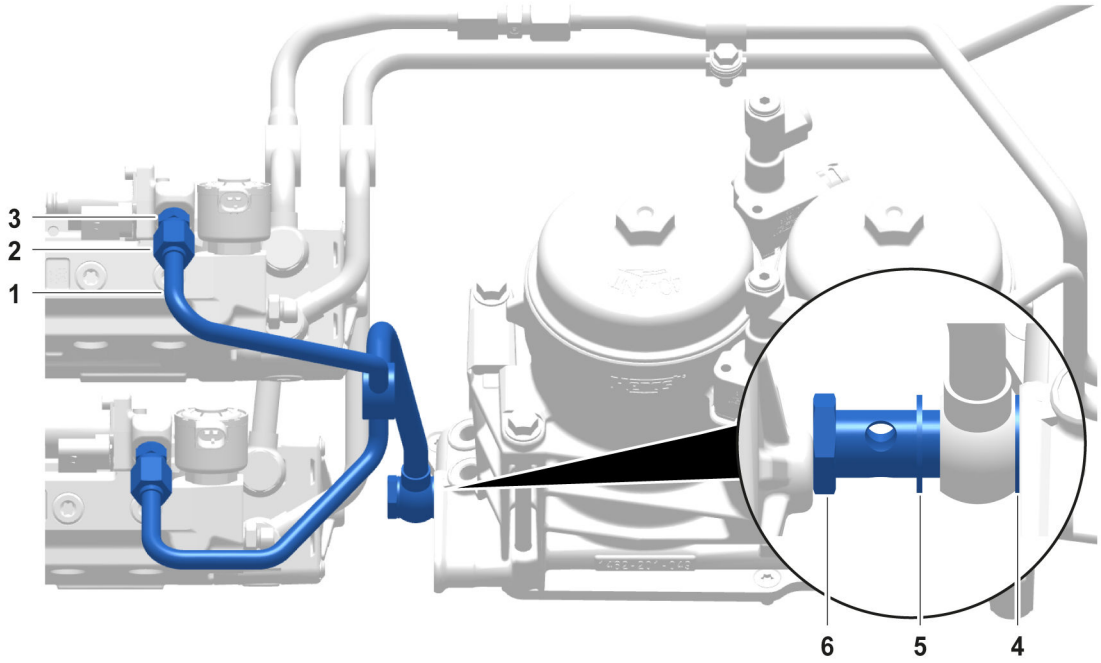

Fig. 242: Fuel fine filter fuel line to fuel high pressure pumps

1	Fuel line	**4**	Sealing ring
2	Box nut (2x)	**5**	Sealing ring
3	Screw fitting (2x)	**6**	Banjo bolt

▶ Unscrew box nuts **2**.

▶ Unscrew banjo bolt **6** and pull it out as far as possible.

▶ Remove sealing ring **4**.

▶ Remove fuel line **1** with banjo bolt **6** and sealing ring **5**.

▶ Seal openings on fuel line **1**.

▶ If necessary, unscrew screw fittings **3**.

▶ Seal openings on fuel high pressure pumps and fuel fine filter console.

Checking the fuel lines

▶ Check fuel lines for damage and replace if necessary.

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Installing the fuel fine filter fuel line to the fuel high pressure pumps

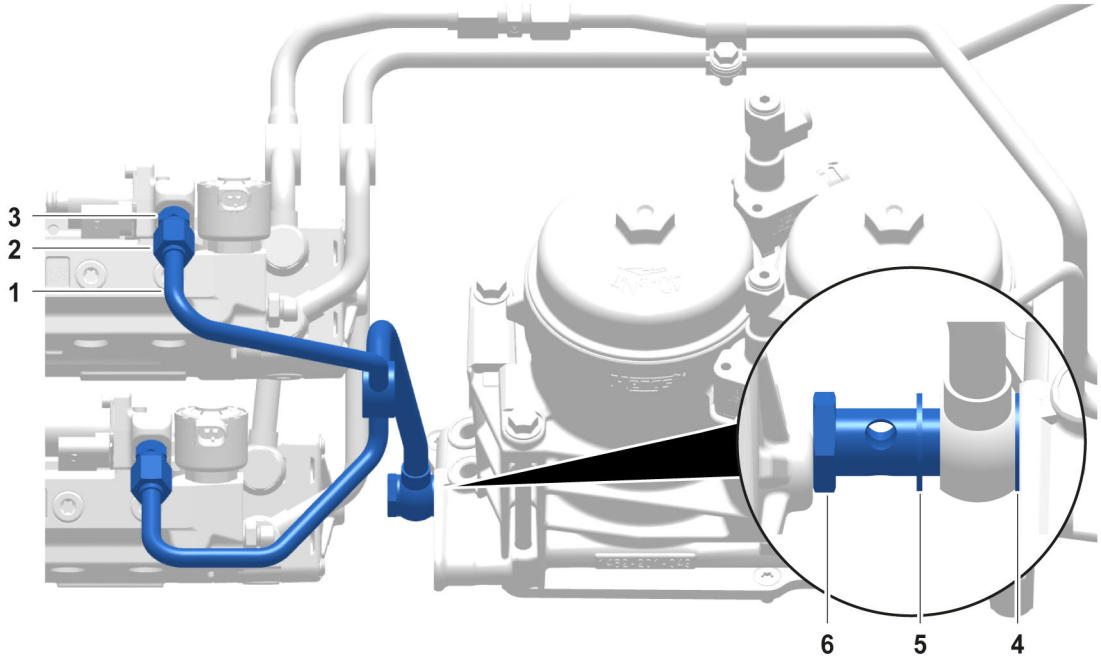

Fig. 243: Fuel fine filter fuel line to fuel high pressure pumps

1	Fuel line	**4**	Sealing ring
2	Box nut (2x)	**5**	Sealing ring
3	Screw fitting (2x)	**6**	Banjo bolt

- ▶ Remove closures from fuel high pressure pumps and fuel fine filter console.
- ▶ Tighten screw fittings **3**.
- ▶ Remove closures from fuel line **1**.
- ▶ Align new sealing ring **5** and banjo bolt **6** on the fuel line **1**.
- ▶ Align fuel line **1** with banjo bolt **6** and sealing ring **5**.
- ▶ Align new sealing ring **4**.
- ▶ Tighten banjo bolt **6**.
- ▶ Tighten box nuts **2**.

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Installing the engine control unit fuel line to the fuel fine filter

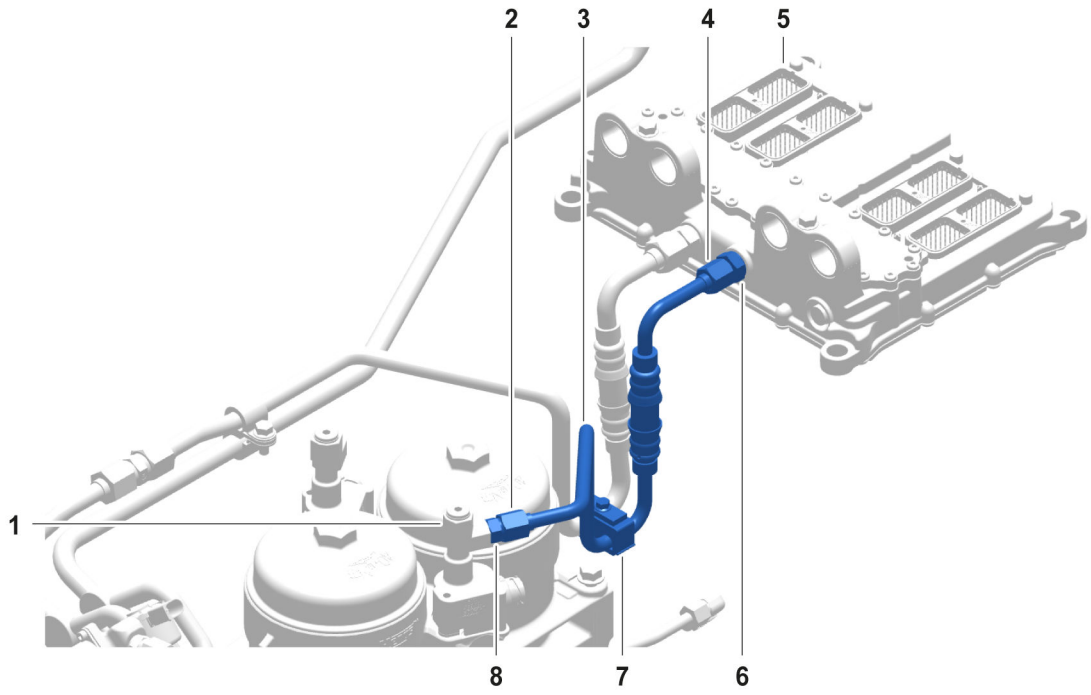

Fig. 244: Engine control unit fuel line to fuel fine filter

1	Adapter part	**5**	Engine control unit
2	Box nut	**6**	Screw fitting
3	Fuel line	**7**	Holding clamp
4	Box nut	**8**	Screw fitting

- ▶ Remove closures from adapter part **1** and engine control unit **5**.
- ▶ Tighten screw fitting **8**.
- ▶ Tighten screw fitting **6**.
- ▶ Remove closures from fuel line **3**.
- ▶ Align fuel line **3**.
- ▶ Tighten box nut **4**.
- ▶ Tighten box nut **2**.
- ▶ Install holding clamp **7**.

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Installing the fuel prefeeding pumps fuel line to the engine control unit

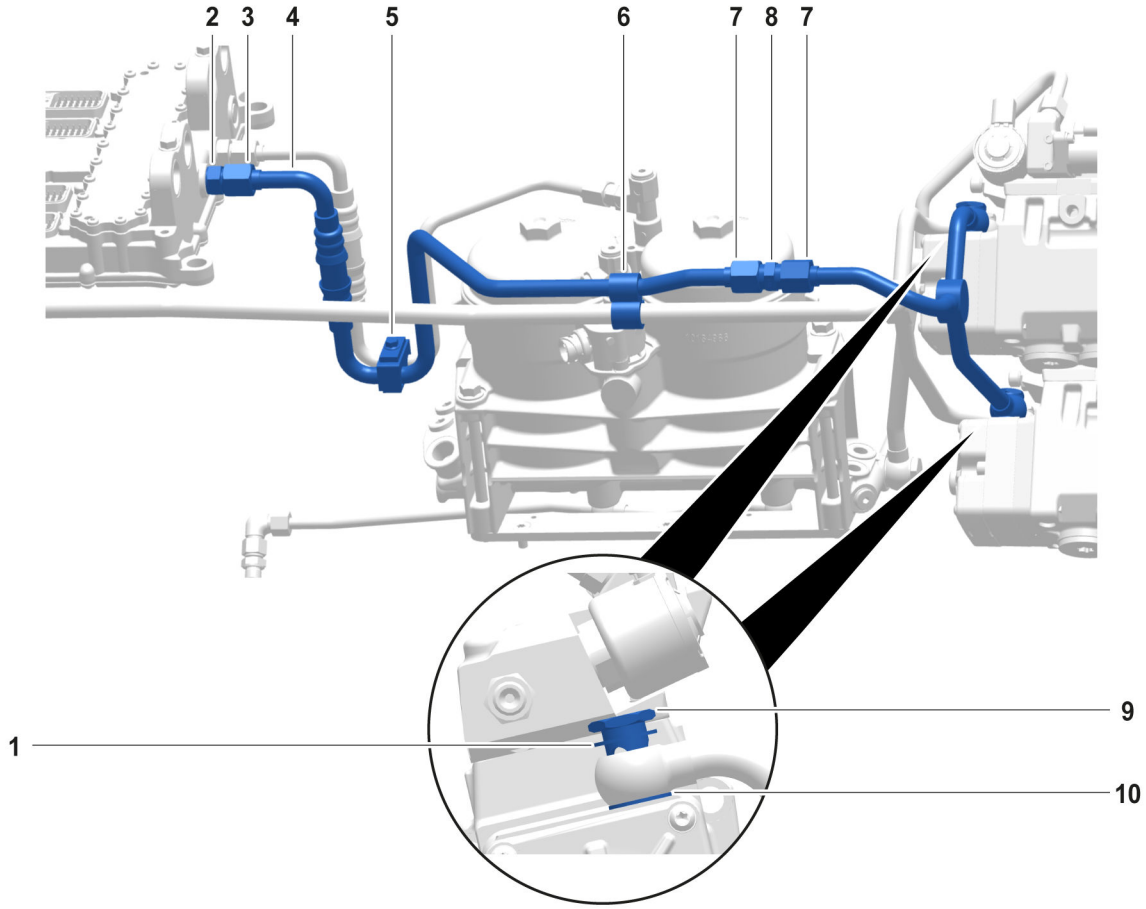

Fig. 245: Fuel prefeeding pumps fuel line to engine control unit

1	Sealing ring (2x)	**6**	Holding clamp
2	Screw fitting	**7**	Box nut
3	Box nut	**8**	Screw fitting
4	Fuel line	**9**	Banjo bolt (2x)
5	Holding clamp	**10**	Sealing ring (2x)

- ▶ Remove closures from engine control unit and fuel prefeeding pumps.
- ▶ Tighten screw fitting **2**.
- ▶ Remove closures from fuel line **4**.
- ▶ Align screw fitting **8**.
- ▶ Tighten box nuts **7**.
- ▶ Align new sealing rings **1** and banjo bolts **9** on fuel line **4**.
- ▶ Align fuel line **4** with banjo bolts **9** and sealing rings **1**.
- ▶ Align new sealing rings **10**.
- ▶ Tighten banjo bolts **9**.
- ▶ Tighten box nut **3**.
- ▶ Install holding clamp **6**.
- ▶ Install holding clamp **5**.

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Removing the device fuel line to the fuel prefeeding pumps

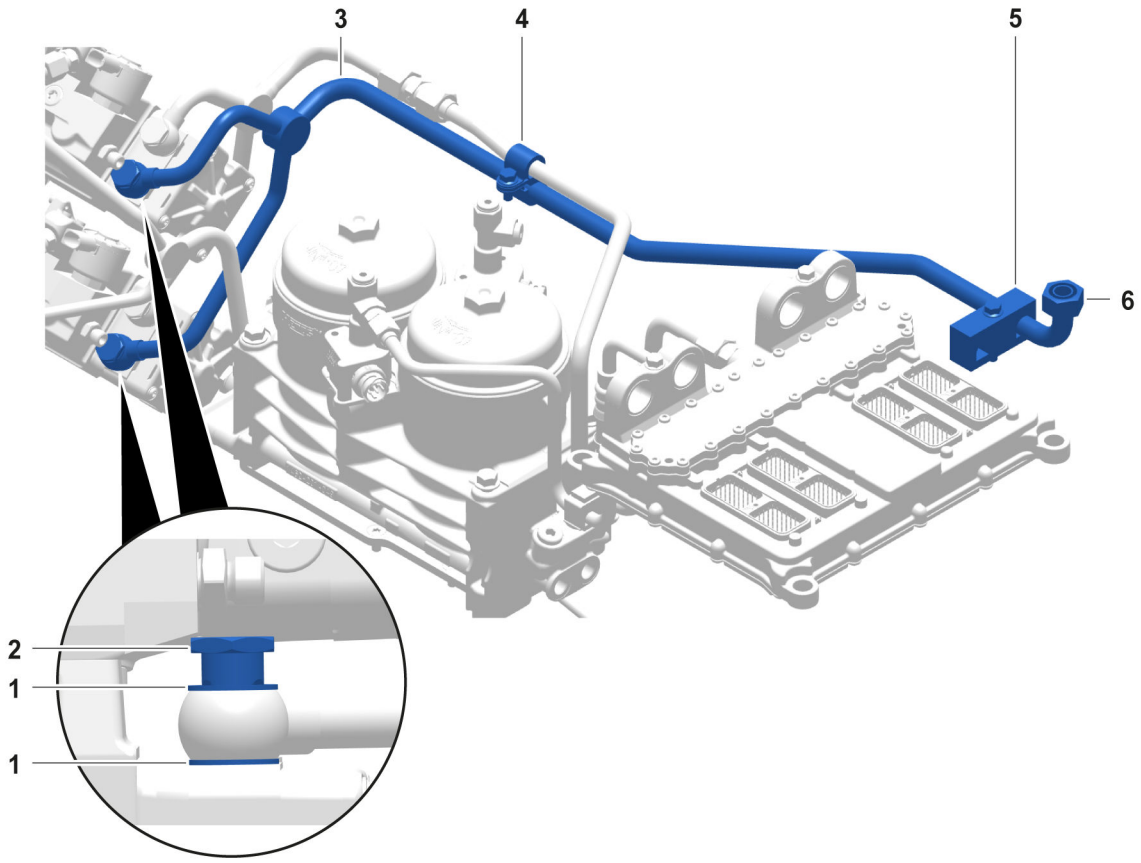

Fig. 246: Device fuel line to tfuel prefeeding pumps

1	Sealing ring (4x)	**4**	Holding clamp
2	Banjo bolt (2x)	**5**	Holding clamp
3	Fuel line	**6**	Box nut

- ▶ Remove closures from fuel prefeeding pumps and device.
- ▶ Remove closures from fuel line **3**.
- ▶ Align new sealing rings **1** and banjo bolts **2** on fuel line **3**.
- ▶ Align fuel line **3** with banjo bolts **2** and sealing rings **1**.
- ▶ Tighten banjo bolts **2**.
- ▶ Tighten box nut **6**.
- ▶ Install holding clamp **5**.
- ▶ Install holding clamp **4**.

3.5.3 Removing and installing the fuel return lines

Removing the left fuel return lines from the injectors to the distributor block

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

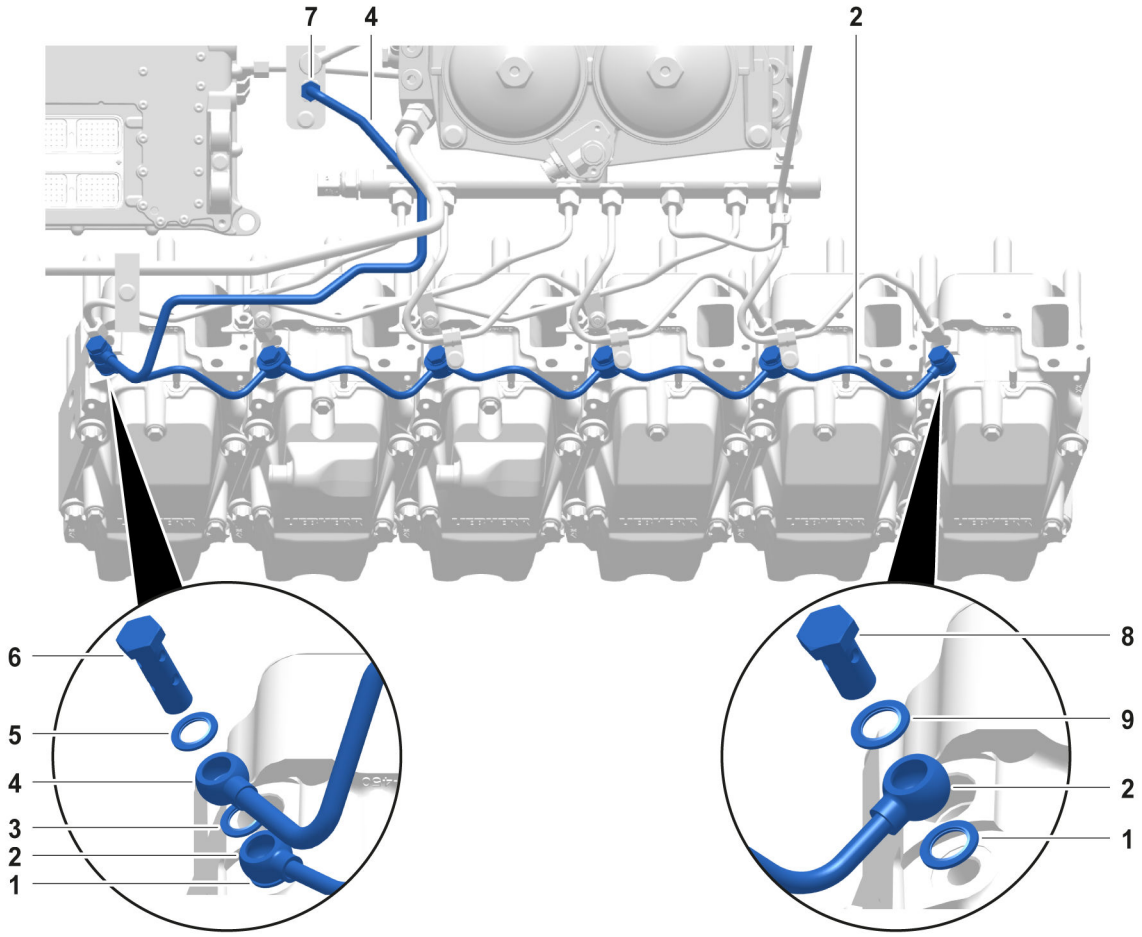

Fig. 247: Left fuel return lines from injectors to distributor block

1 Sealing ring (6x)
2 Fuel line
3 Sealing ring
4 Fuel line
5 Sealing ring
6 Banjo bolt
7 Box nut
8 Banjo bolt (5x)
9 Sealing ring (5x)

- ▶ Unscrew banjo bolt **6**.
- ▶ Remove sealing ring **5**.
- ▶ Unscrew box nut **7**.
- ▶ Remove fuel line **4**.
- ▶ Remove sealing ring **3**.
- ▶ Seal openings on fuel line **4**.
- ▶ Seal opening on distributor block.
- ▶ Unscrew banjo bolts **8**.
- ▶ Remove sealing rings **9**.
- ▶ Remove fuel line **2**.
- ▶ Remove sealing rings **1**.
- ▶ Seal openings on fuel line **2**.
- ▶ Seal openings on cylinder heads.

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Removing the right fuel return lines from the injectors to the distributor block

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

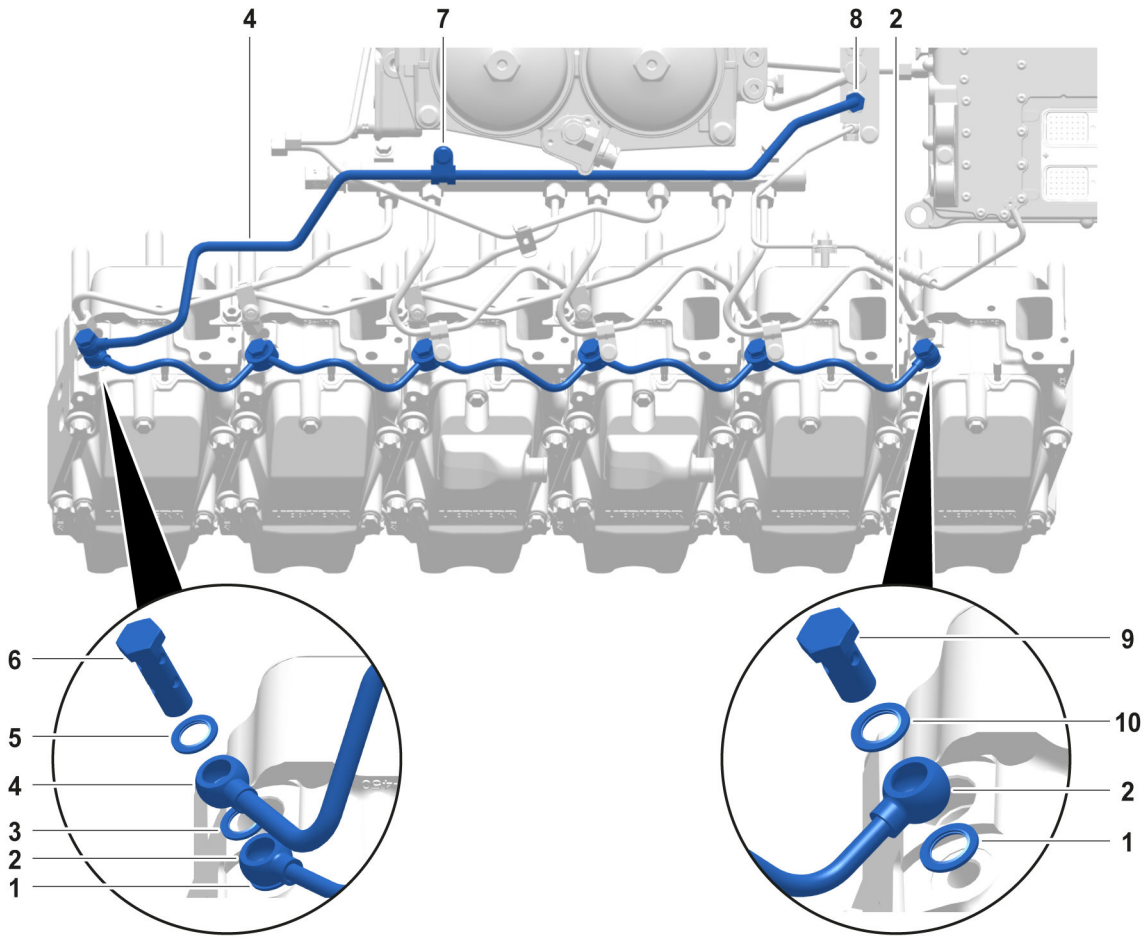

Fig. 248: Right fuel return lines from injectors to distributor block

1	Sealing ring (6x)	**6**	Banjo bolt
2	Fuel line	**7**	Holding clamp
3	Sealing ring	**8**	Box nut
4	Fuel line	**9**	Banjo bolt (5x)
5	Sealing ring	**10**	Sealing ring (5x)

- ▶ Remove holding clamp **7**.
- ▶ Unscrew banjo bolt **6**.
- ▶ Remove sealing ring **5**.
- ▶ Unscrew box nut **8**.
- ▶ Remove fuel line **4**.
- ▶ Remove sealing ring **3**.
- ▶ Seal openings on fuel line **4**.
- ▶ Seal opening on distributor block.

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- ▶ Unscrew banjo bolts **9**.
- ▶ Remove sealing rings **10**.
- ▶ Remove fuel line **2**.
- ▶ Remove sealing rings **1**.
- ▶ Seal openings on fuel line **2**.
- ▶ Seal openings on cylinder heads.

Removing the fuel return line from the engine control unit to the distributor block

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

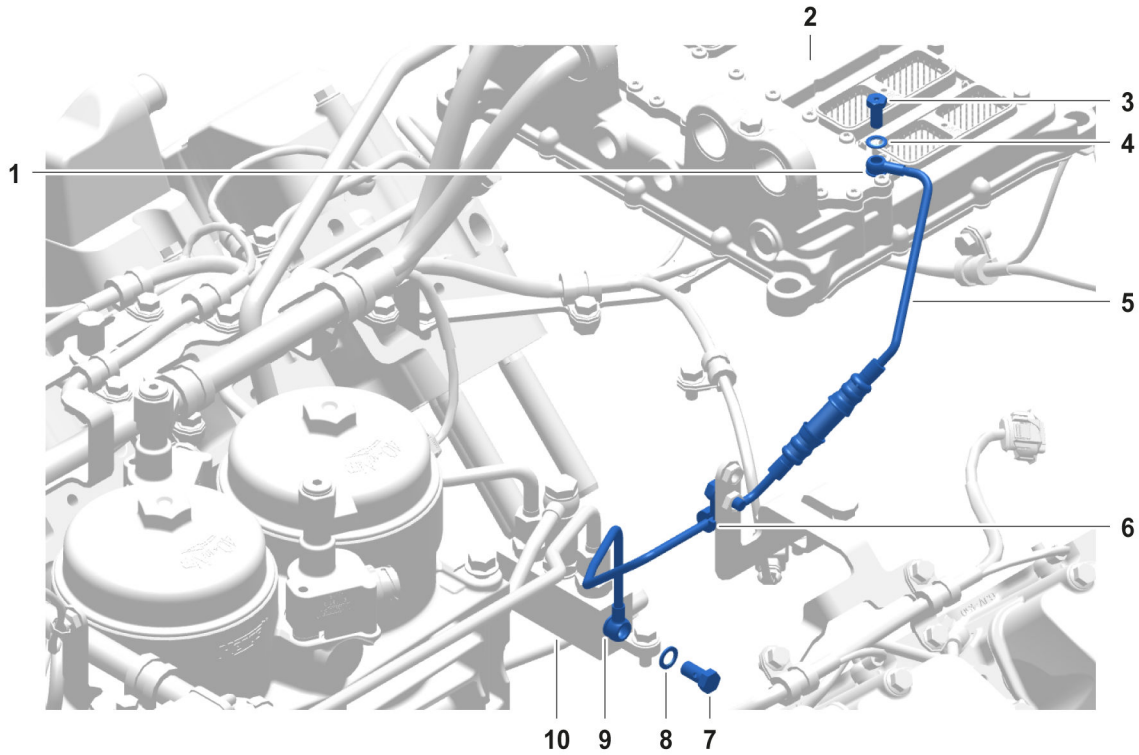

Fig. 249: Fuel return line from engine control unit to distributor block

1	Sealing ring	**6**	Holding clamp
2	Engine control unit	**7**	Banjo bolt
3	Banjo bolt	**8**	Sealing ring
4	Sealing ring	**9**	Sealing ring
5	Fuel line	**10**	Distributor block

- ▶ Remove holding clamp **6**.
- ▶ Unscrew banjo bolt **7**.
- ▶ Remove sealing ring **8**.
- ▶ Remove sealing ring **9**.
- ▶ Unscrew banjo bolt **3**.

- ▶ Remove sealing ring **4**.
- ▶ Remove sealing ring **1**.
- ▶ Remove fuel line **5**.
- ▶ Seal openings on fuel line **5**.
- ▶ Seal openings on engine control unit **2** and distributor block **10**.

Removing the fuel return line from the distributor block to the fuel fine filter

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

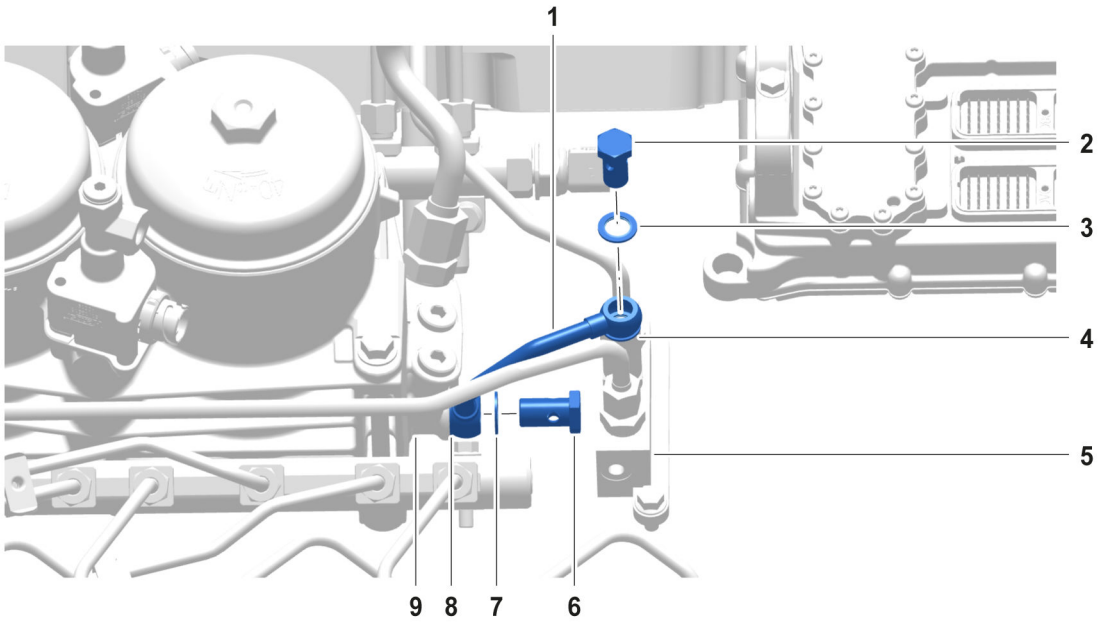

Fig. 250: Fuel return line from distributor block to fuel fine filter

1 Fuel line
2 Banjo bolt
3 Sealing ring
4 Sealing ring
5 Distributor block
6 Banjo bolt
7 Sealing ring
8 Sealing ring
9 Fuel fine filter

- ▶ Unscrew banjo bolt **6**.
- ▶ Remove sealing ring **7**.
- ▶ Remove sealing ring **8**.
- ▶ Unscrew banjo bolt **2**.
- ▶ Remove sealing ring **3**.
- ▶ Remove fuel line **1**.
- ▶ Remove sealing ring **4**.
- ▶ Seal openings on fuel line **1**.
- ▶ Seal openings on distributor block **5** and fuel fine filter **9**.

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Removing the fuel return lines from the fuel high pressure pumps to the fuel fine filter

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

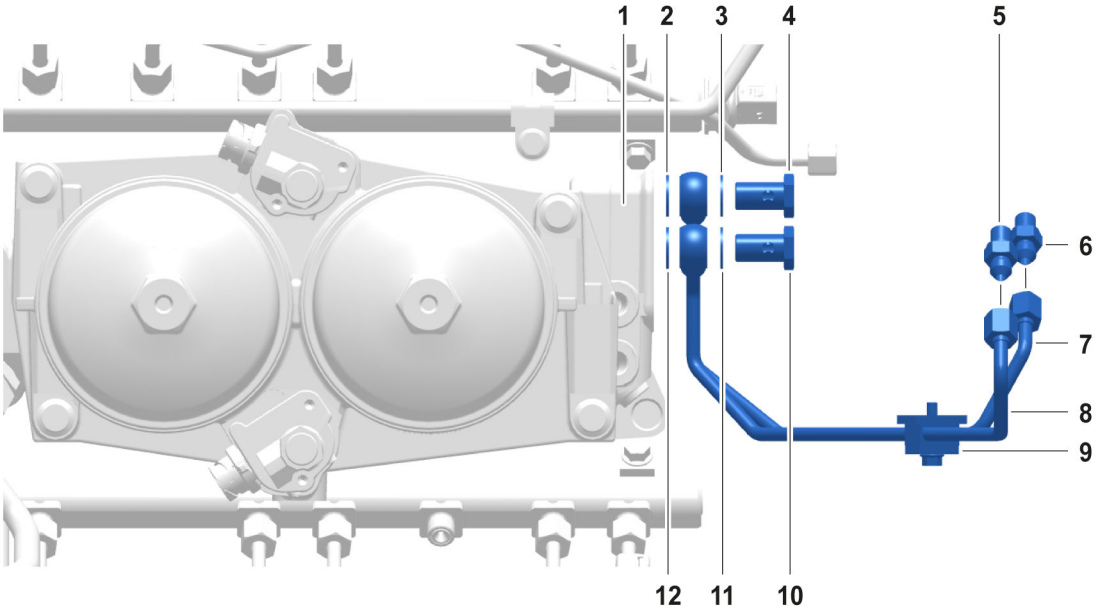

Fig. 251: Fuel return lines from fuel high pressure pumps to fuel fine filter

1	Fuel fine filter	**7**	Fuel line
2	Sealing ring	**8**	Fuel line
3	Sealing ring	**9**	Holding clamp
4	Banjo bolt	**10**	Banjo bolt
5	Screw fitting	**11**	Sealing ring
6	Screw fitting	**12**	Sealing ring

- ▶ Unscrew banjo bolt **4**.
- ▶ Remove sealing ring **3**.
- ▶ Remove sealing ring **2**.
- ▶ Unscrew box nut from fuel line **7**.
- ▶ Remove fuel line **7**.
- ▶ Seal openings on fuel line **7**.
- ▶ If necessary, unscrew screw fitting **6**.
- ▶ Seal openings on fuel fine filter **1** and fuel high pressure pump.
- ▶ Unscrew banjo bolt **10**.
- ▶ Remove sealing ring **11**.
- ▶ Remove sealing ring **12**.
- ▶ Unscrew box nut from fuel line **8**.
- ▶ Remove fuel line **8**.
- ▶ Seal openings on fuel line **8**.

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▶ If necessary, unscrew screw fitting **5**.

▶ Seal openings on fuel fine filter **1** and fuel high pressure pump.

Removing the fuel return line from the fuel fine filter to the fuel tank

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.
❑ Fuel supply is closed, see documentation from the device manufacturer.
❑ Device side fuel return line is removed, see documentation from the device manufacturer.
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

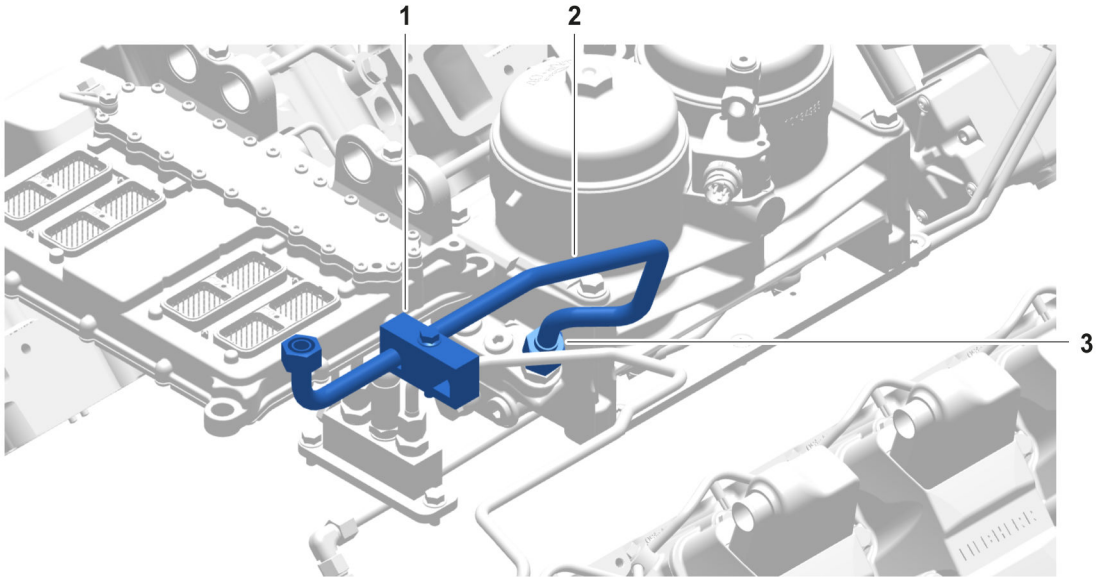

Fig. 252: Fuel return lines from fuel fine filter to fuel tank

1 Holding clamp
2 Fuel line
3 Box nut

▶ Remove holding clamp **1**.

▶ Unscrew box nut **3**.

▶ Remove fuel line **2**.

▶ Seal openings on fuel line **2**.

▶ Seal opening on fuel fine filter.

Checking the fuel return lines

▶ Check fuel return lines for damage and replace if necessary.

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Installing the fuel return lines from the fuel fine filter to the fuel tank

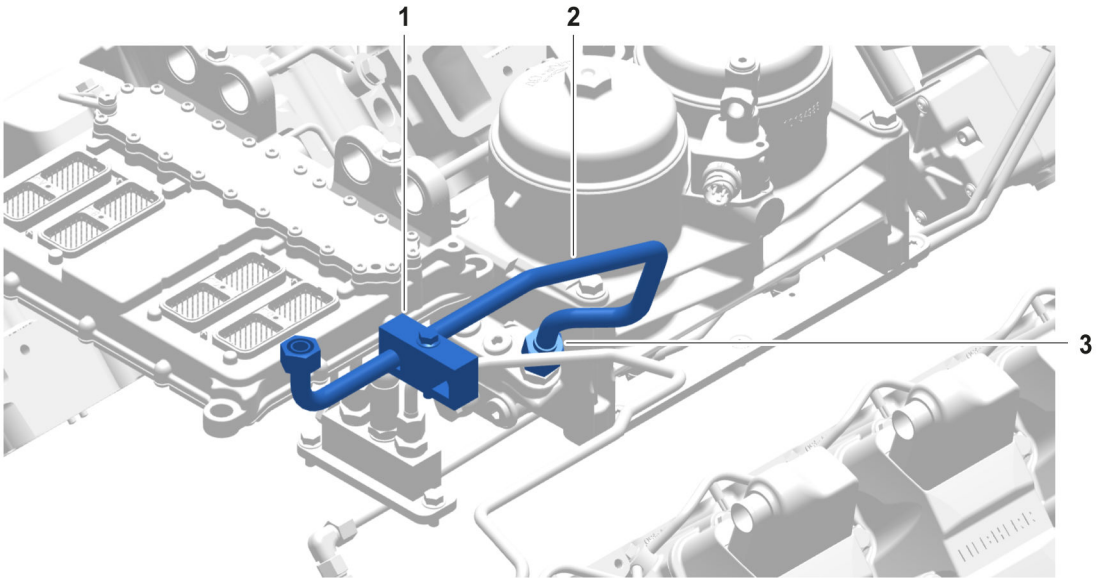

Fig. 253: Fuel return lines from fuel fine filter to fuel tank

1 Holding clamp
2 Fuel line
3 Box nut

▶ Remove closure from fuel fine filter.

▶ Remove closures from fuel line **2**.

▶ Align fuel line **2**.

▶ Tighten box nut **3**.

▶ Install holding clamp **1**.

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Installing the fuel return lines from the fuel high pressure pumps to the fuel fine filter

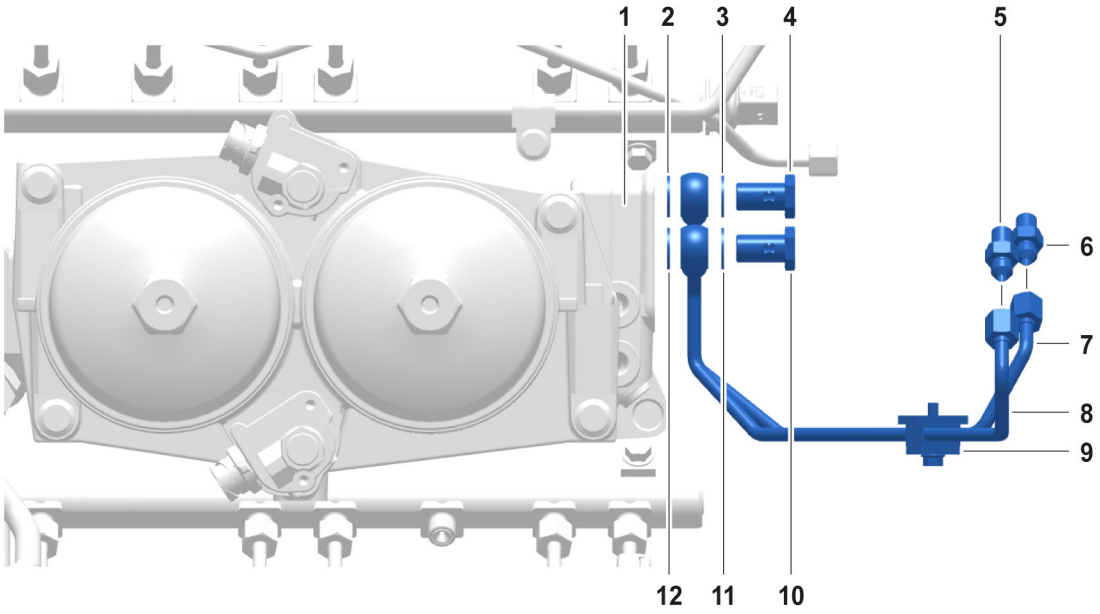

Fig. 254: Fuel return lines from fuel high pressure pumps to fuel fine filter

1	Fuel fine filter	**7**	Fuel line
2	Sealing ring	**8**	Fuel line
3	Sealing ring	**9**	Holding clamp
4	Banjo bolt	**10**	Banjo bolt
5	Screw fitting	**11**	Sealing ring
6	Screw fitting	**12**	Sealing ring

- ▶ Remove closures from fuel fine filter **1** and fuel high pressure pump.
- ▶ Tighten screw fitting **5**.
- ▶ Remove closures from fuel line **8**.
- ▶ Align fuel line **8**.
- ▶ Tighten box nut of fuel line **8**.
- ▶ Align new sealing ring **12**.
- ▶ Align new sealing ring **11**.
- ▶ Tighten banjo bolt **10**.
- ▶ Remove closures from fuel fine filter **1** and fuel high pressure pump.
- ▶ Tighten screw fitting **6**.
- ▶ Remove closures from fuel line **7**.
- ▶ Align fuel line **7**.
- ▶ Tighten box nut of fuel line **7**.
- ▶ Align new sealing ring **2**.
- ▶ Align new sealing ring **3**.
- ▶ Tighten banjo bolt **4**.

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Installing the fuel return line from the distributor block to the fuel fine filter

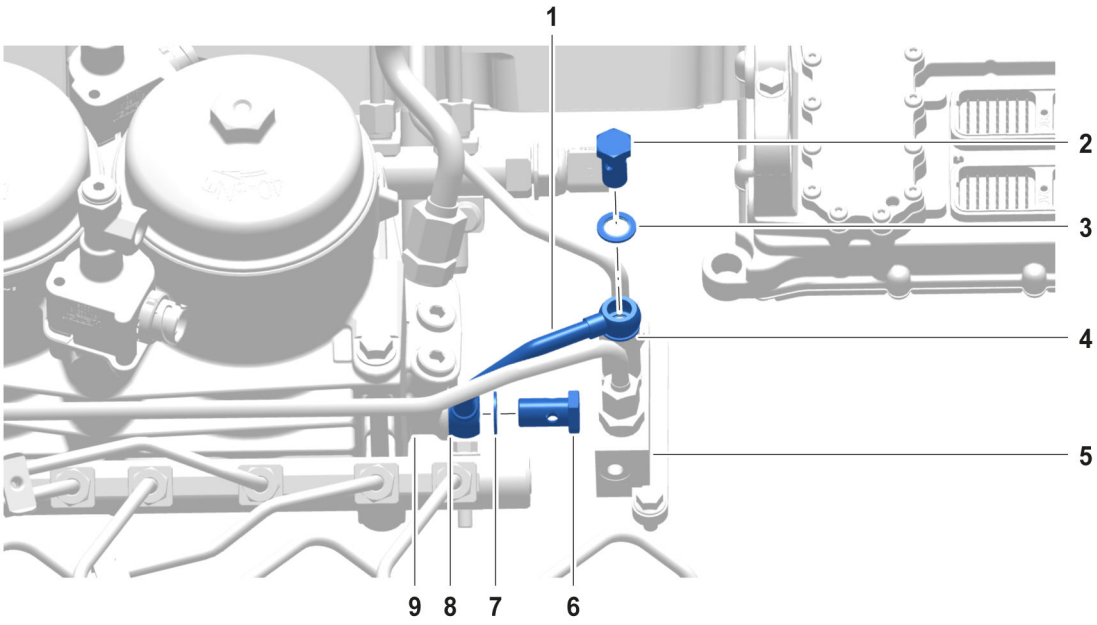

Fig. 255: Fuel return line from distributor block to fuel fine filter

1 Fuel line
2 Banjo bolt
3 Sealing ring
4 Sealing ring
5 Distributor block
6 Banjo bolt
7 Sealing ring
8 Sealing ring
9 Fuel fine filter

- ▶ Remove closures from distributor block **5** and fuel fine filter **9**.
- ▶ Remove closures from fuel line **1**.
- ▶ Align new sealing ring **4**.
- ▶ Align fuel line **1**.
- ▶ Align new sealing ring **3**.
- ▶ Tighten banjo bolt **2**.
- ▶ Align new sealing ring **8**.
- ▶ Align new sealing ring **7**.
- ▶ Tighten banjo bolt **6**.

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Installing the fuel return line from the engine control unit to the distributor block

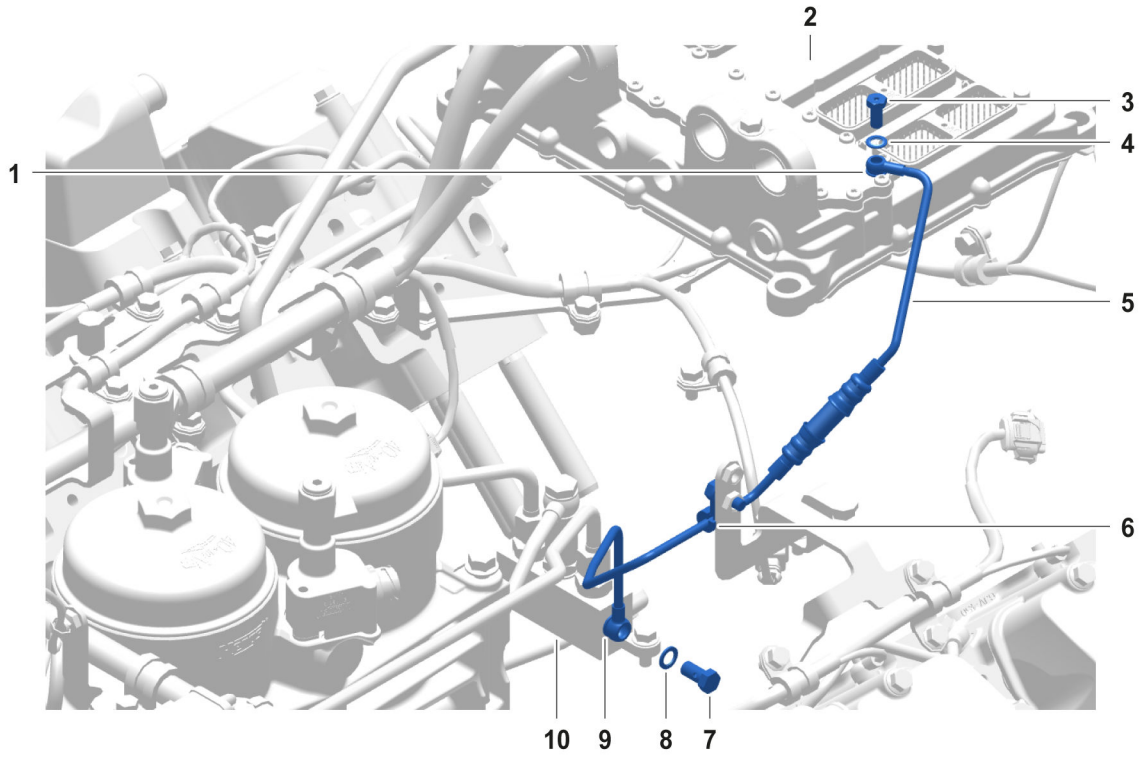

Fig. 256: Fuel return line from engine control unit to distributor block

1	Sealing ring	**6**	Holding clamp
2	Engine control unit	**7**	Banjo bolt
3	Banjo bolt	**8**	Sealing ring
4	Sealing ring	**9**	Sealing ring
5	Fuel line	**10**	Distributor block

- ▶ Remove closures from engine control unit **2** and distributor block **10**.
- ▶ Remove closures from fuel line **5**.
- ▶ Align fuel line **5**.
- ▶ Align new sealing ring **1**.
- ▶ Align new sealing ring **4**.
- ▶ Tighten banjo bolt **3**.
- ▶ Align new sealing ring **9**.
- ▶ Align new sealing ring **8**.
- ▶ Tighten banjo bolt **7**.
- ▶ Install holding clamp **6**.

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Installing the right fuel return lines from the injectors to the distributor block

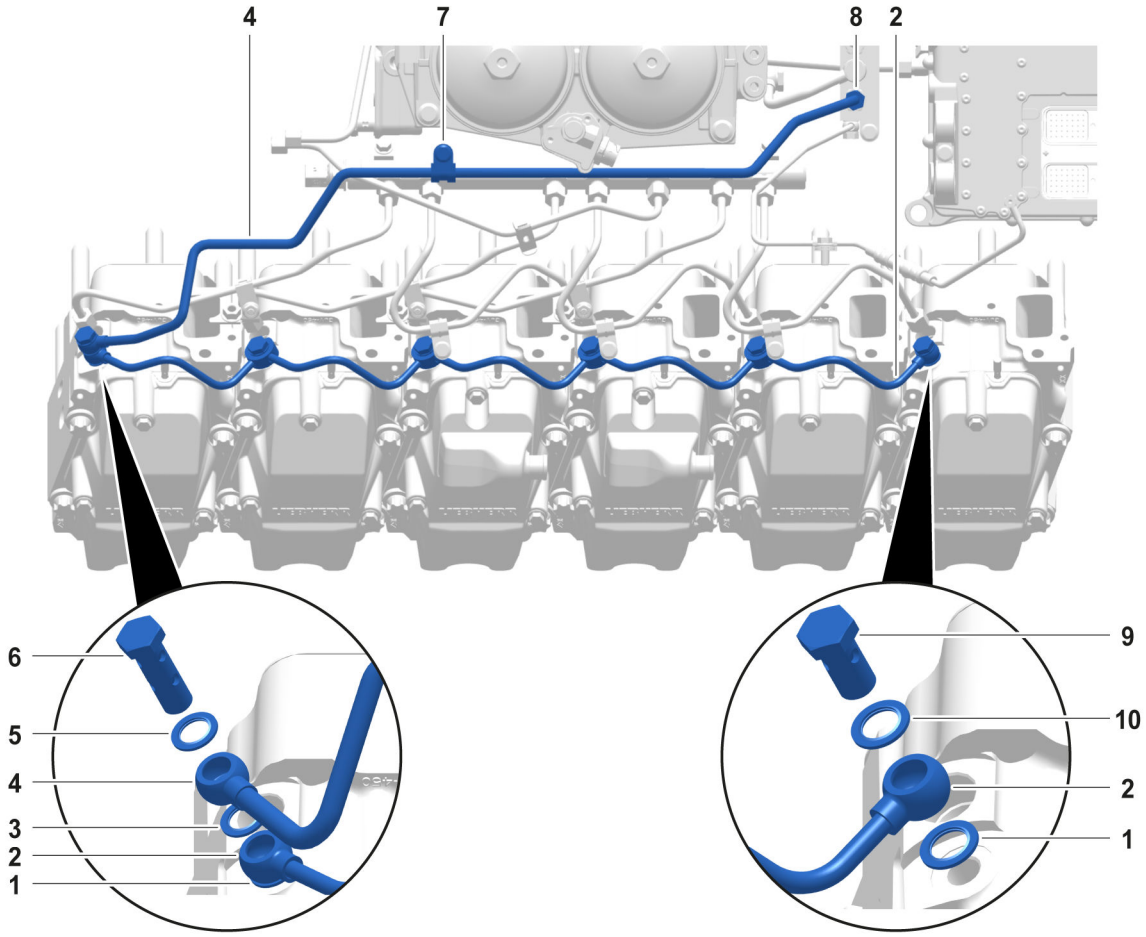

Fig. 257: Right fuel return lines from injectors to distributor block

1 Sealing ring (6x)
2 Fuel line
3 Sealing ring
4 Fuel line
5 Sealing ring
6 Banjo bolt
7 Holding clamp
8 Box nut
9 Banjo bolt (5x)
10 Sealing ring (5x)

- ▶ Remove closures from cylinder heads.
- ▶ Remove closures from fuel line **2**.
- ▶ Align new sealing rings **1**.
- ▶ Align fuel line **2**.
- ▶ Align new sealing rings **10**.
- ▶ Tighten banjo bolts **9**.
- ▶ Remove closure from distributor block.
- ▶ Remove closures from fuel line **4**.
- ▶ Align new sealing ring **3**.
- ▶ Align fuel line **4**.
- ▶ Tighten box nut **8**.

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- ▶ Align new sealing ring **5**.
- ▶ Tighten banjo bolt **6**.
- ▶ Install holding clamp **7**.

Installing the left fuel return lines from the injectors to the distributor block

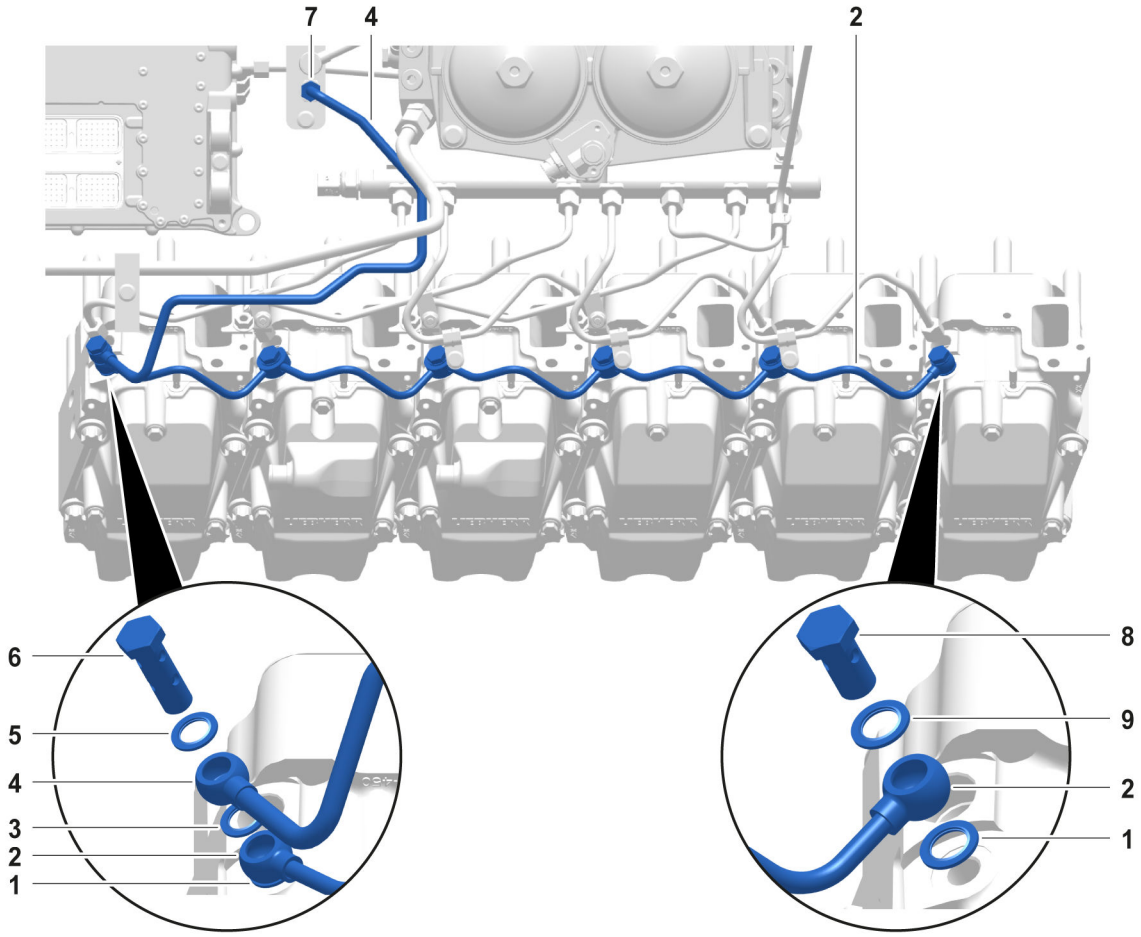

Fig. 258: Left fuel return lines from injectors to distributor block

1 Sealing ring (6x)
2 Fuel line
3 Sealing ring
4 Fuel line
5 Sealing ring
6 Banjo bolt
7 Box nut
8 Banjo bolt (5x)
9 Sealing ring (5x)

- ▶ Remove closures from cylinder heads.
- ▶ Remove closures from fuel line **2**.
- ▶ Align new sealing rings **1**.
- ▶ Align fuel line **2**.
- ▶ Align new sealing rings **9**.
- ▶ Tighten banjo bolts **8**.
- ▶ Remove closures from distributor block.
- ▶ Remove closures from fuel line **4**.

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- ▶ Align new sealing ring **3**.
- ▶ Align fuel line **4**.
- ▶ Tighten box nut **7**.
- ▶ Align sealing ring **5**.
- ▶ Tighten banjo bolt **6**.

3.5.4 Removing and installing the distributor block fuel return lines

Removing the distributor block fuel return lines

Make sure that the following prerequisites are met:

- ❑ A collection container for fuel is available.
- ❑ Left fuel return line from injectors to distributor block is removed from distributor block. (For more information see: Removing the left fuel return lines from the injectors to the distributor block, page 194.)
- ❑ Right fuel return line from injectors to distributor block is removed from distributor block. (For more information see: Removing the right fuel return lines from the injectors to the distributor block, page 196.)
- ❑ Fuel return line from engine control unit to distributor block is removed from distributor block. (For more information see: Removing the fuel return line from the engine control unit to the distributor block, page 197.)
- ❑ Fuel return line from distributor block to fuel fine filter is removed from distributor block. (For more information see: Removing the fuel return line from the distributor block to the fuel fine filter, page 198.)

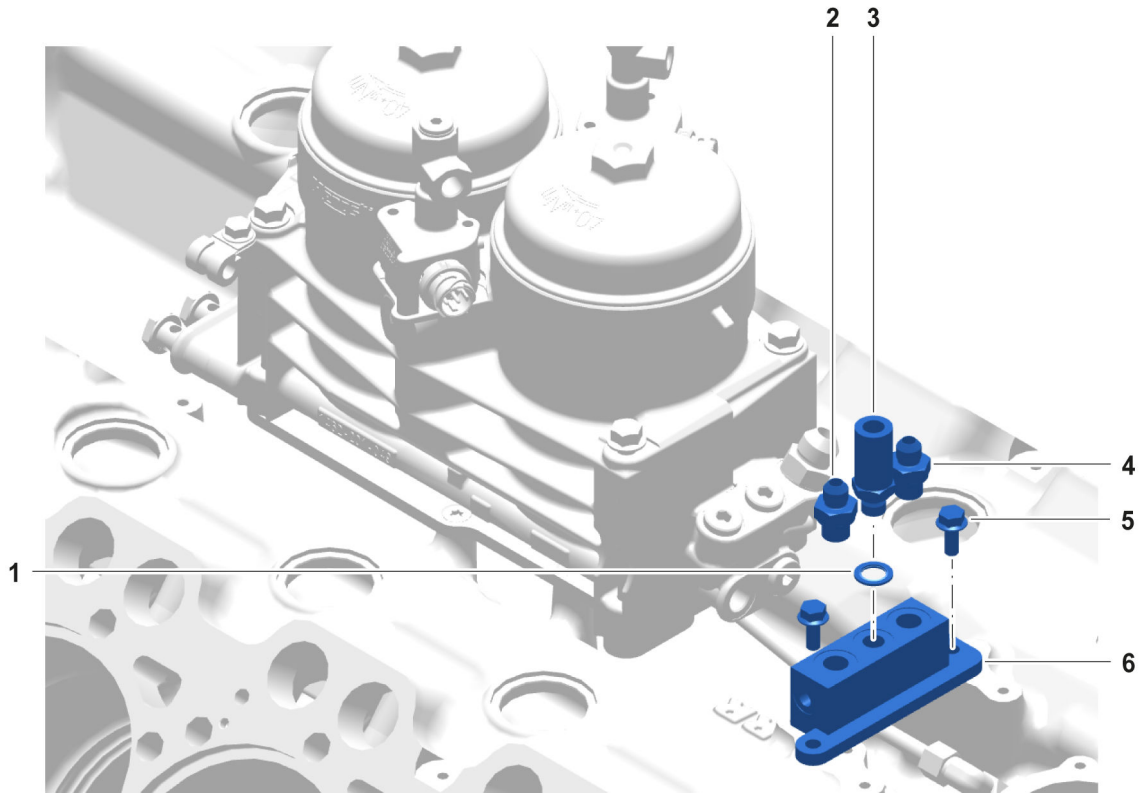

Fig. 259: Distributor block fuel return lines

1 Sealing ring
2 Screw fitting
4 Screw fitting
5 Hex head screw (2x)

See next page for continuation of the image legend

3 Intermediate section
6 Distributor block

- ▶ If necessary, unscrew screw fitting **2**.
- ▶ If necessary, unscrew screw fitting **4**.
- ▶ If necessary, unscrew intermediate section **3**.
- ▶ Remove sealing ring **1**.
- ▶ Unscrew hex head screws **5**.
- ▶ Remove distributor block **6**.

Installing the distributor block fuel return lines

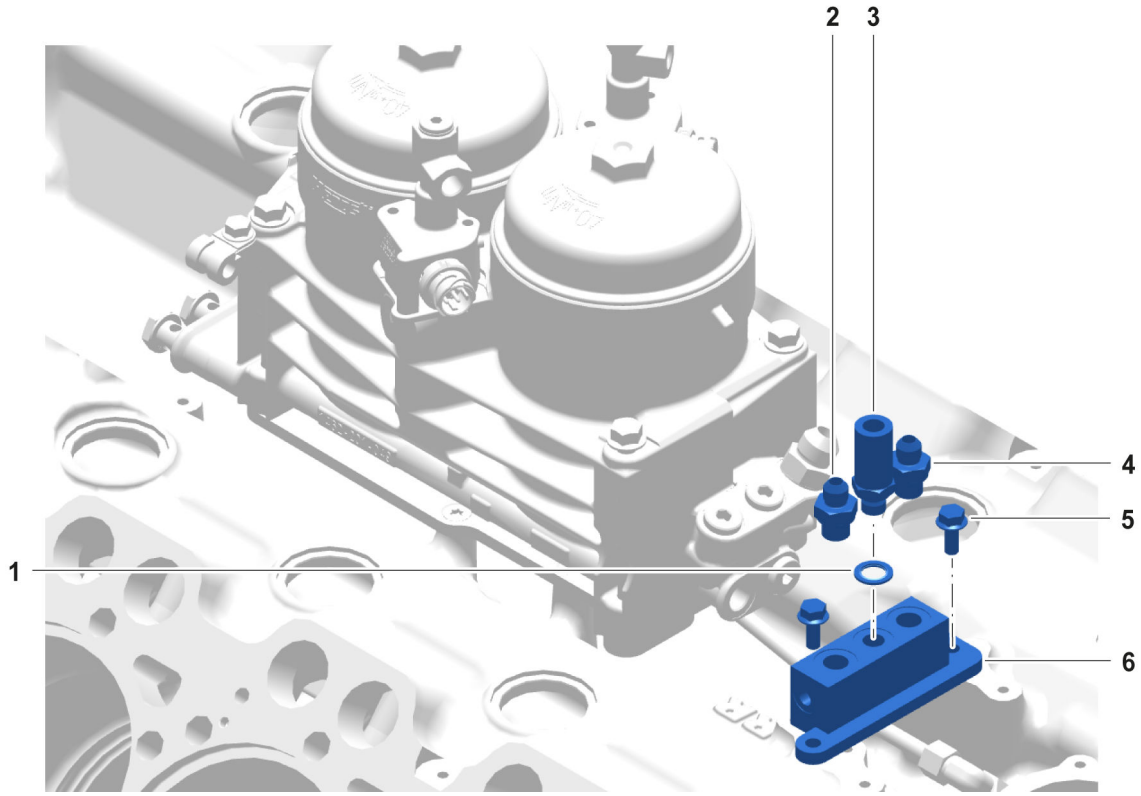

Fig. 260: Distributor block fuel return lines

1 Sealing ring
2 Screw fitting
3 Intermediate section
4 Screw fitting
5 Hex head screw (2x)
6 Distributor block

- ▶ Align distributor block **6**.
- ▶ Tighten hex head screws **5**.
- ▶ Align new sealing ring **1**.
- ▶ Tighten intermediate section **3**.
- ▶ Tighten screw fitting **4**.
- ▶ Tighten screw fitting **2**.

3.5.5 Reducing the pressure in the fuel system

If the engine is running:

▶ Turn off the engine.

▶ Check pressure reduction with diagnostics software (variables: 6996 - Fuel Pressure High 1/ 6997 - Fuel Pressure High 2). (For more information see: 4.1.3 Diagnostic tools, page 503.)

▷ Pressure below 10 bar

3.5.6 Removing and installing the fuel injection pipes

Removing the fuel injection pipes

Representation	Description	Required number	Part number
	Special wrench width across flats 17 for injection pipes	1	10020852
	Special wrench width across flats 19 for injection pipes	1	10289118

Tab. 64: Special tool

Make sure that the following prerequisites are met:

❑ A collection container for fuel is available.

❑ Protecting caps are present. (For more information see: 4.1.2 Locking pieces, page 502.)

❑ Pressure in fuel system has been relieved. (For more information see: 3.5.5 Reducing the pressure in the fuel system, page 209.)

❑ Fuel supply is closed, see documentation from the device manufacturer.

❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

NOTICE

Leaky fuel high pressure line!

▶ Mark box nut with center punch each time it is released.

▶ Replace fuel injection pipes with two marks per box nut.

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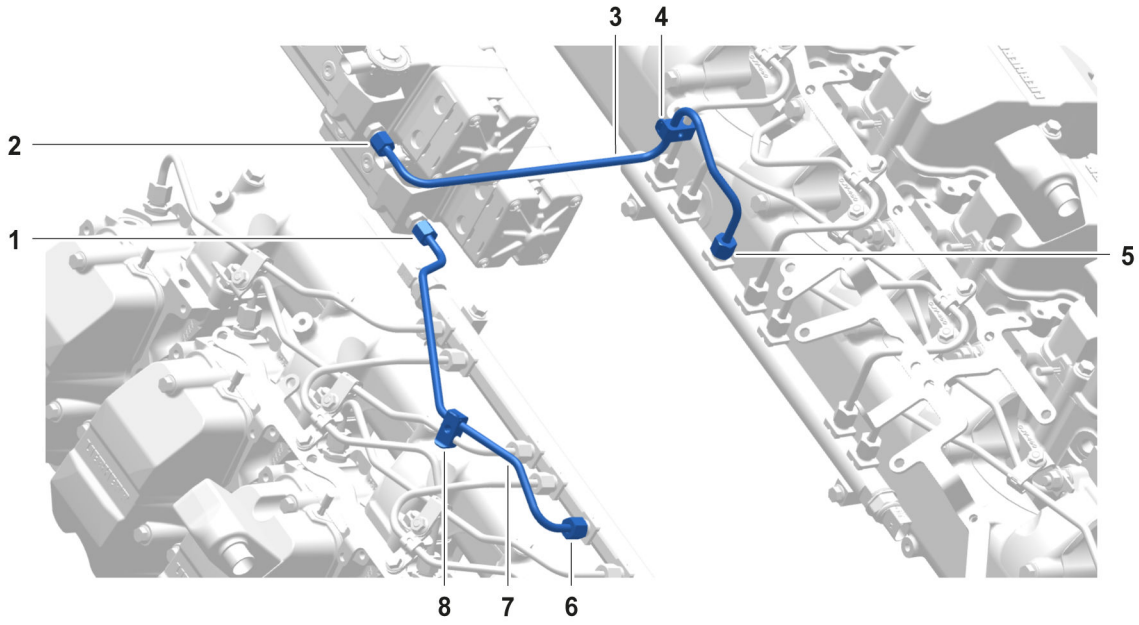

Fig. 263: Fuel injection pipes

1	Box nut	**5**	Box nut
2	Box nut	**6**	Box nut
3	Left fuel injection pipe	**7**	Right fuel injection pipe
4	Holding clamp	**8**	Holding clamp

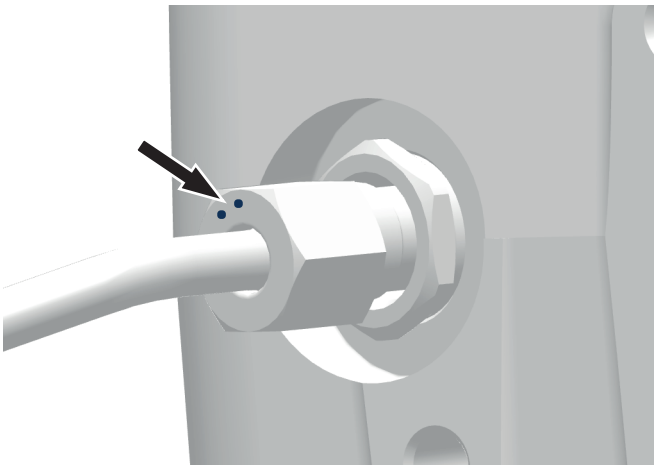

Fig. 264: Center punches

▶ Check number of center punches per box nut. (see: fig. 264, page 210)

If two center punches are present:
▶ Replace the fuel injection pipe. (see: fig. 264, page 210)

If less than two center punches are present:
▶ Mark box nut with a center punch.(see: fig. 264, page 210)

▶ Remove holding clamp **4**.

▶ Unscrew box nut **2** with special wrench 10020852.

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- ▶ Unscrew box nut **5** with special wrench 10289118.
- ▶ Remove left fuel injection pipe **3**.
- ▶ Seal openings on left fuel injection pipe **3** with protecting caps.
- ▶ Seal opening on fuel high pressure pump with protecting cap.
- ▶ Seal opening on left fuel rail with protecting cap.
- ▶ Remove holding clamp **8**.
- ▶ Unscrew box nut **1** with special wrench 10020852.
- ▶ Unscrew box nut **6** with special wrench 10289118.
- ▶ Remove right fuel injection pipe **7**.
- ▶ Seal openings on right fuel injection pipe **7** with protecting caps.
- ▶ Seal opening on fuel high pressure pump with protecting cap.
- ▶ Seal opening on right fuel rail with protecting cap.

Checking the fuel injection pipes

- ▶ Check left fuel injection pipe **3** for damage and replace if necessary.
- ▶ Check right fuel injection pipe **7** for damage and replace if necessary.

Installing the fuel injection pipes

NOTICE
Leaky fuel high pressure line!

- ▶ Tighten fuel injection pipes a maximum of three times according to tightening instruction.
- ▶ Install fuel injection pipes free of stress and friction.

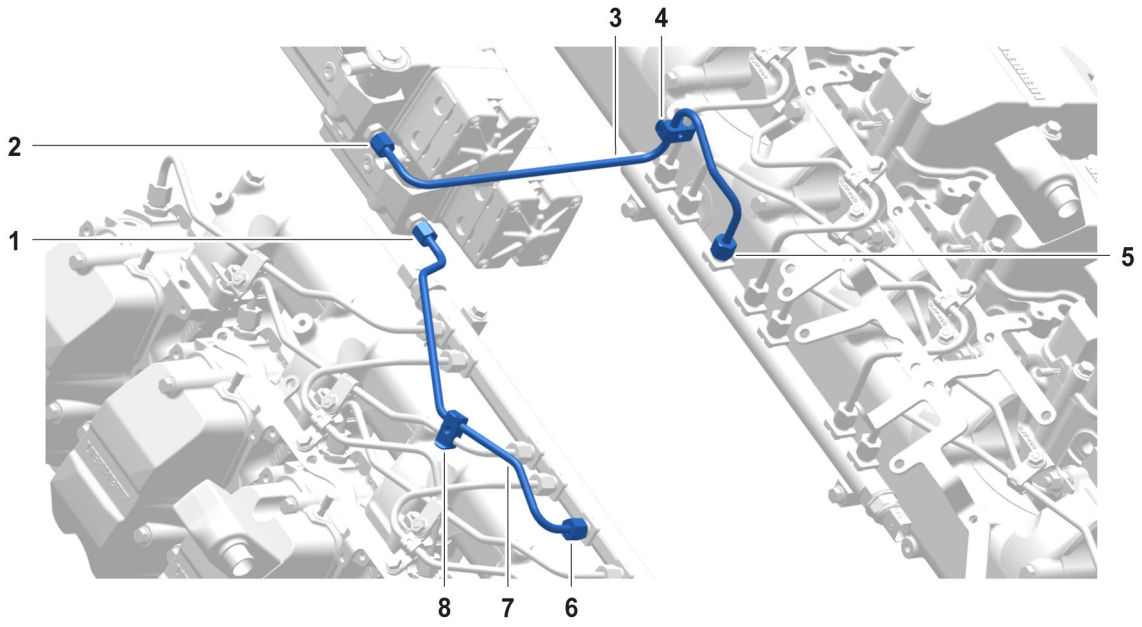


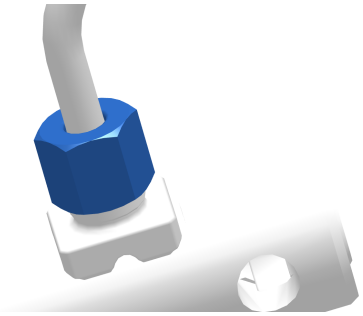
Fig. 265: Fuel injection pipes

1 Box nut
5 Box nut

See next page for continuation of the image legend

2 Box nut
3 Left fuel injection pipe
4 Holding clamp
6 Box nut
7 Right fuel injection pipe
8 Holding clamp

- ▶ Remove protecting caps from right fuel rail.
- ▶ Remove protecting caps from fuel high pressure pump.
- ▶ Remove protecting caps from right fuel injection pipe **7**.
- ▶ Align right fuel injection pipe **7**.
- ▶ Screw on box nut **6** lightly.
- ▶ Screw on box nut **1** lightly.
- ▶ Install holding clamp **8**.
- ▶ Remove protecting caps from left fuel rail.
- ▶ Remove protecting caps from fuel high pressure pump.
- ▶ Remove protecting caps from left fuel injection pipe **3**.
- ▶ Align left fuel injection pipe **3**.
- ▶ Screw on box nut **5** lightly.
- ▶ Screw on box nut **2** lightly.
- ▶ Install holding clamp **4**.

Tightening instruction for box nut width across flats 17 and width across flats 19 (initial assembly)		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable a maximum of two times	
Stage	**Tightening torque**	
1.	15 Nm	
Stage	**Angle of rotation**	
2	60°	

Tab. 65: Tightening instruction 12480200-002

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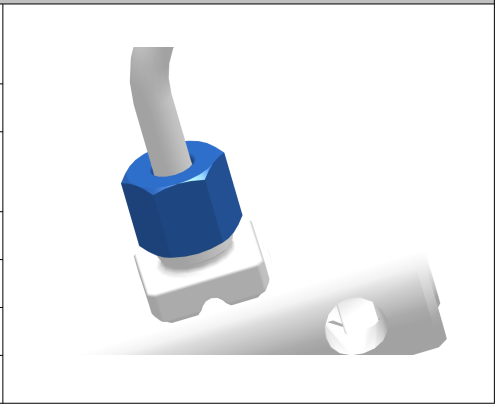
Tightening instruction for box nut width across flats 17 and width across flats 19 (second assembly (one center punch) / third assembly (two center punches))		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable a maximum of two times	
Stage	**Tightening torque**	
1.	15 Nm	
Stage	**Angle of rotation**	
2	30°	

Tab. 66: Tightening instruction 12480200-002

- ▶ Tighten box nut **6** with special wrench 10289118 according to tightening instruction.
- ▶ Tighten box nut **1** with special wrench 1020852 according to tightening instruction.
- ▶ Tighten box nut **5** with special wrench 10289118 according to tightening instruction.
- ▶ Tighten box nut **2** with special wrench 1020852 according to tightening instruction.

3.5.7 Removing and installing the injection pipes

Removing the injection pipes

Representation	Description	Required number	Part number
	Special wrench width across flats 19 for injection pipes	1	10289118

Tab. 67: Special tool

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Protecting caps are present. (For more information see: 4.1.2 Locking pieces, page 502.)
- ❑ Pressure in fuel system has been relieved. (For more information see: 3.5.5 Reducing the pressure in the fuel system, page 209.)
- ❑ Fuel supply is closed, see documentation from the device manufacturer.
- ❑ For removal of right injection pipes, the ventilation line from exhaust gas turbocharger to expansion tank is removed. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)

NOTICE
Leaky injection pipes!

- ▶ Mark box nut with a center punch each time it is released.
- ▶ Replace injection pipes with two marks per box nut.

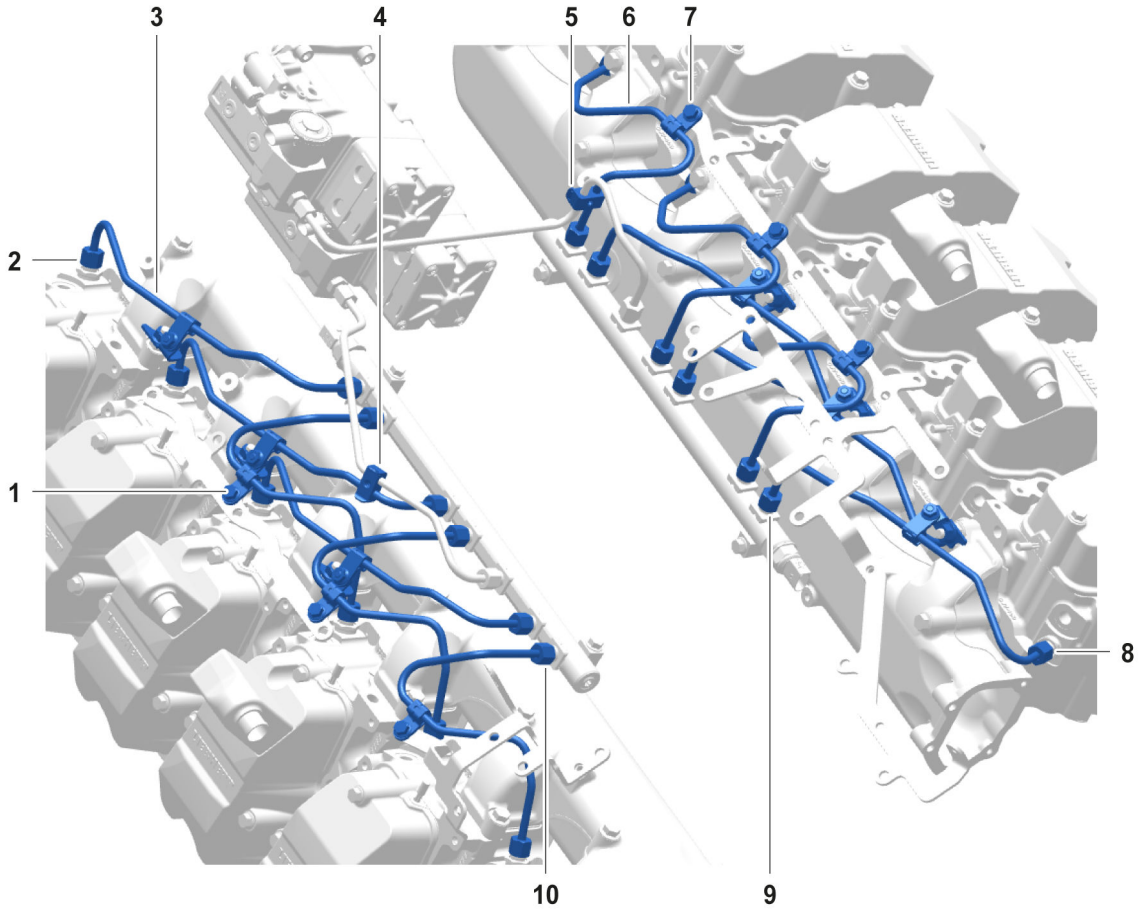


Fig. 269: Injection pipes

1 Holding clamp (6x)
2 Box nut on right pressure pipe socket (6x)
3 Right injection pipe (6x)
4 Holding clamp
5 Holding clamp
6 Left injection pipe (6x)
7 Holding clamp (6x)
8 Box nut on left pressure pipe socket (6x)
9 Box nut on left fuel rail (6x)
10 Box nut on right fuel rail (6x)

▶ Remove holding clamp **5**.

▶ Remove holding clamps **7**.

▶ Remove holding clamp **4**.

▶ Remove holding clamps **1**.

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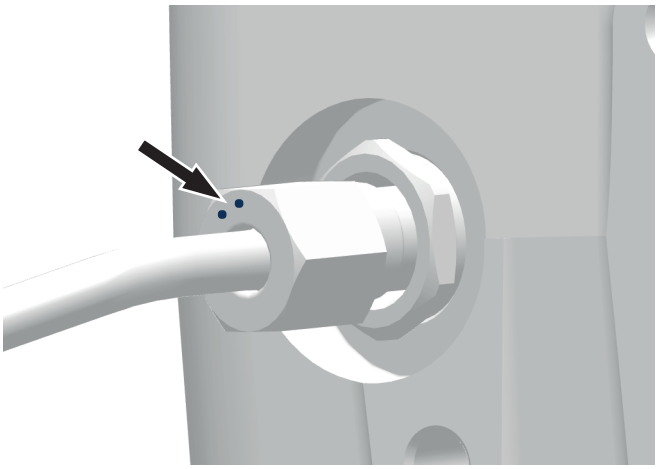

Fig. 270: Center punches

▶ Check the number of center punches per box nut.

If two center punches are present:
▶ Replace injection pipes. (see: fig. 270, page 215)

If less than two center punches are present:
▶ Mark box nut with a center punch. (see: fig. 270, page 215)

▶ Unscrew box nuts on left pressure pipe socket **8** with special wrench 10289118.

▶ Unscrew box nuts on left fuel rail **9** with special wrench 10289118.

▶ Remove left injection pipes **6**.

▶ Seal openings on left injection pipes **6** with protecting caps.

▶ Seal openings of pressure pipe socket with protecting caps.

▶ Seal openings of fuel rail with protecting caps.

▶ Unscrew box nuts on right pressure pipe socket **2** with special wrench 10289118.

▶ Unscrew box nuts on right fuel rail **10** with special wrench 10289118.

▶ Remove right injection pipes **3**.

▶ Seal openings on right injection pipes **3** with protecting caps.

▶ Seal openings of pressure pipe socket with protecting caps.

▶ Seal openings of fuel rail with protecting caps.

Checking the injection pipes

▶ Check injection pipes for damage and replace if necessary.

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Installing the injection pipes

Representation	Description	Required number	Part number
	Special wrench width across flats 19 for injection pipes	1	10289118

Tab. 68: Special tool

NOTICE
Leaky injection pipes!

- ▶ Tighten injection pipes a maximum of three times according to tightening instruction.
- ▶ Install injection pipes free of stress and friction.

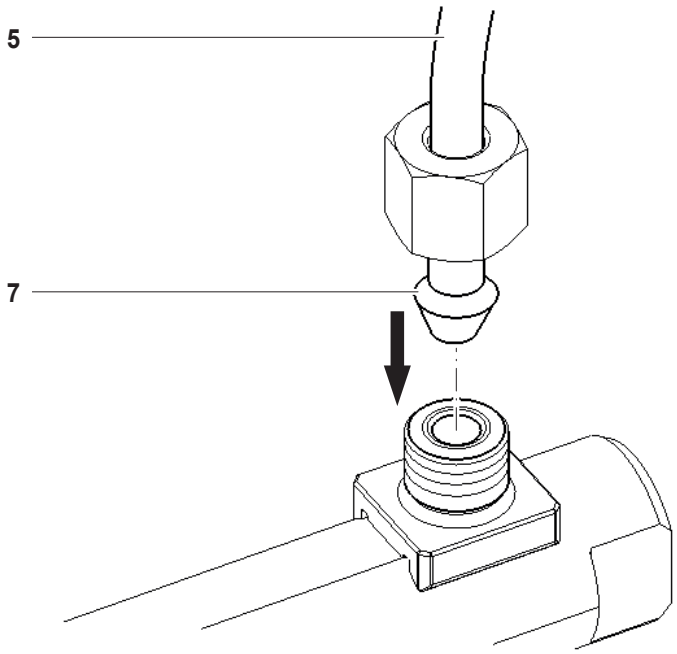

Fig. 272: Installing the injection pipe

5 Injection pipe **7** Cone

- ▶ Remove protecting caps.
- ▶ Press cones **7** of injection pipe **5** on corresponding connection stub.

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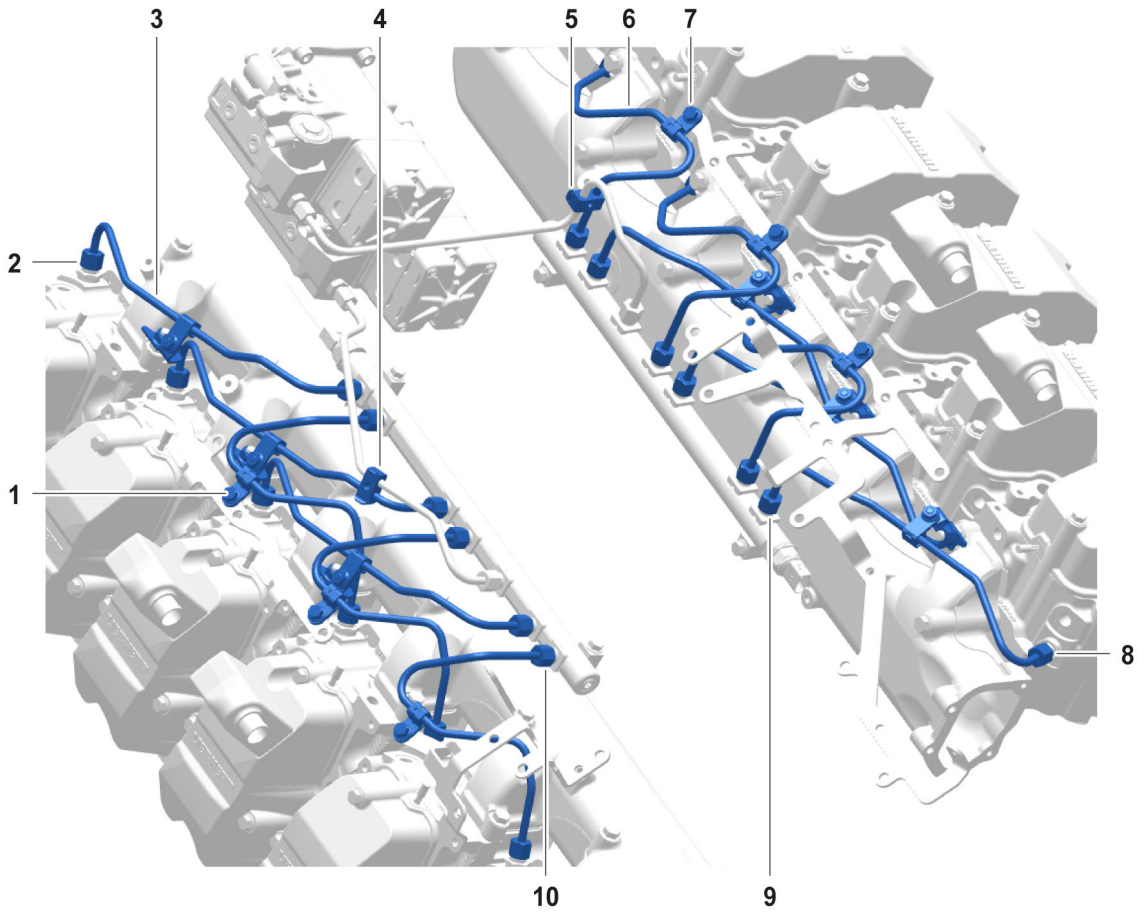

Fig. 273: Injection pipes

1	Holding clamp (6x)	**6**	Left injection pipe (6x)
2	Box nut on right pressure pipe socket (6x)	**7**	Holding clamp (6x)
3	Right injection pipe (6x)	**8**	Box nut on left pressure pipe socket (6x)
4	Holding clamp	**9**	Box nut on left fuel rail (6x)
5	Holding clamp	**10**	Box nut on right fuel rail (6x)

- ▶ Screw on box nuts on right fuel rail **10** lightly.
- ▶ Screw on box nuts on right pressure pipe socket **2** lightly.
- ▶ Screw on box nuts on left fuel rail **9** lightly.
- ▶ Screw on box nuts on left pressure pipe socket **8** lightly.
- ▶ Install holding clamps **1**.
- ▶ Install holding clamp **4**.
- ▶ Install holding clamps **7**.
- ▶ Install holding clamp **5**.

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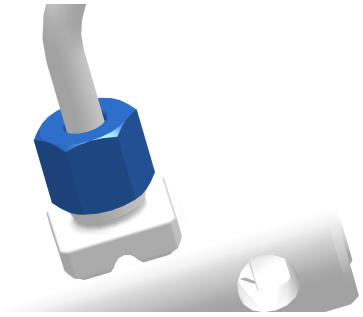
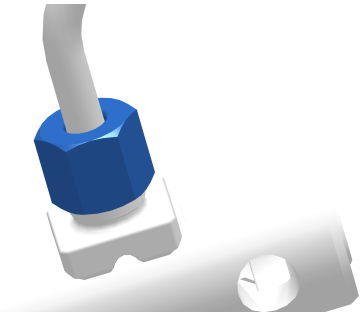
Tightening instruction for box nut (initial assembly)		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable a maximum of two times	
Stage	**Tightening torque**	
1.	15 Nm	
Stage	**Angle of rotation**	
2	60°	

Tab. 69: Tightening instruction 12480200-002

Tightening instruction for box nut (second assembly (one center punch) / third assembly (two center punches))		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable a maximum of two times	
Stage	**Tightening torque**	
1.	15 Nm	
Stage	**Angle of rotation**	
2	30°	

Tab. 70: Tightening instruction 12480200-002

- ▶ Tighten box nuts on right fuel rail **10** with special wrench 10289118 according to tightening instruction.
- ▶ Tighten box nuts on right pressure pipe socket **2** with special wrench 10289118 according to tightening instruction.
- ▶ Tighten box nuts on left fuel rail **9** with special wrench 10289118 according to tightening instruction.
- ▶ Tighten box nuts on left pressure pipe socket **8** with special wrench 10289118 according to tightening instruction.

3.5.8 Removing and installing the fuel rails

Removing the fuel rails

Make sure that the following prerequisites are met:
- ❑ A collection container for escaping fuel is available.
- ❑ Injection pipes are removed from fuel rails. (For more information see: Removing the injection pipes, page 213.)
- ❑ Fuel injection pipes are removed. (For more information see: Removing the fuel injection pipes, page 209.)

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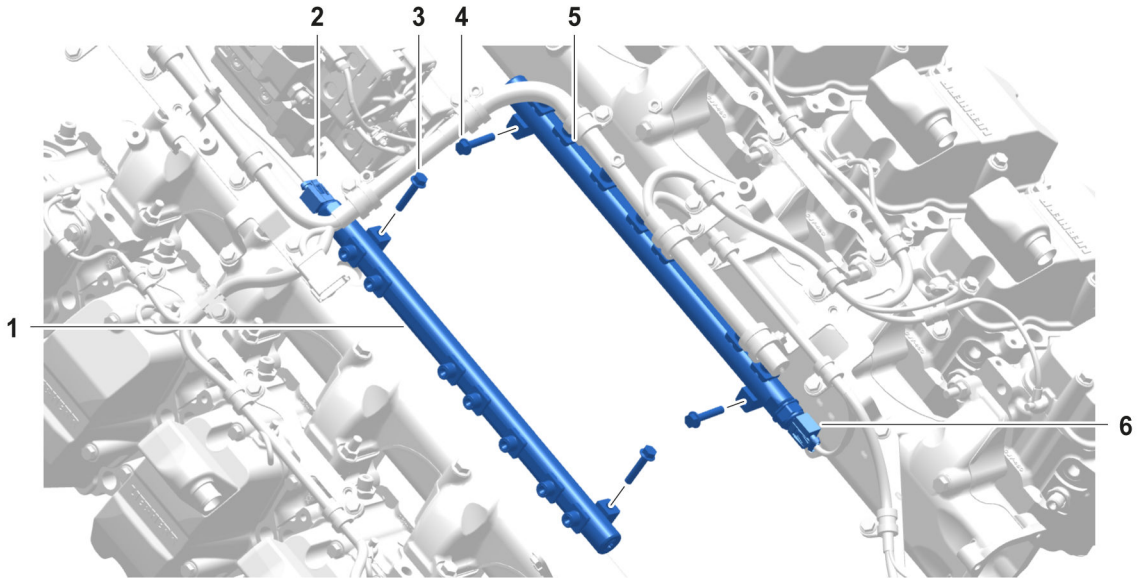


Fig. 276: Fuel rails

1	Right fuel rail	**4**	Hex head screw (2x)
2	Right rail pressure sensor electrical plug connection	**5**	Left fuel rail
3	Hex head screw (2x)	**6**	Left rail pressure sensor electrical plug connection

- ▶ Disconnect left rail pressure sensor electrical plug connection **6**.
- ▶ Unscrew hex head screw **4**.
- ▶ Remove left fuel rail **5**.
- ▶ Disconnect right rail pressure sensor electrical plug connection **2**.
- ▶ Unscrew hex head screw **3**.
- ▶ Remove right fuel rail **1**.

Installing the fuel rails

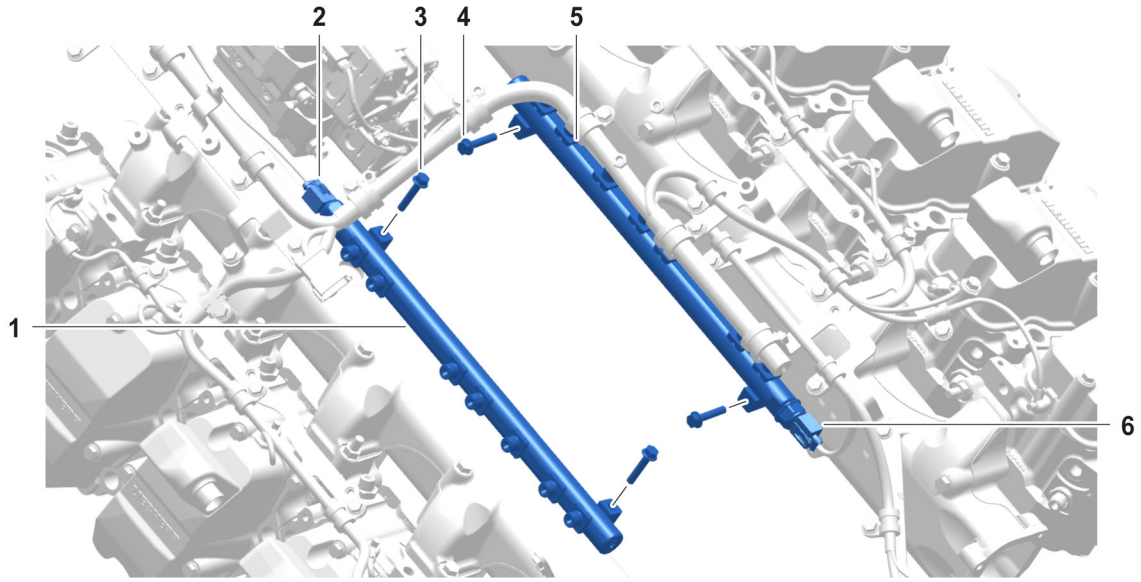


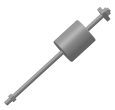
Fig. 277: Fuel rails

1	Right fuel rail	**4**	Hex head screw (2x)
2	Right rail pressure sensor electrical plug connection	**5**	Left fuel rail
3	Hex head screw (2x)	**6**	Left rail pressure sensor electrical plug connection

- ▶ Install right fuel rail **1** on air intake manifold.
- ▶ Tighten hex head screws **3**.
- ▶ Connect right rail pressure sensor electrical plug connection **2** to rail pressure sensor.
- ▶ Install left fuel rail **5** on air intake manifold.
- ▶ Tighten hex head screws **4**.
- ▶ Connect left rail pressure sensor electrical plug connection **6** to rail pressure sensor.

3.5.9 Removing and installing the pressure pipe socket and injector

Removing the pressure pipe socket and injector

Representation	Description	Required number	Part number
	Extraction device	1	0524072
	Adapter for extraction device 0524072	1	12440945

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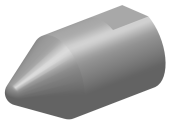
Representation	Description	Required number	Part number
	Extraction device for injector	1	11355589
	Assembly tool for injector (centering aid)	1	10153847
	Replacement tip for assembly tool for injector [10153847]	As needed	10148425

Tab. 71: Special tool

Make sure that the following prerequisites are met:
- ❑ Protecting caps are present. (For more information see: 4.1.2 Locking pieces, page 502.)
- ❑ Cylinder head cover is removed. (For more information see: Removing the cylinder head cover, page 57.)
- ❑ Injection pipe is removed. (For more information see: Removing the injection pipes, page 213.)

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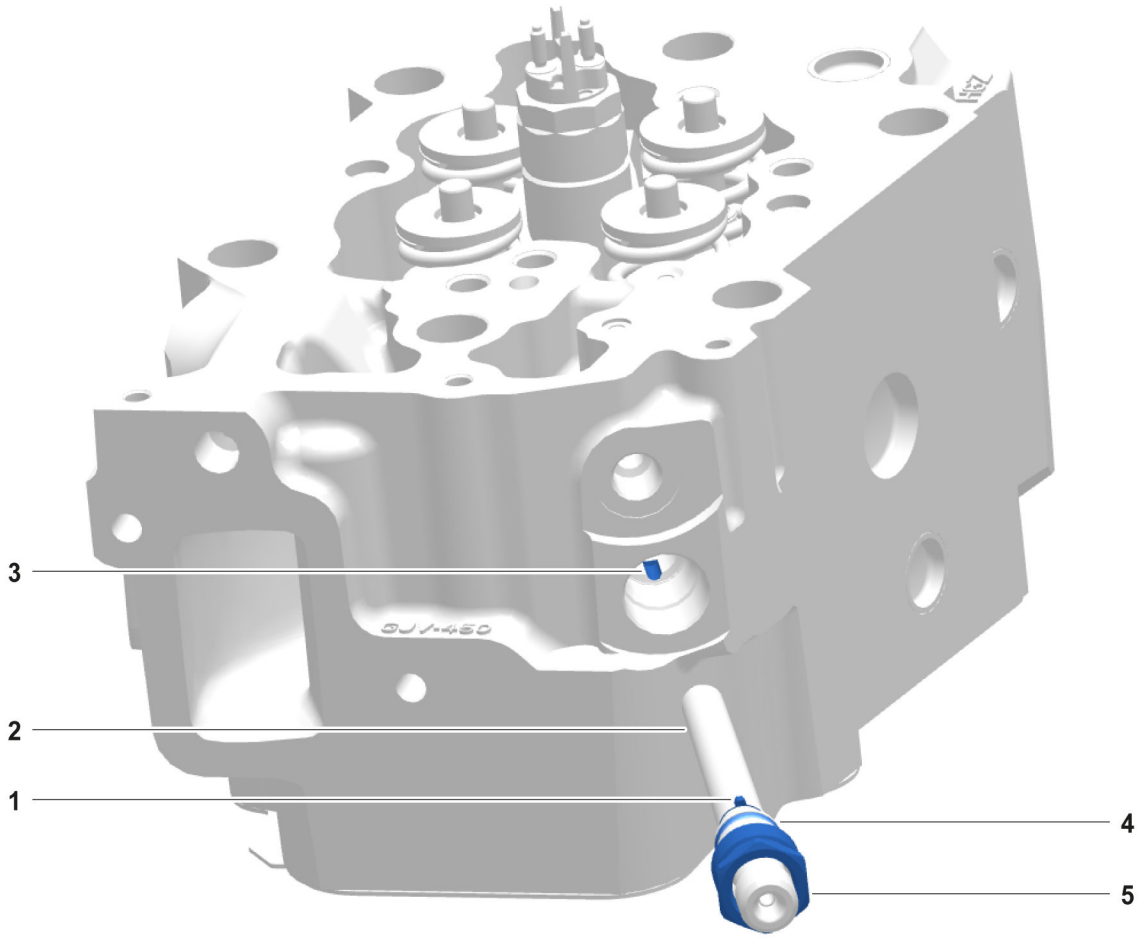

Fig. 283: Pressure pipe socket

1 Centering lug
2 Pressure pipe socket
3 Recess
4 O-ring
5 Box nut

▶ Unscrew box nut **5**.

▶ Remove pressure pipe socket **2**.

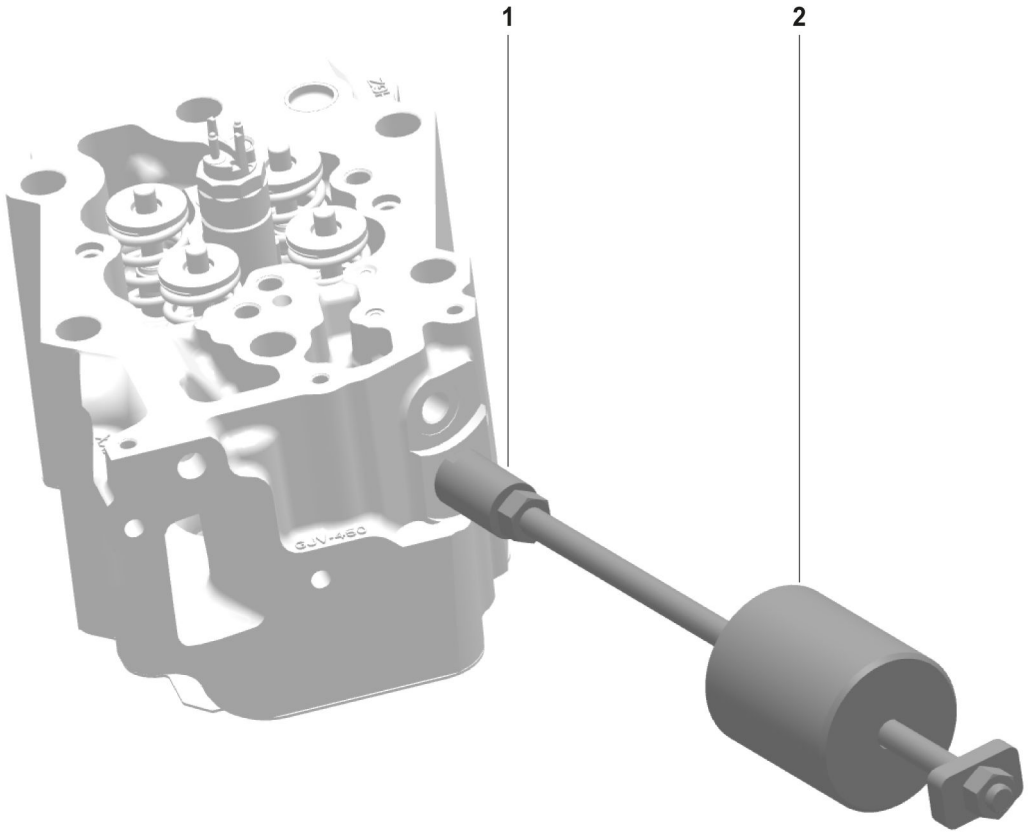

Fig. 284: Pressure pipe socket with adapter and impact extractor

1 Adapter **2** Impact extractor

If the pressure pipe socket cannot be released by hand:

- ▶ Install the adapter **1** and impact extractor **2**.
- ▶ Remove pressure pipe socket.
- ▶ Seal hole in cylinder head.

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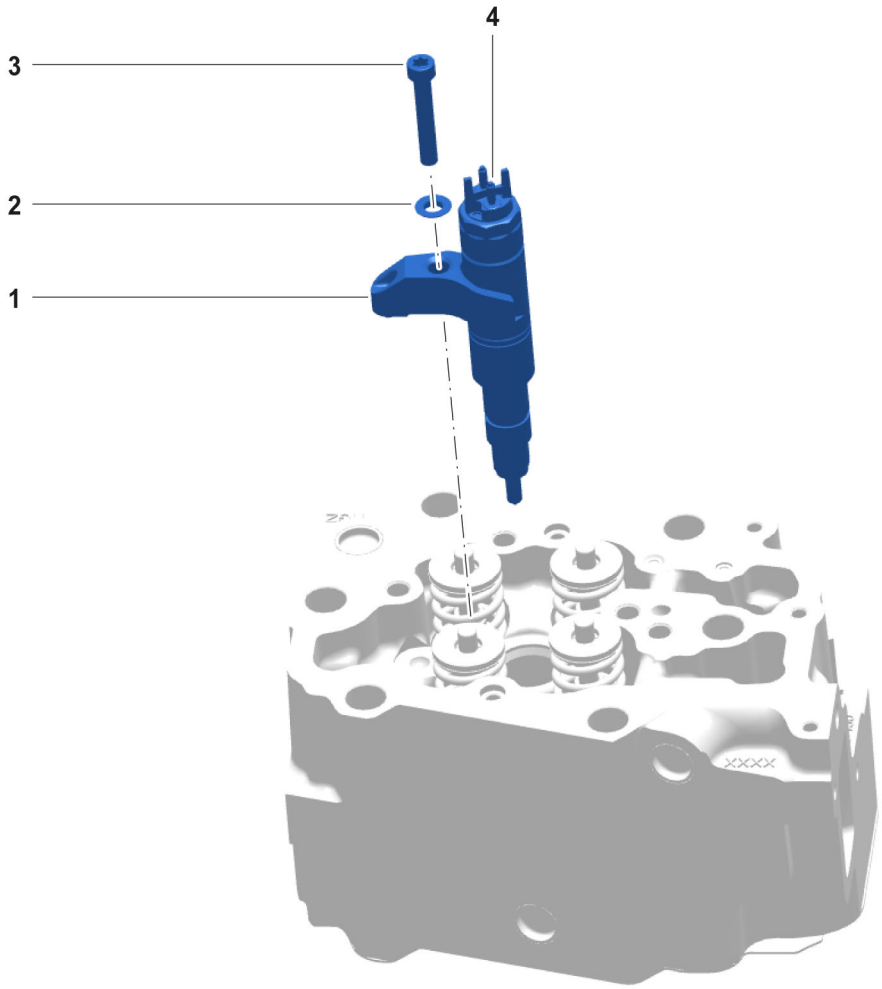

Fig. 285: Injector

1 Injector clamp
2 Spherical washer
3 Hexagon socket screw
4 Injector

▶ Unscrew hexagon socket screw **3**.

▶ Remove spherical washer **2**.

▶ Remove injector **4** and injector clamp **1** from cylinder head with extraction device for injector and impact extractor. (see: tab. 71, page 220)

▶ If necessary, remove injector clamp **1**.

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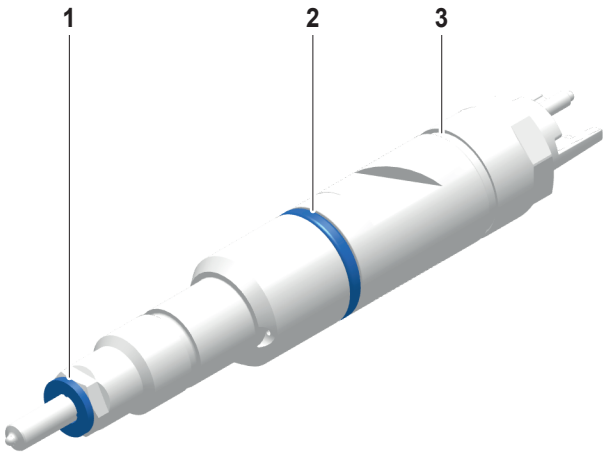

Fig. 286: Injector

1 Sealing washer
2 O-ring
3 Injector

▶ Remove sealing washer **1**.

If sealing washer **1** is stuck in injector sleeve:
▶ Remove sealing washer **1**.

If the injector sleeve is damaged:
▶ Replace cylinder head.

▶ Remove o-ring **2**.

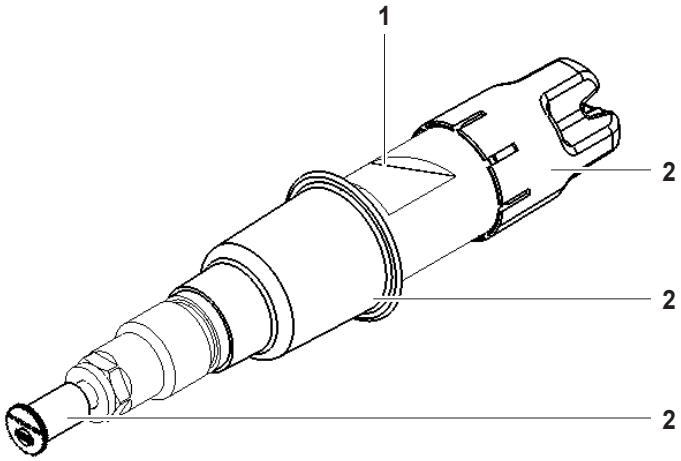

Fig. 287: Injector with covering caps kit

1 Injector
2 Covering caps

▶ Seal injector **1** with covering caps **2**.

▶ Seal hole in cylinder head.

Installing the pressure pipe socket and injector

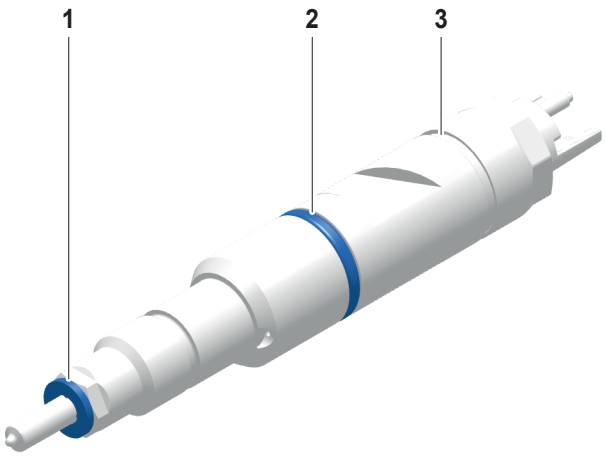

Fig. 288: Injector

1 Sealing washer
2 O-ring
3 Injector

▶ Install new o-ring **2**.

▶ Lubricate o-ring **2** with NBU 30 grease.

▶ Install new sealing washer **1**.

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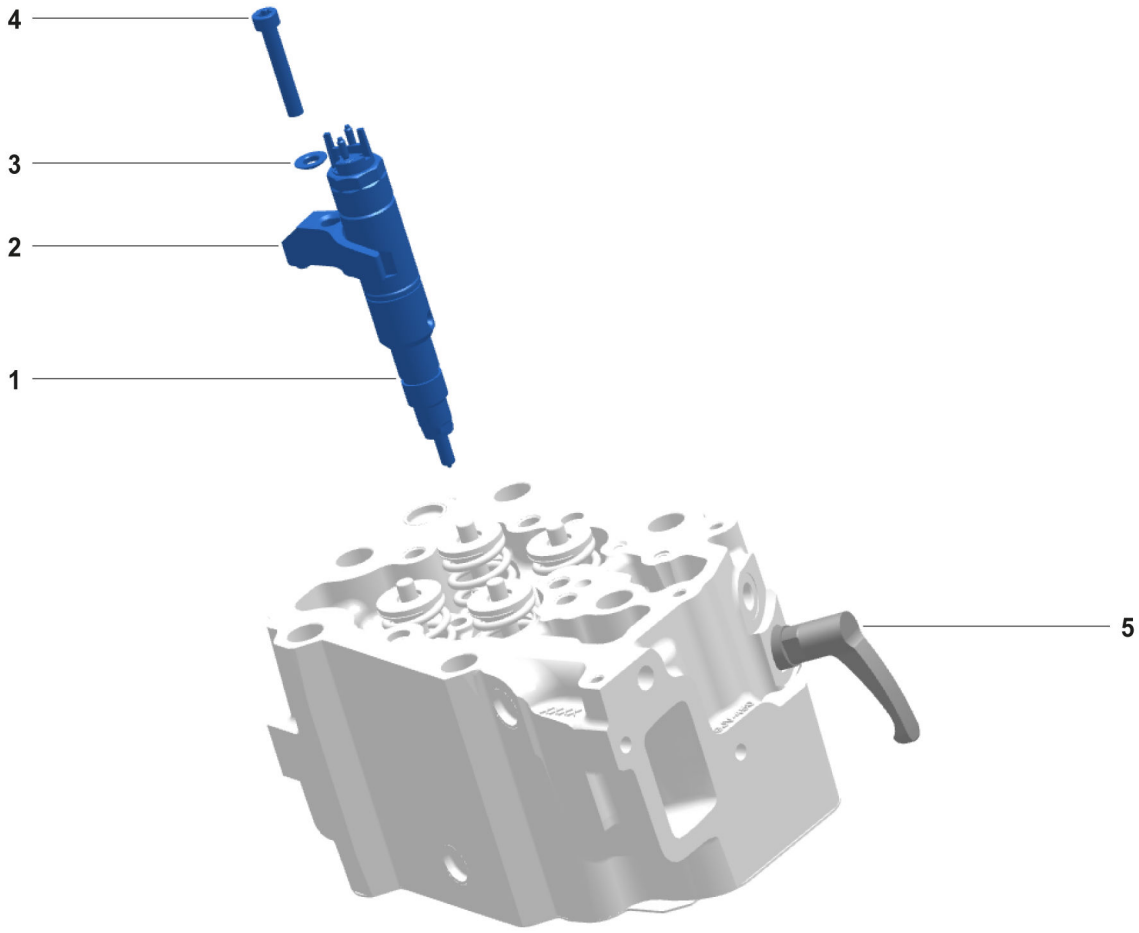

Fig. 289: Injector

1 Injector
2 Injector clamp
3 Spherical washer
4 Hexagon socket screw
5 Centering aid

- ▶ Install injector clamp **2** on injector **1**.
- ▶ Align injector **1**.
- ▶ Install injector **1** into cylinder head by hand.
- ▶ Remove closure from hole of pressure pipe socket.
- ▶ Insert centering aid **5** in hole of pressure pipe socket.
- ▶ Press lightly on face of centering aid **5**.
  ▷ The injector hole is centered.
- ▶ Align spherical washer **3**.

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Tightening instruction for hexagon socket screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	5 Nm	
2.	28 Nm	

Tab. 72: Tightening instruction 10129776-009

▶ Tighten hexagon socket screw **4** according to stage 1 of tightening instruction.

▶ Remove centering aid **5**.

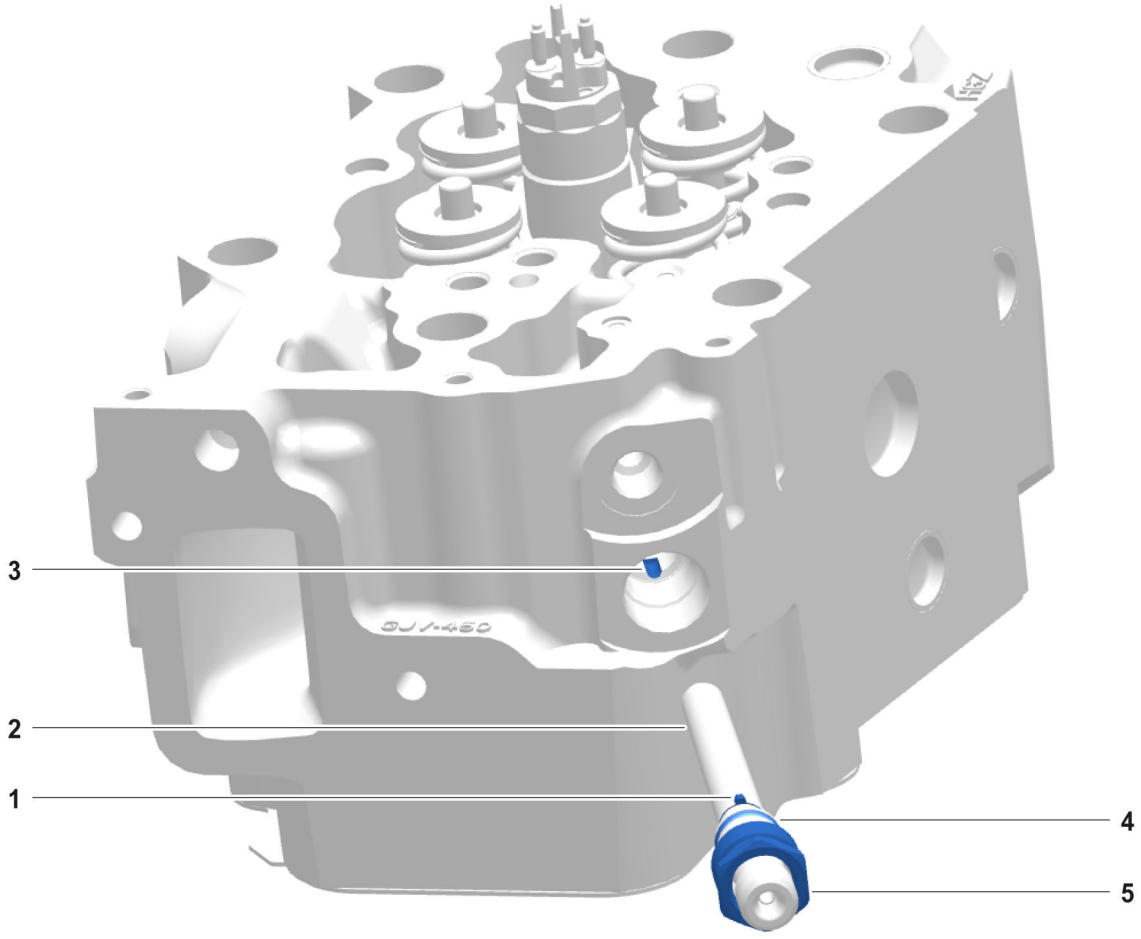
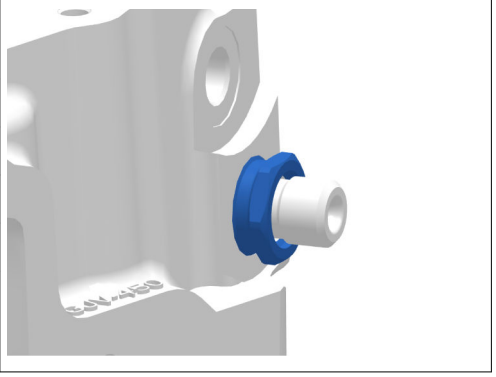


Fig. 291: Pressure pipe socket

1 Centering lug
2 Pressure pipe socket
3 Recess
4 O-ring
5 Box nut

▶ Lubricate new pressure pipe socket **2** with NBU 30 grease.

- ▶ Lubricate new o-ring **4** with NBU 30 grease.
- ▶ Install o-ring **4**.
- ▶ Align centering lugs **1** to recesses **3** in cylinder head.
- ▶ Install pressure pipe socket **2**.

Tightening instruction for box nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	5 Nm	
2.	35 Nm	

Tab. 73: Tightening instruction 10129776-009

- ▶ Tighten new box nut **5** according to stage 1 of tightening instruction.
- ▶ Tighten hexagon socket screw **4** according to stage 2 of tightening instruction. (see: tab. 72, page 228)
- ▶ Tighten box nut **5** according to stage 2 of tightening instruction.

3.5.10 Removing and installing the fuel filter module

Removing the fuel filter module

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Engine control unit fuel line to fuel fine filter is removed. (For more information see: Removing the engine control unit fuel line to the fuel fine filter, page 189.)
- ❑ Fuel fine filter fuel line to fuel high pressure pumps is removed. (For more information see: Removing the fuel fine filter fuel line to the fuel high pressure pumps, page 189.)
- ❑ Fuel return line from distributor block to fuel fine filter is removed. (For more information see: Removing the fuel return line from the distributor block to the fuel fine filter, page 198.)
- ❑ Fuel return lines from fuel high pressure pumps to fuel fine filter are removed. (For more information see: Removing the fuel return lines from the fuel high pressure pumps to the fuel fine filter, page 199.)

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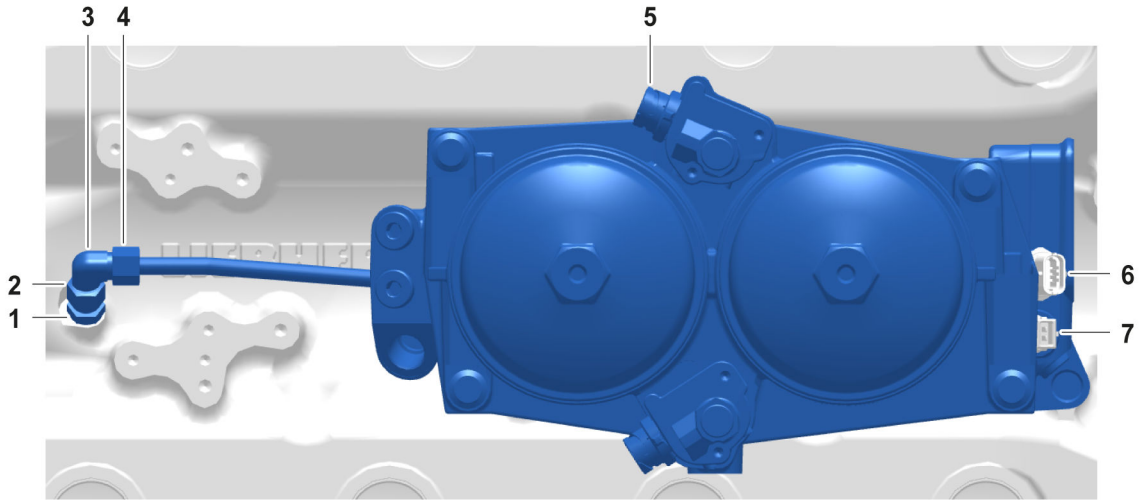

Fig. 293: Fuel filter module

1 Screw fitting
2 Box nut
3 Screw fitting
4 Box nut
5 Connection (2x)
6 Pressure sensor
7 Temperature sensor

- ▶ Disconnect electrical plug connection from pressure sensor **6**.
- ▶ Disconnect the electrical plug connection from the temperature sensor **7**.
- ▶ Remove lines from connections **5**.
- ▶ Unscrew box nut **2**.
- ▶ Unscrew box nut **4**.
- ▶ Remove screw fitting **3**.
- ▶ If necessary, unscrew screw fitting **1**.

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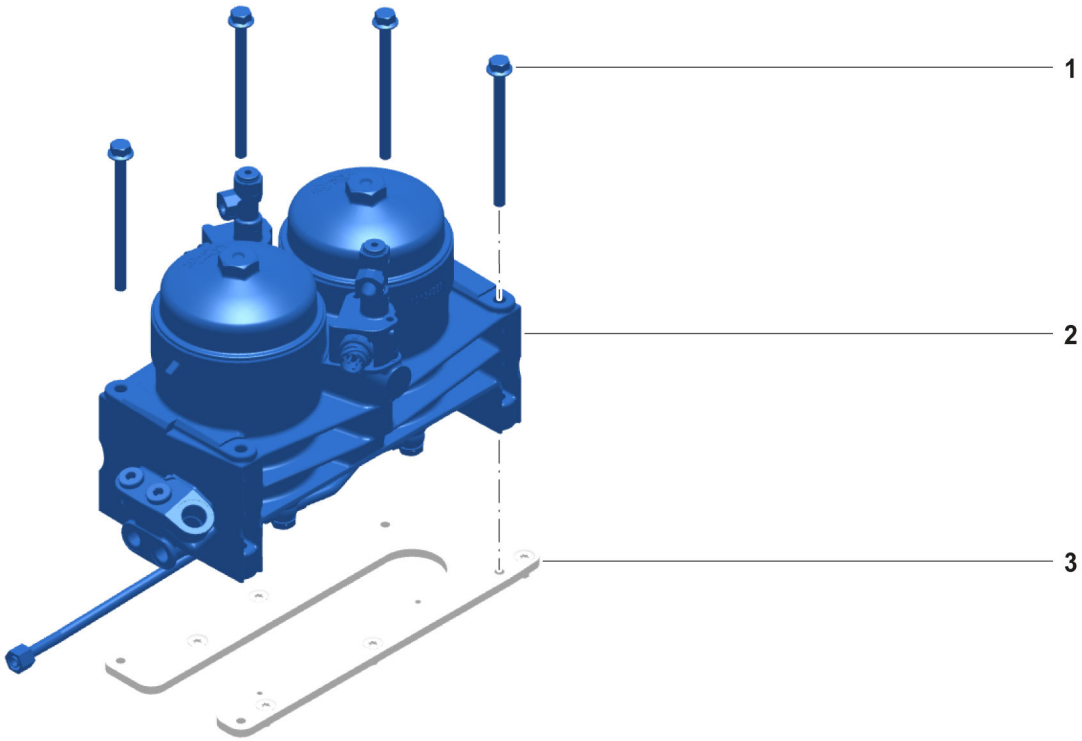

Fig. 294: Fuel filter module

1 Hex head screw (4x)
2 Fuel filter module
3 Console

▶ Unscrew hex head screws **1**.

▶ Remove fuel filter module **2**.

Removing the fuel line

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.
❑ Fuel filter module is removed. (For more information see: Removing the fuel filter module, page 229.)

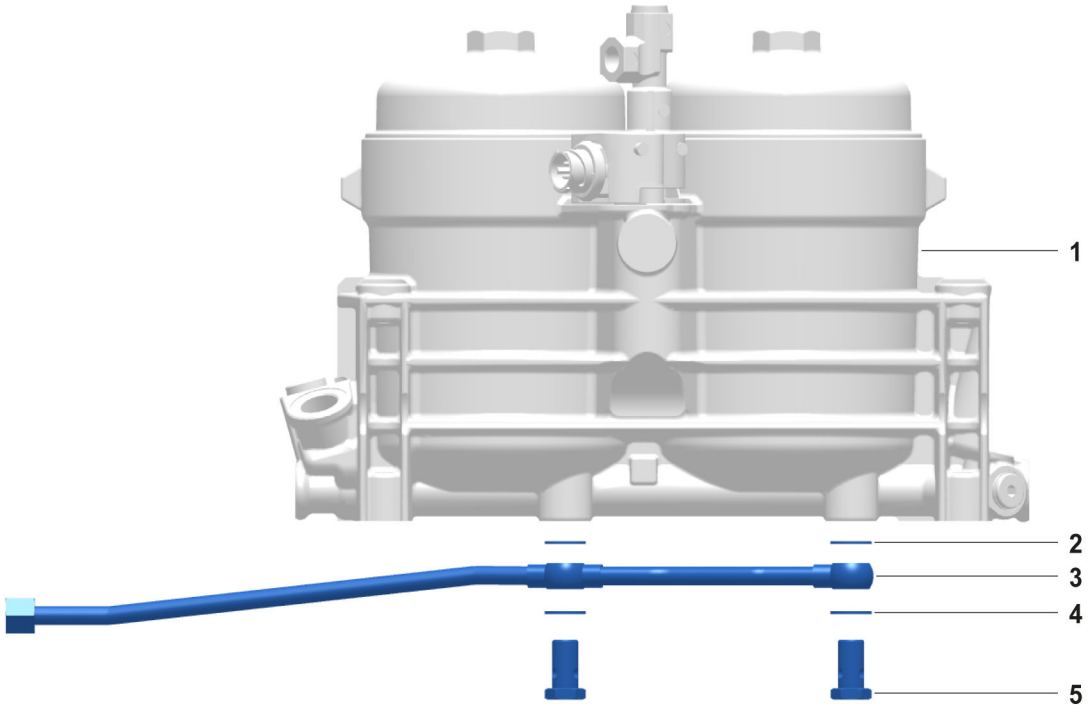

Fig. 295: Fuel line

1 Fuel filter module
2 Sealing ring (2x)
3 Fuel line
4 Sealing ring (2x)
5 Banjo bolt (4x)

▶ Unscrew banjo bolts **5**.

▶ Remove sealing rings **4**.

▶ Remove fuel line **3**.

▶ Remove sealing rings **2**.

▶ Seal openings on fuel line **3**.

▶ Seal openings on fuel filter module **1**.

Removing the pipeline

Make sure that the following prerequisites are met:
❑ A collection container for fuel is available.
❑ Fuel supply is closed, see documentation from the device manufacturer.

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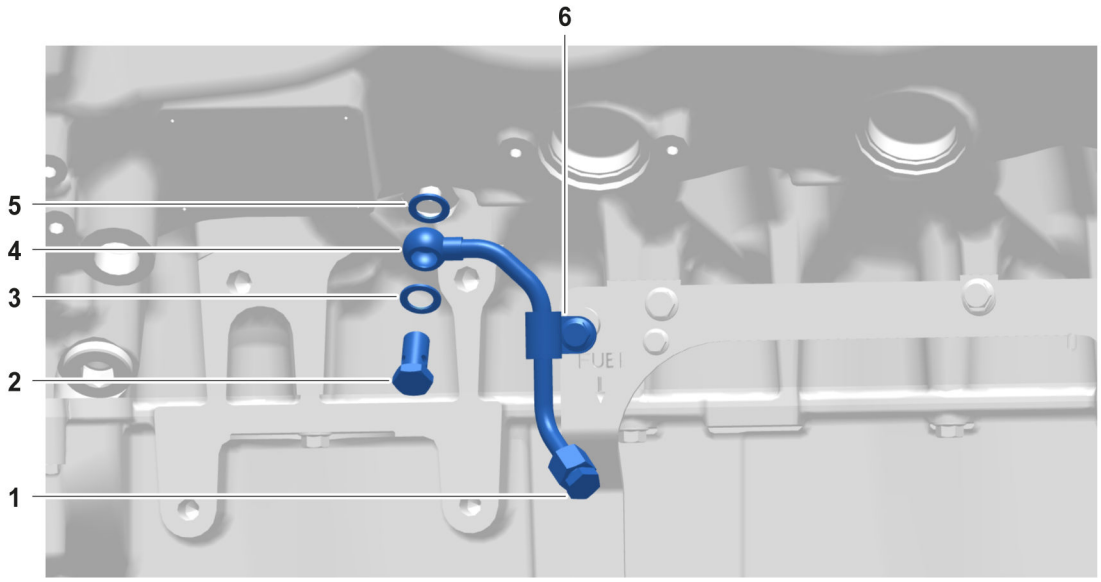

Fig. 296: Fuel line

1 Screw fitting
2 Banjo bolt
3 Sealing ring
4 Pipeline
5 Sealing ring
6 Holding clamp

- ▶ Remove holding clamp **6**.
- ▶ Unscrew banjo bolt **2**.
- ▶ Remove sealing ring **3**.
- ▶ Remove pipeline **4**.
- ▶ Remove sealing ring **3**.
- ▶ Seal opening on pipeline **4**.
- ▶ Seal openings on crankcase.
- ▶ If necessary, unscrew screw fitting **1**.

Removing the console

Make sure that the following prerequisites are met:
- ❑ Fuel filter module is removed. (For more information see: Removing the fuel filter module, page 229.)

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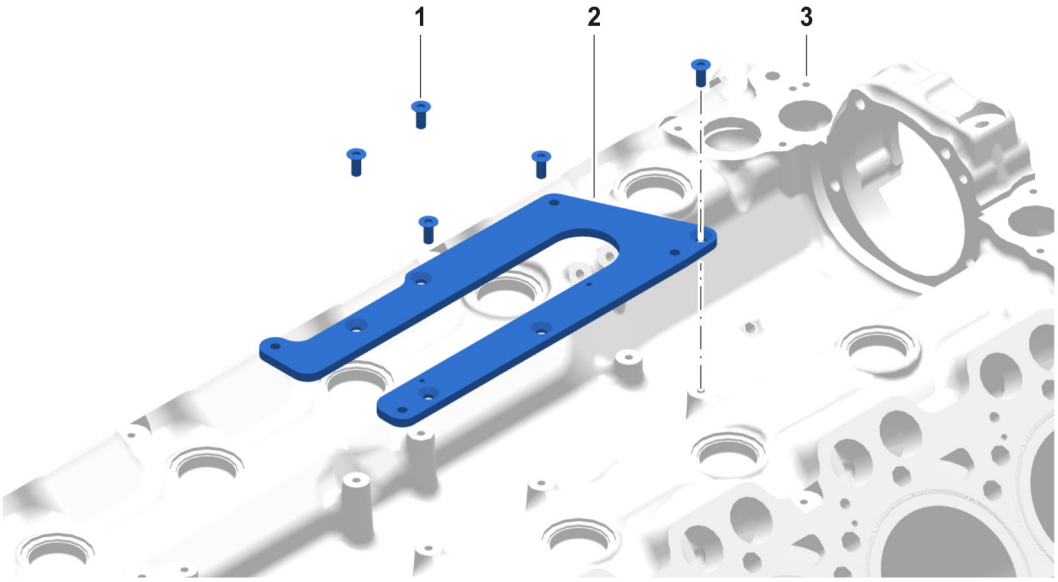

Fig. 297: Console

1 Countersunk screw (5x)
2 Console
3 Crankcase

▶ Unscrew countersunk screws **1**.

▶ Remove console **2**.

Checking and cleaning the fuel filter module

▶ Check fuel line for damage and replace if necessary.

▶ Check pipeline for damage and replace if necessary.

▶ Clean fuel filter module.

▶ Clean sealing surfaces of crankcase.

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Installing the console

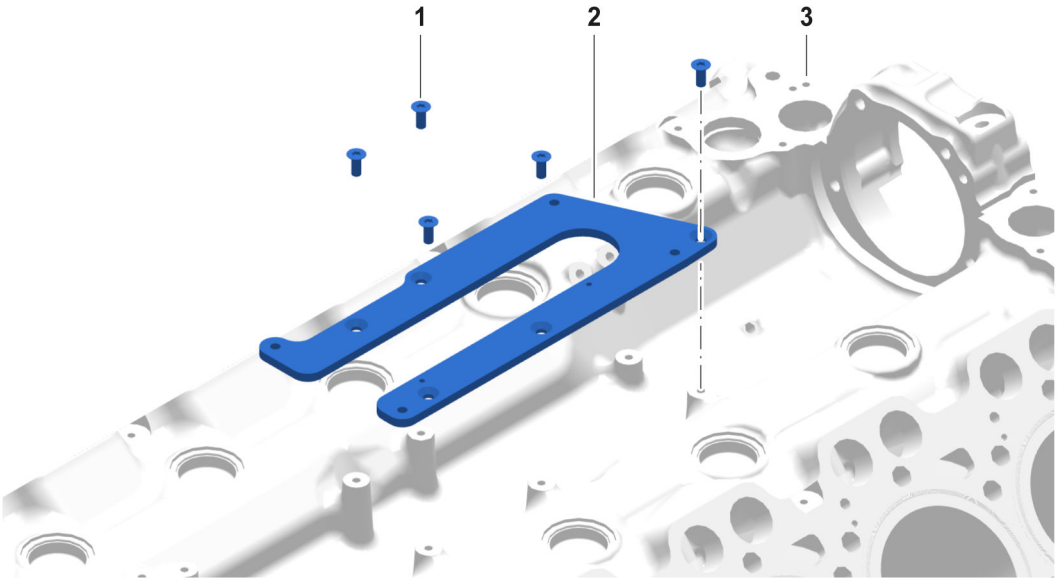

Fig. 298: Console

1 Countersunk screw (5x)
2 Console
3 Crankcase

▶ Align console **2**.

▶ Tighten countersunk screws **1**.

Installing the pipeline

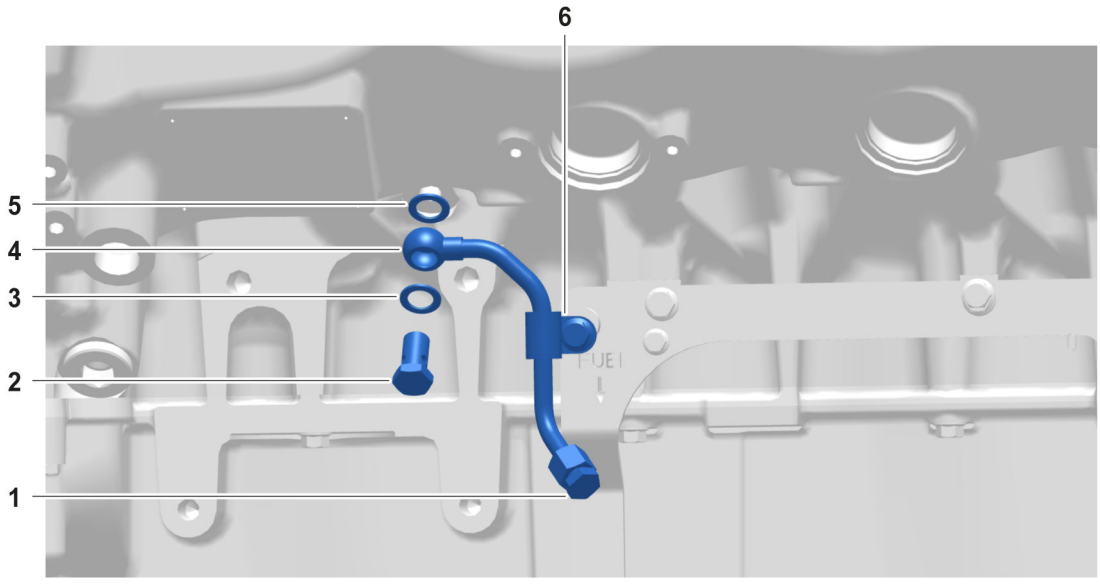

Fig. 299: Fuel line

1 Screw fitting
2 Banjo bolt
3 Sealing ring
4 Pipeline
5 Sealing ring
6 Holding clamp

▶ Tighten screw fitting **1**.

- ▶ Remove closures from crankcase.
- ▶ Remove closures from pipeline **4**.
- ▶ Align new sealing ring **3**.
- ▶ Align pipeline **4**.
- ▶ Align new sealing ring **3**.
- ▶ Tighten banjo bolt **2**.
- ▶ Install holding clamp **6**.

Installing the fuel line

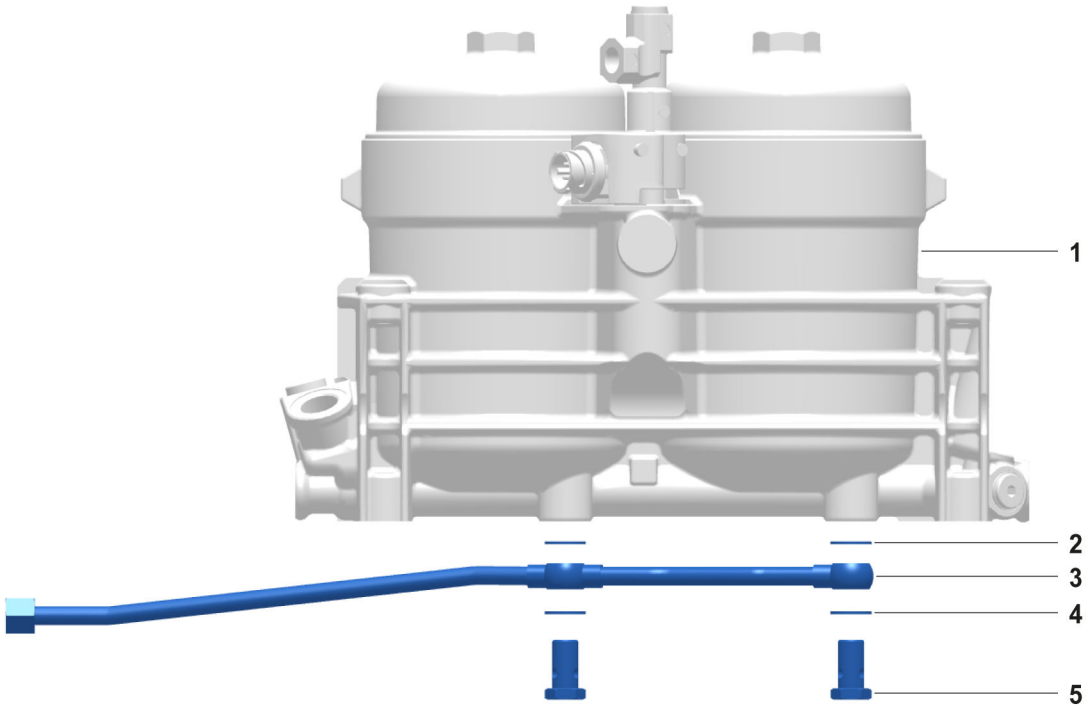

Fig. 300: Fuel line

1 Fuel filter module
2 Sealing ring (2x)
3 Fuel line
4 Sealing ring (2x)
5 Banjo bolt (4x)

- ▶ Remove closures from fuel filter module **1**.
- ▶ Remove closures from fuel line **3**.
- ▶ Align new sealing rings **2**.
- ▶ Align fuel line **3**.
- ▶ Align new sealing rings **4**.
- ▶ Tighten banjo bolts **5**.

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Installing the fuel filter module

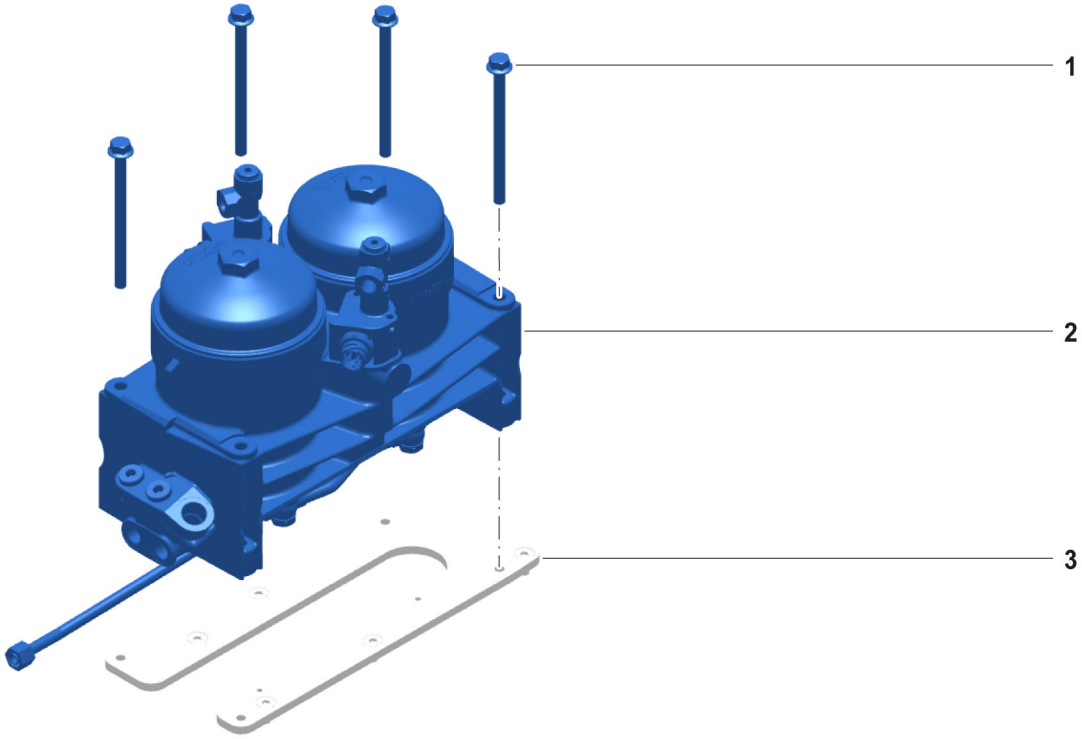

Fig. 301: Fuel filter module

1 Hex head screw (4x)
2 Fuel filter module
3 Console

▶ Align fuel filter module **2**.

▶ Tighten hex head screws **1**.

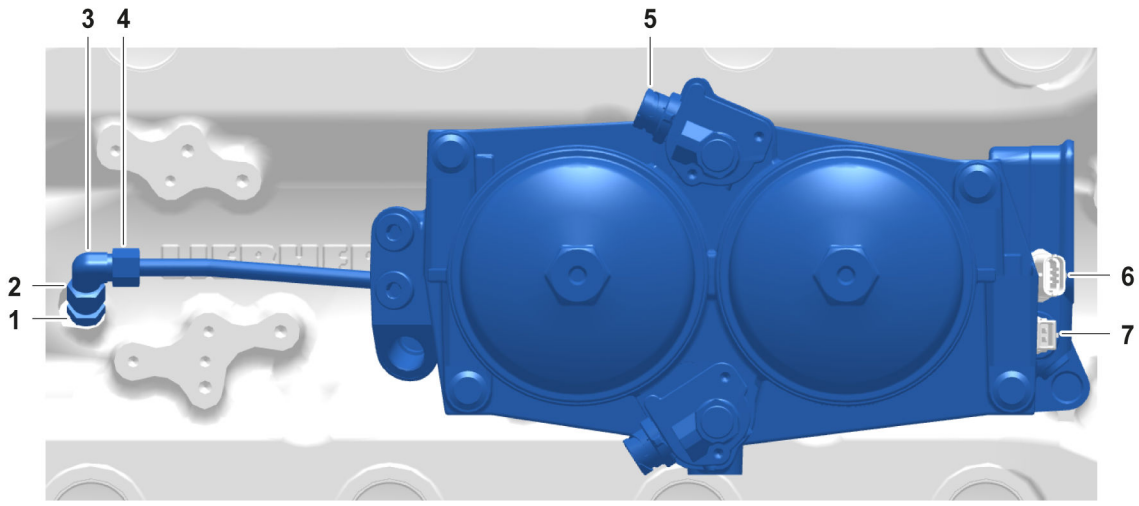

Fig. 302: Fuel filter module

1 Screw fitting
2 Box nut
5 Connection (2x)
6 Pressure sensor

See next page for continuation of the image legend

3 Screw fitting
4 Box nut
7 Temperature sensor

▶ Tighten screw fitting **1**.

▶ Align screw fitting **3**.

▶ Tighten box nut **4**.

▶ Tighten box nut **2**.

▶ Install lines on connections **5**.

▶ Install electrical plug connection on temperature sensor **7**.

▶ Install electrical plug connection on pressure sensor **6**.

3.5.11 Fuel high pressure pump

Removing and installing the fuel high pressure pumps

Removing the fuel high pressure pumps

Make sure that the following prerequisites are met:
- ❑ Cylinder 1 is in ignition TDC position. (For more information see: Setting cylinder 1 to ignition TDC, page 69.)
- ❑ A collection container for fuel is available.
- ❑ Device fuel line to fuel high pressure pumps is removed. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel high pressure pump fuel line to engine control unit is removed. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel fine filter fuel line to fuel high pressure pumps is removed. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel return lines from fuel high pressure pumps to fuel fine filter are removed. (For more information see: Removing the fuel return lines from the fuel high pressure pumps to the fuel fine filter, page 199.)
- ❑ Fuel injection pipes are removed. (For more information see: Removing the fuel injection pipes, page 209.)
- ❑ Cover of high pressure pump drive is removed. (For more information see: Removing the cover of the high pressure pump drive, page 256.)

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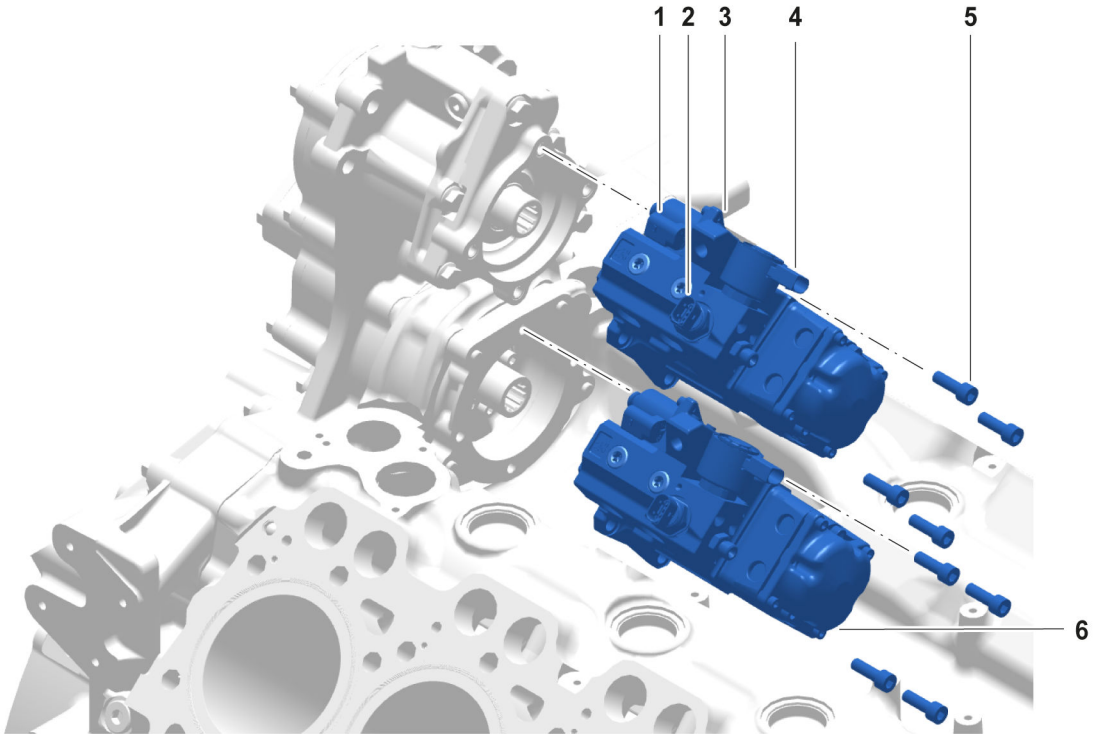

Fig. 303: Fuel high pressure pumps

1	Electrical plug connection of metering unit (2x)	**4**	Electrical plug connection of pressure control valve (2x)
2	Electrical plug connection of high pressure sensor (2x)	**5**	Socket head screw (8x)
3	Upper fuel high pressure pump	**6**	Lower fuel high pressure pump

- ▶ Clean area around upper fuel high pressure pump **2** and lower fuel high pressure pump **5**.
- ▶ Disconnect electrical plug connections of metering units **1**.
- ▶ Disconnect electrical plug connections of high pressure sensors **2**.
- ▶ Disconnect electrical plug connection of pressure control valves **4**.
- ▶ Unscrew socket head screws **5** from upper fuel high pressure pump **3**.
- ▶ Remove upper fuel high pressure pump **3**.
- ▶ Unscrew socket head screws **5** from lower fuel high pressure pump **6**.
- ▶ Remove lower fuel high pressure pump **6**.

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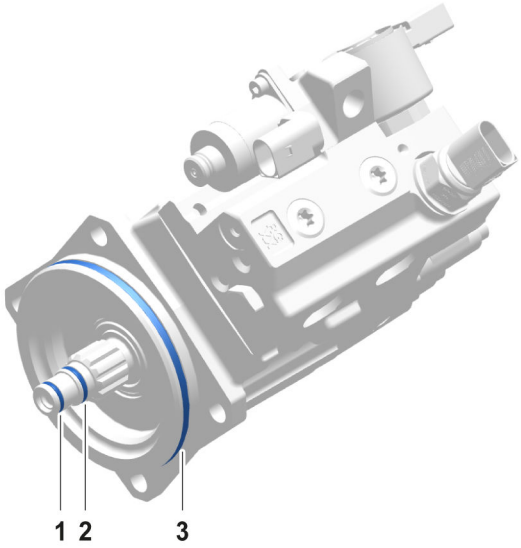

Fig. 304: Fuel high pressure pump o-rings

1 O-ring (2x)
2 O-ring (2x)
3 O-ring (2x)

▶ Remove o-rings **1**.

▶ Remove o-rings **2**.

▶ Remove o-rings **3**.

Cleaning the fuel high pressure pumps

▶ Clean contact surfaces on fuel high pressure pumps.

▶ Clean contact surfaces on high pressure pump drive.

▶ Clean all grooves on fuel high pressure pumps.

Installing the fuel high pressure pumps

Make sure that the following prerequisites are met:
❑ Cylinder 1 is in ignition TDC position. (For more information see: Setting cylinder 1 to ignition TDC, page 69.)

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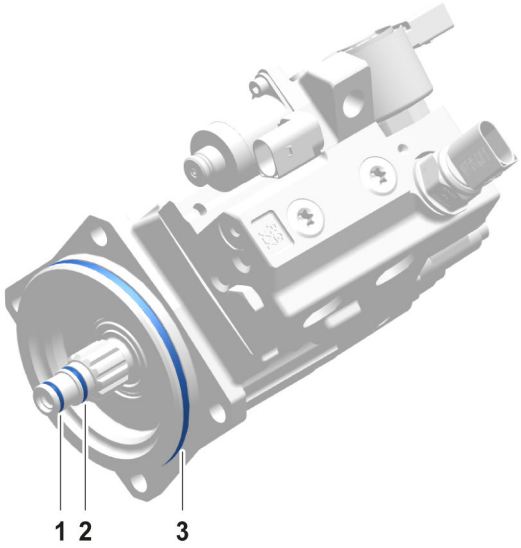

Fig. 305: Fuel high pressure pump o-rings

1 O-ring (2x)
2 O-ring (2x)
3 O-ring (2x)

- ▶ Lubricate new o-rings **3** with NBU 30 grease.
- ▶ Install o-rings **3**.
- ▶ Lubricate new o-rings **2** with NBU 30 grease.
- ▶ Install o-rings **2**.
- ▶ Lubricate new o-rings **1** with NBU 30 grease.
- ▶ Install o-rings **1**.

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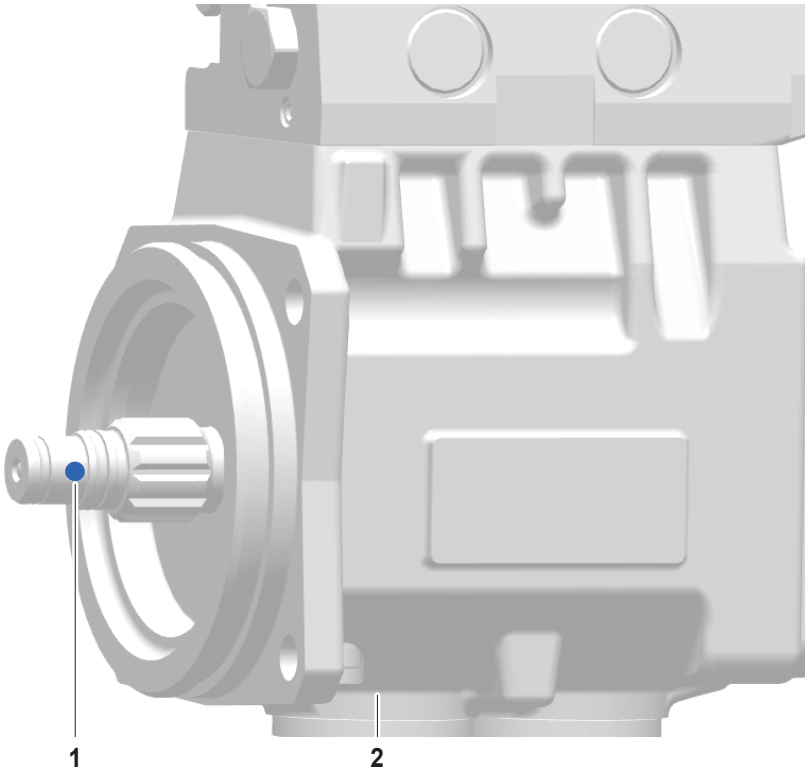

Fig. 306: Fuel high pressure pump oil inlet hole

1 Oil inlet hole (2x) **2** Fuel high pressure pump (2x)

▶ Align oil inlet holes **1** horizontally while fuel high pressure pumps **2** are standing upright.

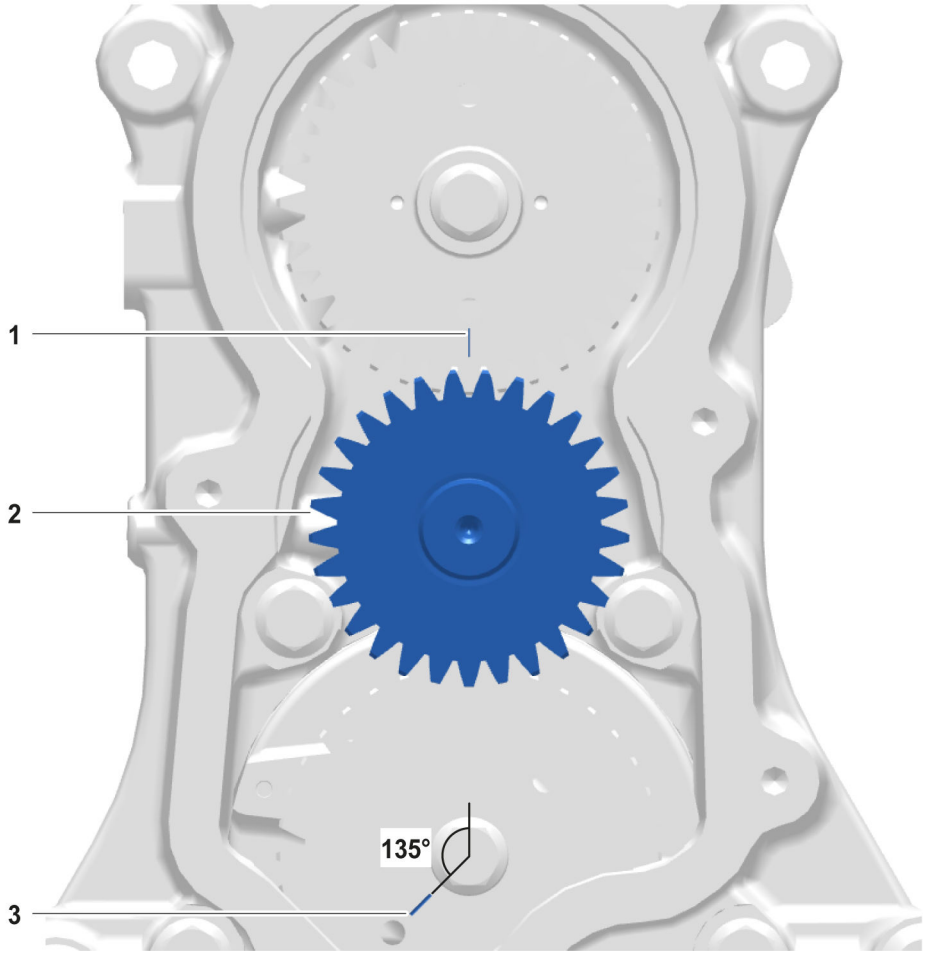

Fig. 307: Drive gears of high pressure pump drive

1 Mark of upper drive gear
2 Intermediate gear wheel
3 Mark of lower drive gear

▶ Remove intermediate gear wheel **2**.

▶ Align mark of upper drive gear **1** vertically down as shown.

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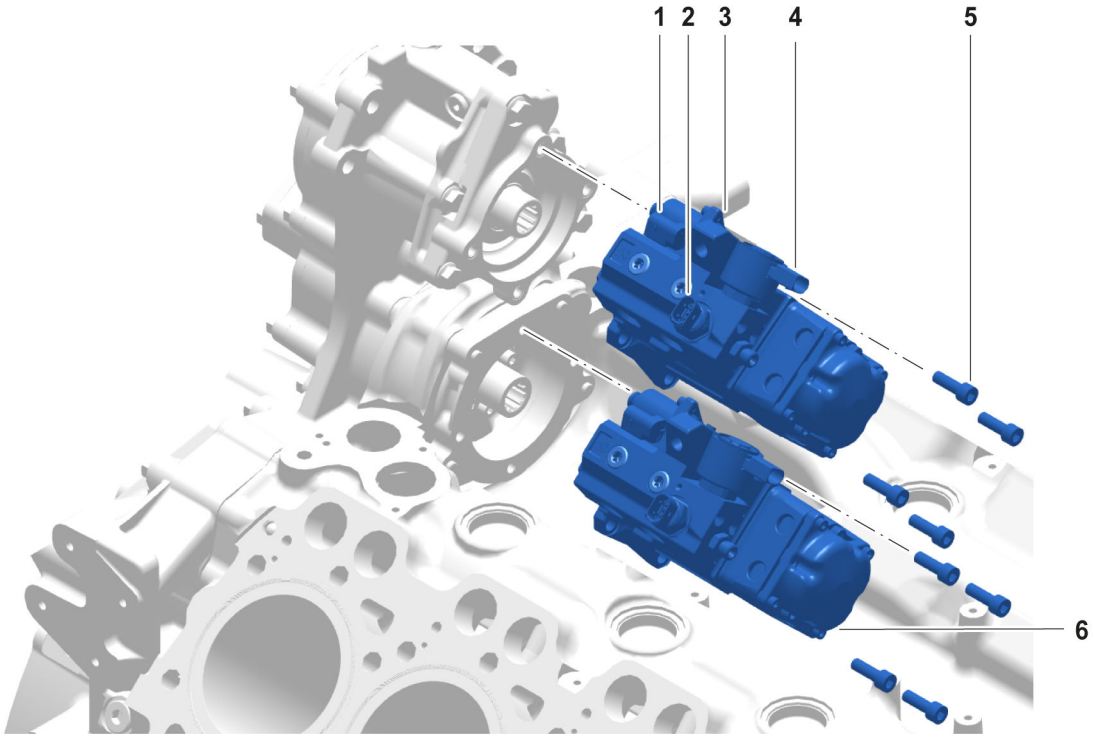
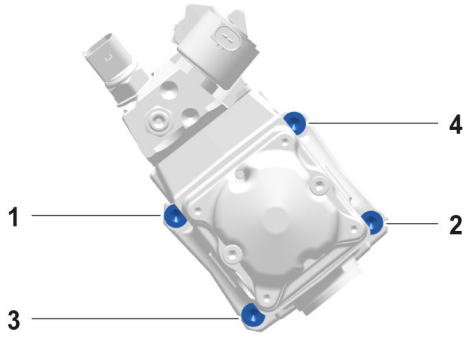


Fig. 308: Fuel high pressure pumps

1	Electrical plug connection of metering unit (2x)	**4**	Electrical plug connection of pressure control valve (2x)
2	Electrical plug connection of high pressure sensor (2x)	**5**	Socket head screw (8x)
3	Upper fuel high pressure pump	**6**	Lower fuel high pressure pump

▶ Install lower fuel high pressure pump **6** in high pressure pump drive at a 45° angle.

▶ Make sure that the upper gear wheel or pump shaft is not turned.

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	15 Nm	
2.	68 Nm	

Tab. 74: Tightening instruction 11433103-001

▶ Tighten socket head screws **5** according to tightening instruction.

▶ Install upper fuel high pressure pump **3** in high pressure pump drive at a 45° angle.

▶ Make sure that the lower gear wheel or pump shaft is not turned.

▶ Tighten socket head screws **5** according to tightening instruction.

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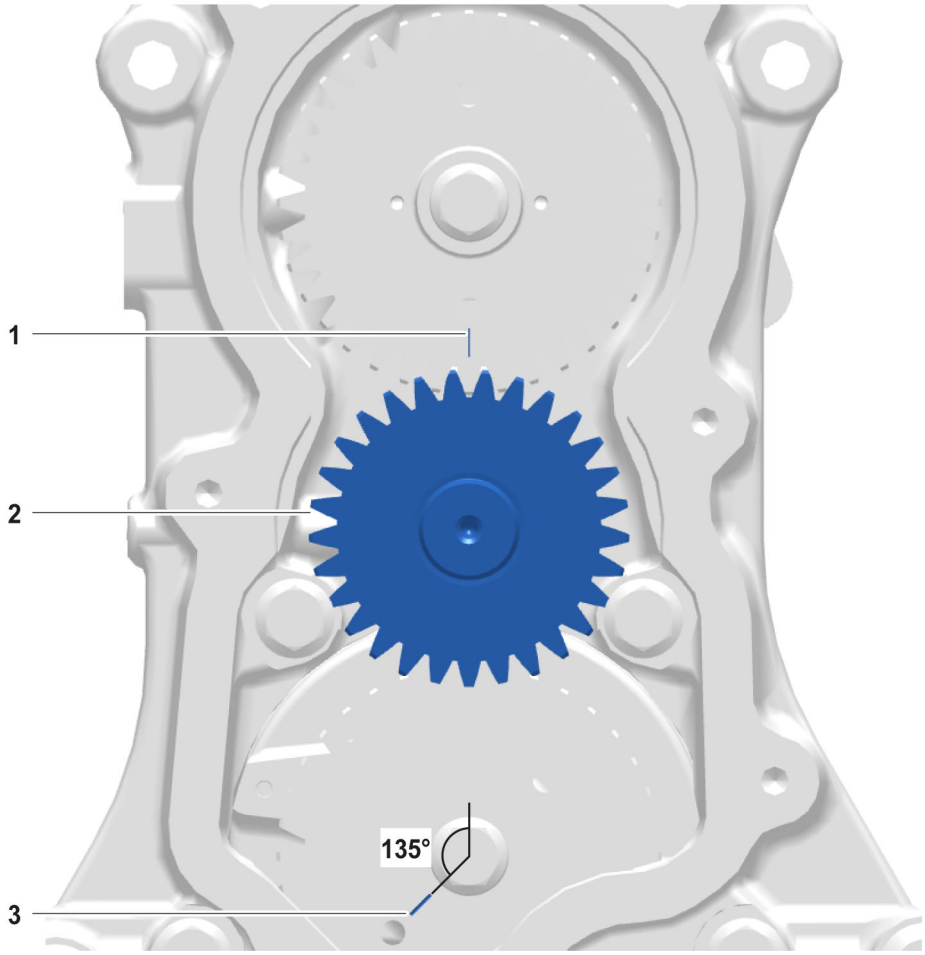

Fig. 310: Drive gears of high pressure pump drive

1 Mark of upper drive gear
2 Intermediate gear wheel
3 Mark of lower drive gear

▶ Turn crankshaft 90° in engine direction of rotation.
▷ Mark of lower drive gear **3** is turned 135° or 13 to 14 teeth.

▶ Install intermediate gear wheel **2**.

▶ Install cover of high pressure pump drive. (For more information see: Installing the cover of the high pressure pump drive, page 261.)

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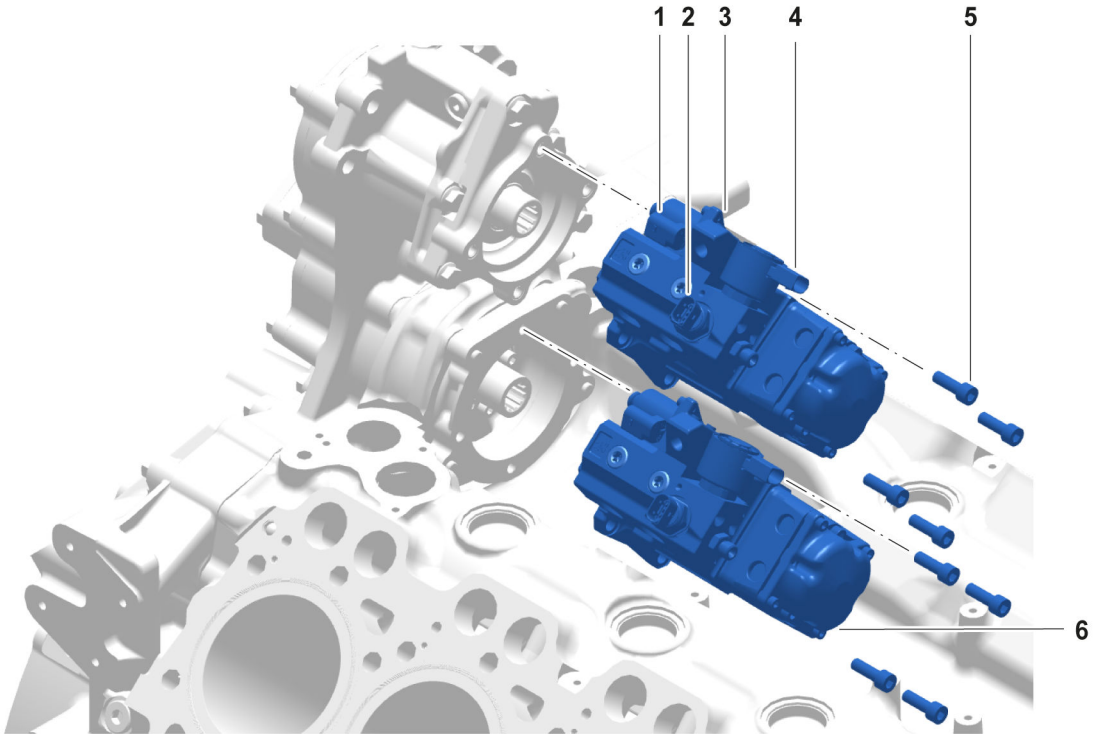

Fig. 311: Fuel high pressure pumps

1	Electrical plug connection of metering unit (2x)	**4**	Electrical plug connection of pressure control valve (2x)
2	Electrical plug connection of high pressure sensor (2x)	**5**	Socket head screw (8x)
3	Upper fuel high pressure pump	**6**	Lower fuel high pressure pump

▶ Connect electrical plug connections of metering units **1**.

▶ Connect electrical plug connections of high pressure sensors **2**.

▶ Connect electrical plug connections of pressure control valves **4**.

Removing and installing the fuel prefeeding pumps

Removing the fuel prefeeding pumps

Make sure that the following prerequisites are met:
- ❑ A collection container for fuel is available.
- ❑ Protecting caps are present. (For more information see: 4.1.2 Locking pieces, page 502.)
- ❑ Device fuel line to fuel high prefeeding pumps is removed from fuel prefeeding pumps. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel prefeeding pump fuel line to engine control unit is removed from fuel prefeeding pumps. (For more information see: Removing the fuel prefeeding pumps fuel line to the engine control unit, page 188.)

Note

Procedure for upper prefeeding pump and lower prefeeding pump is identical.

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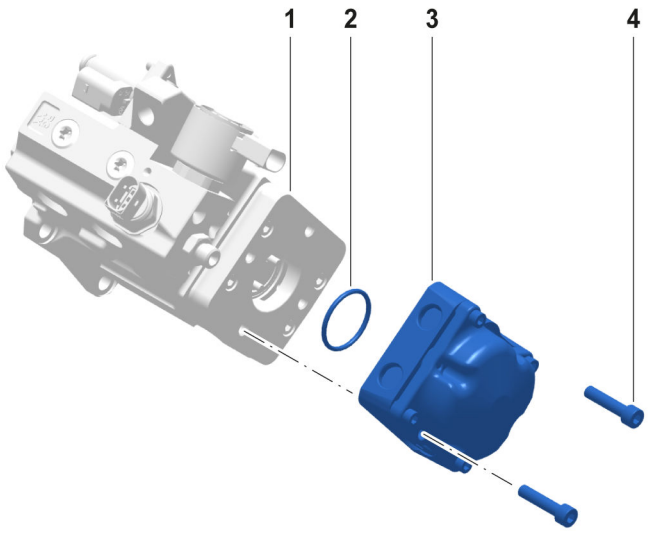

Fig. 312: Fuel prefeeding pump

1 Bearing flange
2 O-ring
3 Fuel prefeeding pump
4 Socket head screw (2x)

▶ Unscrew socket head screws **4**.

▶ Remove fuel prefeeding pump **3**.

▶ Remove o-ring **2**.

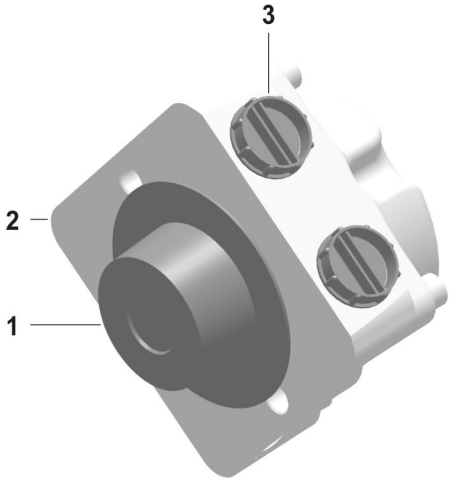

Fig. 313: Covering caps and universal protector

1 Universal protector
2 Fuel prefeeding pump
3 Covering cap (2x)

▶ Seal fuel prefeeding pump **2** with universal protector **1** and covering caps **3**.

Cleaning the fuel prefeeding pumps

▶ Clean contact surfaces of bearing flanges.

▶ Clean contact surfaces of fuel prefeeding pumps.

▶ Clean groove of the o-ring.

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Installing the fuel prefeeding pumps

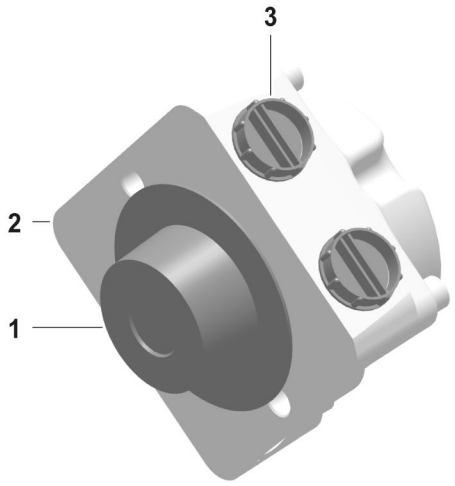

Fig. 314: Covering caps and universal protector

1 Universal protector
2 Fuel prefeeding pump
3 Covering cap (2x)

▶ Remove universal protector **1**.

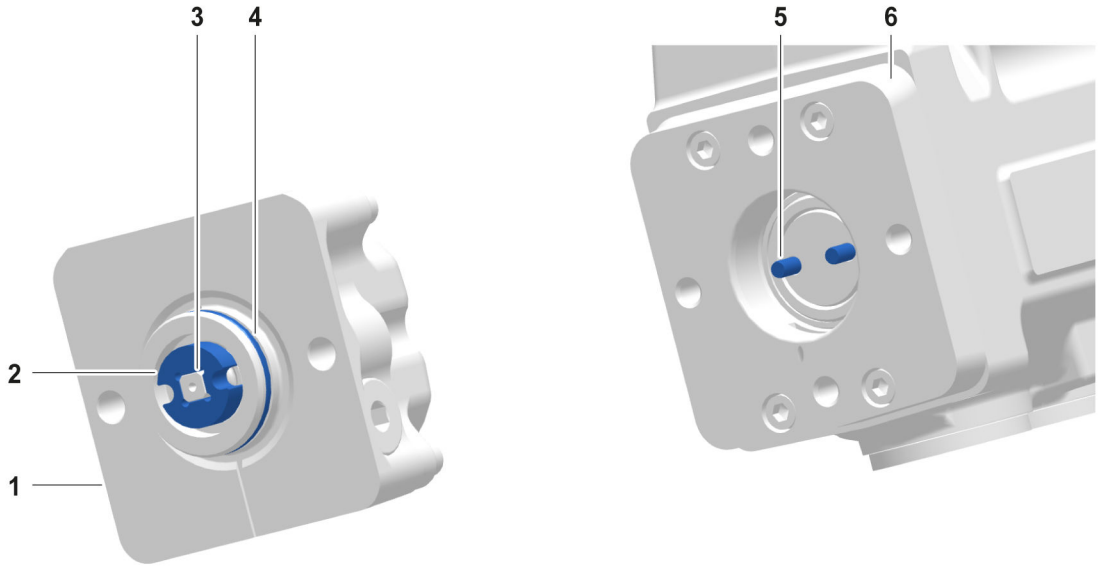

Fig. 315: Fuel prefeeding pump alignment

1 Fuel prefeeding pump
2 Coupling
3 Crankshaft
4 O-ring
5 Parallel pin (2x)
6 Fuel high pressure pump

▶ Install new o-ring **4**.

▶ Install coupling **2** on crankshaft **3**.

▶ Align coupling **2** to parallel pins **5**.

▶ Install fuel prefeeding pump **1** on fuel high pressure pump **6**.

▶ Align fuel prefeeding pump **1** by turning it.

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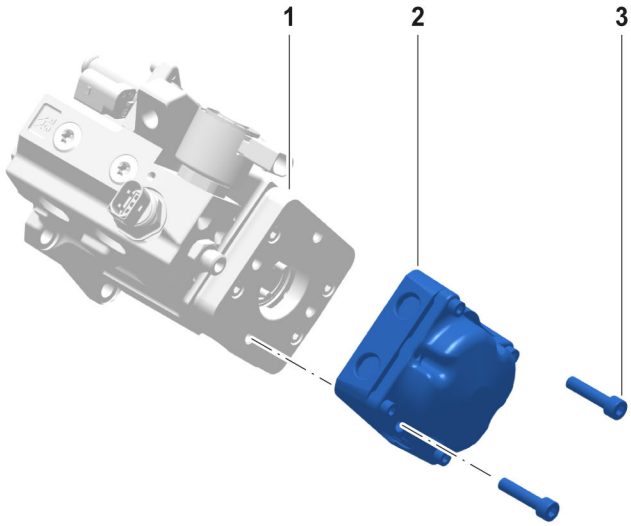
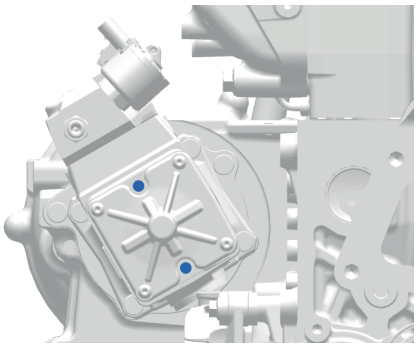


Fig. 316: Fuel prefeeding pump

1 Bearing flange
2 Fuel prefeeding pump
3 Socket head screw (2x)

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	8 Nm	
2.	27 Nm	

Tab. 75: Tightening instruction

▶ Tighten socket head screws **3** according to the tightening instruction.

▶ Remove covering caps.

Removing and installing the volume control valve

Removing the volume control valve

Graphic representation	**Description**	**Required number**	**Part number**
	Volume control valve sealing cap	1	11835061

Tab. 76: Special tool

Make sure that the following prerequisite is met:

- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)
- ❑ When removing the volume control valve on the lower fuel high pressure pump, the upper fuel high pressure pump is removed. (For more information see: Removing the fuel high pressure pumps, page 238.)

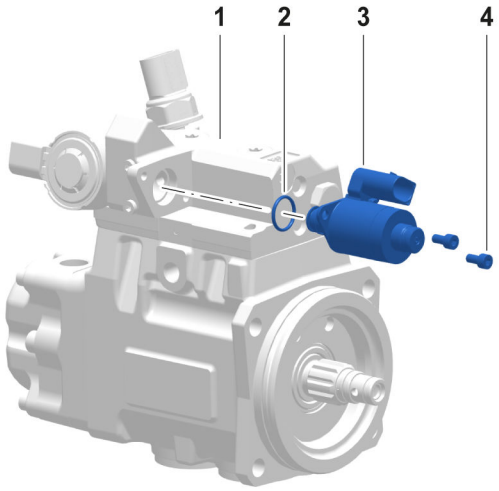


Fig. 319: Volume control valve

1	Fuel high pressure pump	**3**	Volume control valve
2	O-ring	**4**	Socket head screw (2x)

▶ Disconnect electrical plug connection from volume control valve **3**.

▶ Unscrew socket head screws **4**.

▶ Remove volume control valve **3**.

▶ Remove o-ring **2**.

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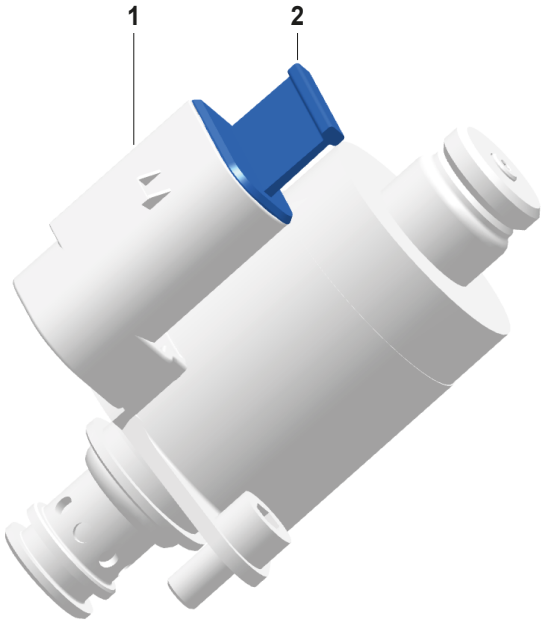

Fig. 320: Sealing plug

1 Volume control valve **2** Sealing cap

▶ Seal electrical connection of volume control valve **1** with sealing cap **2**.

Cleaning the volume control valve

▶ Clean groove on volume control valve **1**.

▶ Clean contact surface on volume control valve **1**.

▶ Clean contact surface on fuel high pressure pump.

Installing the volume control valve

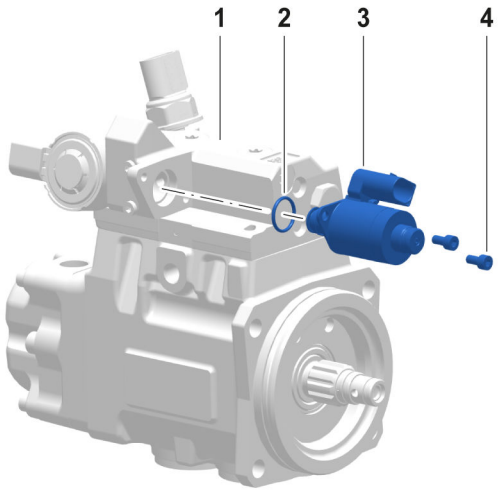

Fig. 321: Volume control valve

1 Fuel high pressure pump
2 O-ring
3 Volume control valve
4 Socket head screw (2x)

▶ Lubricate new o-ring **2** with NBU 30 grease.

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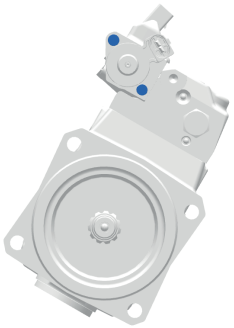
- ▶ Install o-ring **2** in groove of volume control valve **3**.
- ▶ Install volume control valve **3**.

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	6.5 Nm	

Tab. 77: Tightening instruction

- ▶ Tighten socket head screws **4** according to tightening instruction.
- ▶ Remove sealing cap.
- ▶ Connect electrical plug connection to volume control valve **3**.

Removing and installing the pressure control valve

Removing the pressure control valve

Graphic representation	**Description**	**Required number**	**Part number**
	Assembly device	1	12973095

Tab. 78: Special tool

Make sure that the following prerequisites are met:
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)
- ❑ When removing the pressure control valve on the lower fuel high pressure pump, the upper fuel high pressure pump is removed. (For more information see: Removing the fuel high pressure pumps, page 238.)

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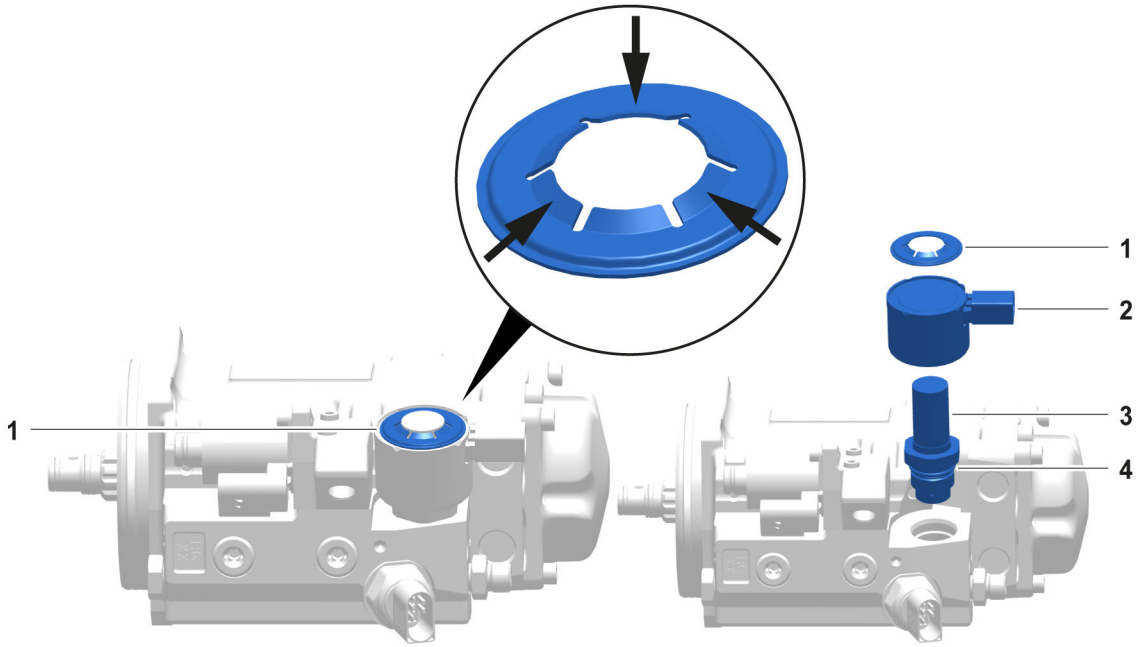

Fig. 324: Removing the pressure control valve

1	Locking ring	**4**	O-ring
2	Coil	**Pfeil**	Teeth of locking ring
3	Pressure control valve		

- ▶ Disconnect electrical plug connection from coil **2**.
- ▶ Carefully release teeth of locking ring **Pfeil** using a chisel and hammer.
- ▶ Remove locking ring **1**.
- ▶ Remove coil **2**.
- ▶ Unscrew pressure control valve **3**.

If o-ring **4** gets stuck in fuel high pressure pump:

- ▶ Remove o-ring **4**.

Checking and cleaning the pressure control valve

- ▶ Clean sealing surface of fuel high pressure pump.

Installing the pressure control valve

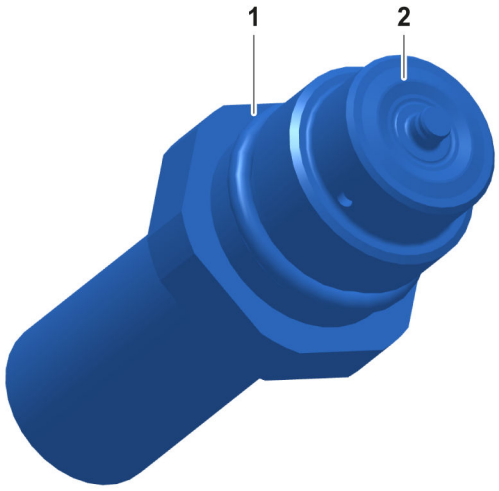

Fig. 325: Pressure control valve

1 O-ring **2** Sealing edge

▶ Lubricate new o-ring **1** with Rock Valley Oil Rockcut lubricant.

▶ Lubricate new pressure control valve on sealing edge **2** with Rock Valley Oil Rockcut lubricant.

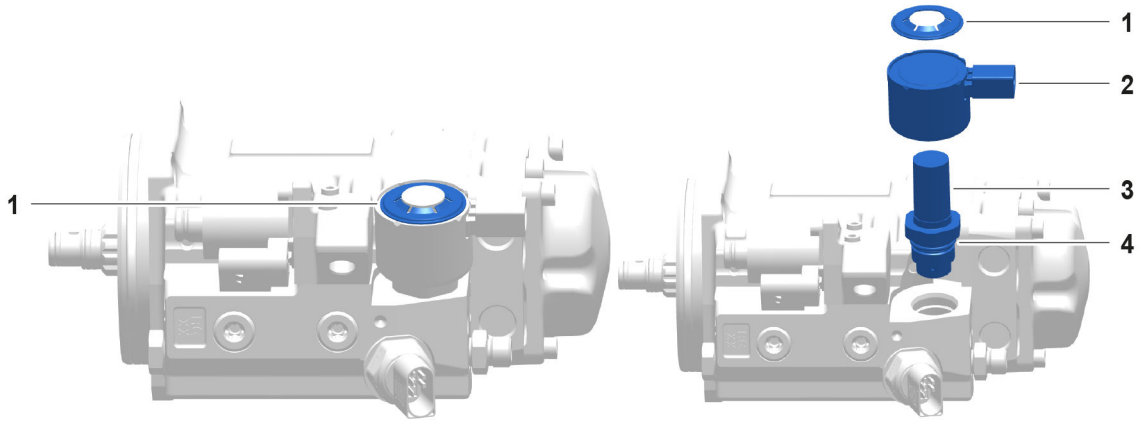

Fig. 326: Installing the pressure control valve

1 Locking ring
2 Coil
3 Pressure control valve
4 O-ring

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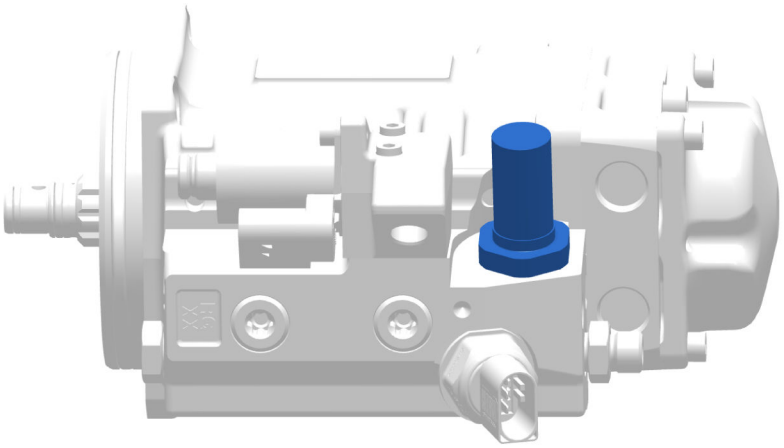
Tightening instruction for pressure control valve	
	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	30 Nm
2.	140 Nm

Tab. 79: Tightening instruction

- ▶ Tighten pressure control valve **3** according to tightening instruction.
- ▶ Align new coil **2**.
- ▶ Align new locking ring **1** with teeth upward.

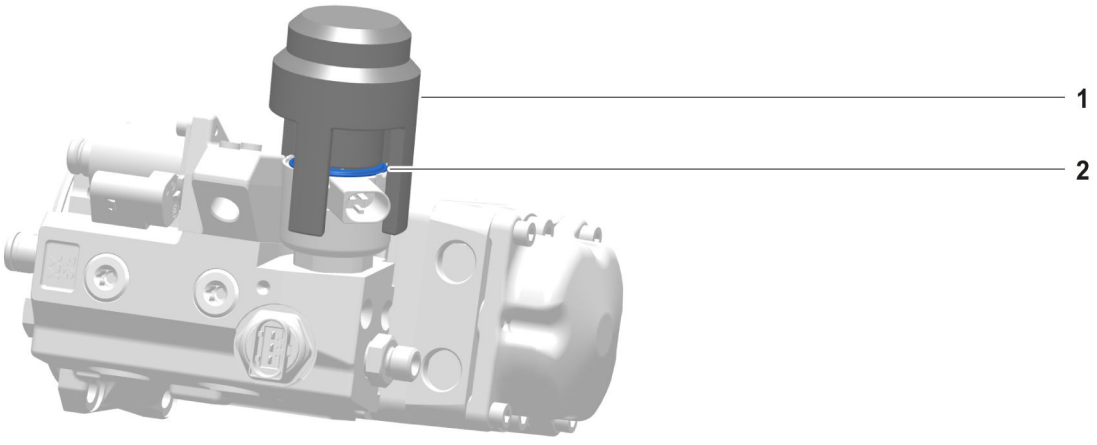


Fig. 328: Assembly device

1 Assembly device **2** Locking ring

- ▶ Carefully secure locking ring **2** with assembly device **1** and hammer.
- ▶ Check for proper seat of locking ring **2**.
- ▶ Connect electrical plug connection to coil **2**.

▶ Turn on ignition.

If electronic errors are present:
▶ Replace fuel high pressure pump. (For more information see: Removing the fuel high pressure pumps, page 238.)

▶ Start engine.

▶ Check pressure control valve for leaks.

If pressure control valve is not tight:
▶ Replace fuel high pressure pump. (For more information see: Removing the fuel high pressure pumps, page 238.)

▶ Let the engine warm up.

▶ Let engine run for 20 min at different load conditions, primarily at high load.

▶ Let engine run primarily at high load.

▶ Check pressure control valve for leaks.

If pressure control valve is not tight:
▶ Replace fuel high pressure pump. (For more information see: Removing the fuel high pressure pumps, page 238.)

3.5.12 Drive for high pressure pump

Removing and installing the high pressure pump drive

Removing the cover of the high pressure pump drive

Make sure that the following prerequisites are met:
❑ Ventilation line from exhaust gas turbocharger to expansion tank is removed. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)
❑ Left intake manifold is removed. (For more information see: Removing the left intake manifold, page 286.)

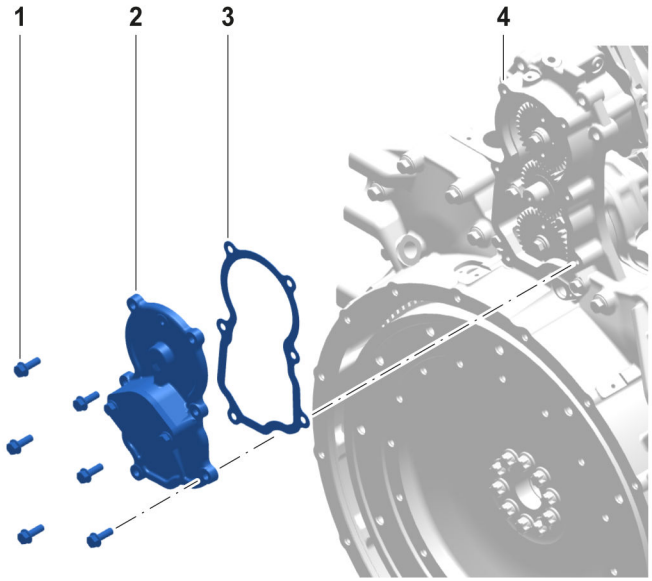


Fig. 329: Cover of high pressure pump drive

1 Hex head screw (6x)
3 Seal
See next page for continuation of the image legend

2 Cover
4 Flywheel housing

▶ Unscrew hex head screws **1**.

▶ Remove cover **2**.

▶ Remove seal **3**.

Removing the high pressure pump drive

Make sure that the following prerequisites are met:
❑ Fuel high pressure pumps are removed. (For more information see: Removing the fuel high pressure pumps, page 238.)
❑ Cover of high pressure pump drive is removed. (For more information see: Removing the cover of the high pressure pump drive, page 256.)

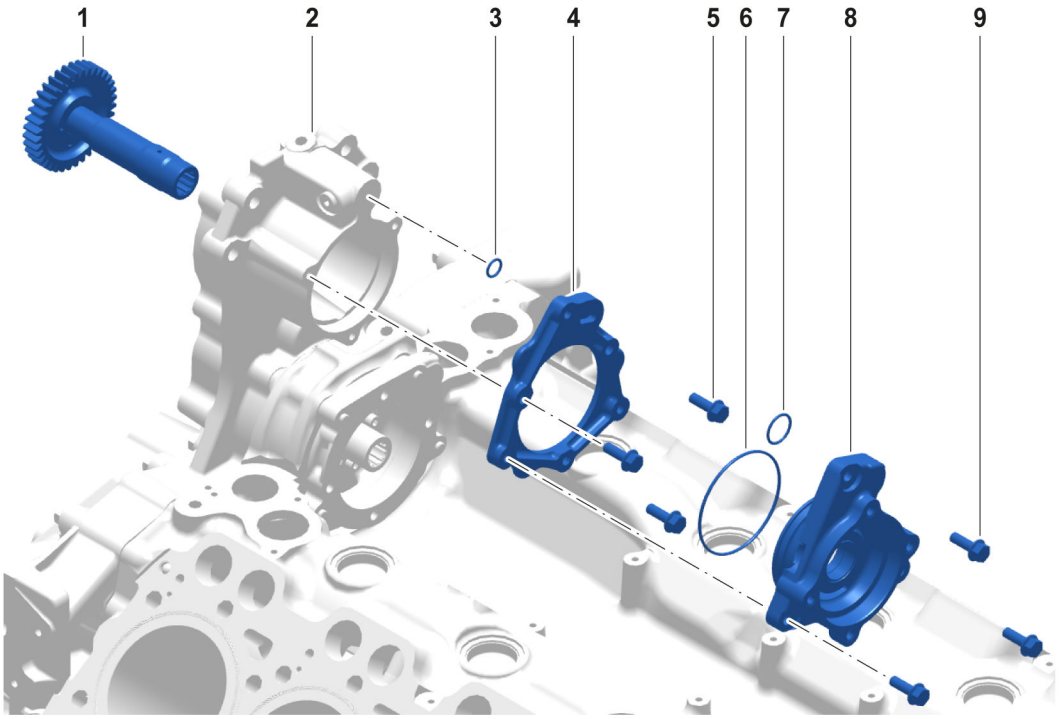


Fig. 330: Top high pressure pump drive

1 Gear wheel with drive shaft
2 Flywheel housing
3 O-ring
4 Housing
5 Hex head screw (3x)
6 O-ring
7 O-ring
8 Housing
9 Hex head screw (3x)

▶ Unscrew hex head screws **9**.

▶ Remove housing **8**.

▶ Remove o-ring **7**.

▶ Remove o-ring **6**.

▶ Remove gear wheel with drive shaft **1**.

▶ Unscrew hex head screws **5**.

▶ Remove housing **4**.

▶ Remove o-ring **3**.

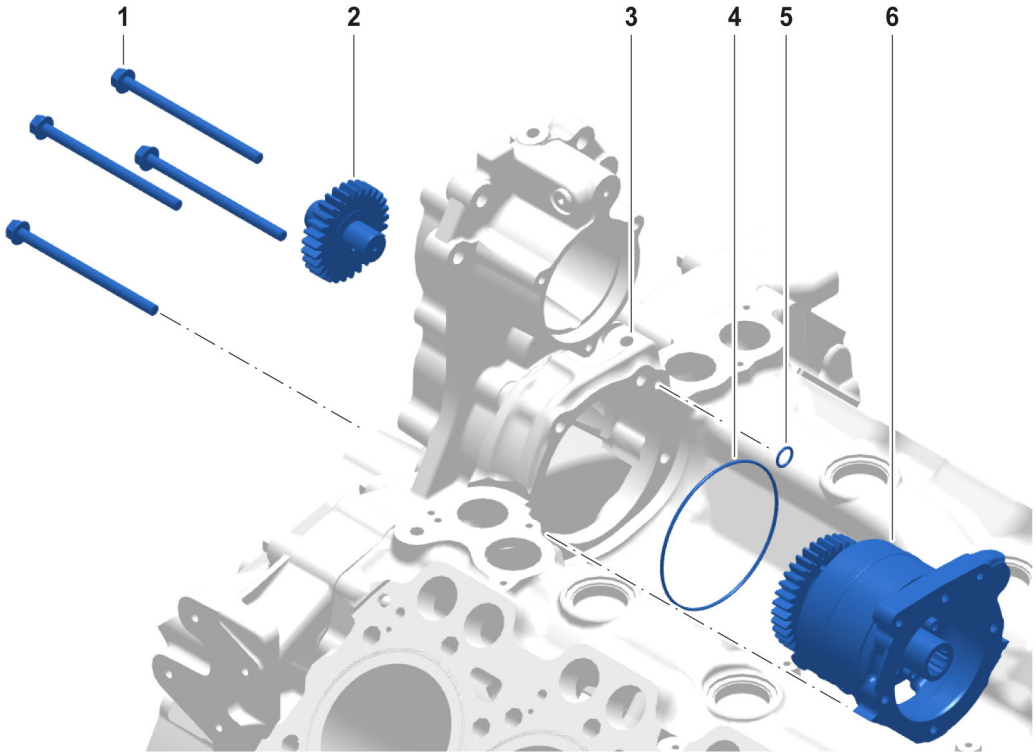


Fig. 331: Bottom high pressure pump drive

1 Hex head screw (4x)
2 Intermediate wheel
3 Crankcase
4 O-ring
5 O-ring
6 Bottom high pressure pump drive

- ▶ If necessary, remove intermediate wheel **2**.
- ▶ Unscrew hex head screws **1**.
- ▶ Remove bottom high pressure pump drive **6**.
- ▶ Remove o-ring **4**.
- ▶ Remove o-ring **5**.

Cleaning the high pressure pump drive

- ▶ Clean grooves of housing.
- ▶ Clean grooves of flywheel housing.
- ▶ Clean grooves of crankcase.
- ▶ Clean grooves of bottom high pressure pump drive.
- ▶ Clean contact surfaces of housing.
- ▶ Clean contact surfaces of high pressure pump drive.
- ▶ Clean contact surfaces of flywheel housing.
- ▶ Clean contact surface of crankcase.

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Installing the high pressure pump drive

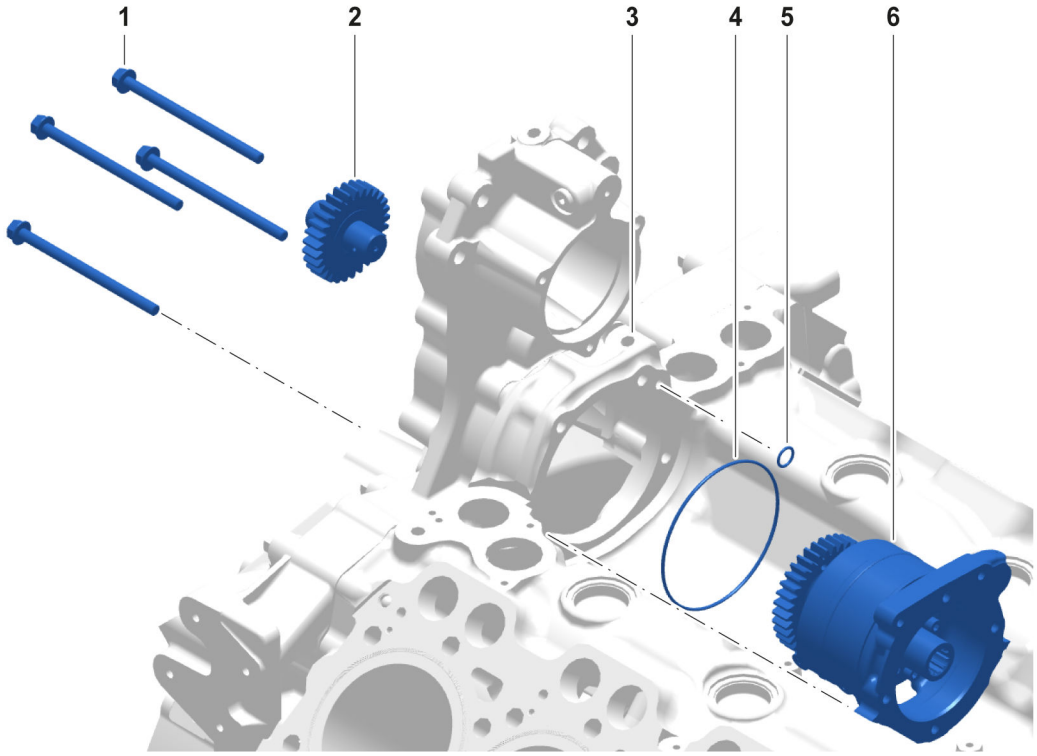
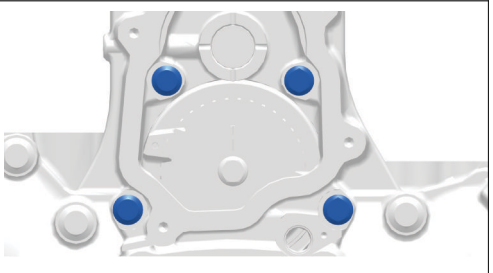


Fig. 332: Bottom high pressure pump drive

1 Hex head screw (4x)
2 Intermediate wheel
3 Crankcase
4 O-ring
5 O-ring
6 Bottom high pressure pump drive

- ▶ Lubricate new o-ring **5** with NBU 30 grease.
- ▶ Align o-ring **5**.
- ▶ Lubricate new o-ring **4** with NBU 30 grease.
- ▶ Align o-ring **4**.
- ▶ Install bottom high pressure pump drive **6**.

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	Motorex 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	25 Nm	
2.	70 Nm	

Tab. 80: Tightening instruction 9078270-002

- ▶ Lubricate hex head screws **1** according to tightening instruction.
- ▶ Tighten hex head screws **1** according to tightening instruction.
- ▶ Install intermediate wheel **2**.

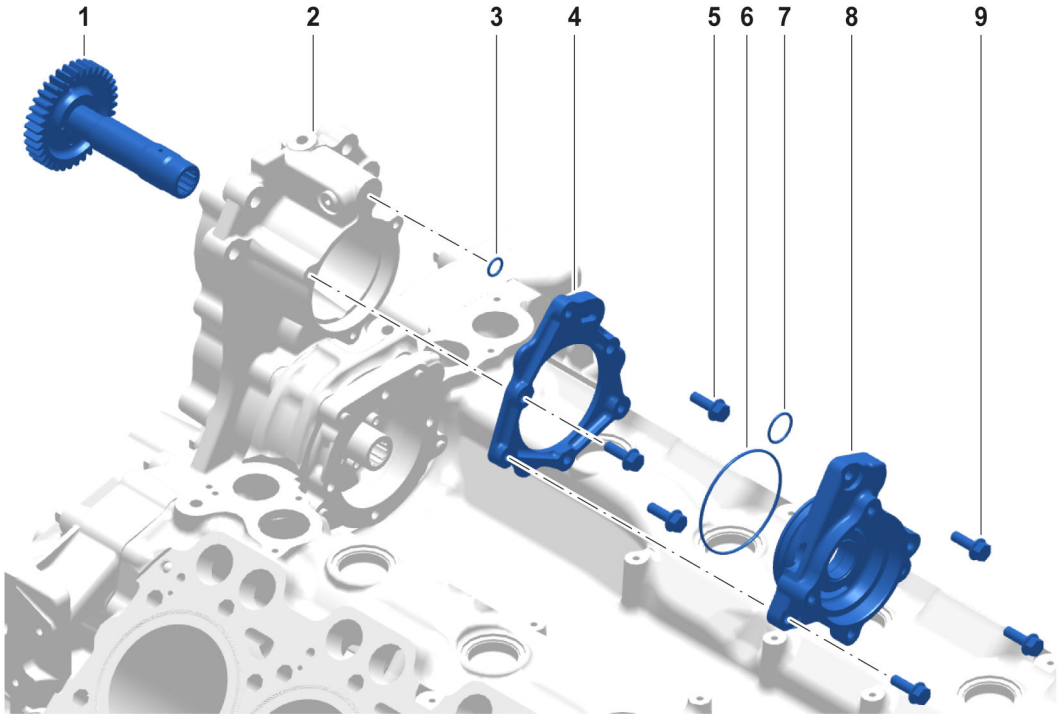


Fig. 334: Top high pressure pump drive

1 Gear wheel with drive shaft
2 Flywheel housing
3 O-ring
4 Housing
5 Hex head screw (3x)
6 O-ring
7 O-ring
8 Housing
9 Hex head screw (3x)

- ▶ Lubricate new o-ring **3** with NBU 30 grease.
- ▶ Align o-ring **3**.
- ▶ Install housing **4**.
- ▶ Tighten hex head screws **5**.
- ▶ Lubricate contact surfaces of gear wheel with drive shaft **1** and housing **8** with new engine oil.
- ▶ Install gear wheel with drive shaft **1**.
- ▶ Lubricate new o-ring **6** with NBU 30 grease.
- ▶ Align o-ring **6**.
- ▶ Lubricate new o-ring **7** with NBU 30 grease.
- ▶ Align o-ring **7**.
- ▶ Install housing **8**.
- ▶ Tighten hex head screws **9**.

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Installing the cover of the high pressure pump drive

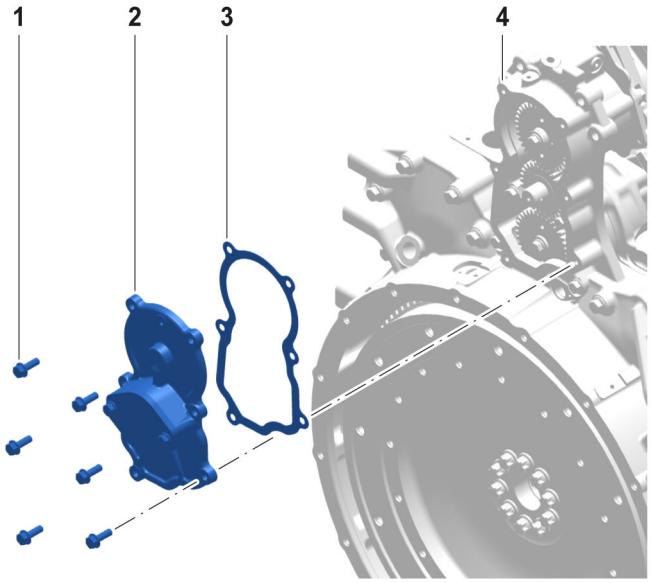

Fig. 335: Cover of high pressure pump drive

1 Hex head screw (6x)
2 Cover
3 Seal
4 Flywheel housing

▶ Align new seal **3**.

▶ Install cover **2**.

▶ Tighten hex head screws **1**.

Dismantling and assembling the bottom high pressure pump drive

Dismantling the bottom high pressure pump drive

Make sure that the following prerequisite is met:
❑ Bottom high pressure pump drive is removed. (For more information see: Removing the high pressure pump drive, page 257.)

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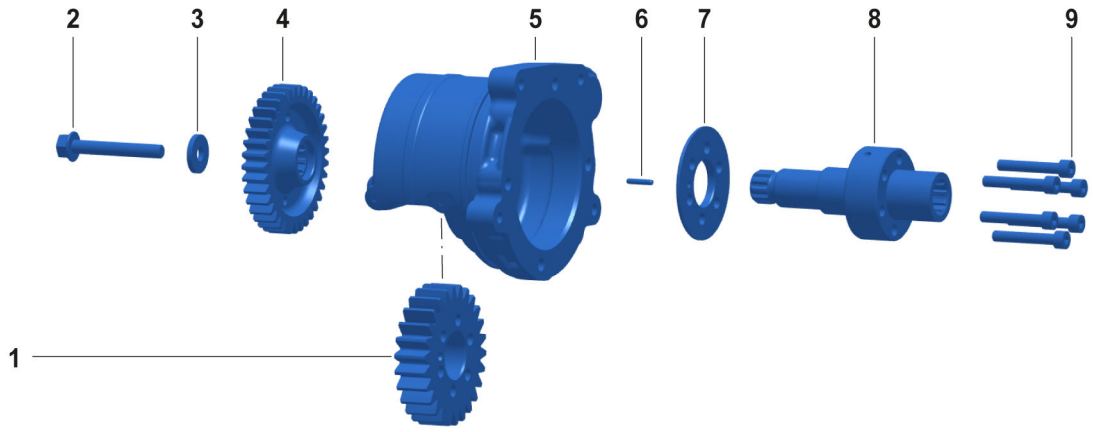

Fig. 336: High pressure pump drive

1 Gear wheel
2 Hex head screw
3 Washer
4 Gear wheel
5 Housing
6 Dowel pin
7 Thrust washer
8 Drive shaft
9 Socket head screw (6x)

- ▶ Unscrew hex head screw **2**.
- ▶ Remove washer **3**.
- ▶ Remove gear wheel **4**.
- ▶ Unscrew socket head screws **9**.
- ▶ Remove drive shaft **8**.
- ▶ Remove thrust washer **7**.
- ▶ Remove dowel pin **6**.
- ▶ Remove gear wheel **1**.

Assembling the bottom high pressure pump drive

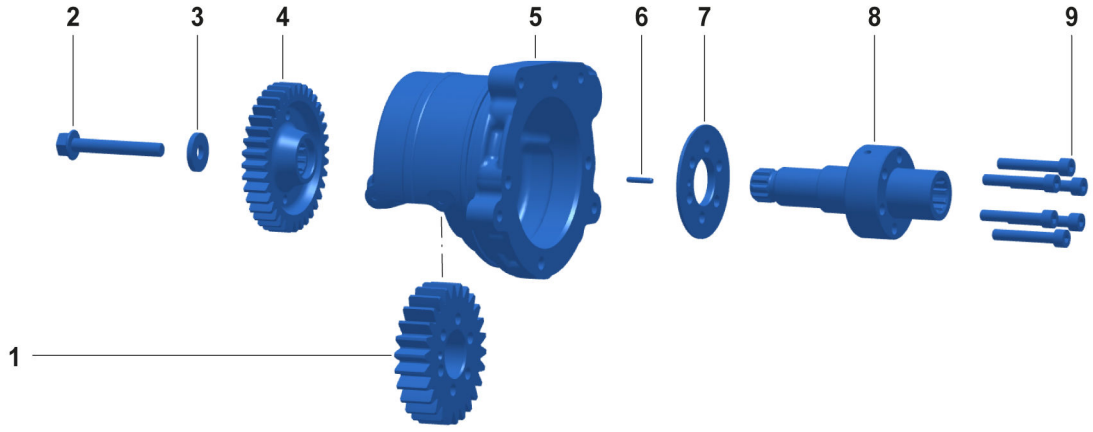

Fig. 337: High pressure pump drive

1 Gear wheel
2 Hex head screw
3 Washer
4 Gear wheel
5 Housing
6 Dowel pin
7 Thrust washer
8 Drive shaft
9 Socket head screw (6x)

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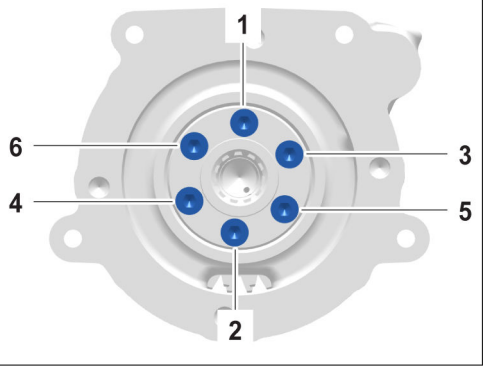
- ▶ Align gear wheel **1**.
- ▶ Install new dowel pin **6**.
- ▶ Align thrust washer **7**.
- ▶ Lubricate contact surfaces of drive shaft **8** with new engine oil.
- ▶ Install drive shaft **8**.

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	Engine oil	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	20 Nm	
Stage	**Angle of rotation**	
2.	45°	

Tab. 81: Tightening instruction 13453262-000

- ▶ Lubricate new socket head screws **9** according to tightening instruction.
- ▶ Tighten socket head screws **9** according to tightening instruction.
- ▶ Install gear wheel **4**.
- ▶ Align washer **3**.
- ▶ Tighten hex head screw **2**.

3.6 Belt drive

3.6.1 Removing and installing the V-ribbed belt

Removing the V-ribbed belt

Make sure that the following prerequisites are met:
- ❑ Tension pulley (self-tensioning) cover is removed. (For more information see: Removing the tension pulley (self-tensioning) cover, page 266.)
- ❑ 1/2” socket wrench transition piece (external square) with lever is available.

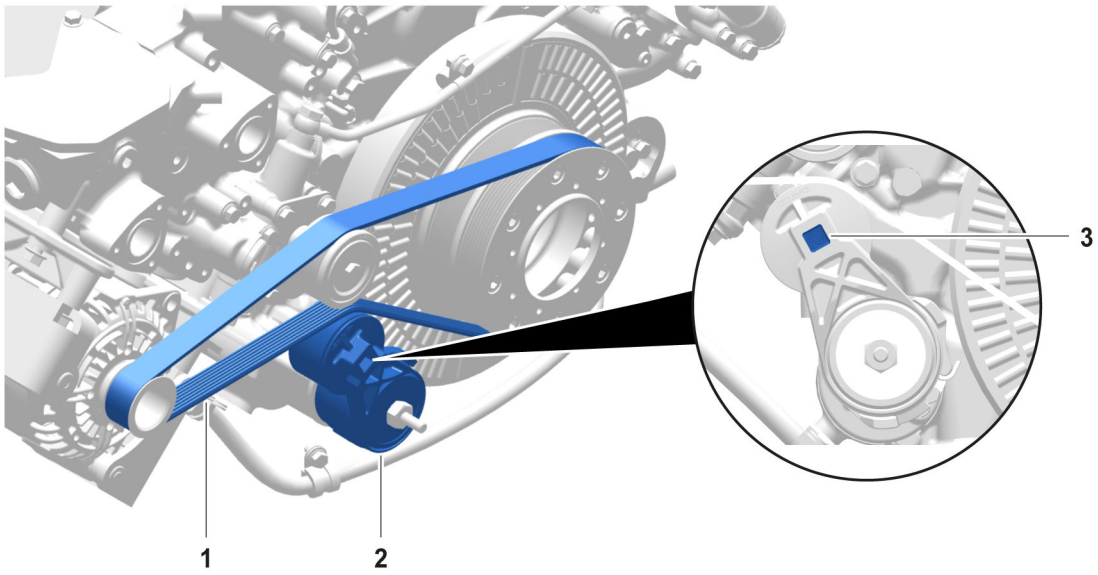


Fig. 339: V-ribbed belt

1 V-ribbed belt
2 Tension pulley (self-tensioning)
3 Internal square

▶ Attach 1/2” socket wrench transition piece (external square) with lever to internal square **3** of the tension pulley (self-tensioning) **2**.

WARNING
Unexpected recoil of the tension pulley (self-tensioning)!
Injuries.

▶ Make sure that the tool is correctly connected to tension pulley (self-tensioning).

▶ Carefully turn tension pulley (self-tensioning).

▶ When V-ribbed belt is loose, do not let go of tool on tension pulley (self-tensioning).

▶ Swivel back tension pulley (self-tensioning) **2** counterclockwise to the limit stop.
▷ The V-ribbed belt **1** is free.

▶ Remove V-ribbed belt **1**.

▶ Turn back tension pulley (self-tensioning) **2**.

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Installing the V-ribbed belt

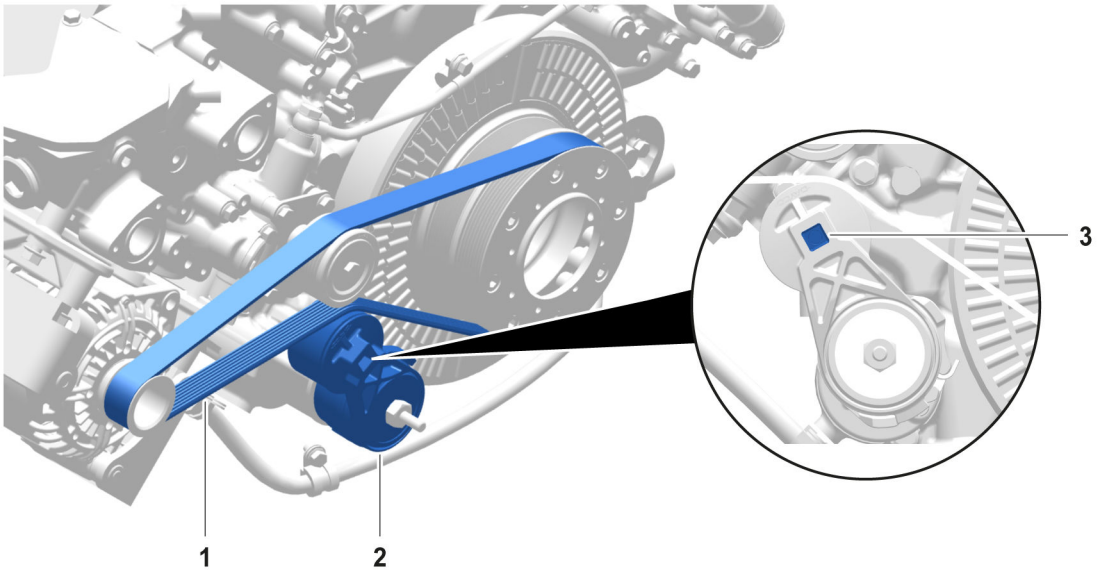

Fig. 340: V-ribbed belt

1 V-ribbed belt
2 Tension pulley (self-tensioning)
3 Internal square

▶ Swivel back tension pulley (self-tensioning) **2** counterclockwise against the spring force to the limit stop.

▶ Fit V-ribbed belt **1** on belt pulleys of crankshaft, alternator and deflection pulley.

▶ Turn tension pulley (self-tensioning) **2** carefully into the original position.
▷ Tension pulley (self-tensioning) **2** is tensioned.

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3.6.2 Removing and installing the tension pulley (self-tensioning) cover

Removing the tension pulley (self-tensioning) cover

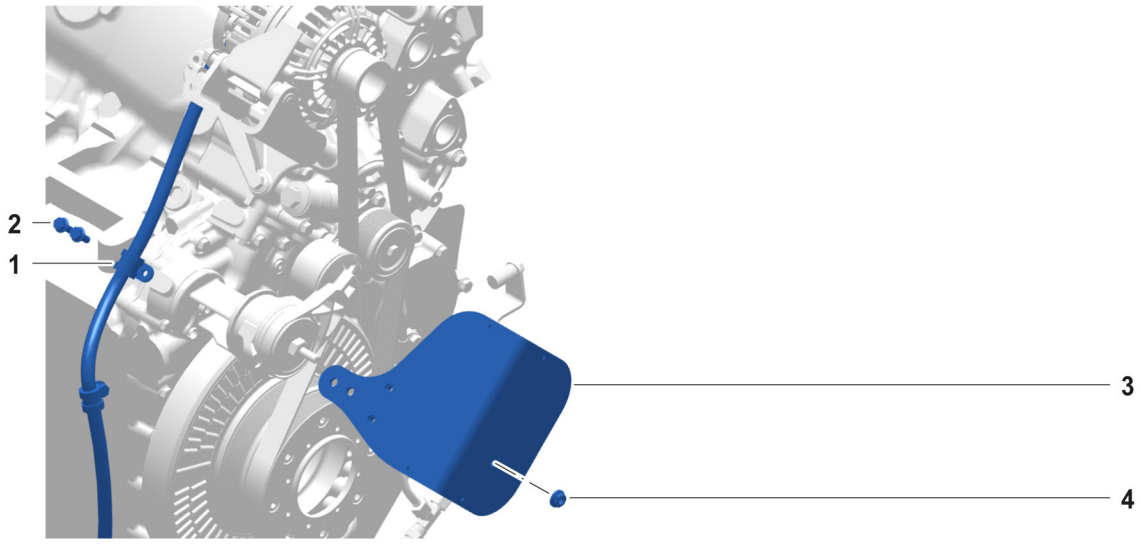

Fig. 341: Cover

1 Holding clamp
2 Hex head screw (2x)
3 Cover
4 Hex nut

▶ Unscrew hex head screws **2**.

▶ Unscrew hex nut **4**.

▶ Remove cover **3**.

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Installing the tension pulley (self-tensioning) cover

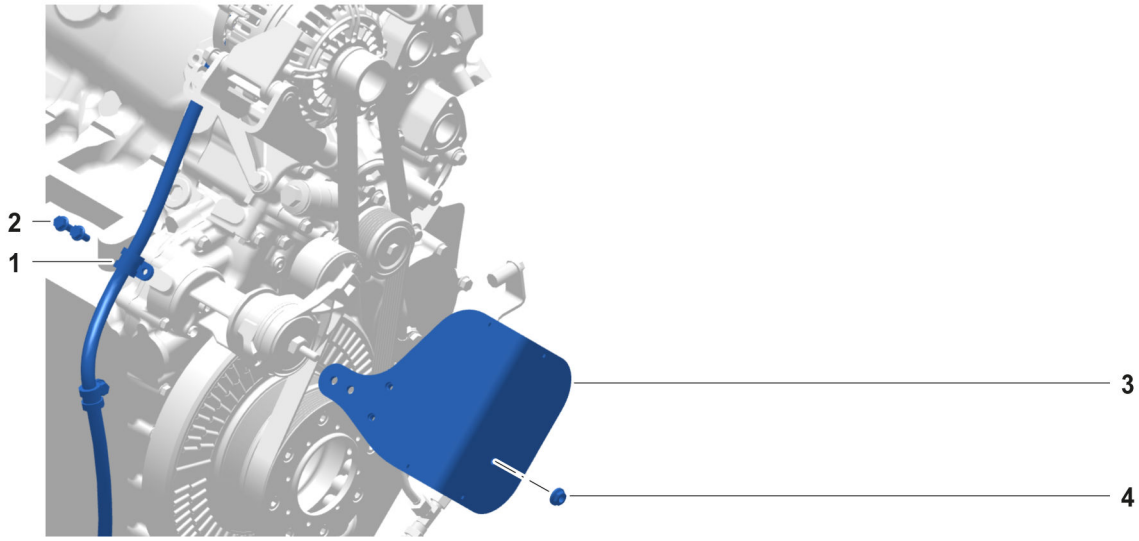

Fig. 342: Cover

1 Holding clamp
2 Hex head screw (2x)
3 Cover
4 Hex nut

▶ Install cover **3**.

▶ Tighten hex nut **4**.

▶ Align holding clamp **1**.

▶ Tighten hex head screws **2**.

3.6.3 Removing and installing the tension pulley (self-tensioning)

Removing the tension pulley (self-tensioning)

Make sure that the following prerequisite is met:
❑ V-ribbed belt is removed. (For more information see: Removing the V-ribbed belt, page 264.)

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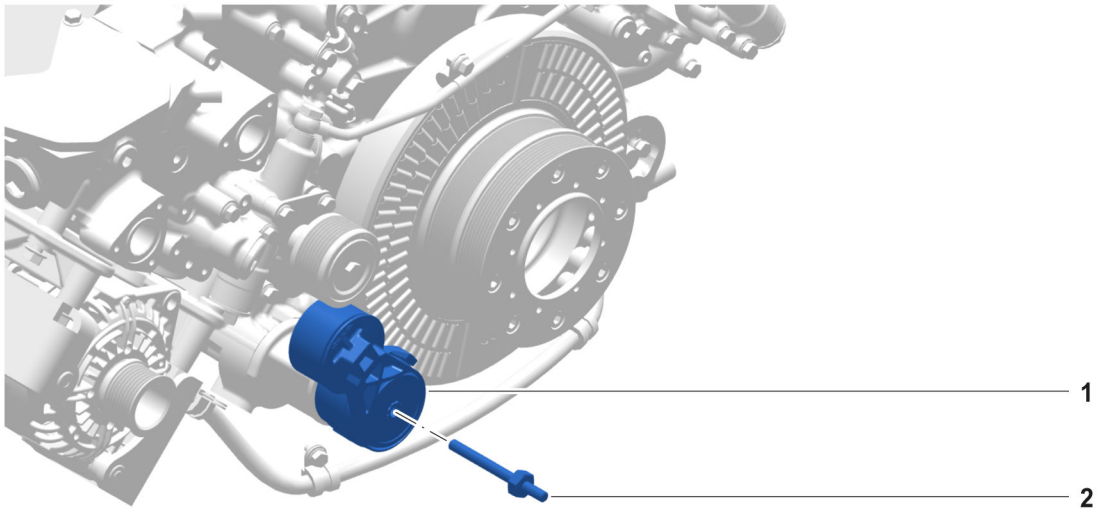

Fig. 343: Tension pulley (self-tensioning)

1 Tension pulley (self-tensioning) **2** Fastening screw

▶ Unscrew fastening screw **2**.

▶ Remove tension pulley (self-tensioning) **1**.

Removing the intermediate section

Make sure that the following prerequisites are met:

❑ Tension pulley (self-tensioning) is removed. (For more information see: Removing the tension pulley (self-tensioning), page 267.)

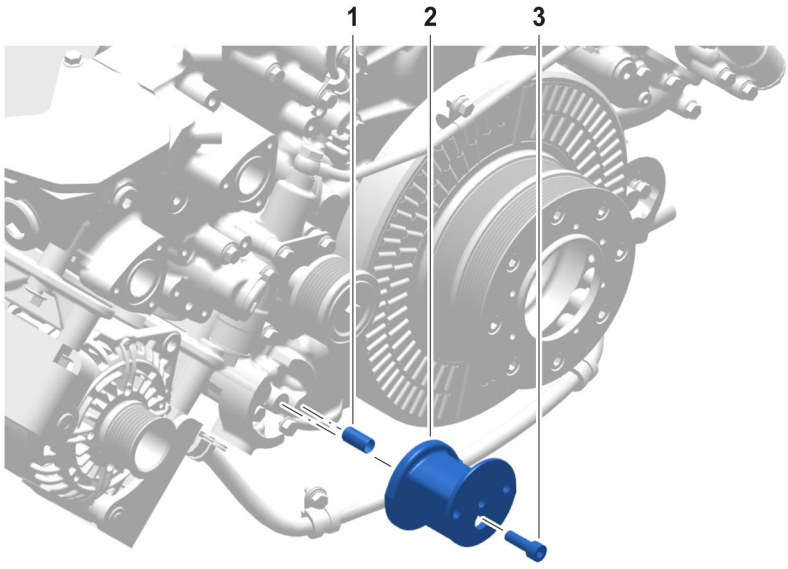

Fig. 344: Intermediate section

1 Dowel pin **3** Socket head screw
2 Intermediate section

▶ Unscrew socket head screw **3**.

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- ▶ Remove intermediate section **2**.
- ▶ Remove dowel pin **1**.

Installing the intermediate section

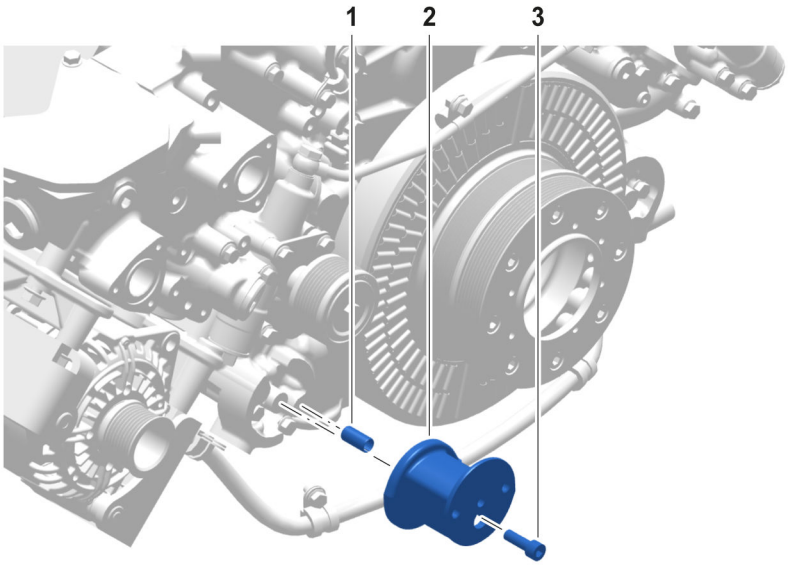

Fig. 345: Intermediate section

1 Dowel pin
2 Intermediate section
3 Socket head screw

- ▶ Install new dowel pin **1**.
- ▶ Install intermediate section **2**.
- ▶ Lubricate socket head screw **3** with Loctite® 243 thread locker.
- ▶ Tighten socket head screw **3**.

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Installing the tension pulley (self-tensioning)

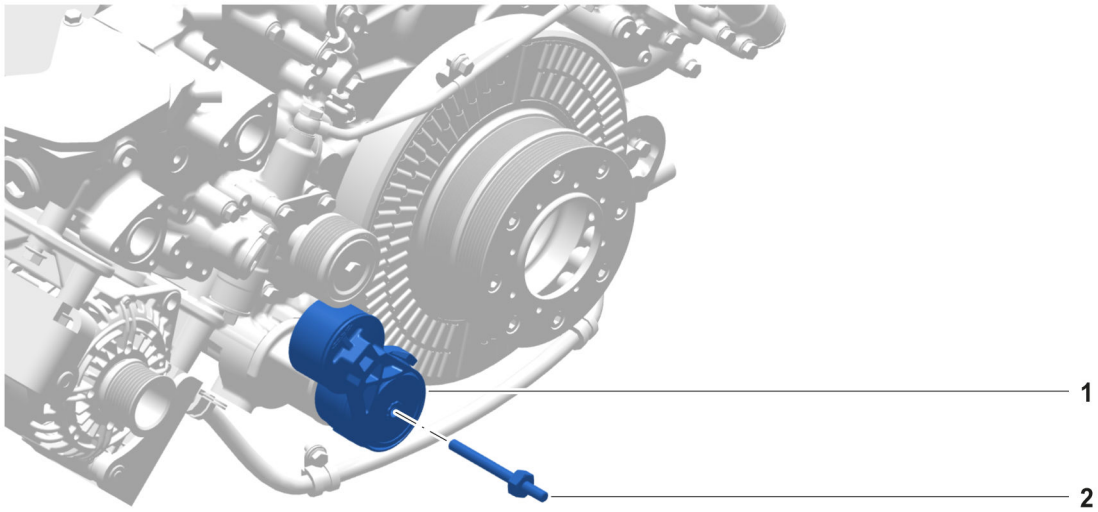

Fig. 346: Tension pulley (self-tensioning)

1 Tension pulley (self-tensioning) **2** Fastening screw

▶ Install tension pulley (self-tensioning) **1**.

Tightening instruction for fastening screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	Loctite® 243	
Screws	Not reusable	
Stage	**Tightening torque**	
1.	30 Nm	

Tab. 82: Tightening instruction 10146345-000

▶ Lubricate new fastening screw **2** according to tightening instruction.

▶ Tighten fastening screw **2** according to tightening instruction.

3.6.4 Removing and installing the deflection pulley

Removing the deflection pulley

Make sure that the following prerequisite is met:

❑ V-ribbed belt is removed. (For more information see: Removing the V-ribbed belt, page 264.)

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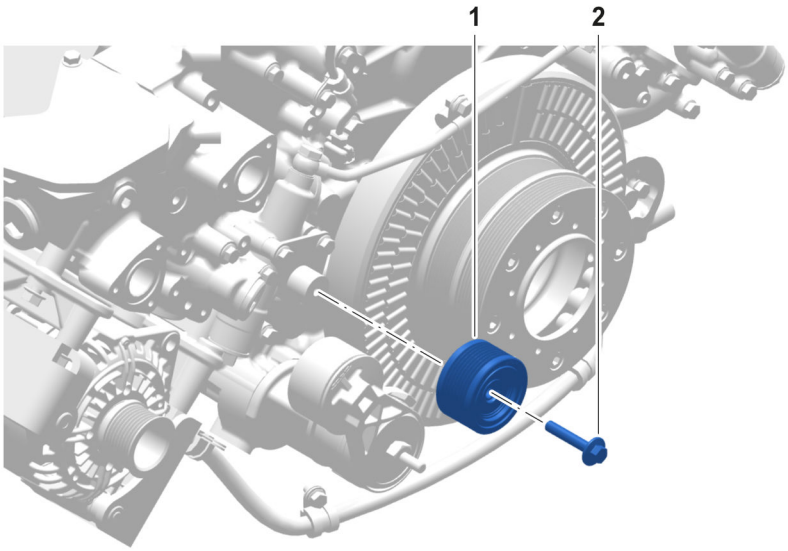

Fig. 348: Deflection pulley

1 Hex head screw

2 Deflection pulley

▶ Unscrew hex head screw **1**.

▶ Remove deflection pulley **2**.

Removing the bracket

Make sure that the following prerequisites are met:

❑ Deflection pulley is removed. (For more information see: Removing the deflection pulley, page 270.)

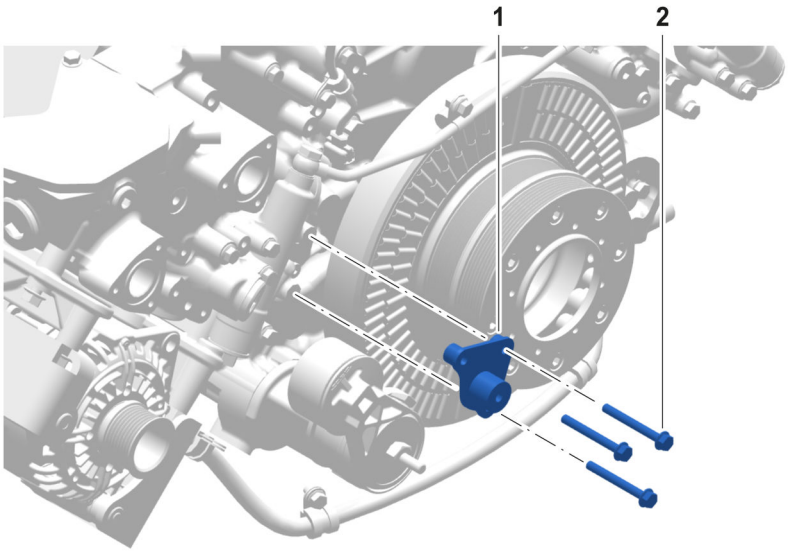

Fig. 349: Bracket

1 Bracket

2 Hex head screw (3x)

▶ Unscrew hex head screws **2**.

▶ Remove bracket **1**.

Installing the bracket

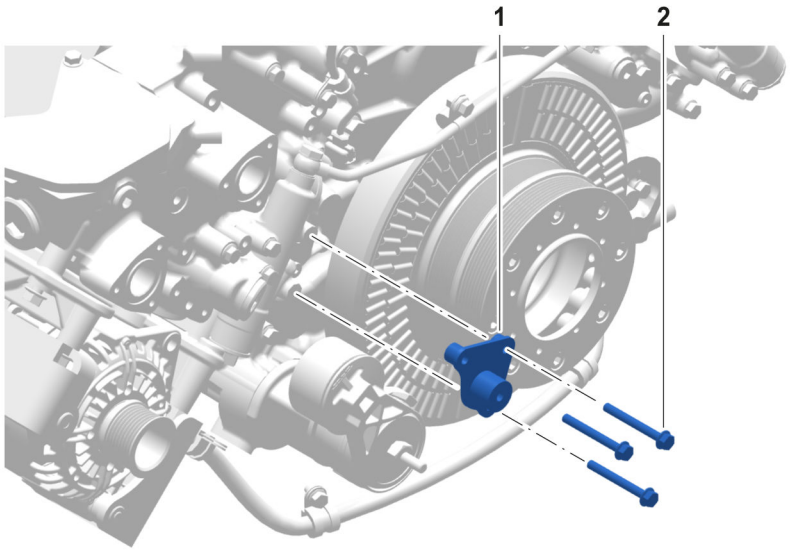

Fig. 350: Bracket

1 Bracket

2 Hex head screw (3x)

▶ Install bracket **1**.

▶ Tighten hex head screws **2**.

Installing the deflection pulley

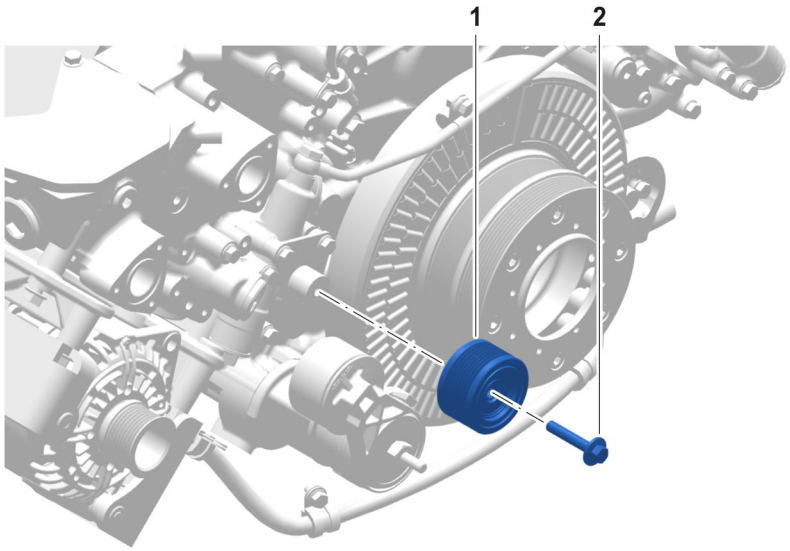

Fig. 351: Deflection pulley

1 Hex head screw

2 Deflection pulley

▶ Install deflection pulley **2**.

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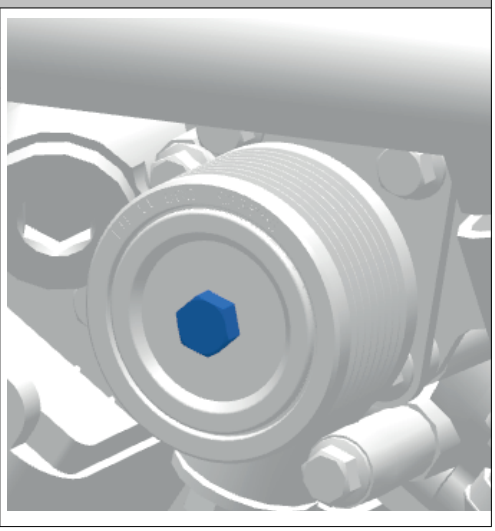
Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	65 Nm	

Tab. 83: Tightening instruction 11419835-001

▶ Tighten external hex bolt **1** according to tightening instruction.

3.6.5 Removing and installing the belt pulley

Removing the belt pulley

Make sure that the following prerequisite is met:
❑ V-ribbed belt is removed. (For more information see: Removing the V-ribbed belt, page 264.)

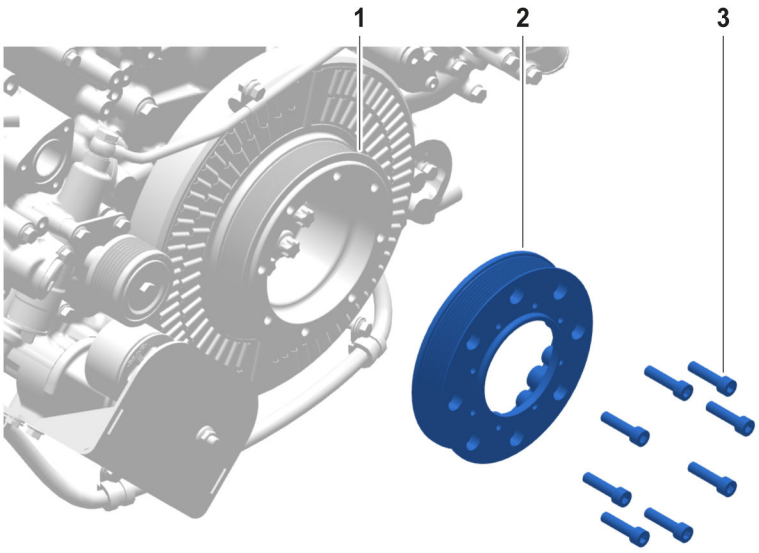


Fig. 353: Belt pulley

1 Viscous damper
2 Belt pulley
3 Socket head screw (8x)

▶ Unscrew socket head screws **3**.

▶ Remove belt pulley **2**.

Installing the belt pulley

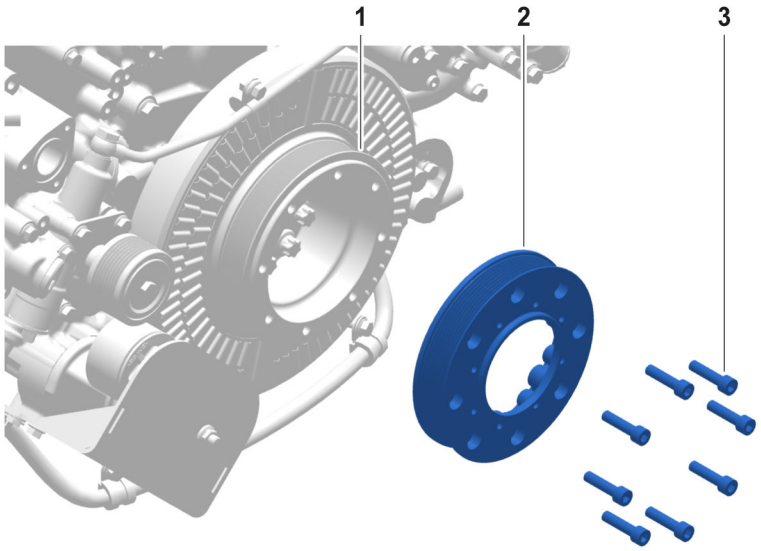


Fig. 354: Belt pulley

1 Viscous damper
2 Belt pulley
3 Socket head screw (8x)

▶ Install belt pulley **2** on viscous damper **1**.

▶ Tighten socket head screws **3**.

3.7 Charge air system

3.7.1 Air intake manifold

Removing and installing the left air intake manifold

Removing the left air intake manifold

Make sure that the following prerequisites are met:
- ❑ Connection line is removed. (For more information see: Removing the connection line, page 282.)
- ❑ Charge air pipes are removed. (For more information see: Removing the charge air pipe, page 291.)
- ❑ Left oil mist separator pipeline to intake manifold is removed. (For more information see: Removing the left oil mist separator pipeline to the intake manifold, page 360.)
- ❑ Device fuel line to fuel high pressure pumps is removed. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel high pressure pump fuel line to engine control unit is removed. (For more information see: Removing the fuel prefeeding pumps fuel line to the engine control unit, page 188.)
- ❑ Fuel return line from fuel fine filter to fuel tank is removed. (For more information see: Removing the fuel return line from the fuel fine filter to the fuel tank, page 200.)
- ❑ Left fuel return line from injectors to distributor block is removed. (For more information see: Removing the left fuel return lines from the injectors to the distributor block, page 194.)
- ❑ Left fuel rail is removed. (For more information see: Removing the fuel rails, page 218.)

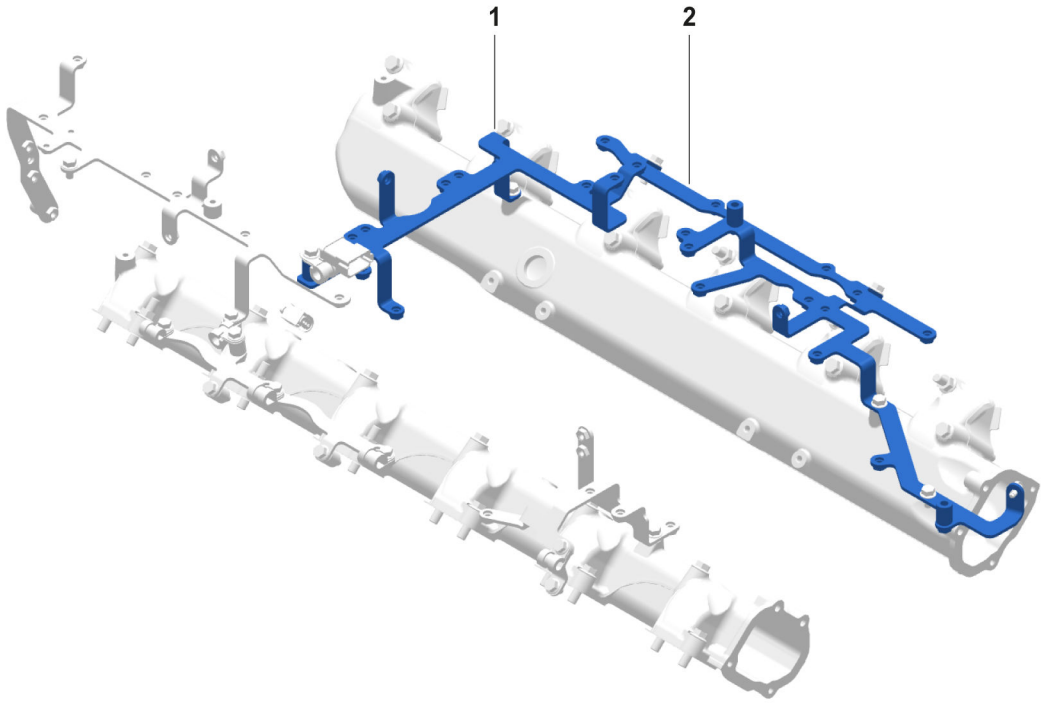


Fig. 355: Left air intake manifold

1 Bracket **2** Bracket

▶ Remove cable harness as needed. (For more information see: Removing the cable harness, page 475.)

▶ Remove bracket **1**.

▶ Remove bracket **2**.

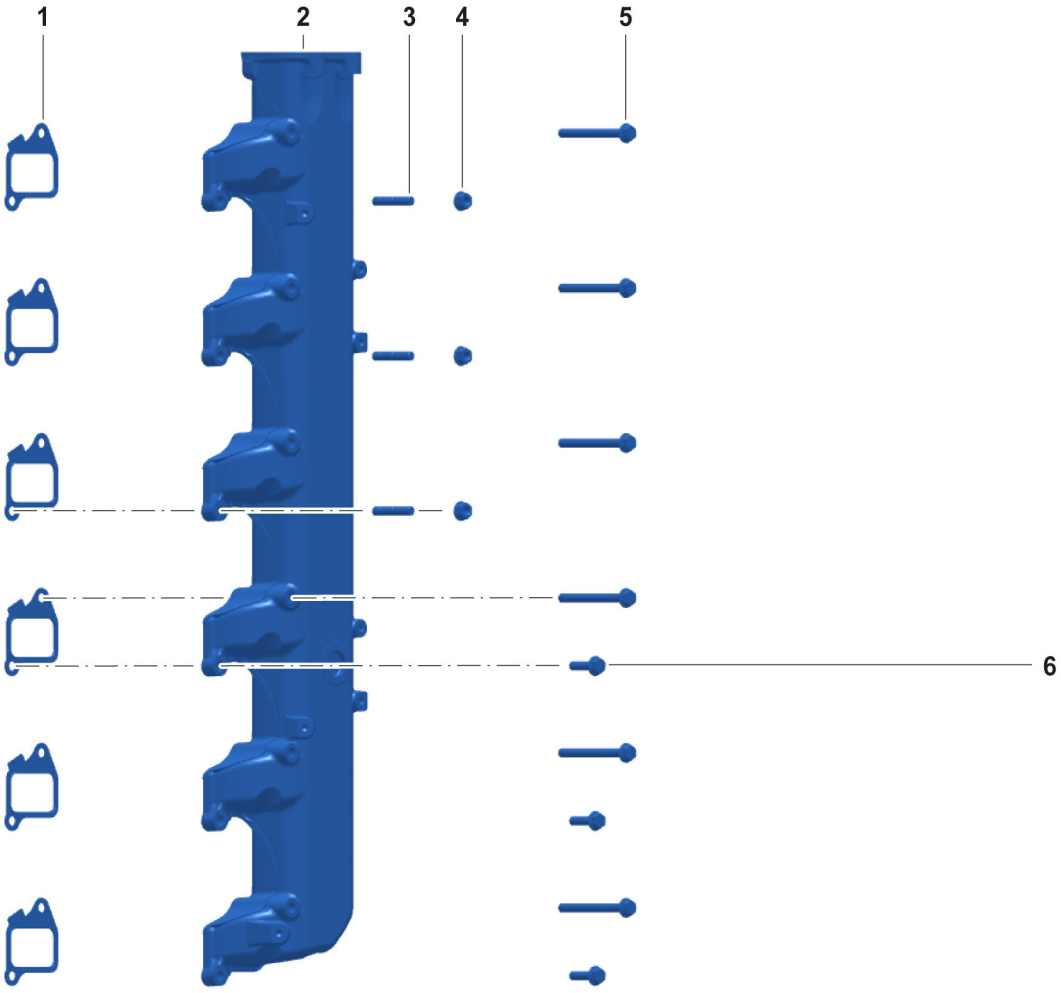


Fig. 356: Left air intake manifold

1 Seal (6x)
2 Air intake manifold
3 Stud bolt (3x)
4 Hex nut (3x)
5 Hex head screw (6x)
6 Hex head screw (3x)

▶ Unscrew hex nuts **4**.

▶ Unscrew stud bolts **3**.

▶ Unscrew hex head screws **5**.

▶ Unscrew hex head screws **6**.

▶ Remove air intake manifold **2**.

▶ Remove seals **1**.

Checking and cleaning the left air intake manifold

▶ Check air intake manifold **2** for damage and replace if necessary.

▶ Clean sealing surfaces of air intake manifold **2**.

▶ Clean sealing surfaces of cylinder heads.

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Installing the left air intake manifold

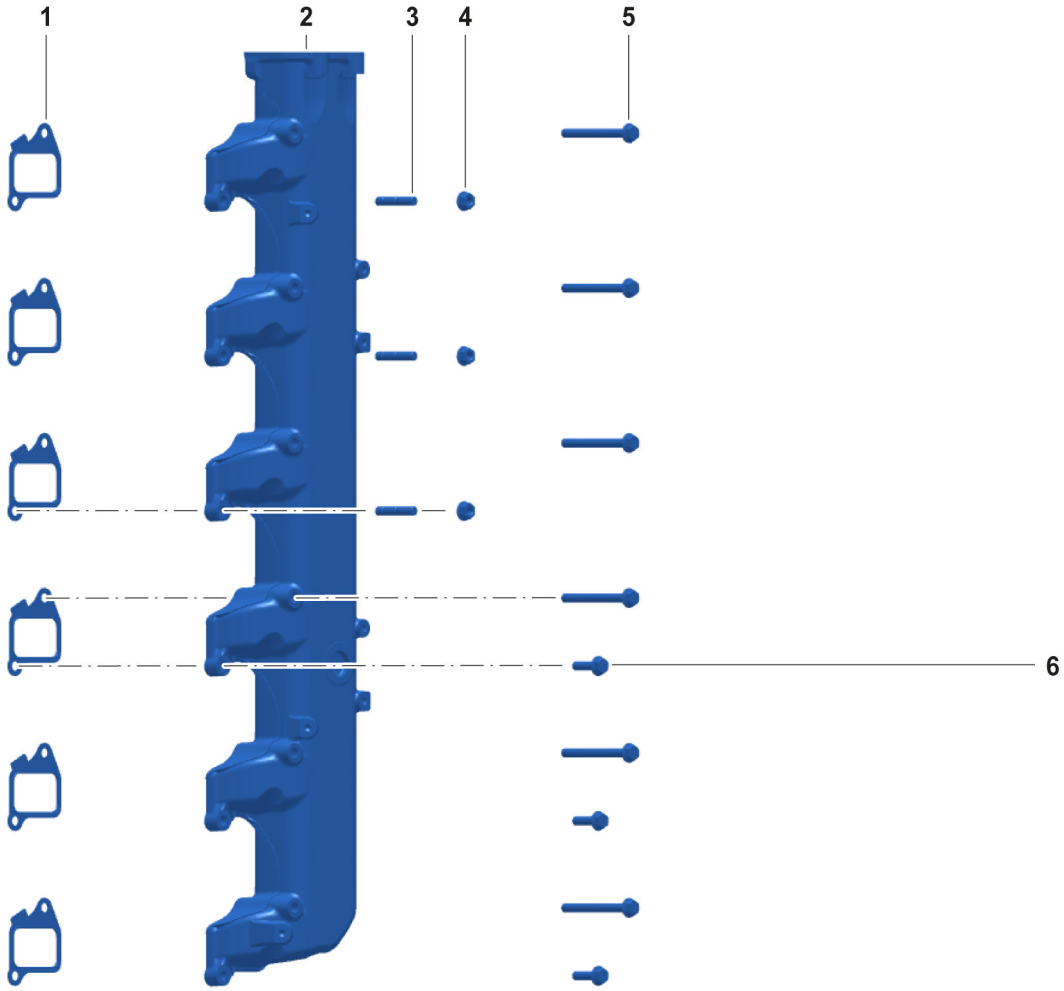
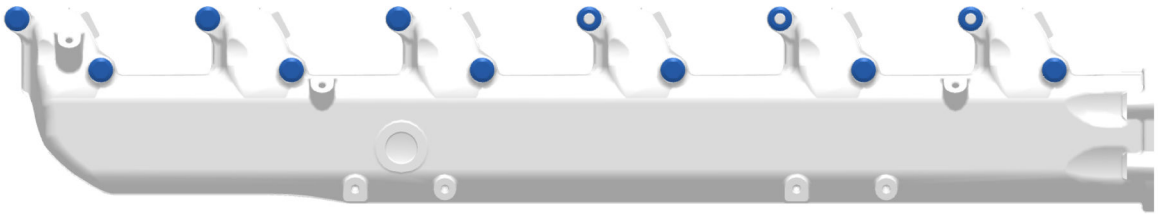


Fig. 357: Left air intake manifold

1 Seal (6x)
2 Air intake manifold
3 Stud bolt (3x)
4 Hex nut (3x)
5 Hex head screw (6x)
6 Hex head screw (3x)

▶ Align new seals **1**.

▶ Align air intake manifold **2**.

Tightening instruction for hex head screw and hex nut	
	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable

Tightening instruction for hex head screw and hex nut	
Stage	**Tightening torque**
1.	53 Nm

Tab. 84: Tightening instruction 12489993-000

- ▶ Tighten hex head screws **6** according to tightening instruction.
- ▶ Tighten hex head screws **5** according to tightening instruction.
- ▶ Tighten stud bolts **3**.
- ▶ Tighten hex nuts **4** according to tightening instruction.

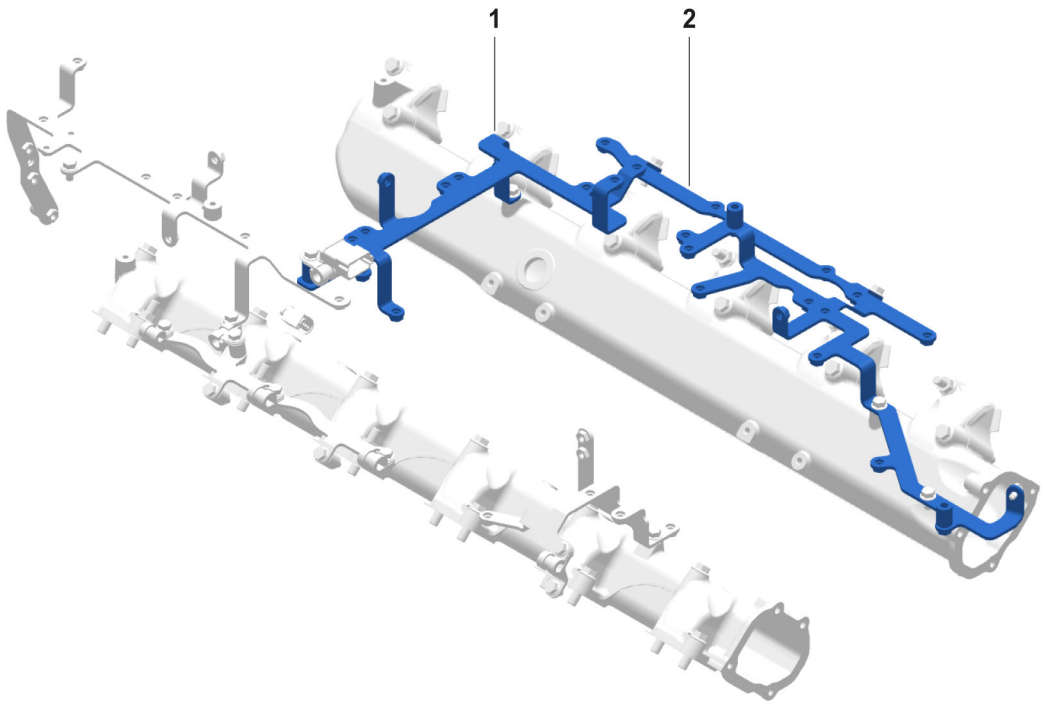


Fig. 359: Left air intake manifold

1 Bracket **2** Bracket

- ▶ Install bracket **2**.
- ▶ Install bracket **1**.
- ▶ Install cable harness. (For more information see: Installing the cable harness, page 476.)

Removing and installing the right air intake manifold

Removing the right air intake manifold

Make sure that the following prerequisites are met:
- ❑ Connection line is removed. (For more information see: Removing the connection line, page 282.)
- ❑ Charge air pipes are removed. (For more information see: Removing the charge air pipe, page 291.)
- ❑ Right oil mist separator pipeline to intake manifold is removed. (For more information see: Removing the right oil mist separator pipeline to the intake manifold, page 364.)

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- ❑ Pipeline from cycle valve to connection line is removed. (For more information see: Removing the pipeline from the cycle valve to the connection line, page 301.)
- ❑ Ventilation line from exhaust gas turbocharger to expansion tank is removed. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)
- ❑ Fuel return line from engine control unit to distributor block is removed. (For more information see: Removing the fuel return line from the engine control unit to the distributor block, page 197.)
- ❑ Right fuel return line from injectors to distributor block is removed. (For more information see: Removing the right fuel return lines from the injectors to the distributor block, page 196.)
- ❑ Right fuel rail is removed. (For more information see: Removing the fuel rails, page 218.)

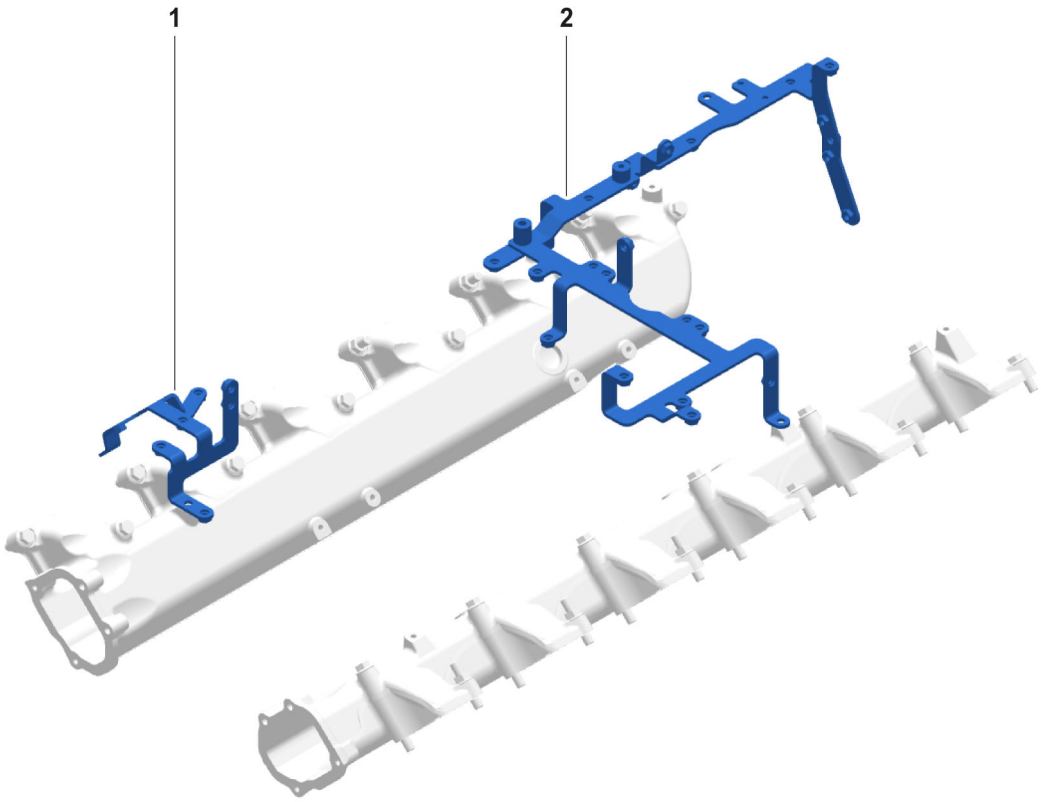

Fig. 360: Right air intake manifold

1 Bracket **2** Bracket

▶ Remove cable harness as needed. (For more information see: Removing the cable harness, page 475.)

▶ Remove bracket **1**.

▶ Remove bracket **2**.

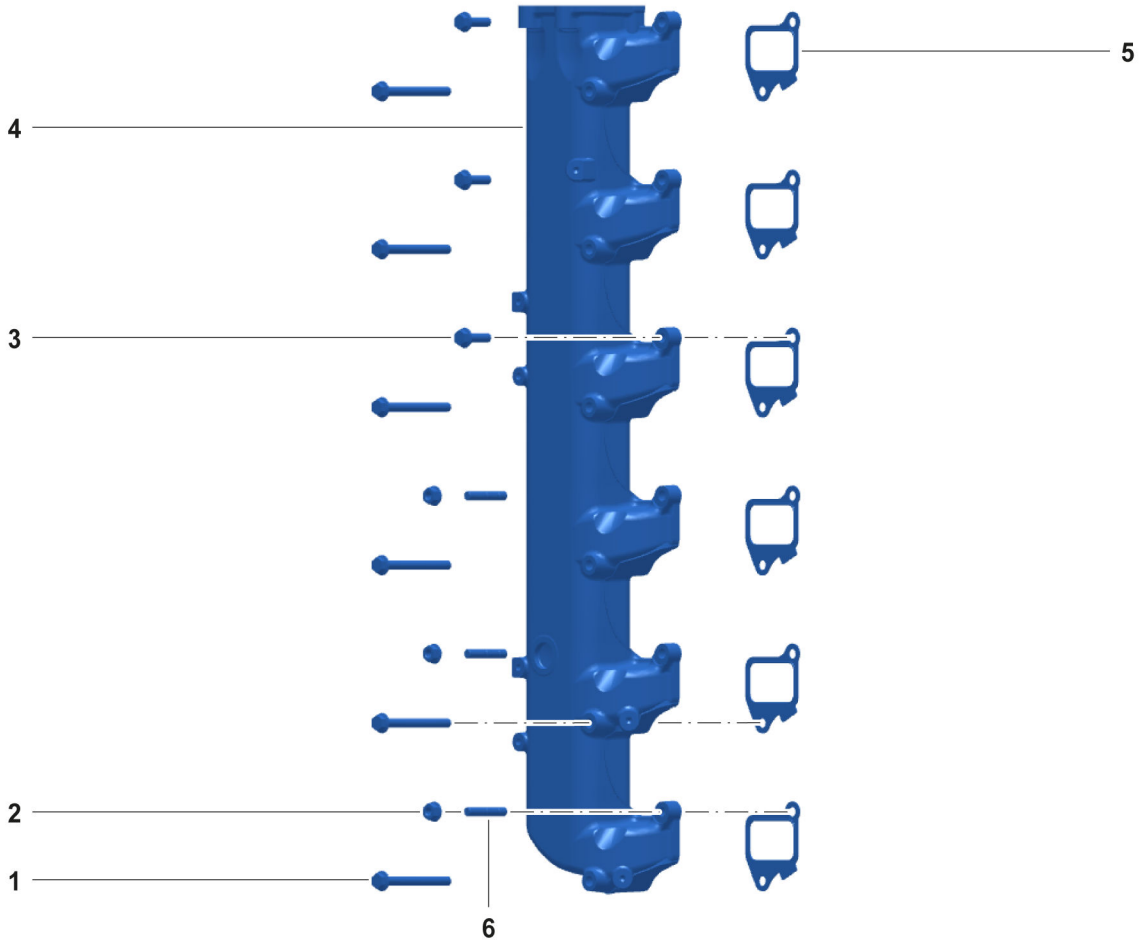

Fig. 361: Right air intake manifold

1 Hex head screw (6x)
2 Hex nut (3x)
3 Hex head screw (3x)
4 Air intake manifold
5 Seal (6x)
6 Stud bolt (3x)

- ▶ Unscrew hex nuts **2**.
- ▶ Unscrew stud bolts **6**.
- ▶ Unscrew hex head screws **3**.
- ▶ Unscrew hex head screws **1**.
- ▶ Remove air intake manifold **4**.
- ▶ Remove seals **5**.

Checking and cleaning the right air intake manifold

- ▶ Check air intake manifold **4** for damage and replace if necessary.
- ▶ Clean sealing surfaces of air intake manifold **4**.
- ▶ Clean sealing surfaces of cylinder heads.

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Installing the right air intake manifold

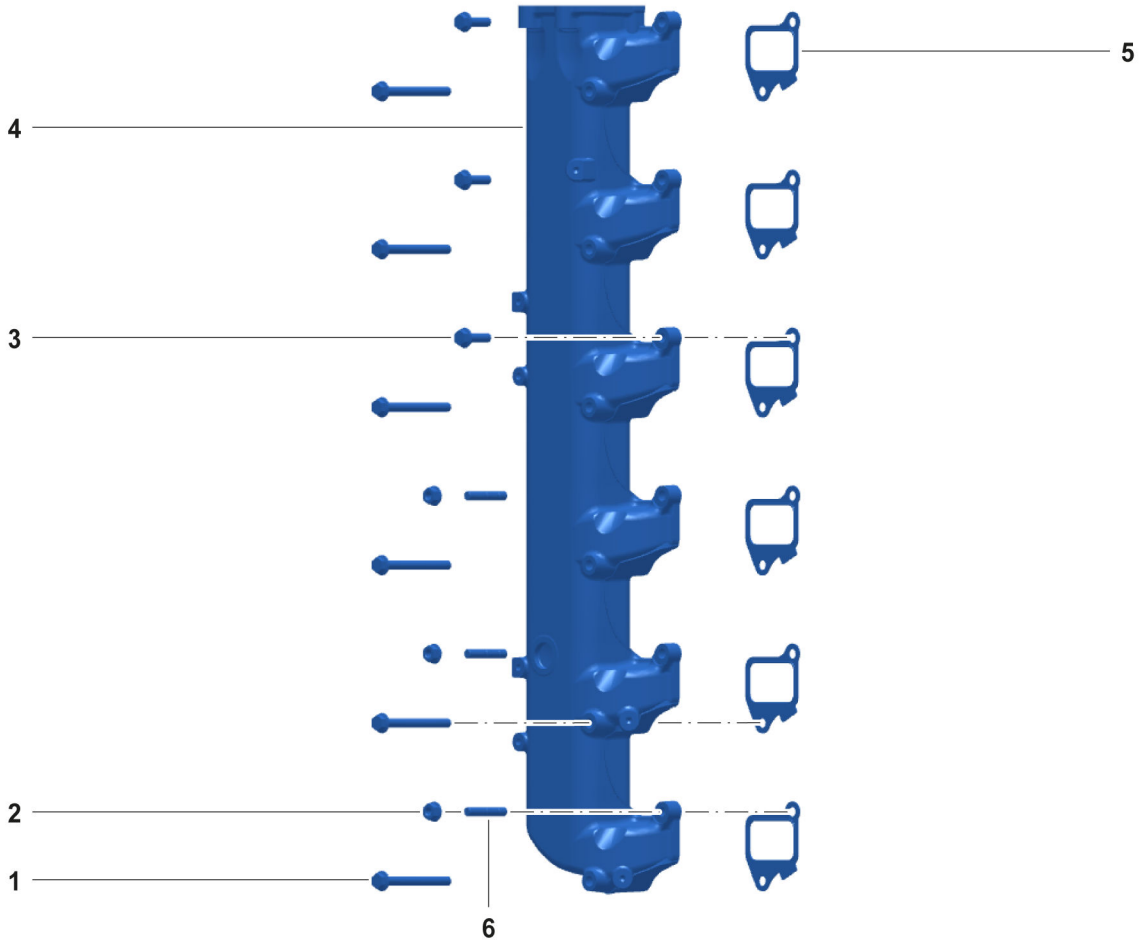
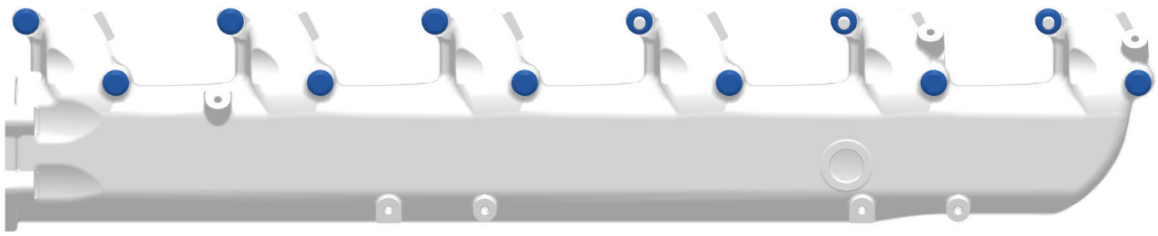


Fig. 362: Right air intake manifold

1 Hex head screw (6x)
2 Hex nut (3x)
3 Hex head screw (3x)
4 Air intake manifold
5 Seal (6x)
6 Stud bolt (3x)

▶ Align new seals **5**.

▶ Align air intake manifold **4**.

Tightening instruction for hex head screw and hex nut	
	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-

Tightening instruction for hex head screw and hex nut	
Screws	Reusable
Stage	**Tightening torque**
1.	53 Nm

Tab. 85: Tightening instruction 12489993-000

- ▶ Tighten hex head screws **1** according to tightening instruction.
- ▶ Tighten hex head screws **3** according to tightening instruction.
- ▶ Tighten stud bolts **6**.
- ▶ Tighten hex nuts **2** according to tightening instruction.

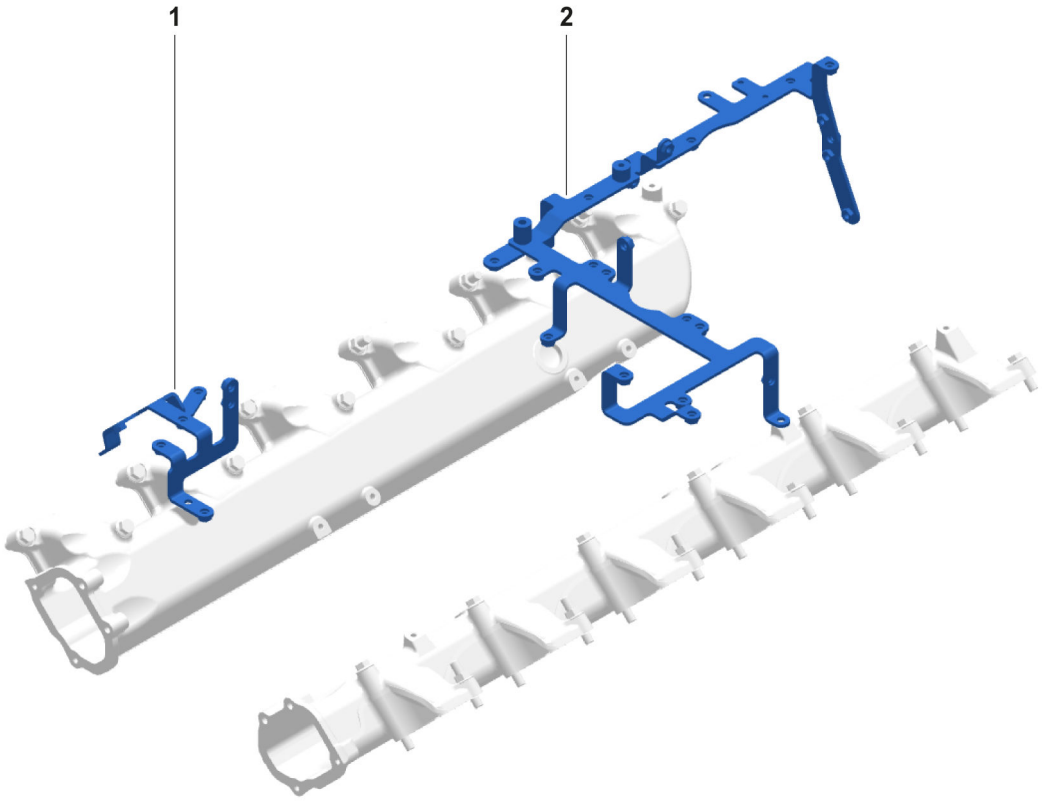


Fig. 364: Right air intake manifold

1 Bracket **2** Bracket

- ▶ Install bracket **2**.
- ▶ Install bracket **1**.
- ▶ Install cable harness. (For more information see: Installing the cable harness, page 476.)

Removing and installing the connection line

Removing the connection line

Make sure that the following prerequisites are met:
- ❑ Device side line is removed from the connection line, see documentation from the device manufacturer.

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- ❑ Ventilation line from cylinder banks to expansion tank is removed from connection line. (For more information see: Removing the ventilation line from the cylinder banks to the expansion tank, page 412.)
- ❑ Left heating flange is removed. (For more information see: 3.12.1 Removing and installing the left heating flange, page 460.)
- ❑ Right heating flange is removed. (For more information see: 3.12.2 Removing and installing the right heating flange, page 462.)
- ❑ Bracket of coolant manifold is removed. (For more information see: Removing the coolant manifold, page 425.)
- ❑ Bracket of left oil mist separator pipeline to intake manifold is removed from connection line. (For more information see: Removing the left oil mist separator pipeline to the intake manifold, page 360.)
- ❑ Bracket of right oil mist separator pipeline to intake manifold is removed from connection line. (For more information see: Removing the right oil mist separator pipeline to the intake manifold, page 364.)
- ❑ Pipeline from cycle valve to connection line is removed from connection line. (For more information see: Removing the pipeline from the cycle valve to the connection line, page 301.)

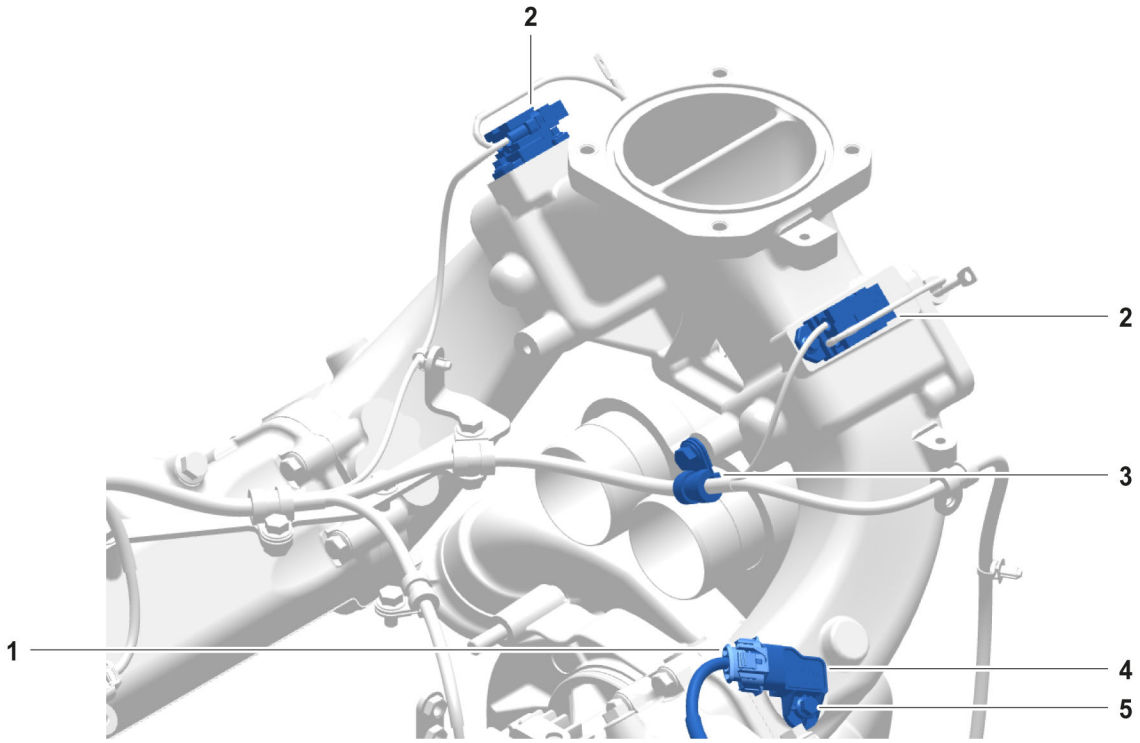

Fig. 365: Connection line

1 Electrical plug connection
2 Bracket
3 Holding clamp
4 Pressure sensor and temperature sensor
5 Hex head screw

▶ Remove bracket **2**.

▶ Remove holding clamp **3**.

▶ Disconnect electrical plug connection **1**.

▶ Unscrew hex head screw **5**.

▶ Remove pressure sensor and temperature sensor **4**.

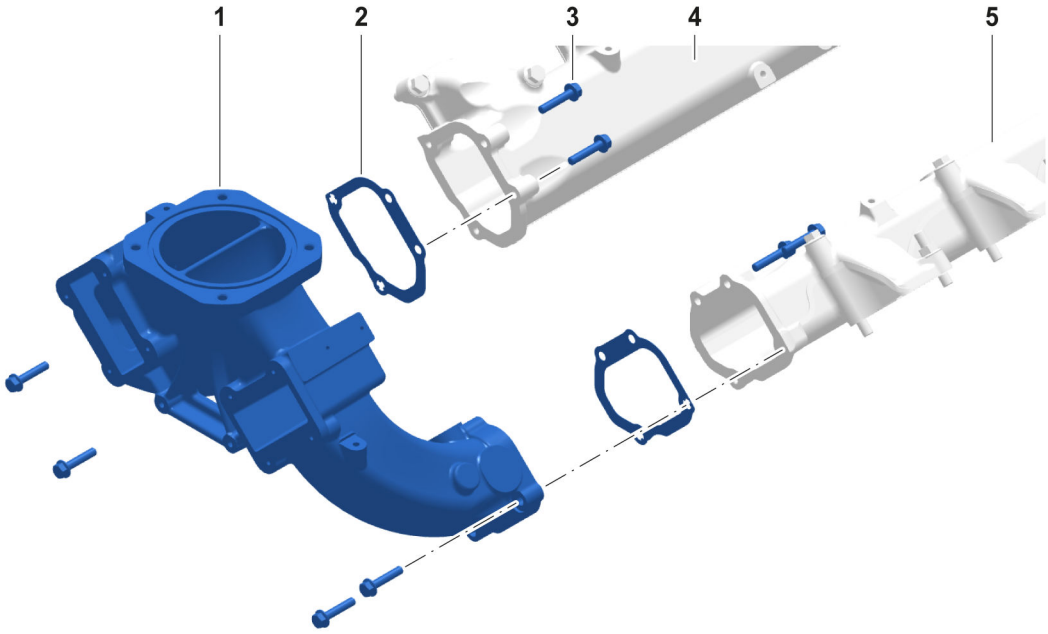

Fig. 366: Connection line

1 Connection line
2 Seal (2x)
3 Hex head screw (8x)
4 Right air intake manifold
5 Left air intake manifold

▶ Unscrew hex head screws **3**.

▶ Remove connection line **1**.

▶ Remove seals **2**.

Cleaning the connection line

▶ Clean sealing surfaces on connection line **1**.

▶ Clean sealing surfaces on right air intake manifold **4**.

▶ Clean sealing surfaces on left air intake manifold **5**.

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Installing the connection line

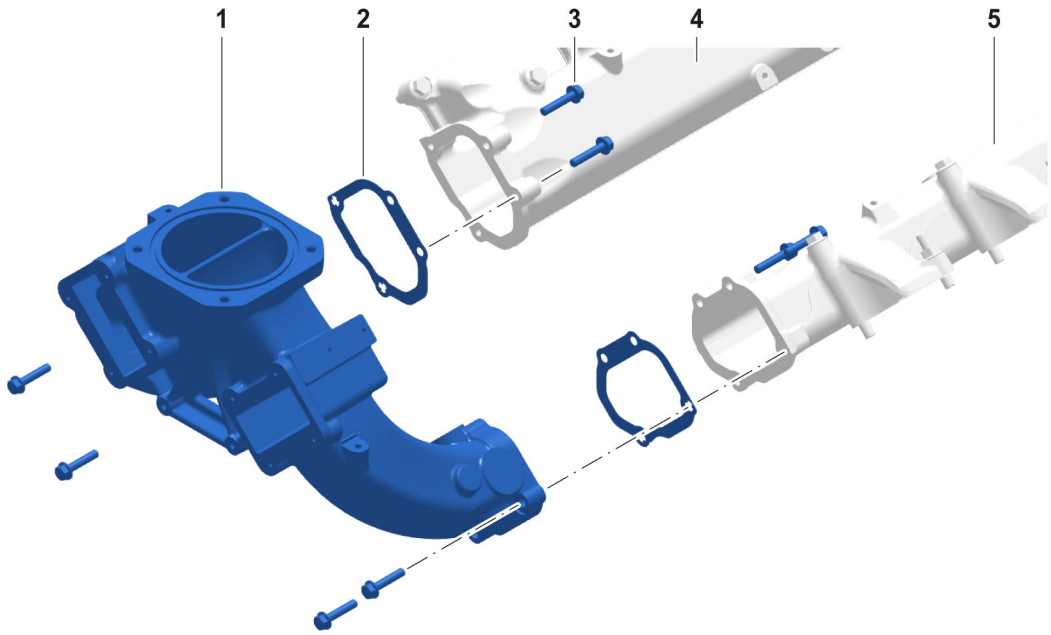

Fig. 367: Connection line

1 Connection line
2 Seal (2x)
3 Hex head screw (8x)
4 Right air intake manifold
5 Left air intake manifold

▶ Align new seals **2**.

▶ Install connection line **1**.

▶ Tighten hex head screws **3**.

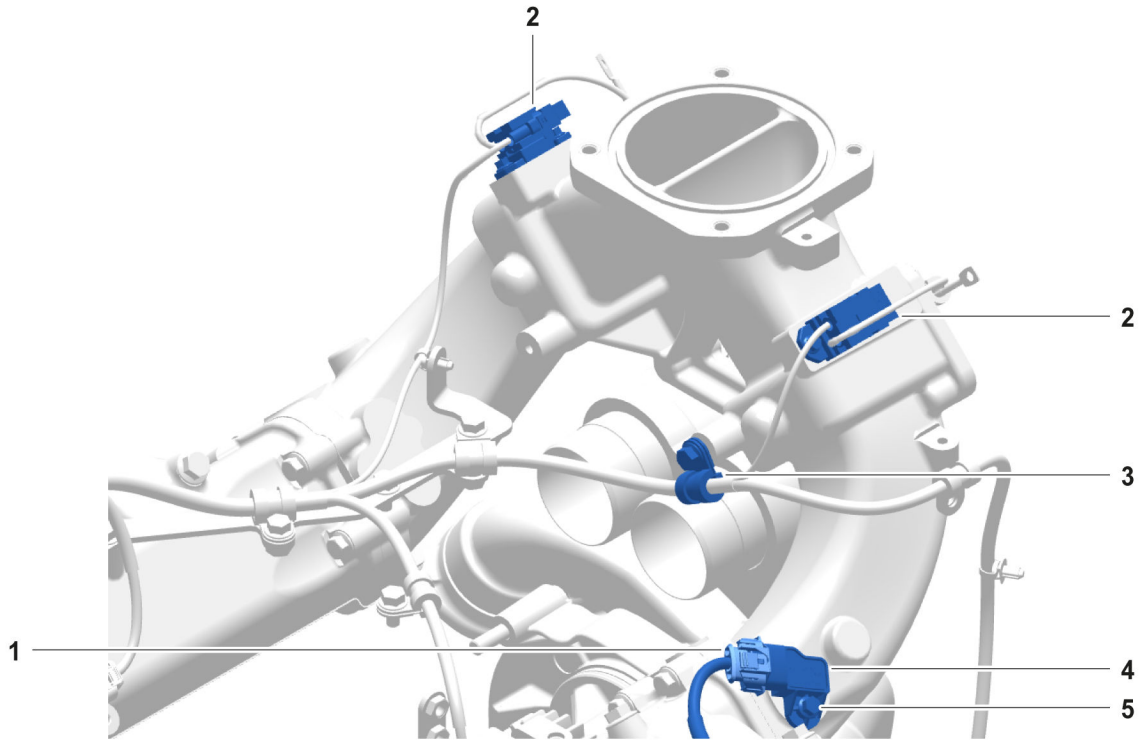

Fig. 368: Connection line

1 Electrical plug connection
2 Bracket
3 Holding clamp
4 Pressure sensor and temperature sensor
5 Hex head screw

▶ Install pressure sensor and temperature sensor **4**.

▶ Tighten hex head screw **5** according to tightening instruction. (see: tab. 112, page 474)

▶ Connect electrical plug connection **1**.

▶ Install holding clamp **3**.

▶ Install bracket **2**.

3.7.2 Removing and installing the left intake manifold

Removing the left intake manifold

Make sure that the following prerequisites are met:
❑ Device side intake line is removed from left intake manifold, see documentation from the device manufacturer.
❑ Left oil mist separator pipeline to intake manifold is removed from intake manifold. (For more information see: Removing the left oil mist separator pipeline to the intake manifold, page 360.)

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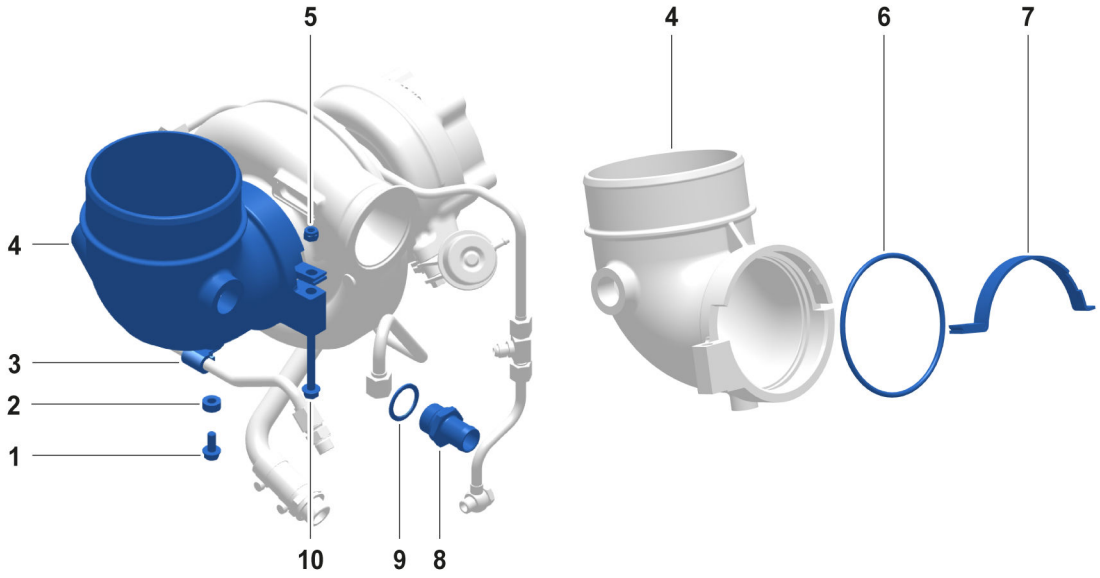

Fig. 369: Intake manifold

1 Hex head screw
2 Spacer
3 Holding clamp
4 Intake manifold
5 Locknut
6 O-ring
7 U-clamp
8 Hose nipple
9 Sealing ring
10 Hex head screw

- ▶ Unscrew hex head screw **1**.
- ▶ Remove spacer **2**.
- ▶ Unscrew locknut **5**.
- ▶ Unscrew hex head screw **10**.
- ▶ Remove intake manifold **4**.
- ▶ If necessary, remove u-clamp **7**.
- ▶ Remove o-ring **6**.
- ▶ If necessary, unscrew hose nipple **8**.
- ▶ Remove sealing ring **9**.

Cleaning the left intake manifold

- ▶ Clean groove of sealing ring **9**.
- ▶ Clean sealing surface of hose nipple **8**.

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Installing the left intake manifold

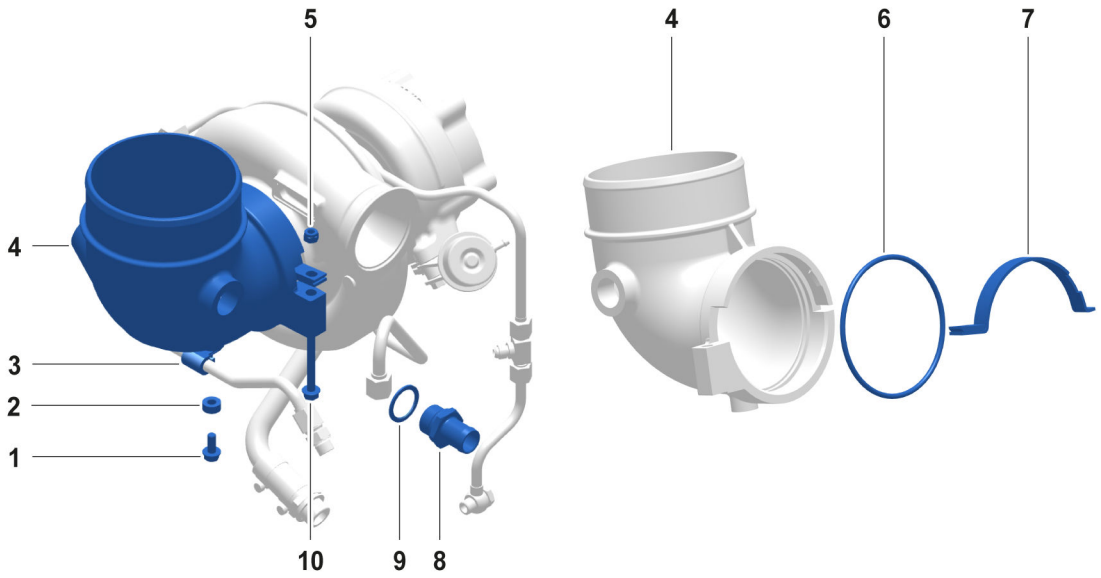

Fig. 370: Intake manifold

1 Hex head screw
2 Spacer
3 Holding clamp
4 Intake manifold
5 Locknut
6 O-ring
7 U-clamp
8 Hose nipple
9 Sealing ring
10 Hex head screw

▶ Install new sealing ring **9**.

▶ Tighten hose nipple **8**.

▶ Lubricate new o-ring **6** with NBU 30 grease.

▶ Install o-ring **6**.

▶ Install u-clamp **7**.

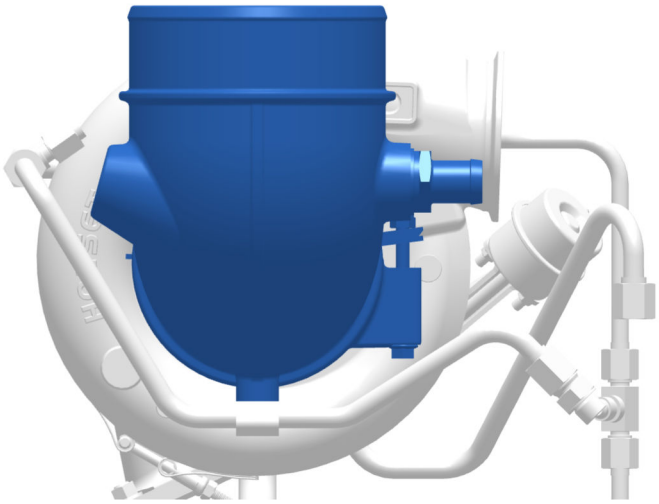

Fig. 371: Intake manifold mounting angle

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- ▶ Install intake manifold **4** at a 90° angle.
- ▶ Install hex head screw **10**.
- ▶ Tighten new locknut **5**.
- ▶ Install holding clamp **3**.
- ▶ Tighten spacer **2** with hex head screw **1**.

3.7.3 Removing and installing the right intake manifold

Removing the right intake manifold

Make sure that the following prerequisites are met:

- ❑ Device side intake line is removed from right intake manifold, see documentation from the device manufacturer.
- ❑ Right oil mist separator pipeline to intake manifold is removed from intake manifold. (For more information see: Removing the right oil mist separator pipeline to the intake manifold, page 364.)
- ❑ Pipeline is removed from intake manifold. (For more information see: Removing the pipeline, page 451.)

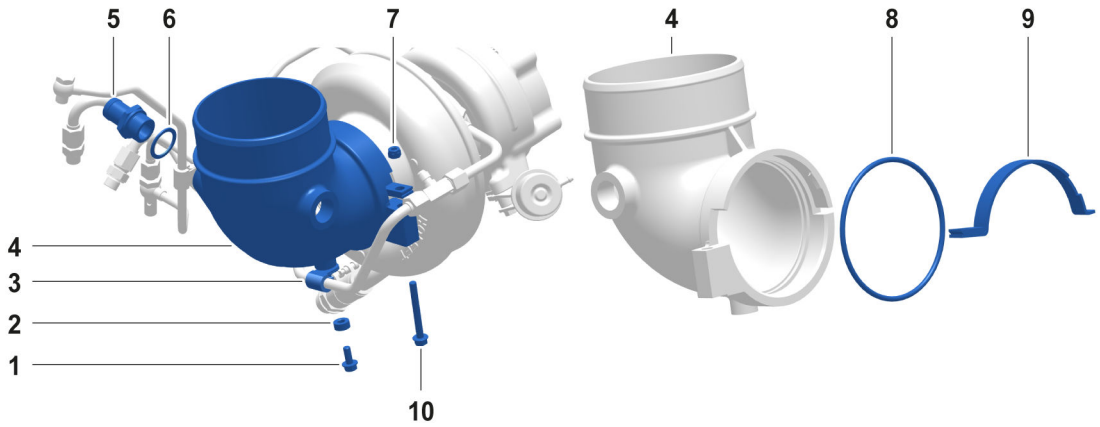

Fig. 372: Intake manifold

1	Hex head screw	**6**	Sealing ring
2	Spacer	**7**	Locknut
3	Holding clamp	**8**	O-ring
4	Intake manifold	**9**	U-clamp
5	Hose nipple	**10**	Hex head screw

- ▶ Unscrew hex head screw **1**.
- ▶ Remove spacer **2**.
- ▶ Unscrew locknut **7**.
- ▶ Unscrew hex head screw **10**.
- ▶ Remove intake manifold **4**.
- ▶ If necessary, remove u-clamp **9**.
- ▶ Remove o-ring **8**.
- ▶ If necessary, unscrew hose nipple **5**.
- ▶ Remove sealing ring **6**.

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Cleaning the right intake manifold

- ▶ Clean groove of sealing ring **6**.
- ▶ Clean sealing surface of hose nipple **5**.

Installing the right intake manifold

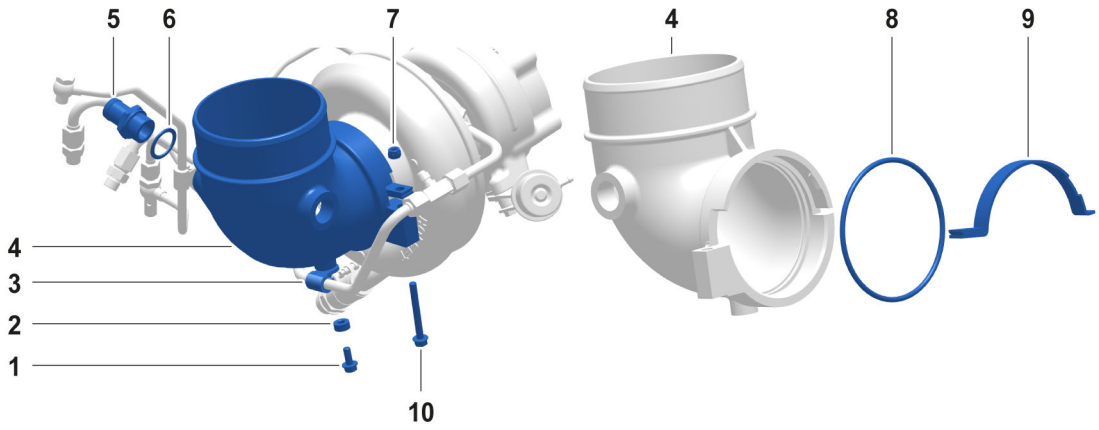

Fig. 373: Intake manifold

1 Hex head screw
2 Spacer
3 Holding clamp
4 Intake manifold
5 Hose nipple
6 Sealing ring
7 Locknut
8 O-ring
9 U-clamp
10 Hex head screw

- ▶ Install new sealing ring **6**.
- ▶ Tighten hose nipple **5**.
- ▶ Lubricate new o-ring **8** with NBU 30 grease.
- ▶ Install o-ring **8**.
- ▶ Install u-clamp **9**.

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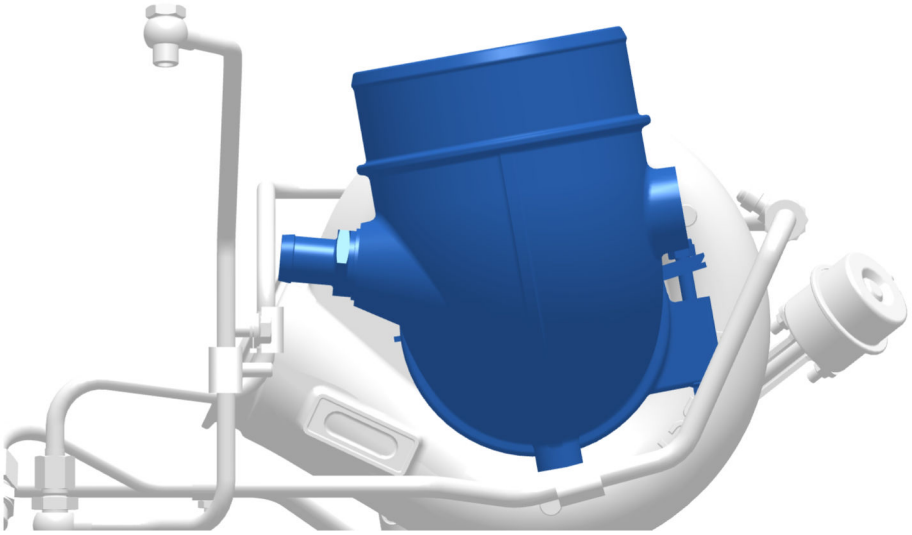

Fig. 374: Intake manifold mounting angle

- ▶ Install intake manifold **4** at a 80° angle.
- ▶ Install hex head screw **10**.
- ▶ Tighten new locknut **7**.
- ▶ Install holding clamp **3**.
- ▶ Tighten spacer **2** with hex head screw **1**.

3.7.4 Removing and installing the charge air pipe

Removing the charge air pipe

Make sure that the following prerequisites are met:

- ❑ Device side charge air pipe is removed, see documentation from the device manufacturer.
- ❑ Engine control unit is removed. (For more information see: Removing the engine control unit, page 470.)
- ❑ Pipeline of coolant manifold is removed. (For more information see: Removing the pipeline, page 417.)
- ❑ End control valve pipeline and bracket are removed. (For more information see: Removing the end control valve pipeline, page 348.) (For more information see: Removing the bracket, page 352.)
- ❑ Ventilation line from exhaust gas turbocharger to expansion tank is removed. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)
- ❑ Device fuel line to fuel high pressure pumps is removed. (For more information see: Removing the device fuel line to the fuel prefeeding pumps, page 187.)
- ❑ Fuel return lines from fuel fine filter to fuel tank are removed. (For more information see: Removing the fuel return line from the fuel fine filter to the fuel tank, page 200.)
- ❑ Old holding clamps of cable harness are removed from charge air pipe.

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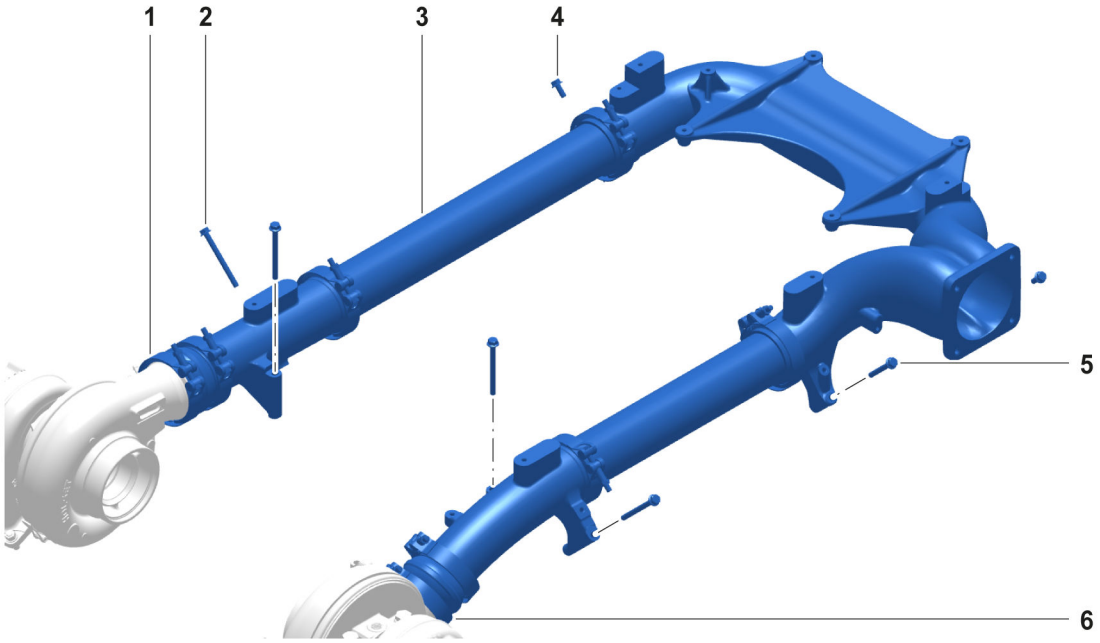

Fig. 375: Charge air pipe

1 Left tension clamp
2 Hex head screw (4x)
3 Charge air pipe
4 Hex head screw (2x)
5 Hex head screw
6 Right tension clamp

▶ Remove tension clamp **1**.

▶ Remove tension clamp **6**.

▶ Unscrew hex head screw **5**.

▶ Unscrew hex head screws **4**.

▶ Unscrew hex head screws **2**.

▶ Remove charge air pipe **3**.

Dismantling the charge air pipe

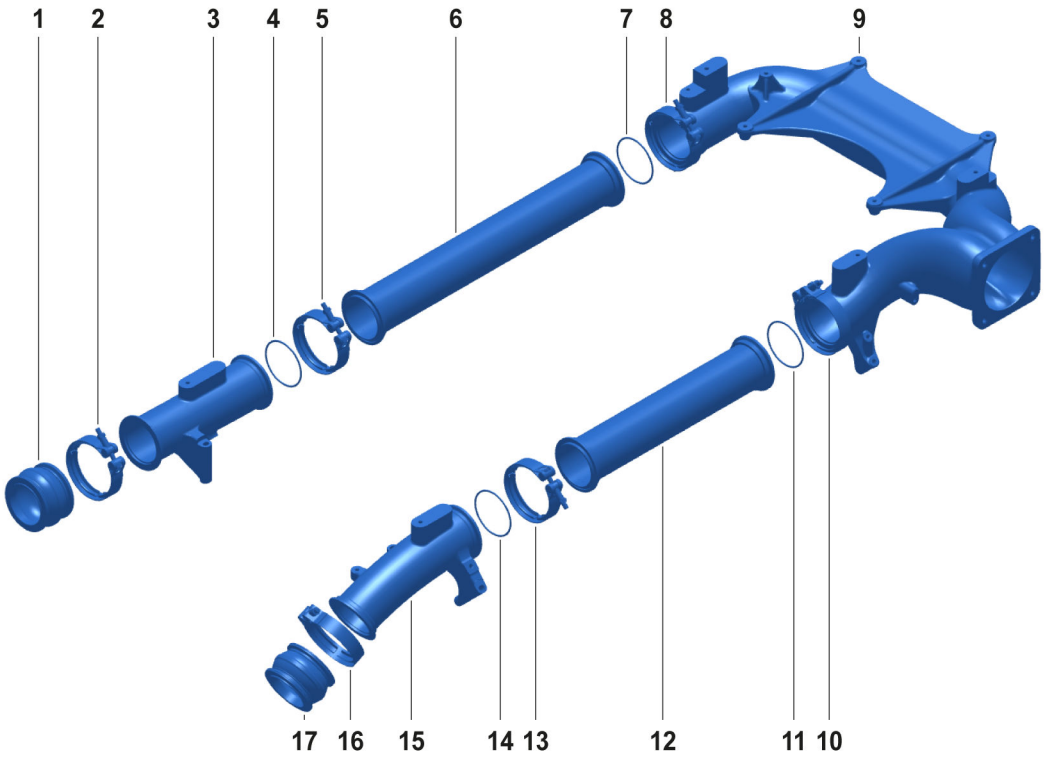

Fig. 376: Dismantling the charge air pipe

1 Rubber sleeve
2 Tension clamp
3 Left pipeline
4 O-ring
5 Tension clamp
6 Left pipe socket
7 O-ring
8 Tension clamp
9 Charge air pipe
10 Tension clamp
11 O-ring
12 Right pipeline
13 Tension clamp
14 O-ring
15 Right pipe socket
16 Tension clamp
17 Rubber sleeve

- ▶ Remove tension clamp **2**.
- ▶ Remove rubber sleeve **1**.
- ▶ Remove tension clamp **5**.
- ▶ Remove left pipeline **3**.
- ▶ Remove o-ring **4**.
- ▶ Remove tension clamp **8**.
- ▶ Remove left pipe socket **6**.
- ▶ Remove o-ring **7**.
- ▶ Remove tension clamp **16**.
- ▶ Remove rubber sleeve **17**.
- ▶ Remove tension clamp **13**.
- ▶ Remove right pipe socket **15**.
- ▶ Remove o-ring **14**.

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- ▶ Remove tension clamp **10**.
- ▶ Remove right pipeline **12**.
- ▶ Remove o-ring **11**.

Checking and cleaning the charge air pipe

- ▶ Check pipelines for damage and replace if necessary.
- ▶ Check pipe socket for damage and replace if necessary.
- ▶ Check rubber sleeves for damage and replace if necessary.
- ▶ Check tension clamps for damage and replace if necessary.
- ▶ Clean sealing surfaces on exhaust gas turbochargers.
- ▶ Clean sealing surfaces on charge air pipe.
- ▶ Clean sealing surfaces on pipelines and pipe socket.

Assembling the charge air pipe

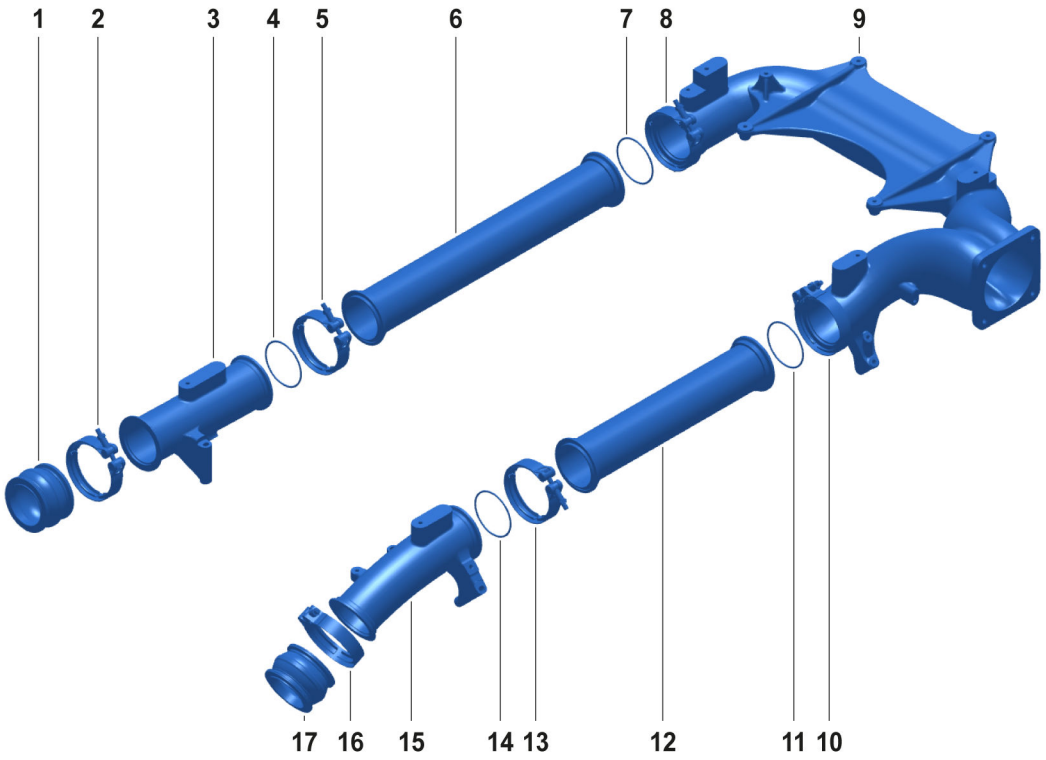

Fig. 377: Assembling the charge air pipe

1 Rubber sleeve
2 Tension clamp
3 Left pipeline
4 O-ring
5 Tension clamp
6 Left pipe socket
7 O-ring
8 Tension clamp
9 Charge air pipe
10 Tension clamp
11 O-ring
12 Right pipeline
13 Tension clamp
14 O-ring
15 Right pipe socket
16 Tension clamp
17 Rubber sleeve

- ▶ Install new o-ring **11**.

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▶ Install right pipeline **12**.

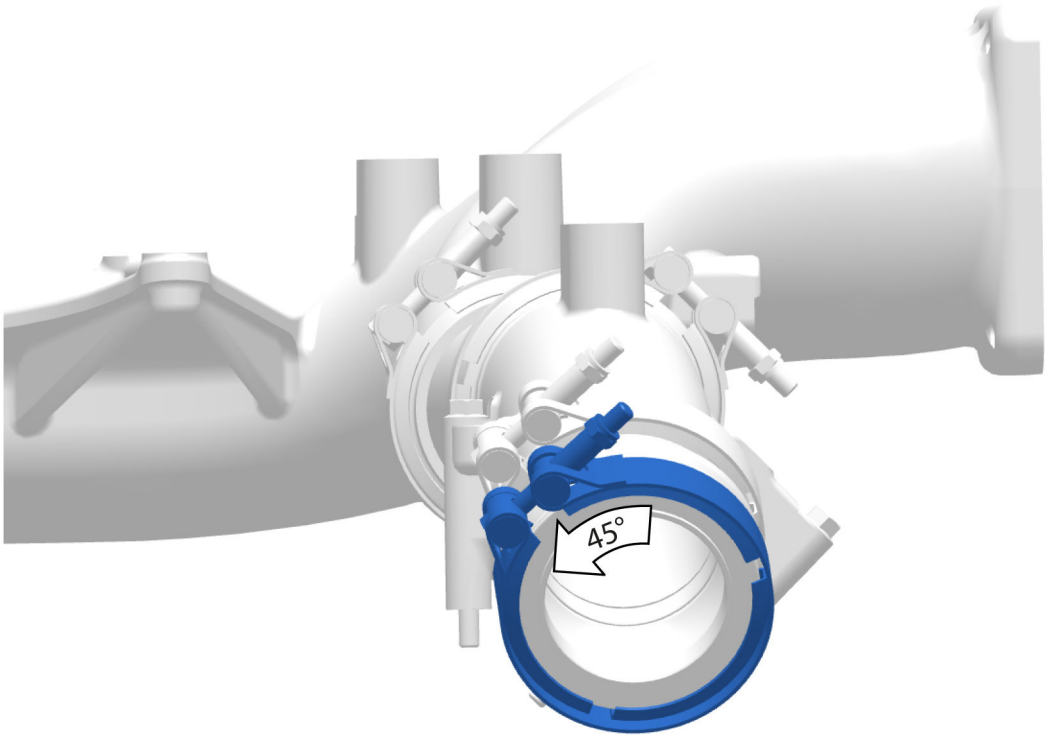

Fig. 378: Mounting angle of right tension clamps

▶ Install tension clamp **10** at a 45° angle.

▶ Install new o-ring **14**.

▶ Install right pipe socket **15**.

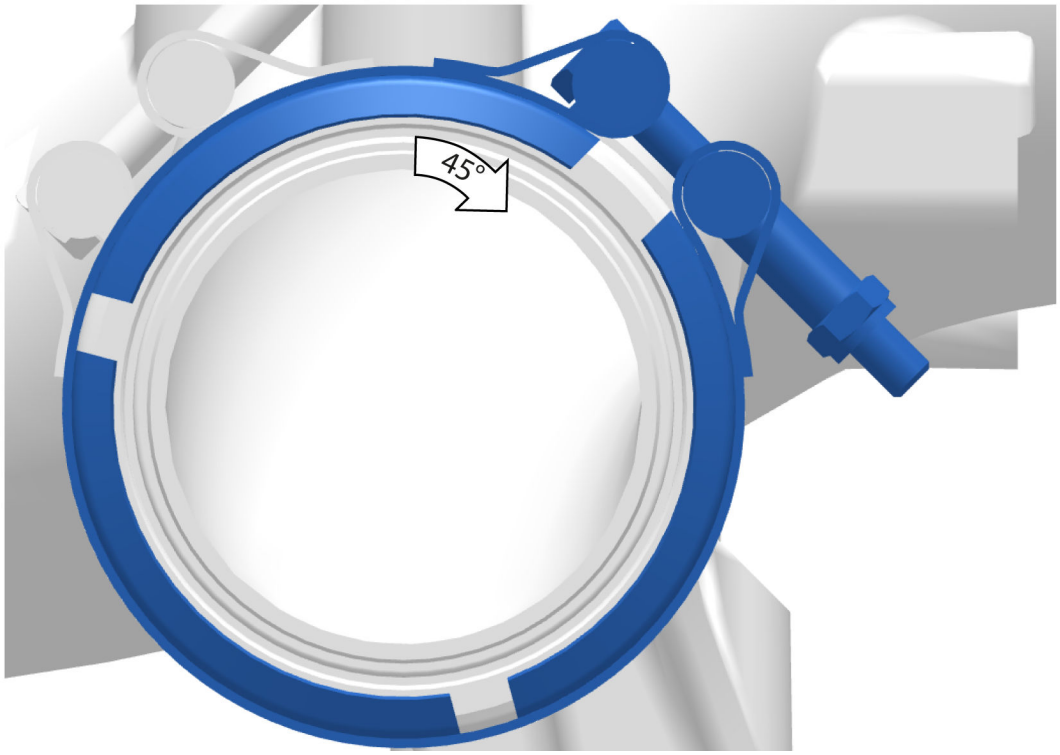

Fig. 379: Mounting angle of right pipeline tension clamp to right pipe socket

- ▶ Install tension clamp **13** at a 45° angle.
- ▶ Install rubber sleeve **17**.
- ▶ Install tension clamp **16** at a 45° angle. (see: fig. 378, page 295)
- ▶ Install new o-ring **7**.
- ▶ Install left pipe socket **6**.

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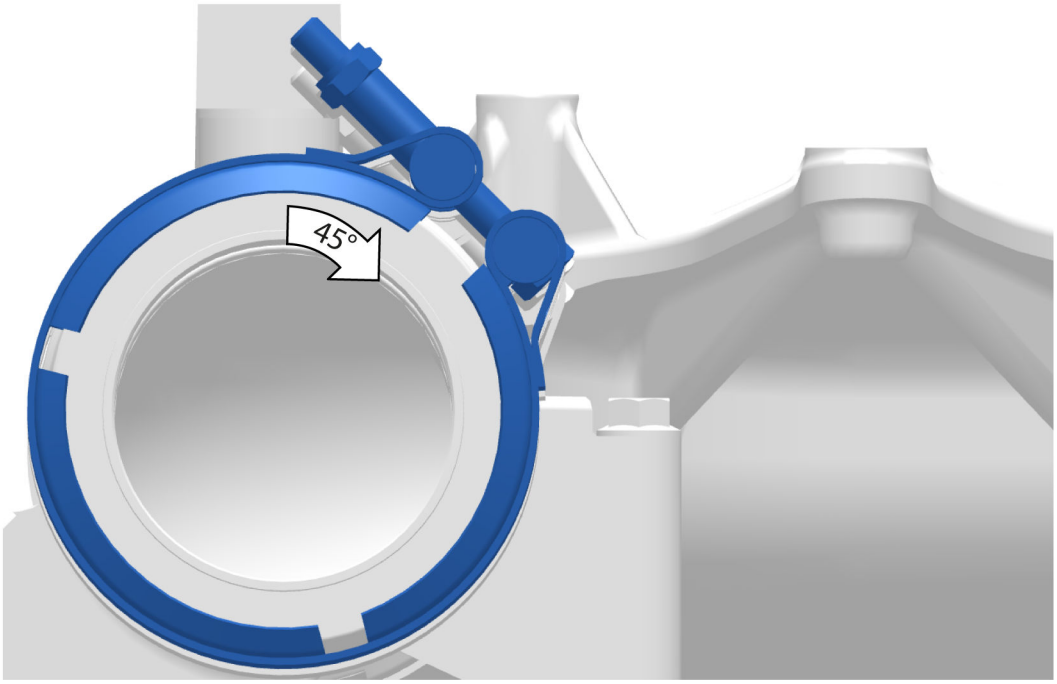

Fig. 380: Mounting angle of left tension clamps

- ▶ Install tension clamp **8** at a 45° angle.
- ▶ Install new o-ring **4**.
- ▶ Install left pipeline **3**.
- ▶ Install tension clamp **5** at a 45° angle. (see: fig. 380, page 297)
- ▶ Install rubber sleeve **1**.
- ▶ Install tension clamp **2** at a 45° angle. (see: fig. 380, page 297)

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Installing the charge air pipe

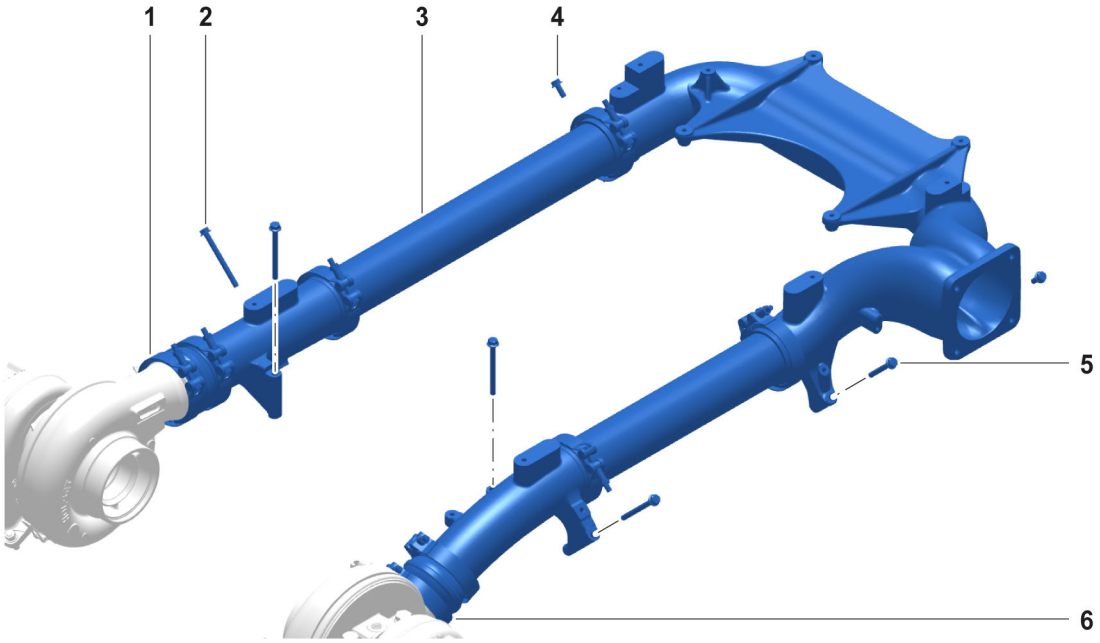

Fig. 381: Charge air pipe

1 Left tension clamp
2 Hex head screw (4x)
3 Charge air pipe
4 Hex head screw (2x)
5 Hex head screw
6 Right tension clamp

▶ Install charge air pipe **3**.

▶ Tighten hex head screws **2**.

▶ Tighten hex head screws **4**.

▶ Tighten hex head screw **5**.

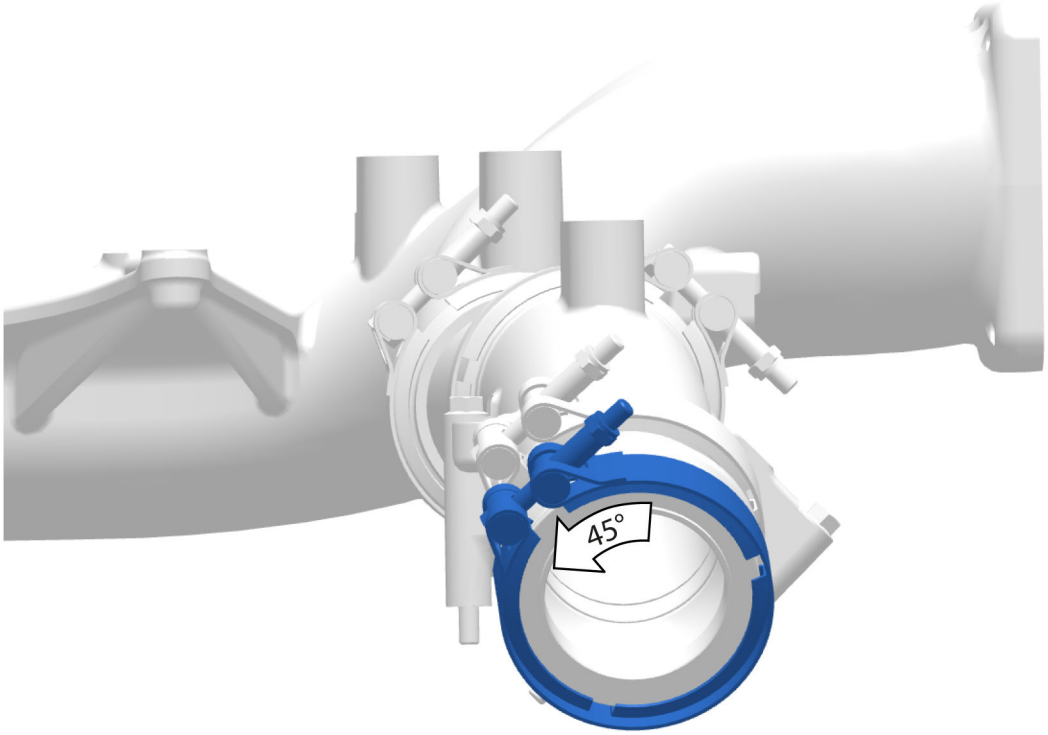

Fig. 382: Mounting angle of right tension clamps

▶ Install tension clamp **6** at a 45° angle.

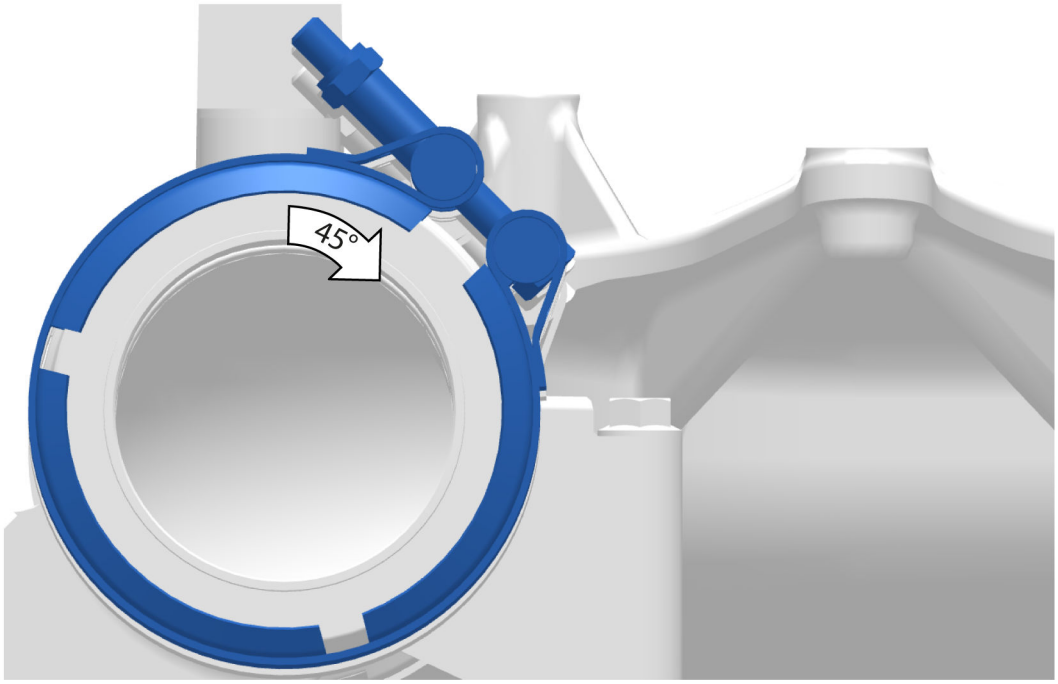

Fig. 383: Mounting angle of left tension clamps

▶ Install tension clamp **1** at a 45° angle.

3.7.5 Charging pressure regulation

Removing and installing the charging pressure regulation

Removing the pipeline from the cycle valve to the vacuum actuator

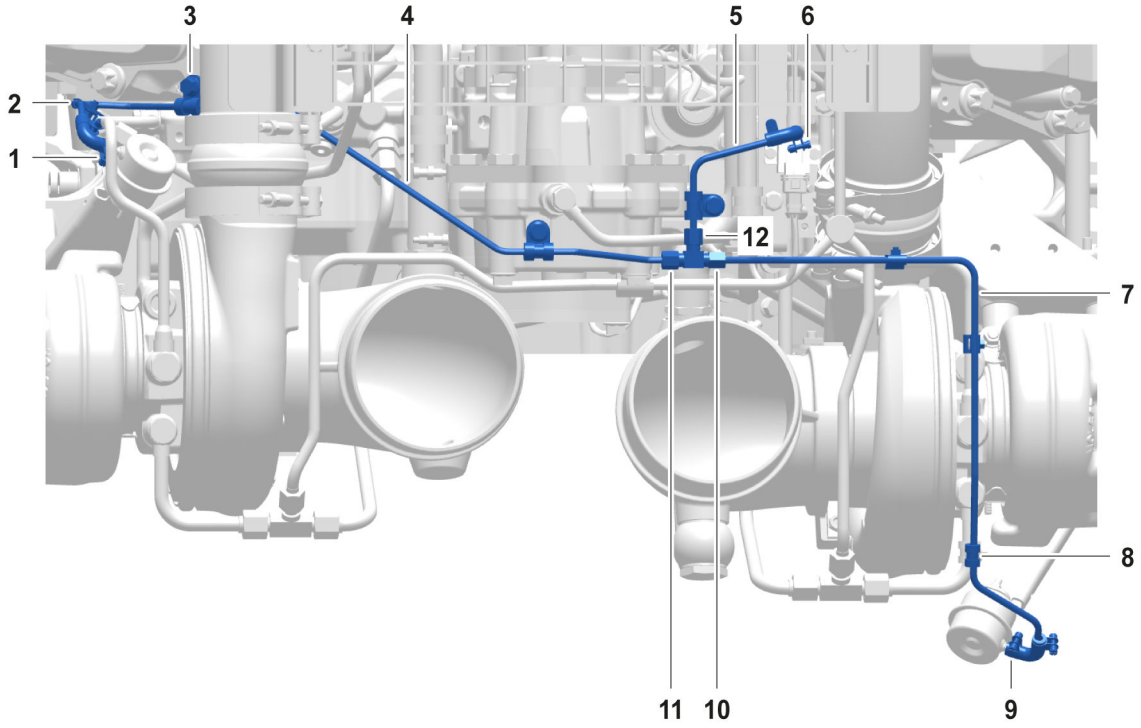

Fig. 384: Pipeline

1 Hose clamp
2 Holding clamp (3x)
3 Holding clamp (3x)
4 Pipeline
5 Pipeline
6 Hose clamp
7 Pipeline
8 Holding clamp
9 Hose clamp
10 Box nut
11 Box nut
12 Box nut

- ▶ Remove holding clamp **2** from pipeline **4**.
- ▶ Remove holding clamps **3** from pipeline **4**.
- ▶ Unscrew box nut **11**.
- ▶ Remove hose clamp **1**.
- ▶ Remove pipeline **4** from vacuum actuator.
- ▶ Remove pipeline **4**.
- ▶ Seal openings of pipeline **4**.
- ▶ Remove holding clamp **3** from pipeline **5**.
- ▶ Unscrew box nut **12**.
- ▶ Remove hose clamp **6**.
- ▶ Remove pipeline **5** from cycle valve.
- ▶ Remove pipeline **5**.
- ▶ Seal openings of pipeline **5**.

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- ▶ Remove holding clamps **2** from pipeline **7**.
- ▶ Remove holding clamp **8**.
- ▶ Unscrew box nut **10**.
- ▶ Remove hose clamp **9**.
- ▶ Remove pipeline **7** from vacuum actuator.
- ▶ Remove pipeline **7**.
- ▶ Seal openings of pipeline **7**.

Removing the pipeline from the cycle valve to the connection line

Make sure that the following prerequisite is met:
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

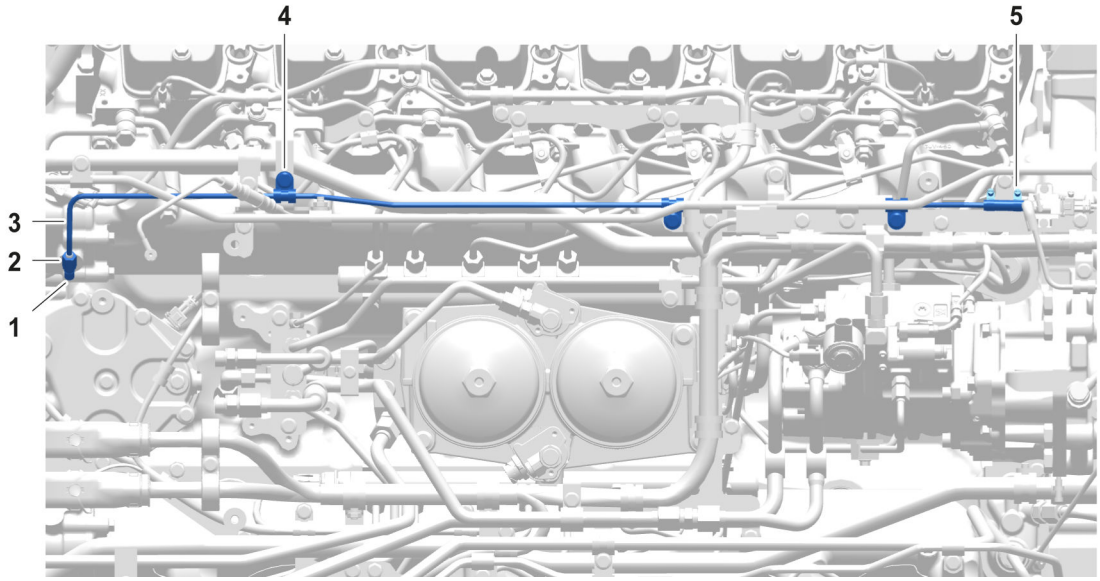

Fig. 385: Pipeline

1 Screw fitting
2 Box nut
3 Pipeline
4 Holding clamp
5 Hose clamp

- ▶ Remove holding clamps **4** from pipeline **3**.
- ▶ Unscrew box nut **2**.
- ▶ Remove hose clamp **5**.
- ▶ Remove pipeline **3** from cycle valve.
- ▶ Remove pipeline **3**.
- ▶ Seal openings of pipeline **3**.
- ▶ If necessary, unscrew screw fitting **1**.
- ▶ Seal opening of charge air pipe.

Checking the pipelines

- ▶ Check rubber sleeves for damage and replace if necessary.
- ▶ Check pipelines for damage and replace if necessary.

Installing the pipeline from the cycle valve to the connection line

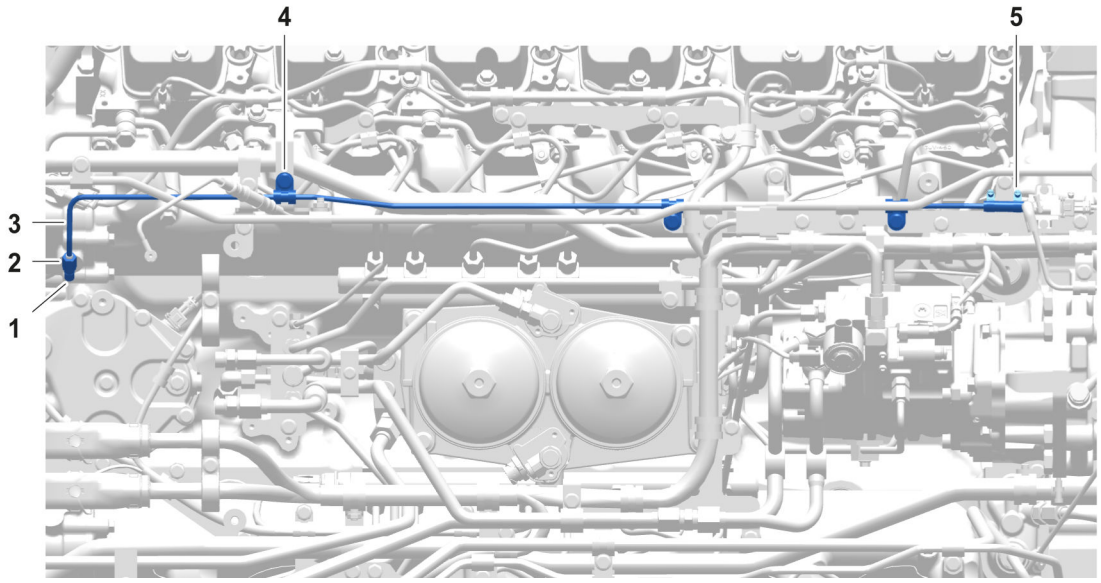

Fig. 386: Pipeline

1 Screw fitting
2 Box nut
3 Pipeline
4 Holding clamp
5 Hose clamp

- ▶ Remove closure of charge air pipe.
- ▶ Tighten screw fitting **1**.
- ▶ Remove closures of pipeline **3**.
- ▶ Align pipeline **3**.
- ▶ Install pipeline **3** on cycle valve.
- ▶ Install hose clamp **5**.
- ▶ Tighten box nut **2**.
- ▶ Install holding clamps **4** on pipeline **3**.

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Installing the pipeline from the cycle valve to the vacuum actuator

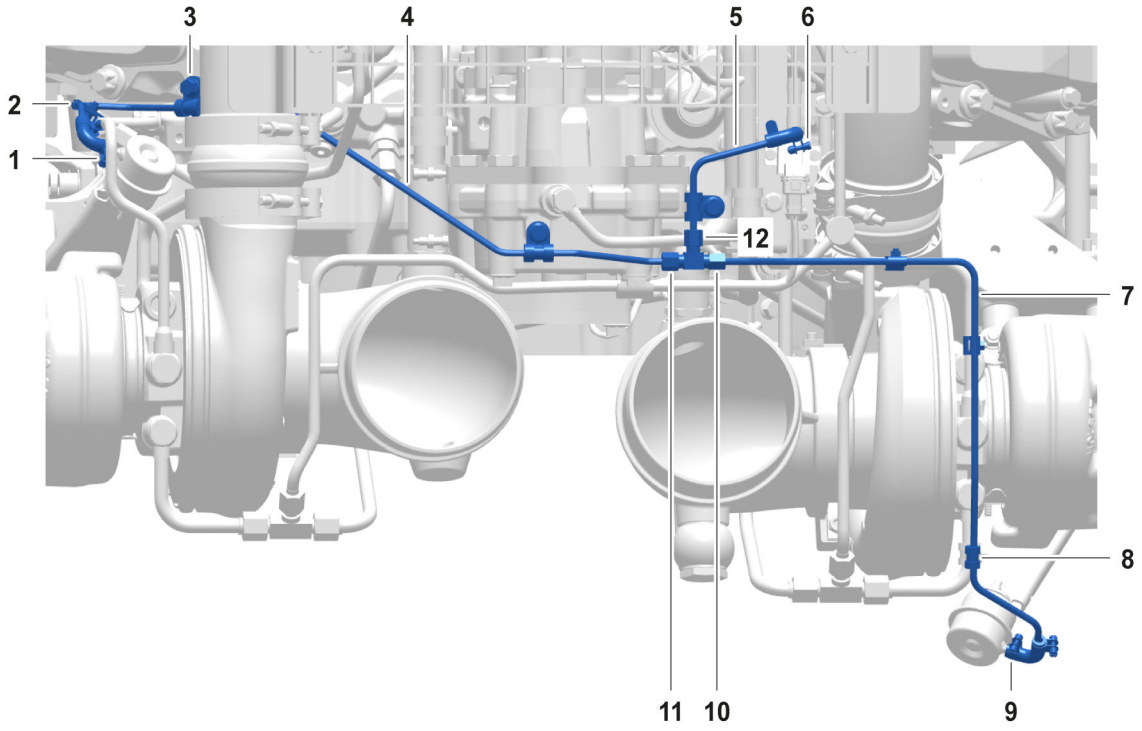

Fig. 387: Pipeline

1 Hose clamp
2 Holding clamp (3x)
3 Holding clamp (3x)
4 Pipeline
5 Pipeline
6 Hose clamp
7 Pipeline
8 Holding clamp
9 Hose clamp
10 Box nut
11 Box nut
12 Box nut

- ▶ Remove closures of pipeline **7**.
- ▶ Align pipeline **7**.
- ▶ Install pipeline **7** on vacuum actuator.
- ▶ Install hose clamp **9**.
- ▶ Tighten box nut **10**.
- ▶ Install holding clamp **8**.
- ▶ Install holding clamps **2** on pipeline **7**.
- ▶ Remove closures of pipeline **5**.
- ▶ Align pipeline **5**.
- ▶ Install pipeline **5** on cycle valve.
- ▶ Install hose clamp **6**.
- ▶ Tighten box nut **12**.
- ▶ Install holding clamp **3** on pipeline **5**.
- ▶ Remove closures of pipeline **4**.
- ▶ Align pipeline **4**.
- ▶ Install pipeline **4** on vacuum actuator.

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- ▶ Install hose clamp **1**.
- ▶ Tighten box nut **11**.
- ▶ Install holding clamps **3** on pipeline **4**.
- ▶ Install holding clamp **2** on pipeline **4**.

Removing and installing the cycle valve

Removing the cycle valve

Make sure that the following prerequisites are met:

- ❑ Pipeline from cycle valve to vacuum actuator is removed from cycle valve. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)
- ❑ Pipeline from cycle valve to charge air pipe is removed from cycle valve. (For more information see: Removing the pipeline from the cycle valve to the connection line, page 301.)

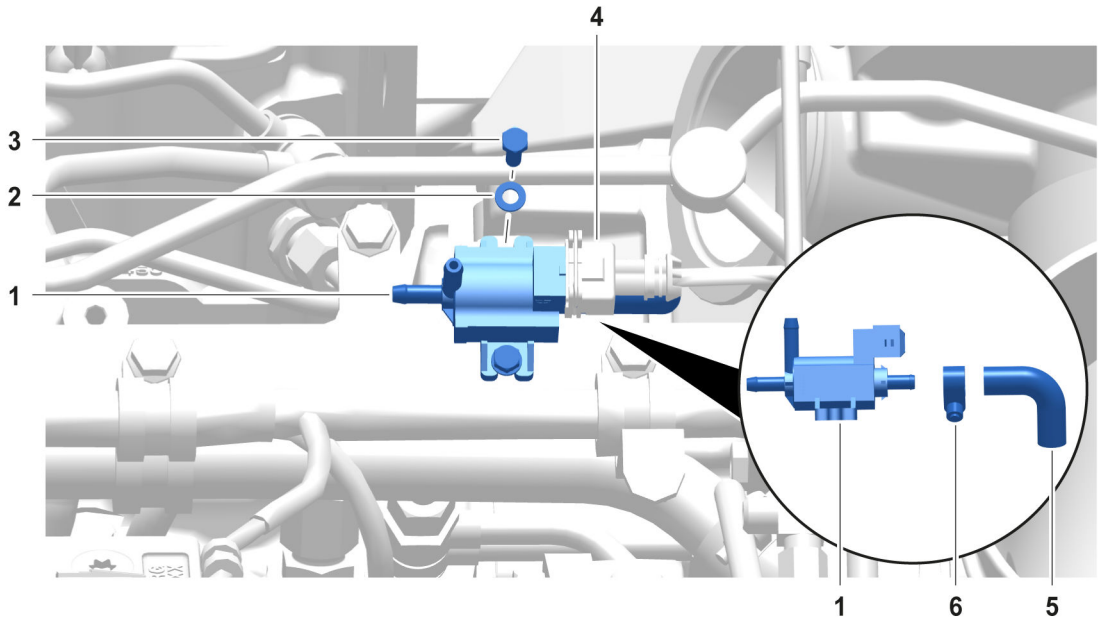

Fig. 388: Cycle valve

1 Cycle valve
2 Washer (2x)
3 Hex head screw (2x)
4 Electrical plug connection
5 Rubber sleeve
6 Hose clamp

- ▶ Disconnect electrical plug connection **4**.
- ▶ Unscrew hex head screws **3**.
- ▶ Remove washers **2**.
- ▶ Remove cycle valve **1**.
- ▶ If necessary, remove hose clamp **6**.
- ▶ Remove rubber sleeve **5**.

Checking the cycle valve

- ▶ Check rubber sleeve **5** for damage and replace if necessary.

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Installing the cycle valve

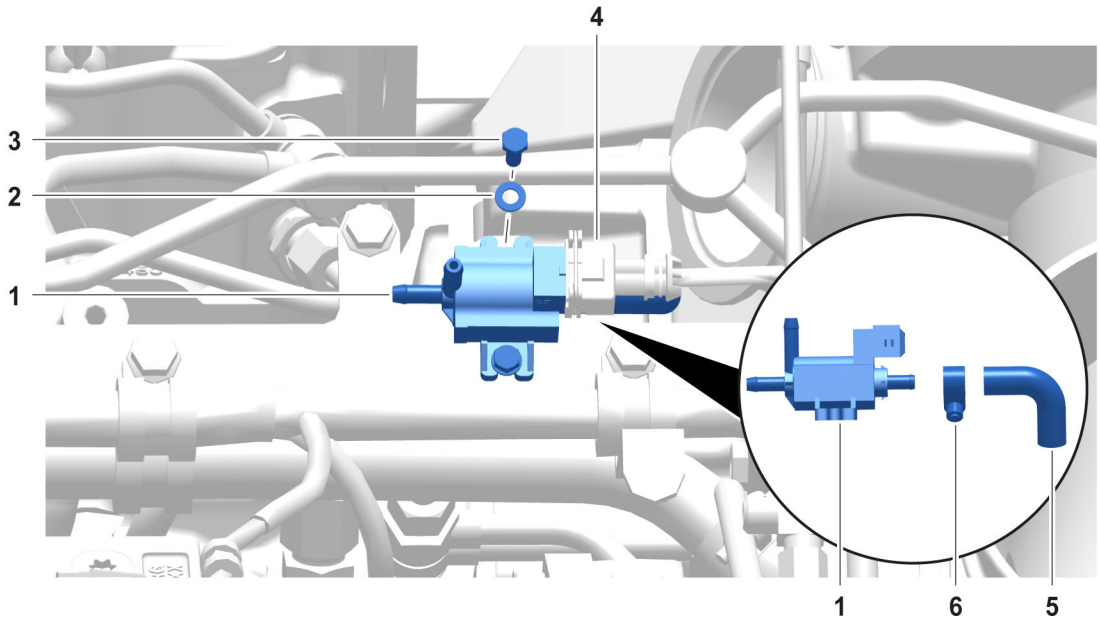

Fig. 389: Cycle valve

1 Cycle valve
2 Washer (2x)
3 Hex head screw (2x)
4 Electrical plug connection
5 Rubber sleeve
6 Hose clamp

- ▶ Install rubber sleeve **5**.
- ▶ Install hose clamp **6**.
- ▶ Install cycle valve **1**.
- ▶ Install washers **2**.
- ▶ Tighten hex head screws **3**.
- ▶ Connect electrical plug connection **4**.

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3.8 Exhaust system

3.8.1 Exhaust gas stub

Removing and installing the left exhaust gas stub

Removing the left exhaust gas stub from the exhaust gas turbocharger to the device

Make sure that the following prerequisite is met:
❑ Device side exhaust pipe is removed from the exhaust gas stub, see documentation from the device manufacturer.

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

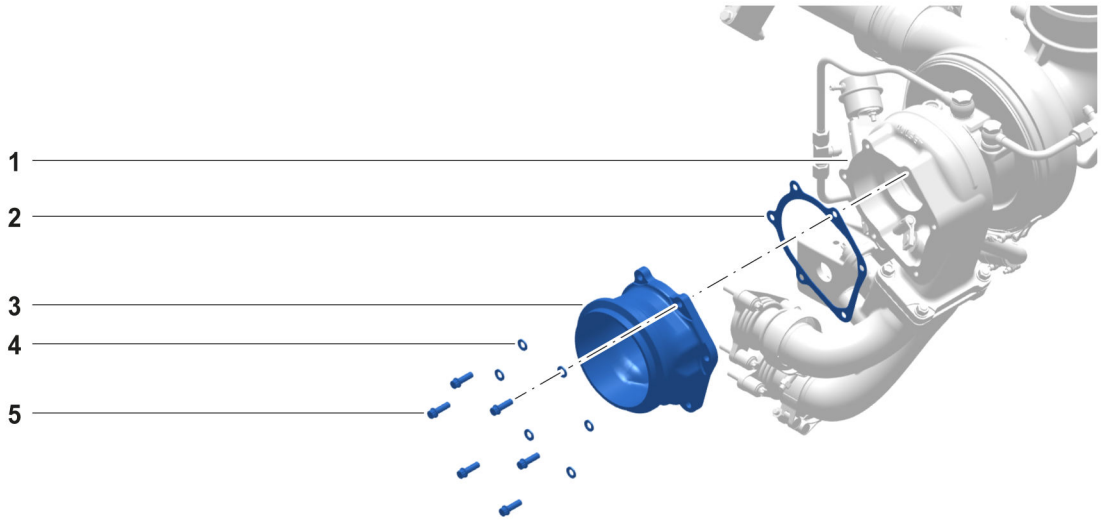

Fig. 390: Left exhaust gas stub

1 Exhaust gas turbocharger
2 Seal
3 Exhaust gas stub
4 Washer (6x)
5 Double hexagon bolt (6x)

▶ Unscrew double hexagon bolts **5**.

▶ Remove washers **4**.

▶ Remove exhaust gas stub **3**.

▶ Remove seal **2**.

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Removing the left exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger

Make sure that the following prerequisite is met:

❑ Left exhaust gas turbocharger is removed on the left exhaust gas stub. (For more information see: Removing the left exhaust gas turbocharger, page 335.)

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

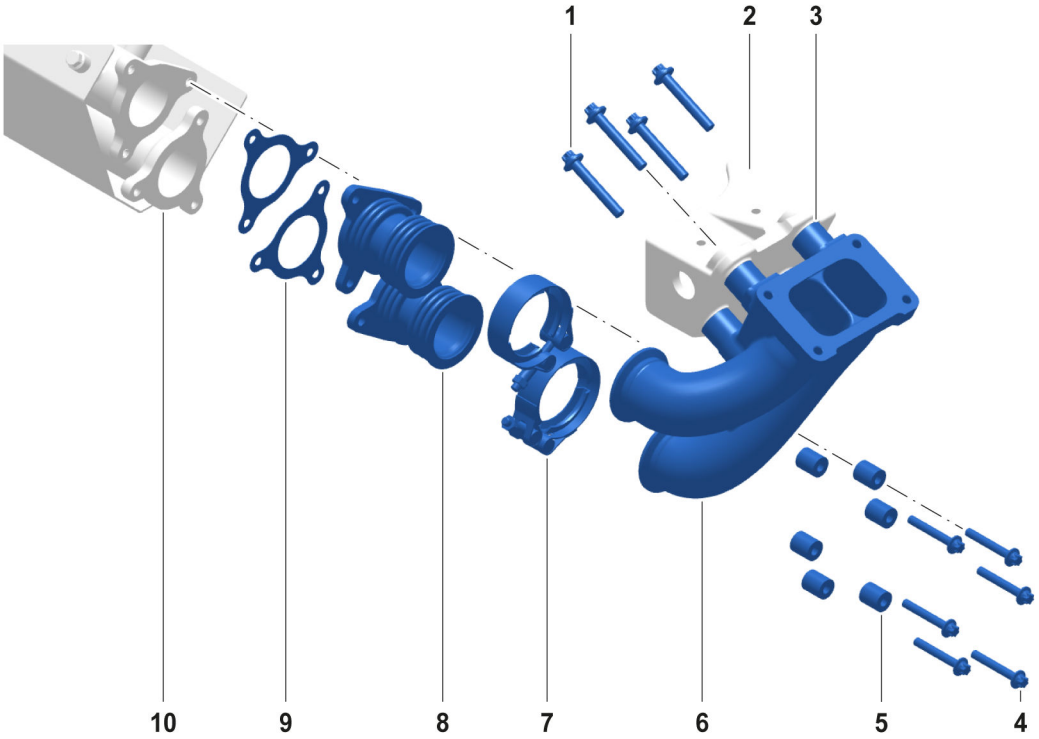

Fig. 391: Left exhaust gas stub

1 Hexalobular flange head screw (4x)
2 Bracket
3 Spacer sleeve (4x)
4 Hexalobular flange head screw (6x)
5 Spacer sleeve (6x)
6 Exhaust gas stub
7 V-band clamp (2x)
8 Compensator (2x)
9 Seal (2x)
10 Exhaust manifold (2x)

▶ Remove tension clamps **7**.

▶ Unscrew hexalobular flange head screws **1**.

▶ Remove spacer sleeves **3**.

▶ Remove exhaust gas stub **6**.

▶ Unscrew hexalobular flange head screws **4**.

▶ Remove spacer sleeves **5**.

▶ Remove compensators **8**.

▶ Remove seals **9**.

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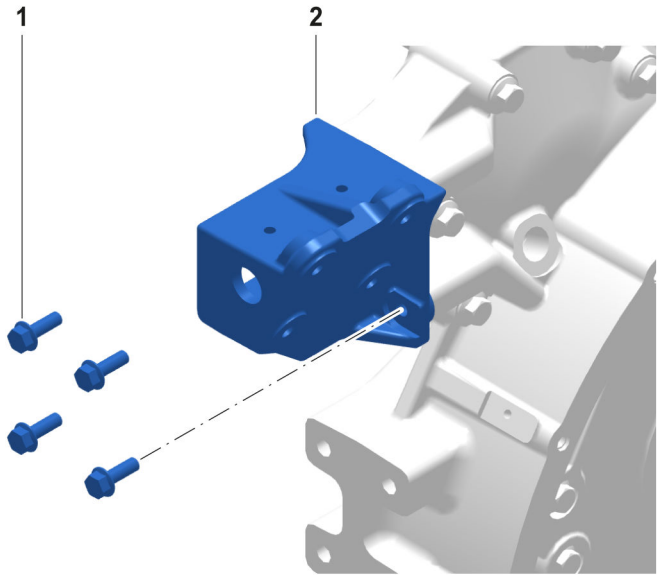

Fig. 392: Bracket

1 Hex head screw (4x) **2** Bracket

▶ Unscrew hex head screws **1**.

▶ Remove bracket **2**.

Cleaning the left exhaust gas stub

▶ Clean sealing surfaces of exhaust gas stub.

▶ Clean sealing surface of exhaust gas turbocharger.

▶ Clean the sealing surfaces of exhaust manifold.

Installing the left exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger

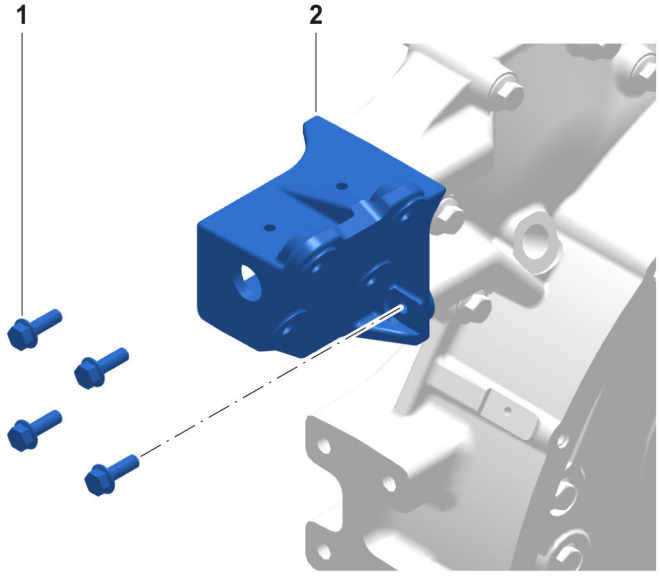

Fig. 393: Bracket

1 Hex head screw (4x) **2** Bracket

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- ▶ Install bracket **2**.
- ▶ Tighten hex head screws **1**.

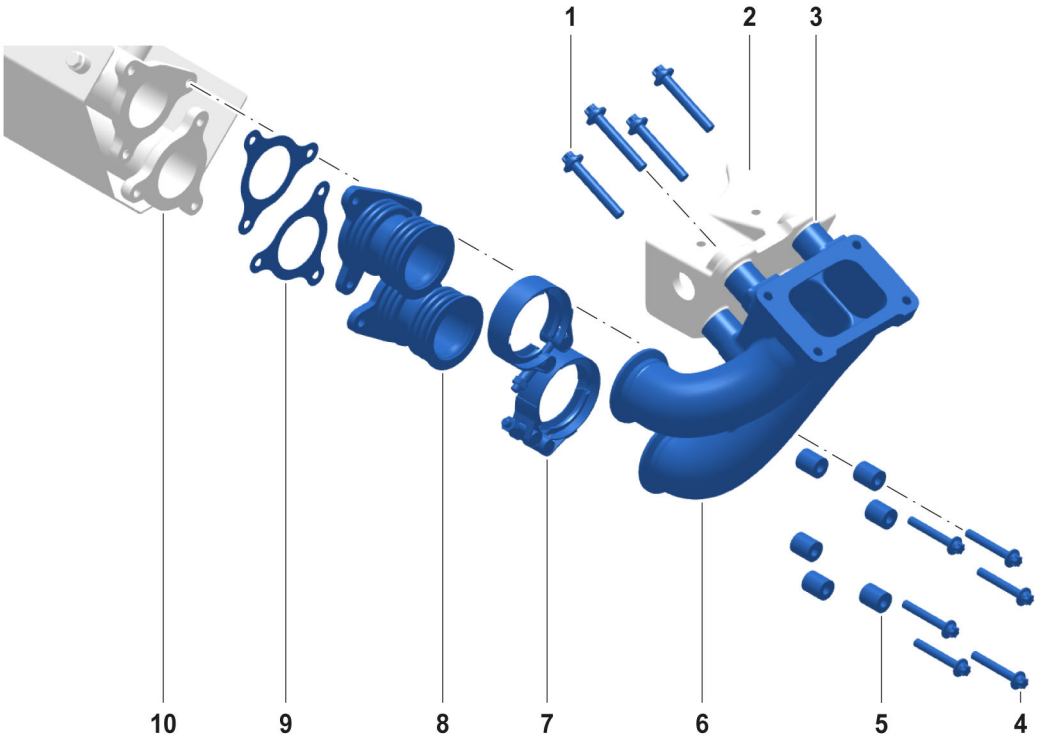

Fig. 394: Left exhaust gas stub

1	Hexalobular flange head screw (4x)	**6**	Exhaust gas stub
2	Bracket	**7**	V-band clamp (2x)
3	Spacer sleeve (4x)	**8**	Compensator (2x)
4	Hexalobular flange head screw (6x)	**9**	Seal (2x)
5	Spacer sleeve (6x)	**10**	Exhaust manifold (2x)

- ▶ Install new seals **9**.
- ▶ Install compensators **8**.

Tightening instruction for hexalobular flange head screws		
Lubricant (thread and head contact surface)	MOTOREX 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	10 Nm	
2.	27 Nm	

Tab. 86: Tightening instruction 12439089-001

- ▶ Lubricate hexalobular flange head screws **4** according to tightening instruction.
- ▶ Tighten spacer sleeves **5** with hexalobular flange head screws **4** according to tightening instruction.

- ▶ Install exhaust gas stub **6**.
- ▶ Install spacer sleeves **3**.
- ▶ Lubricate hexalobular flange head screws **1** with MOTOREX 14 copper paste.
- ▶ Tighten hexalobular flange head screws **1**.

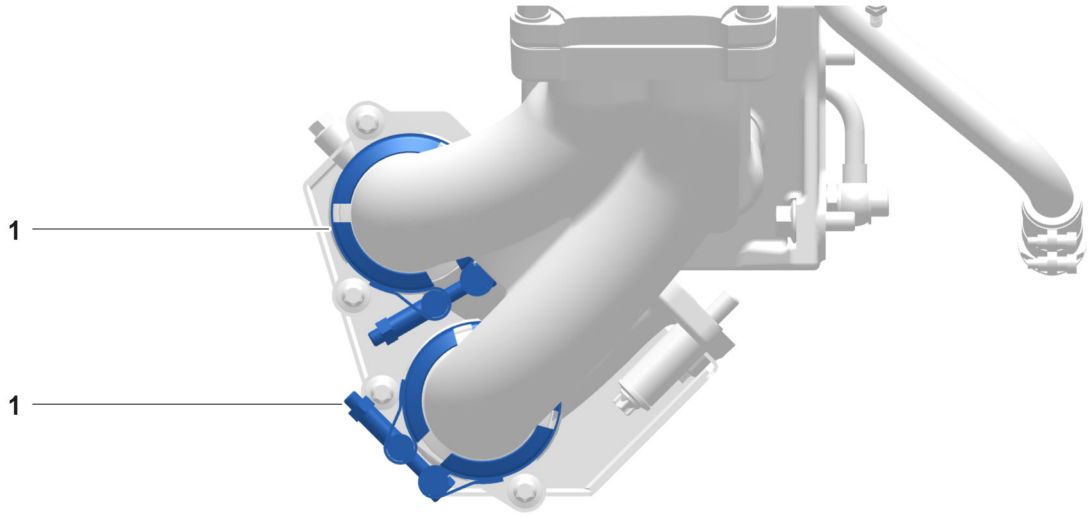

Fig. 396: Alignment of V-band clamps

1 V-band clamp

- ▶ Install V-band clamps **1** as shown.

Installing the left exhaust gas stub from the exhaust gas turbocharger to the device

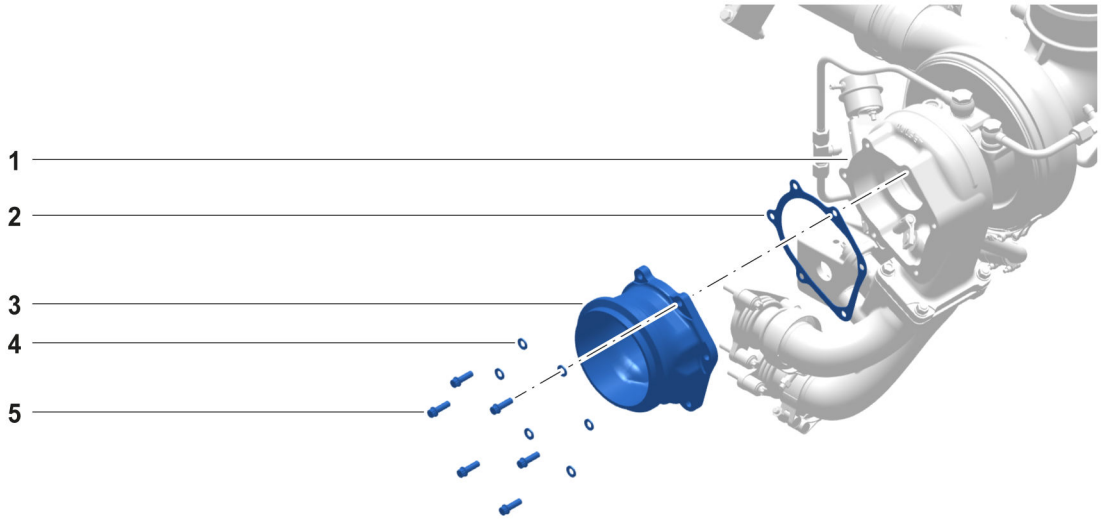

Fig. 397: Left exhaust gas stub

1 Exhaust gas turbocharger
2 Seal
4 Washer (6x)
5 Double hexagon bolt (6x)

See next page for continuation of the image legend

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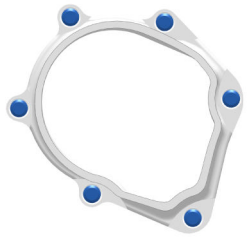
3 Exhaust gas stub

▶ Install new seal **2**.

▶ Install exhaust gas stub **3**.

▶ Install washers **4**.

Tightening instruction for double hexagon bolt		
Lubricant (thread and head contact surface)	MOTOREX 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	10 Nm	
2.	21 Nm	

Tab. 87: Tightening instruction 12952999-000

▶ Lubricate double hexagon bolts **5** according to tightening instruction.

▶ Tighten double hexagon bolts **5** according to tightening instruction.

Removing and installing the right exhaust gas stub

Removing the right exhaust gas stub from the exhaust gas turbocharger to the device

Make sure that the following prerequisite is met:

❑ Device side exhaust pipe is removed from the exhaust gas stub, see documentation from the device manufacturer.

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

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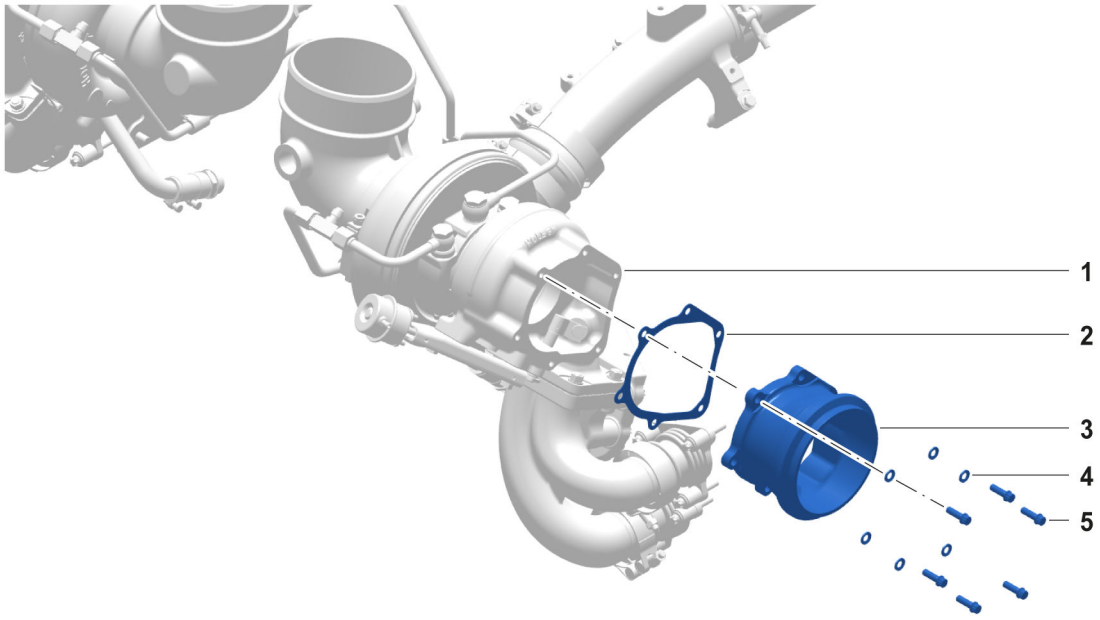

Fig. 399: Right exhaust gas stub

1 Exhaust gas turbocharger
2 Seal
3 Exhaust gas stub
4 Washer (6x)
5 Double hexagon bolt (6x)

▶ Unscrew double hexagon bolts **5**.

▶ Remove washers **4**.

▶ Remove exhaust gas stub **3**.

▶ Remove seal **2**.

Removing the right exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger

Make sure that the following prerequisite is met:
❑ Right exhaust gas turbocharger is removed from right exhaust gas stub. (For more information see: Removing the right exhaust gas turbocharger, page 337.)

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

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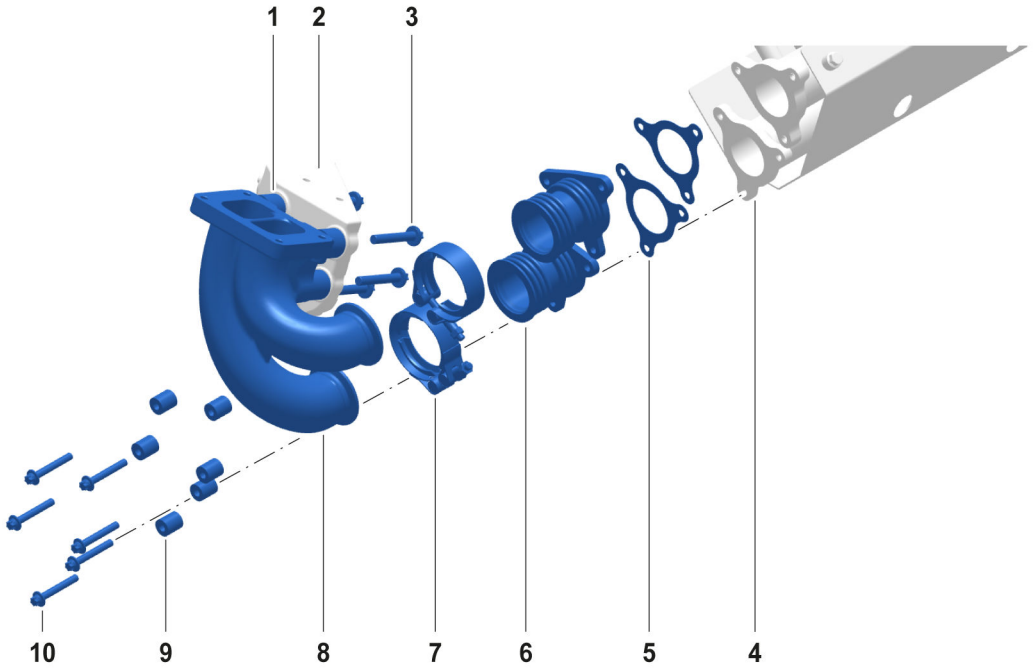

Fig. 400: Right exhaust gas stub

1 Spacer sleeve (4x)
2 Bracket
3 Hexalobular flange head screw (5x)
4 Exhaust manifold (2x)
5 Seal (2x)
6 Compensator (2x)
7 V-band clamp (2x)
8 Exhaust gas stub
9 Spacer sleeve (6x)
10 Hexalobular flange head screw (6x)

- ▶ Remove V-band clamps **7**.
- ▶ Unscrew hexalobular flange head screws **3**.
- ▶ Remove spacer sleeves **1**.
- ▶ Remove exhaust gas stub **8**.
- ▶ Unscrew hexalobular flange head screws **10**.
- ▶ Remove spacer sleeves **9**.
- ▶ Remove compensators **6**.
- ▶ Remove seals **5**.

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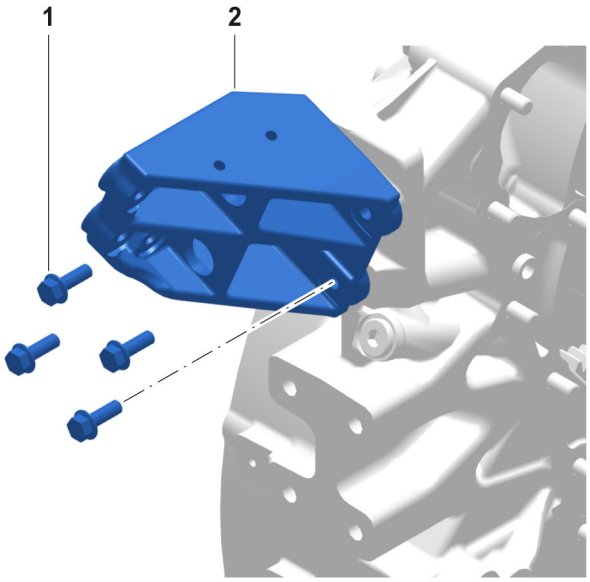

Fig. 401: Bracket

1 Hex head screw (4x) **2** Bracket

▶ Unscrew hex head screws **1**.

▶ Remove bracket **2**.

Cleaning the right exhaust gas stub

▶ Clean sealing surfaces of exhaust gas stub.

▶ Clean sealing surface of exhaust gas turbocharger.

▶ Clean the sealing surfaces of exhaust manifold.

Installing the right exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger

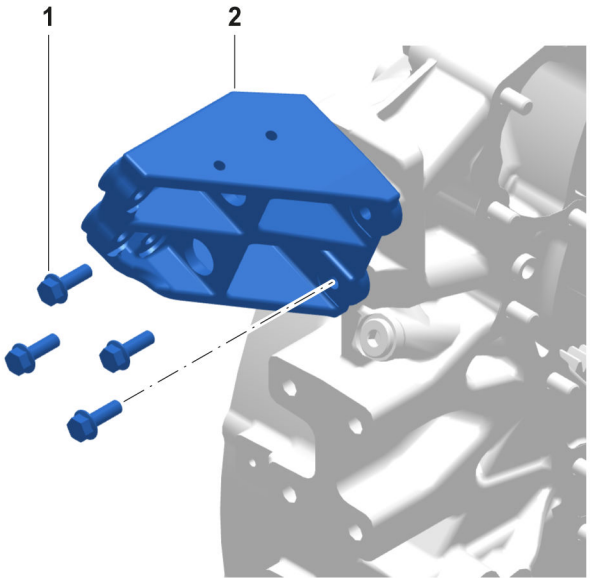

Fig. 402: Bracket

1 Hex head screw (4x) **2** Bracket

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- ▶ Install bracket **2**.
- ▶ Tighten hex head screws **1**.

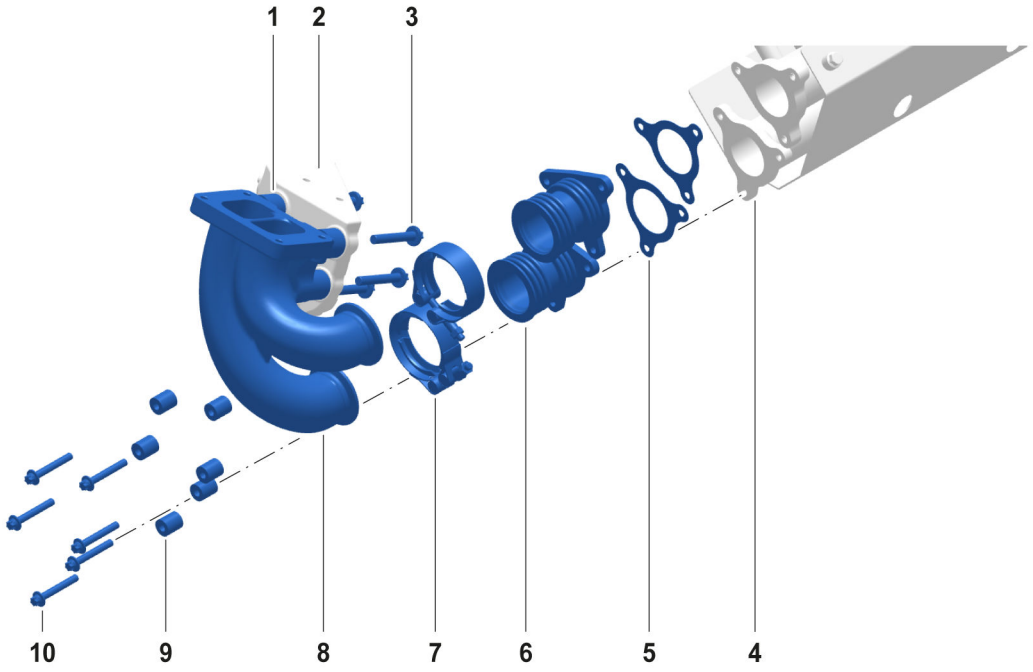


Fig. 403: Right exhaust gas stub

1 Spacer sleeve (4x)
2 Bracket
3 Hexalobular flange head screw (5x)
4 Exhaust manifold (2x)
5 Seal (2x)
6 Compensator (2x)
7 V-band clamp (2x)
8 Exhaust gas stub
9 Spacer sleeve (6x)
10 Hexalobular flange head screw (6x)

- ▶ Install new seals **5**.
- ▶ Install compensators **6**.

Tightening instruction for hexalobular flange head screws		
Lubricant (thread and head contact surface)	Motorex 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	10 Nm	
2.	27 Nm	

Tab. 88: Tightening instruction 12439089-001

- ▶ Lubricate hexalobular flange head screws **10** according to tightening instruction.
- ▶ Tighten spacer sleeves **9** with hexalobular flange head screws **10** according to tightening instruction.
- ▶ Install exhaust gas stub **8**.

- ▶ Install spacer sleeves **1**.
- ▶ Lubricate hexalobular flange head screws **3** with Motorex 14 copper paste.
- ▶ Tighten hexalobular flange head screws **3**.

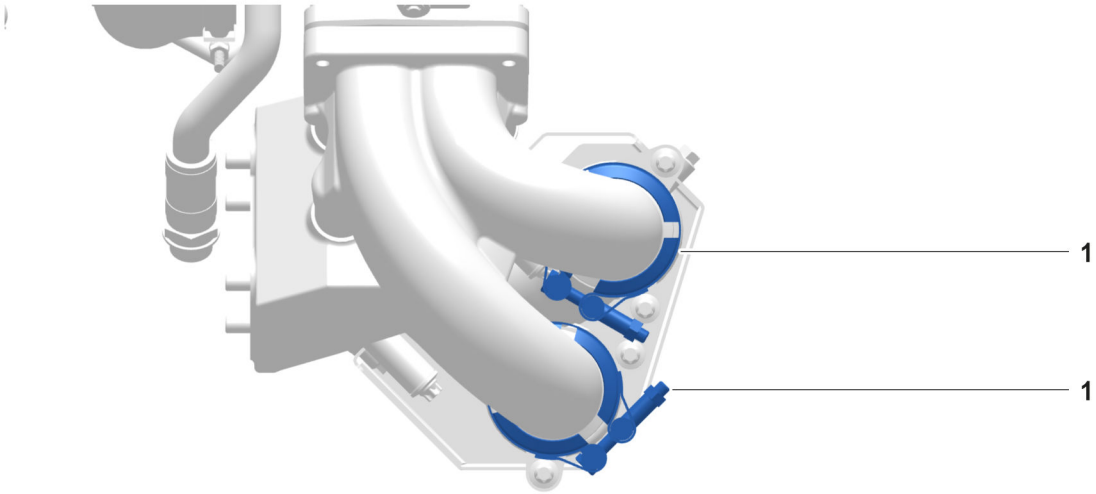


Fig. 405: Alignment of V-band clamps

1 V-band clamp

- ▶ Install V-band clamps **1** as shown.

Installing the right exhaust gas stub from the exhaust gas turbocharger to the device

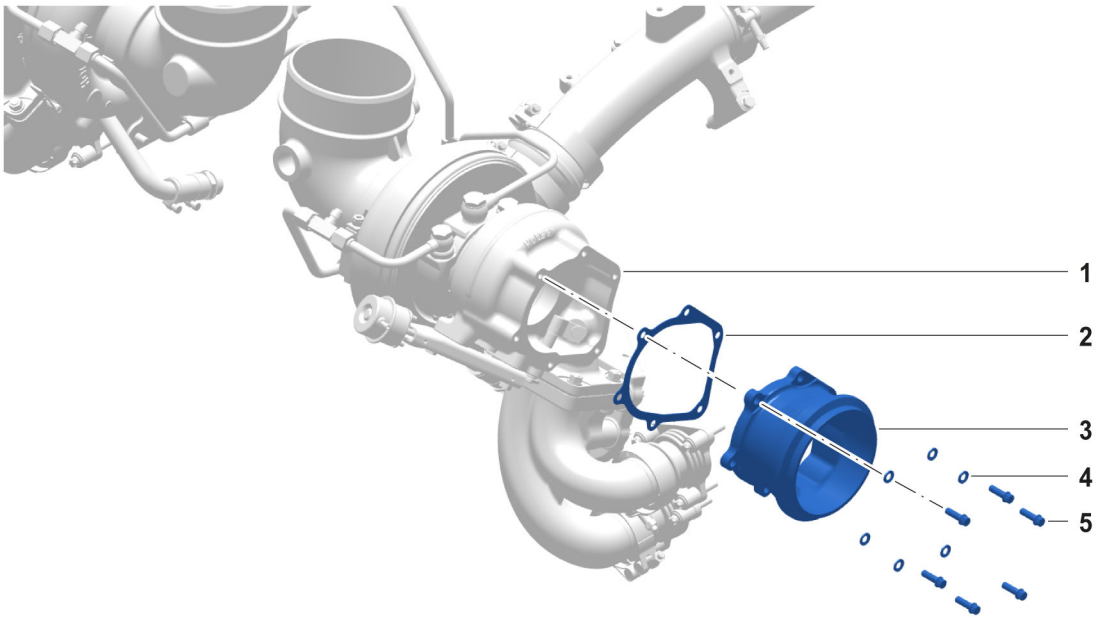


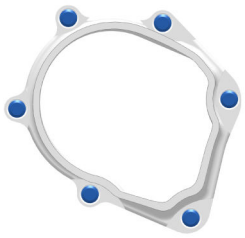
Fig. 406: Right exhaust gas stub

1 Exhaust gas turbocharger
2 Seal
3 Exhaust gas stub
4 Washer (6x)
5 Double hexagon bolt (6x)

▶ Install new seal **2**.

▶ Install exhaust gas stub **3**.

▶ Install washers **4**.

Tightening instruction for double hexagon bolt		
Lubricant (thread and head contact surface)	Motorex 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	10 Nm	
2.	21 Nm	

Tab. 89: Tightening instruction 12952999-000

▶ Lubricate double hexagon bolts **5** according to tightening instruction.

▶ Tighten double hexagon bolts **5** according to tightening instruction.

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3.8.2 Exhaust gas turbocharger

Removing and installing the left oil supply line

Removing the left oil supply line

Make sure that the following prerequisites are met:
- ❑ A collection container for engine oil is available.
- ❑ End control valve pipeline is removed from oil supply line. (For more information see: Removing the end control valve pipeline, page 348.)

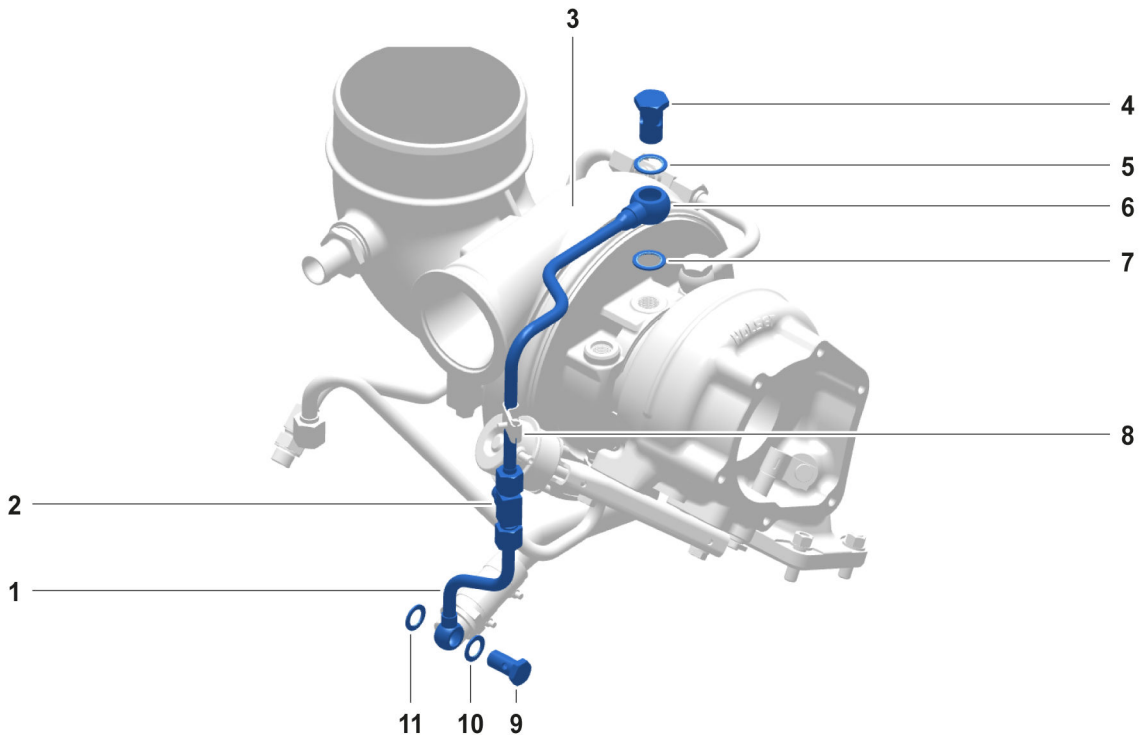

Fig. 408: Oil supply line

1	Oil supply line	**7**	Sealing ring
2	Screw fitting	**8**	Holding clamp
3	Exhaust gas turbocharger	**9**	Banjo bolt
4	Banjo bolt	**10**	Sealing ring
5	Sealing ring	**11**	Sealing ring
6	Oil supply line		

▶ Remove holding clamp **8**.

▶ Unscrew banjo bolt **4**.

▶ Remove sealing ring **5**.

▶ Remove sealing ring **7**.

▶ Unscrew banjo bolt **9**.

▶ Remove sealing ring **10**.

▶ Remove oil supply line **1** and oil supply line **6**.

▶ Seal openings of oil supply line **1** and oil supply line **6**.

▶ Remove sealing ring **11**.

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- ▶ Seal opening of exhaust gas turbocharger **3**.
- ▶ Seal opening of crankcase.
- ▶ If necessary, remove screw **2**.
- ▶ Seal openings of oil supply line **1** and oil supply line **6**.

Cleaning the left oil supply line

- ▶ Clean sealing surface of exhaust gas turbocharger **3**.
- ▶ Clean sealing surface of crankcase.

Installing the left oil supply line

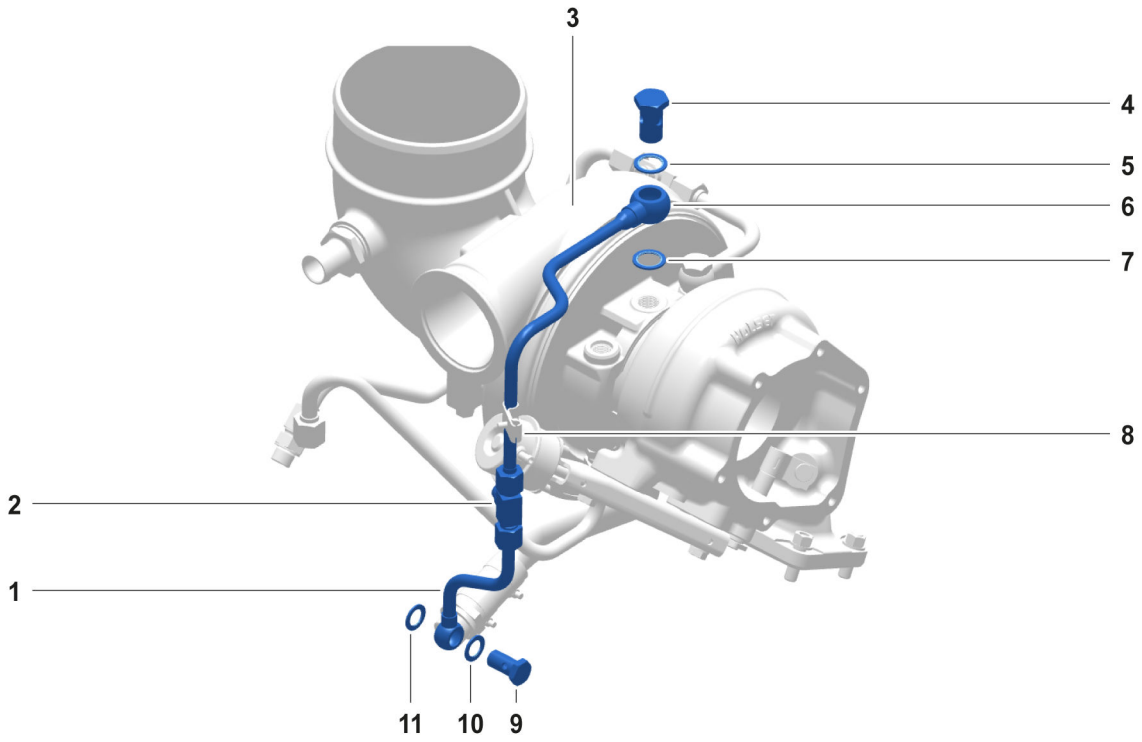

Fig. 409: Oil supply line

1	Oil supply line	**7**	Sealing ring
2	Screw fitting	**8**	Holding clamp
3	Exhaust gas turbocharger	**9**	Banjo bolt
4	Banjo bolt	**10**	Sealing ring
5	Sealing ring	**11**	Sealing ring
6	Oil supply line		

- ▶ Remove closures of oil supply line **1** and oil supply line **6**.
- ▶ Install screw fitting **2**.
- ▶ Remove closure of crankcase.
- ▶ Remove closure of exhaust gas turbocharger **3**.
- ▶ Install new sealing ring **11**.
- ▶ Install oil supply line **1** and oil supply line **6**.
- ▶ Install new sealing ring **10**.
- ▶ Tighten banjo bolt **9**.

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- ▶ Install new sealing ring **7**.
- ▶ Install new sealing ring **5**.
- ▶ Tighten banjo bolt **4**.
- ▶ Install holding clamp **8**.

Removing and installing the right oil supply line

Removing the right oil supply line

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

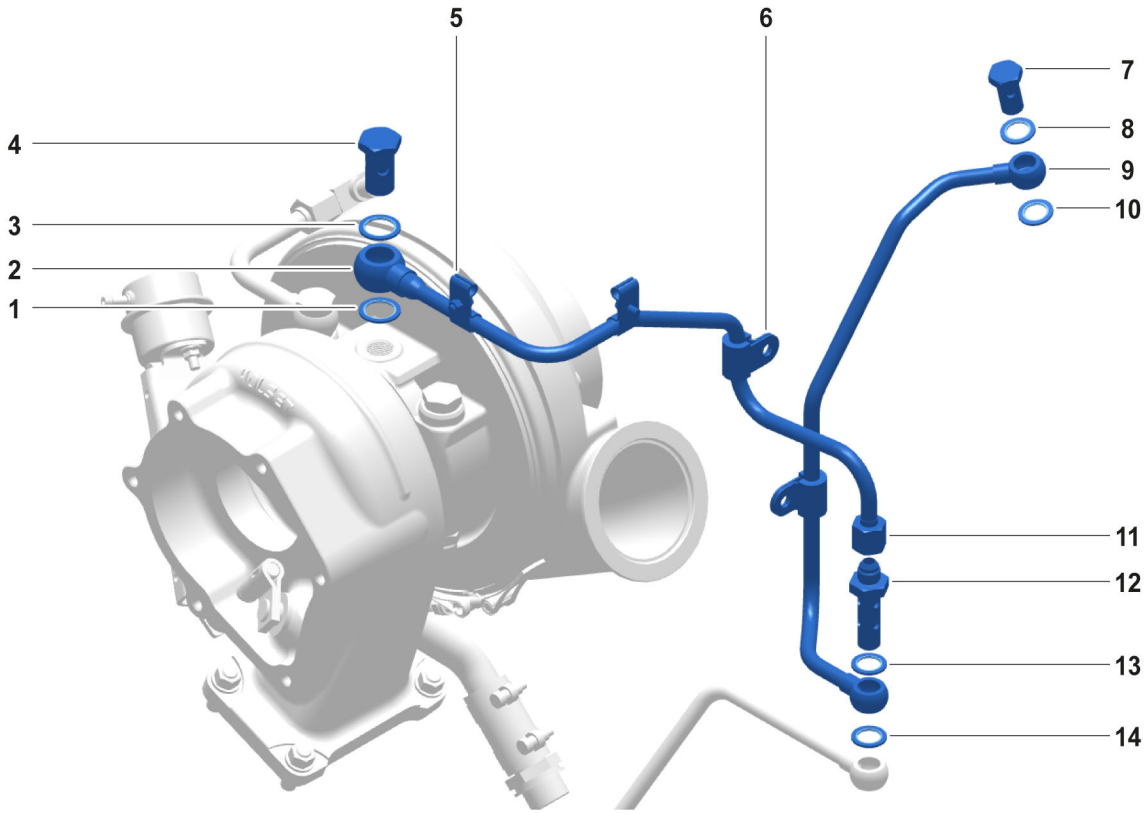

Fig. 410: Oil supply line

1	Sealing ring	**8**	Sealing ring
2	Oil supply line	**9**	Oil supply line
3	Sealing ring	**10**	Sealing ring
4	Banjo bolt	**11**	Box nut
5	Holding clamp (2x)	**12**	Double banjo bolt
6	Holding clamp (2x)	**13**	Sealing ring
7	Banjo bolt	**14**	Sealing ring

- ▶ Remove holding clamps **5**.
- ▶ Remove holding clamps **6**.
- ▶ Unscrew banjo bolt **4** and remove charging pressure regulation pipeline if necessary. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)
- ▶ Remove sealing ring **3**.
- ▶ Unscrew box nut **11**.

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- ▶ Remove oil supply line **2**.
- ▶ Seal openings of oil supply line **2**.
- ▶ Remove sealing ring **1**.
- ▶ Seal opening of exhaust gas turbocharger.
- ▶ Unscrew double banjo bolt **12**.
- ▶ Remove sealing ring **13**.
- ▶ Unscrew banjo bolt **7**.
- ▶ Remove sealing ring **8**.
- ▶ Remove oil supply line **9**.
- ▶ Seal openings of oil supply line **9**.
- ▶ Remove sealing ring **10**.
- ▶ Remove sealing ring **14**.
- ▶ Seal opening of crankcase.

Cleaning the right oil supply line

- ▶ Clean sealing surface of exhaust gas turbocharger.
- ▶ Clean sealing surface of crankcase.

Installing the right oil supply line

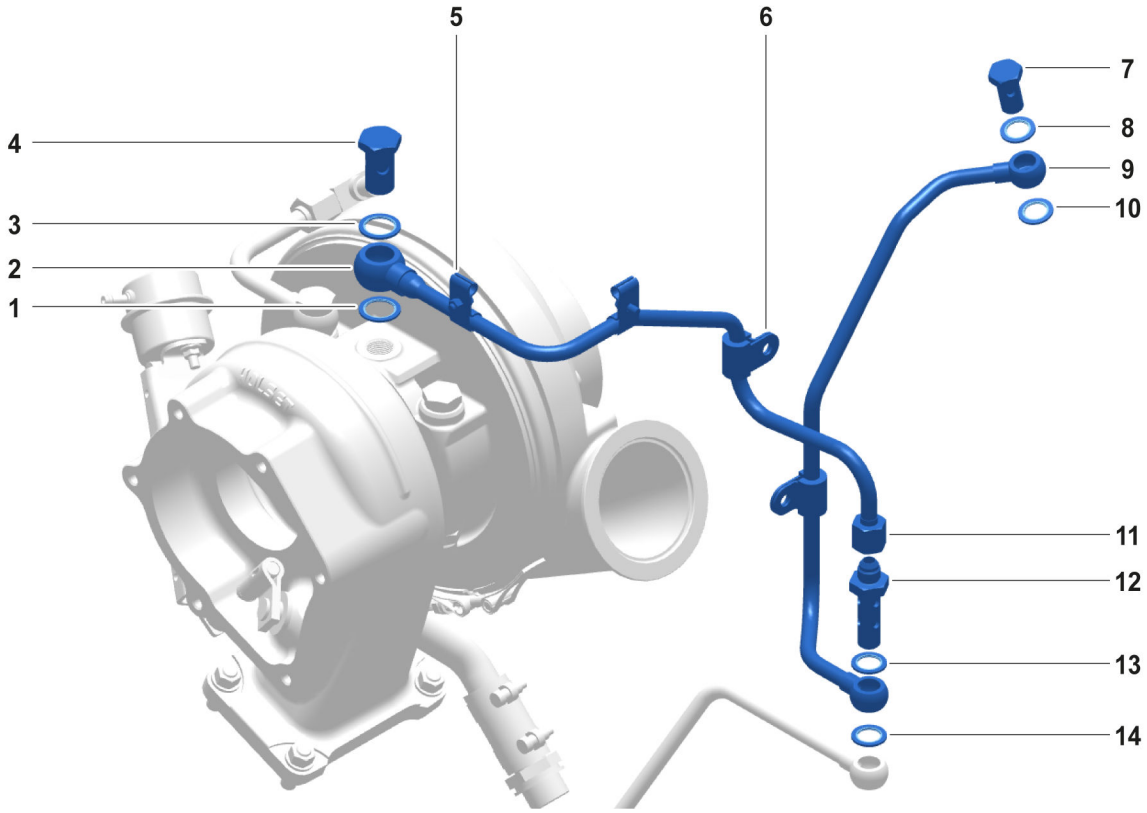

Fig. 411: Oil supply line

1 Sealing ring

8 Sealing ring

See next page for continuation of the image legend

2 Oil supply line
3 Sealing ring
4 Banjo bolt
5 Holding clamp (2x)
6 Holding clamp (2x)
7 Banjo bolt
9 Oil supply line
10 Sealing ring
11 Box nut
12 Double banjo bolt
13 Sealing ring
14 Sealing ring

- ▶ Remove closure of crankcase.
- ▶ Remove closures of oil supply line **9**.
- ▶ Install new sealing ring **14**.
- ▶ Install new sealing ring **10**.
- ▶ Install oil supply line **9**.
- ▶ Install new sealing ring **8**.
- ▶ Tighten banjo bolt **7**.
- ▶ Install new sealing ring **13**.
- ▶ Tighten double banjo bolt **12**.
- ▶ Remove closure of exhaust gas turbocharger.
- ▶ Install new sealing ring **1**.
- ▶ Remove closures of oil supply line **2**.
- ▶ Install oil supply line **2**.
- ▶ Tighten box nut **11**.
- ▶ Install new sealing ring **3**.
- ▶ Tighten banjo bolt **4**.
- ▶ Install holding clamps **6**.
- ▶ Install holding clamp **5**.
- ▶ Install charging pressure regulation. (For more information see: Installing the pipeline from the cycle valve to the vacuum actuator, page 303.)

Removing and installing the left oil return line

Removing the left oil return line

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

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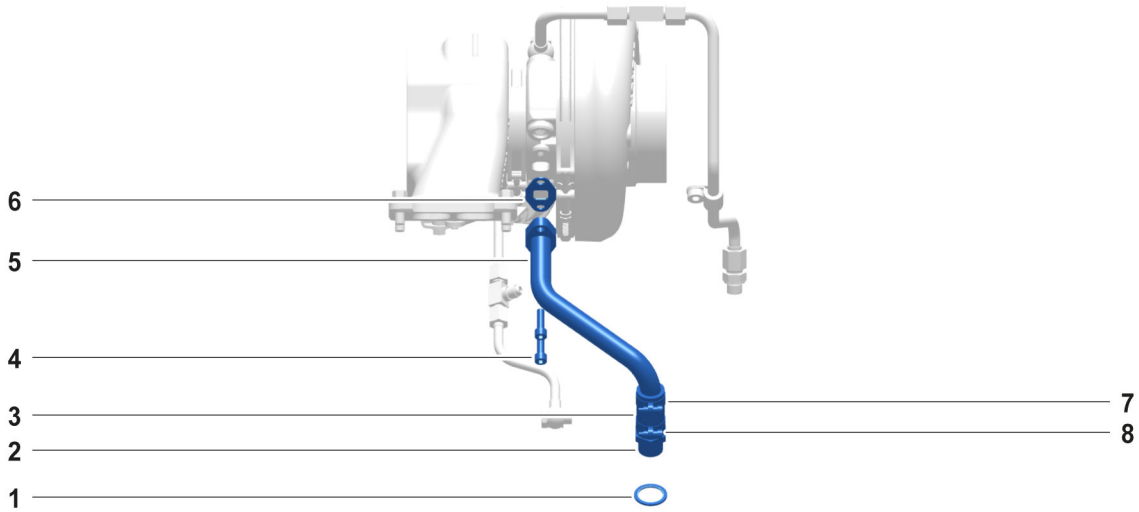

Fig. 412: Oil return line

1 Sealing ring
2 Hose nipple
3 Rubber sleeve
4 Socket head screw (2x)
5 Oil return line
6 Seal
7 Hose clamp
8 Hose clamp

- ▶ Unscrew socket head screws **4**.
- ▶ Release hose clamp **8**.
- ▶ Remove oil return line **5**.
- ▶ Seal openings of oil return line **5**.
- ▶ Remove seal **6**.
- ▶ If necessary, unscrew hose nipple **2**.
- ▶ Remove seal **6**.
- ▶ Seal opening of flywheel housing or hose nipple **2**.
- ▶ Seal opening of exhaust gas turbocharger.
- ▶ If necessary, release hose clamp **7**.
- ▶ Remove rubber sleeve **3** from oil return line **5**.

Cleaning and checking the left oil return line

- ▶ Clean sealing surface of exhaust gas turbocharger.
- ▶ Clean sealing surface of oil return line **5**.
- ▶ Clean sealing surface of flywheel housing.
- ▶ Check rubber sleeve **3** for damage and replace if necessary.

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Installing the left oil return line

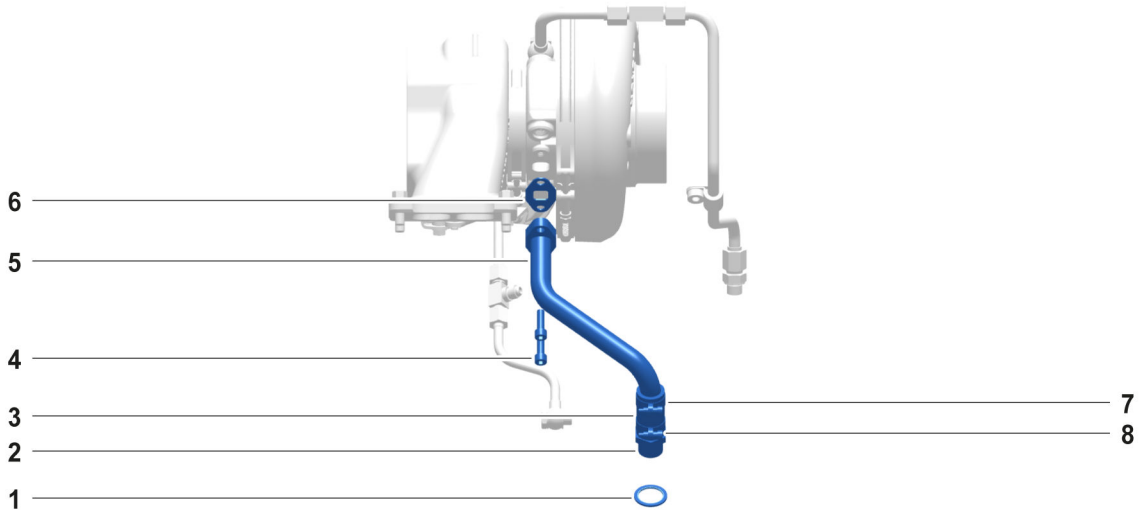

Fig. 413: Oil return line

1	Sealing ring	**5**	Oil return line
2	Hose nipple	**6**	Seal
3	Rubber sleeve	**7**	Hose clamp
4	Socket head screw (2x)	**8**	Hose clamp

- ▶ Install rubber sleeve **3** on oil return line **5**.
- ▶ Tighten hose clamp **7**.
- ▶ Remove closure from exhaust gas turbocharger.
- ▶ Remove closure from flywheel housing.
- ▶ Install new sealing ring **1**.
- ▶ Tighten hose nipple **2**.
- ▶ Remove closures from oil return line **5**.
- ▶ Install oil return line **5** on hose nipple **2**.
- ▶ Install new seal **6**.
- ▶ Tighten socket head screws **4**.
- ▶ Tighten hose clamp **8**.

Removing and installing the right oil return line

Removing the right oil return line

Make sure that the following prerequisite is met:
- ❑ A collection container for engine oil is available.

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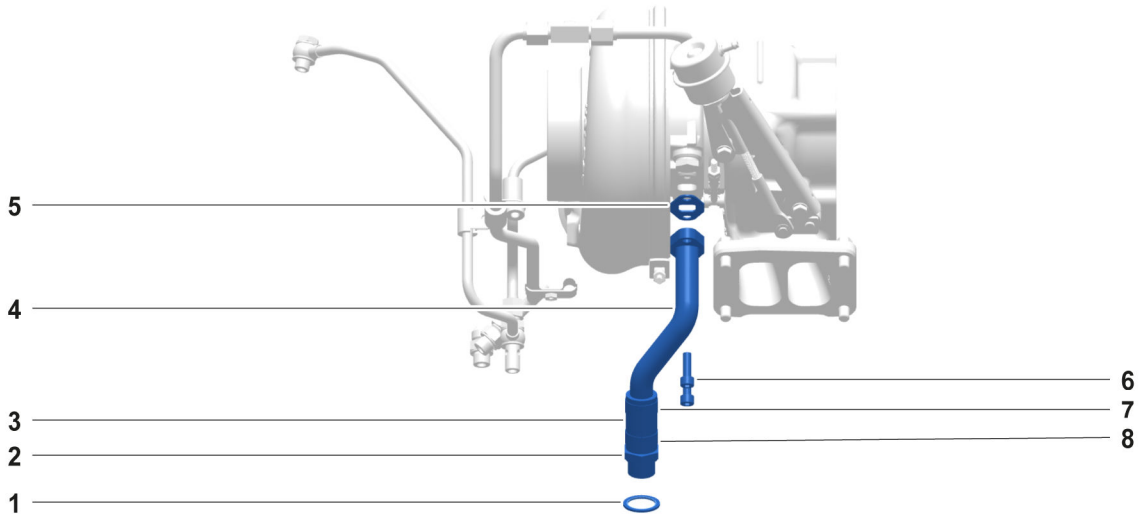

Fig. 414: Oil return line

1 Sealing ring
2 Hose nipple
3 Rubber sleeve
4 Oil return line
5 Seal
6 Socket head screw (2x)
7 Hose clamp
8 Hose clamp

- ▶ Unscrew socket head screws **6**.
- ▶ Release hose clamp **8**.
- ▶ Remove oil return line **4**.
- ▶ Seal openings of oil return line **4**.
- ▶ Remove seal **5**.
- ▶ If necessary, unscrew hose nipple **2**.
- ▶ Remove seal **5**.
- ▶ Seal opening of flywheel housing or hose nipple **2**.
- ▶ Seal opening of exhaust gas turbocharger.
- ▶ If necessary, release hose clamp **7**.
- ▶ Remove rubber sleeve **3** from oil return line **4**.

Cleaning and checking the right oil return line

- ▶ Clean sealing surface of exhaust gas turbocharger.
- ▶ Clean sealing surface of oil return line **4**.
- ▶ Clean sealing surface of flywheel housing.
- ▶ Check rubber sleeve **3** for damage and replace if necessary.

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Installing the right oil return line

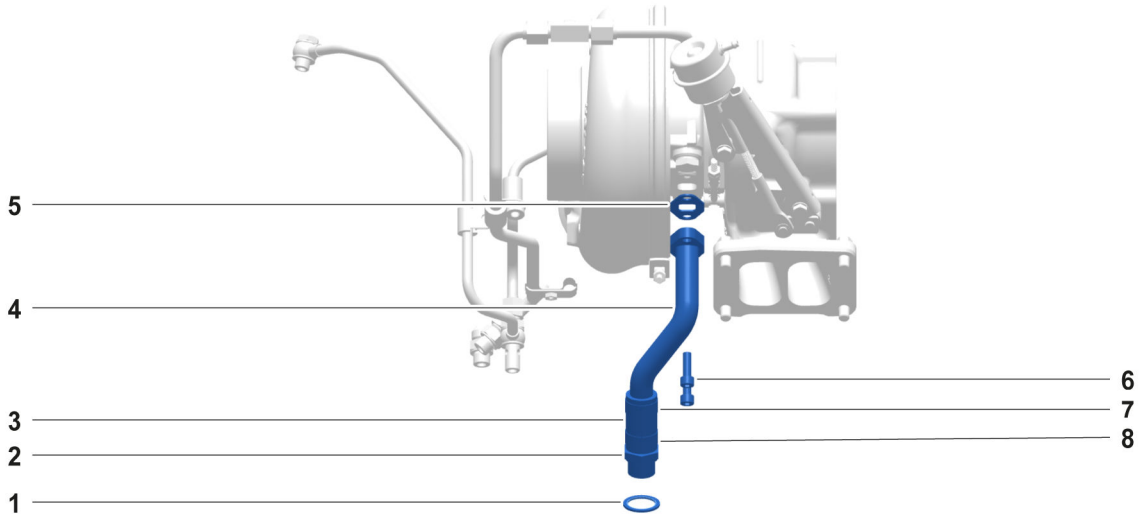

Fig. 415: Oil return line

1	Sealing ring	**5**	Seal
2	Hose nipple	**6**	Socket head screw (2x)
3	Rubber sleeve	**7**	Hose clamp
4	Oil return line	**8**	Hose clamp

- ▶ Install rubber sleeve **3** on oil return line **4**.
- ▶ Tighten hose clamp **7**.
- ▶ Remove closure from exhaust gas turbocharger.
- ▶ Remove closure from flywheel housing.
- ▶ Install new sealing ring **1**.
- ▶ Tighten hose nipple **2**.
- ▶ Remove closures from oil return line **4**.
- ▶ Install oil return line **4** on hose nipple **2**.
- ▶ Install new seal **5**.
- ▶ Tighten socket head screws **6**.
- ▶ Tighten hose clamp **8**.

Removing and installing the left coolant supply line

Removing the left coolant supply line

Make sure that the following prerequisite is met:
❑ A collection container for coolant is available.

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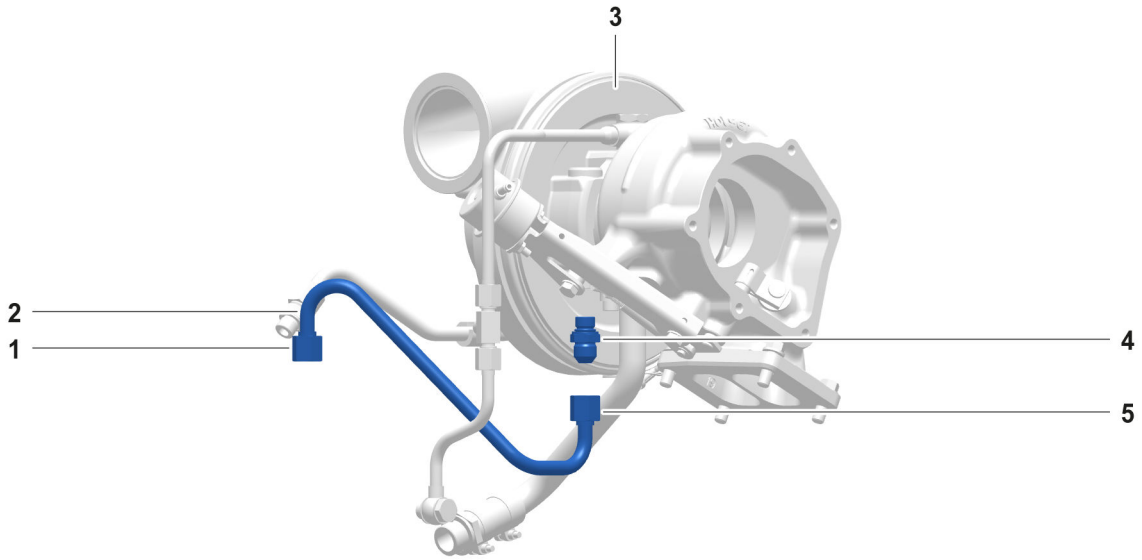

Fig. 416: Coolant supply line

1 Box nut
2 Coolant supply line
3 Exhaust gas turbocharger
4 Screw fitting
5 Box nut

- ▶ Unscrew box nut **1** on coolant manifold.
- ▶ Unscrew box nut **5**.
- ▶ Remove coolant supply line **2**.
- ▶ Seal openings of coolant supply line **2**.
- ▶ If necessary, unscrew screw fitting **4**.
- ▶ Seal opening of exhaust gas turbocharger **3**.
- ▶ Seal opening of coolant manifold.

Cleaning the left coolant supply line

- ▶ Clean sealing surface of exhaust gas turbocharger **3**.
- ▶ Clean sealing surface of coolant manifold.

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Installing the left coolant supply line

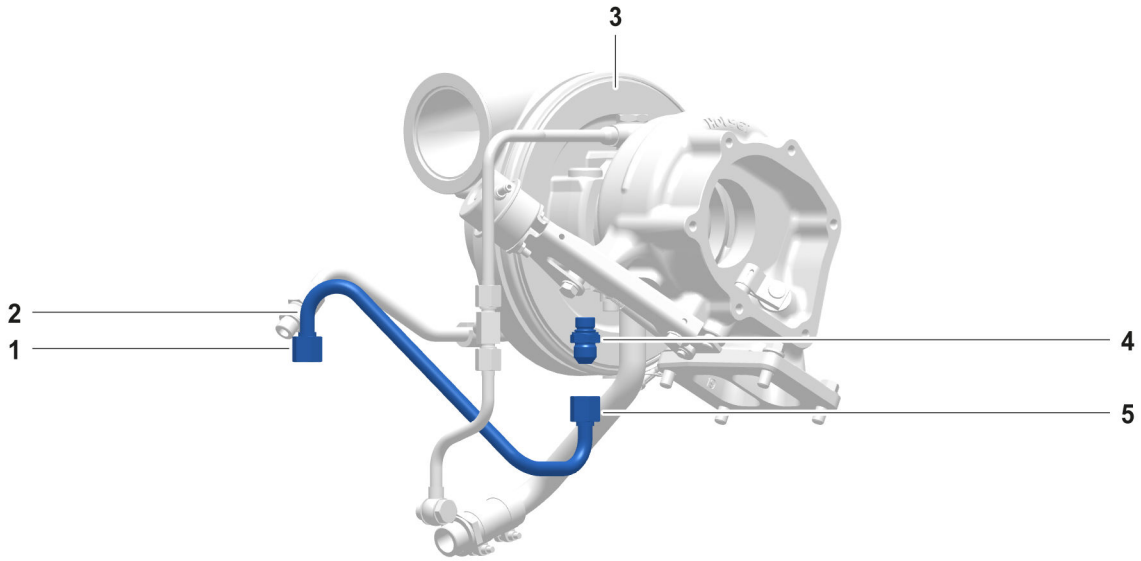

Fig. 417: Coolant supply line

1 Box nut
2 Coolant supply line
3 Exhaust gas turbocharger
4 Screw fitting
5 Box nut

▶ Remove closure from coolant manifold.

▶ Remove closure from exhaust gas turbocharger **3**.

▶ Tighten screw fitting **4**.

▶ Remove closures from coolant supply line **2**.

▶ Install coolant supply line **2**.

▶ Tighten box nut **5**.

▶ Tighten box nut **1** on coolant manifold.

Removing and installing the right coolant supply line

Removing the right coolant supply line

Make sure that the following prerequisite is met:
❑ A collection container for coolant is available.

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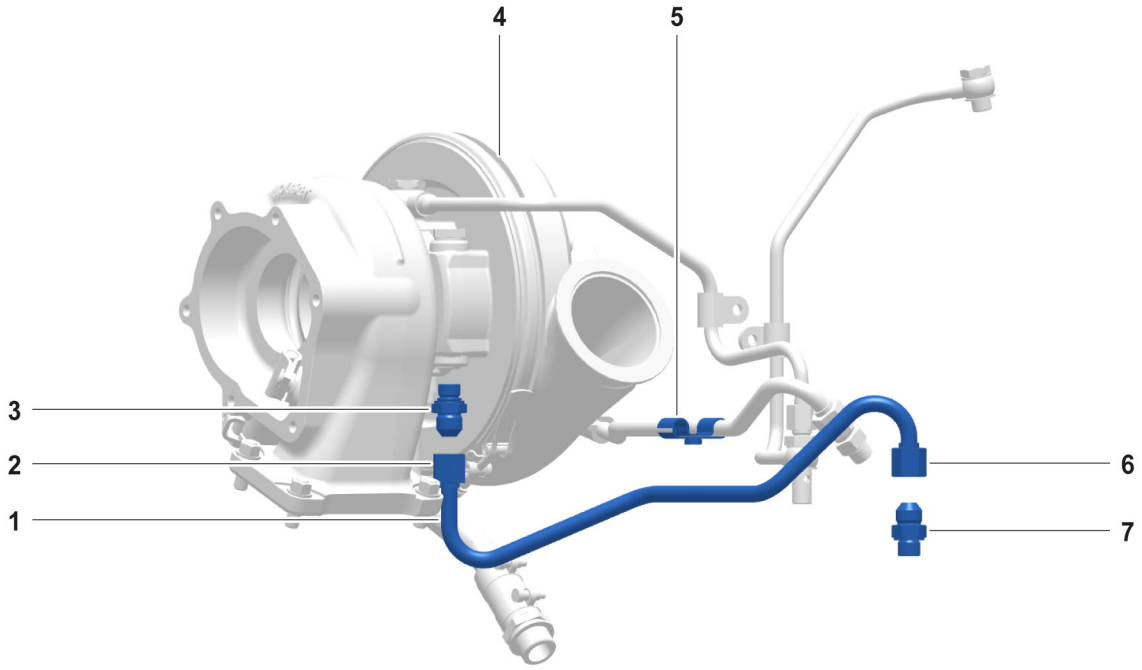

Fig. 418: Coolant supply line

1 Coolant supply line
2 Box nut
3 Screw fitting
4 Exhaust gas turbocharger
5 Holding clamp
6 Box nut
7 Screw fitting

- ▶ Remove holding clamp **5**.
- ▶ Unscrew box nut **6** on coolant manifold.
- ▶ Unscrew box nut **2**.
- ▶ Remove coolant supply line **1**.
- ▶ Seal openings of coolant supply line **1**.
- ▶ If necessary, unscrew screw fitting **3**.
- ▶ Seal opening of exhaust gas turbocharger **4**.
- ▶ If necessary, unscrew screw fitting **7**.
- ▶ Seal opening of coolant manifold.

Cleaning the right coolant supply line

- ▶ Clean sealing surface of exhaust gas turbocharger **4**.
- ▶ Clean sealing surface of coolant manifold.

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Installing the right coolant supply line

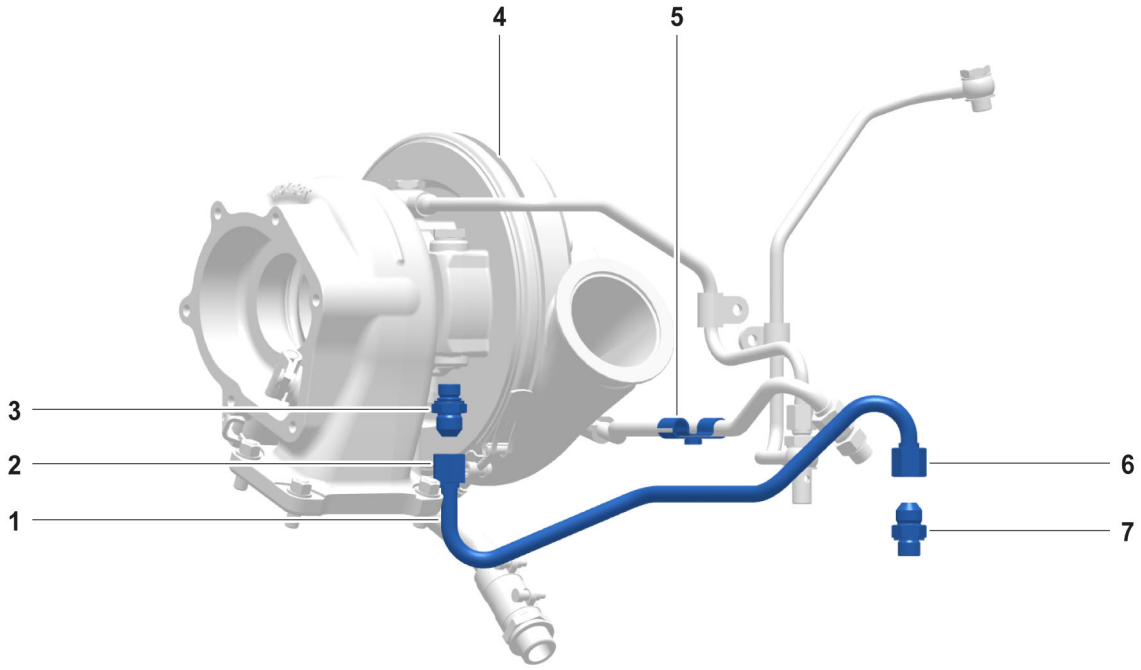

Fig. 419: Coolant supply line

1 Coolant supply line
2 Box nut
3 Screw fitting
4 Exhaust gas turbocharger
5 Holding clamp
6 Box nut
7 Screw fitting

▶ Remove closure from coolant manifold.

▶ Tighten screw fitting **7**.

▶ Remove closure from exhaust gas turbocharger **4**.

▶ Tighten screw fitting **3**.

▶ Remove closures from coolant supply line **1**.

▶ Install coolant supply line **1**.

▶ Tighten box nut **2**.

▶ Tighten box nut **6** on coolant manifold.

▶ Install holding clamp **5**.

Removing and installing the left coolant return line

Removing the left coolant return line

Make sure that the following prerequisites are met:
❑ A collection container for coolant is available.
❑ Ventilation line is removed from coolant return line. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)

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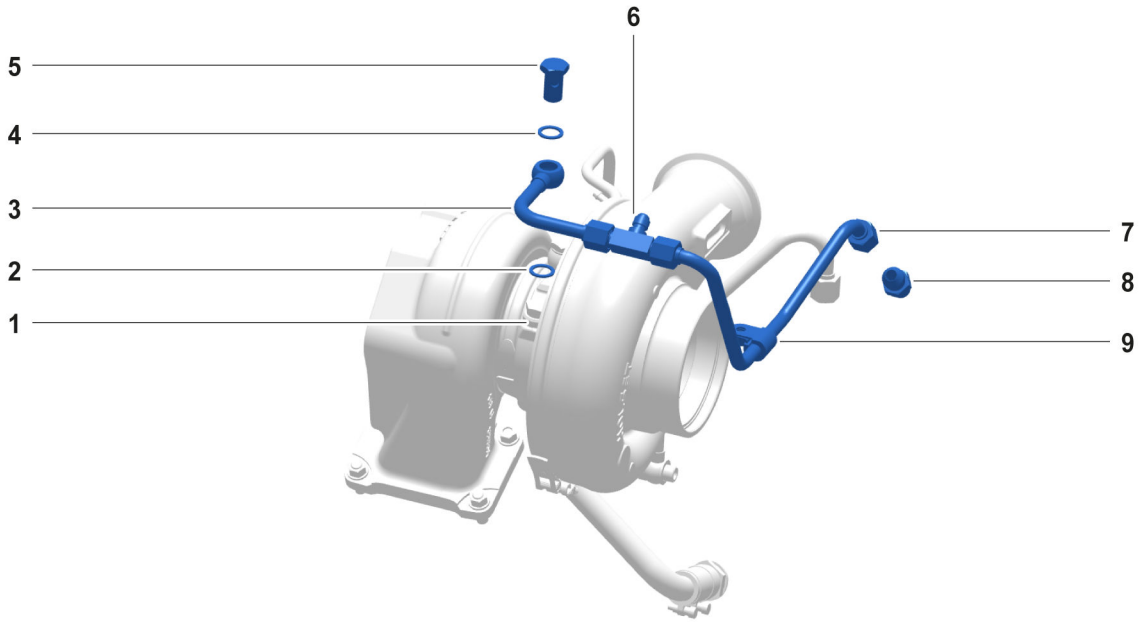

Fig. 420: Coolant return line

1 Exhaust gas turbocharger
2 Sealing ring
3 Coolant return line
4 Sealing ring
5 Banjo bolt
6 Screw fitting
7 Box nut
8 Screw fitting
9 Holding clamp

- ▶ Remove holding clamp **9**.
- ▶ Unscrew box nut **7** on coolant manifold.
- ▶ Unscrew banjo bolt **5**.
- ▶ Remove sealing ring **4**.
- ▶ Remove coolant return line **3**.
- ▶ Seal openings of coolant return line **3**.
- ▶ Remove sealing ring **2**.
- ▶ Seal opening of exhaust gas turbocharger **1**.
- ▶ If necessary, unscrew screw fitting **8**.
- ▶ Seal opening of coolant manifold.
- ▶ If necessary, remove screw **6**.

Cleaning the left coolant return line

- ▶ Clean sealing surface of exhaust gas turbocharger **1**.
- ▶ Clean sealing surface of coolant manifold.

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Installing the left coolant return line

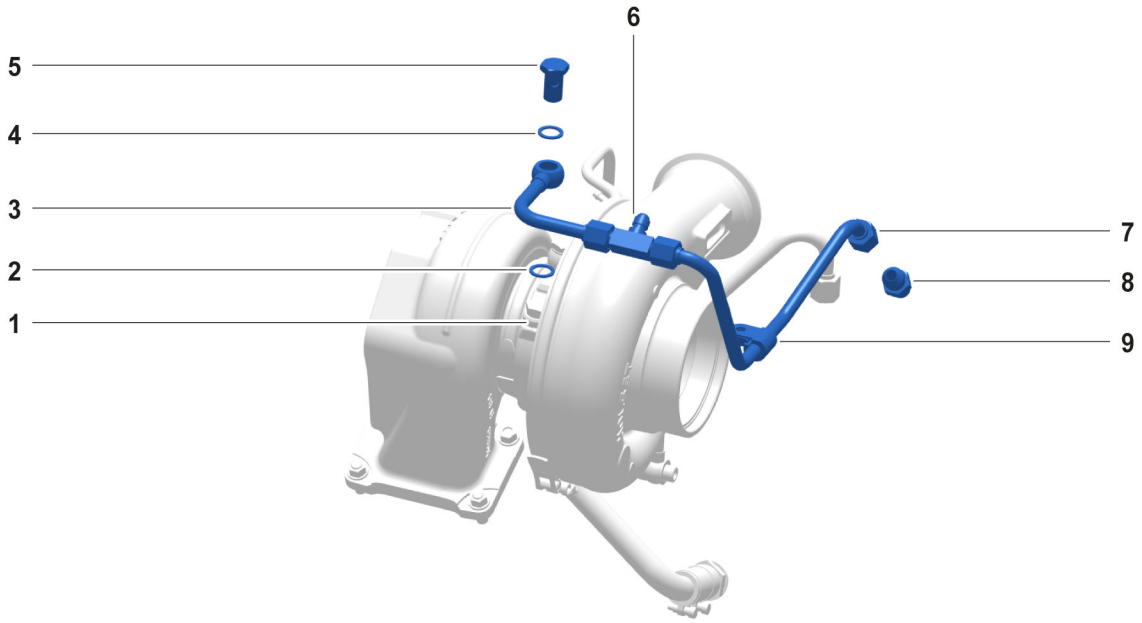

Fig. 421: Coolant return line

1 Exhaust gas turbocharger
2 Sealing ring
3 Coolant return line
4 Sealing ring
5 Banjo bolt
6 Screw fitting
7 Box nut
8 Screw fitting
9 Holding clamp

- ▶ Install screw fitting **6**.
- ▶ Remove closures from coolant manifold.
- ▶ Tighten screw fitting **8**.
- ▶ Remove closure from exhaust gas turbocharger **1**.
- ▶ Install new sealing ring **2**.
- ▶ Remove closures from coolant return line **3**.
- ▶ Install coolant return line **3**.
- ▶ Install new sealing ring **4**.
- ▶ Tighten banjo bolt **5**.
- ▶ Tighten box nut **7** on coolant manifold.
- ▶ Install holding clamp **9**.

Removing and installing the right coolant return line

Removing the right coolant return line

Make sure that the following prerequisites are met:
- ❑ A collection container for coolant is available.
- ❑ Ventilation line is removed from coolant return line. (For more information see: Removing the ventilation line from the exhaust gas turbocharger to the expansion tank, page 412.)
- ❑ Pipeline from cycle valve to vacuum actuator is removed from coolant return line. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)

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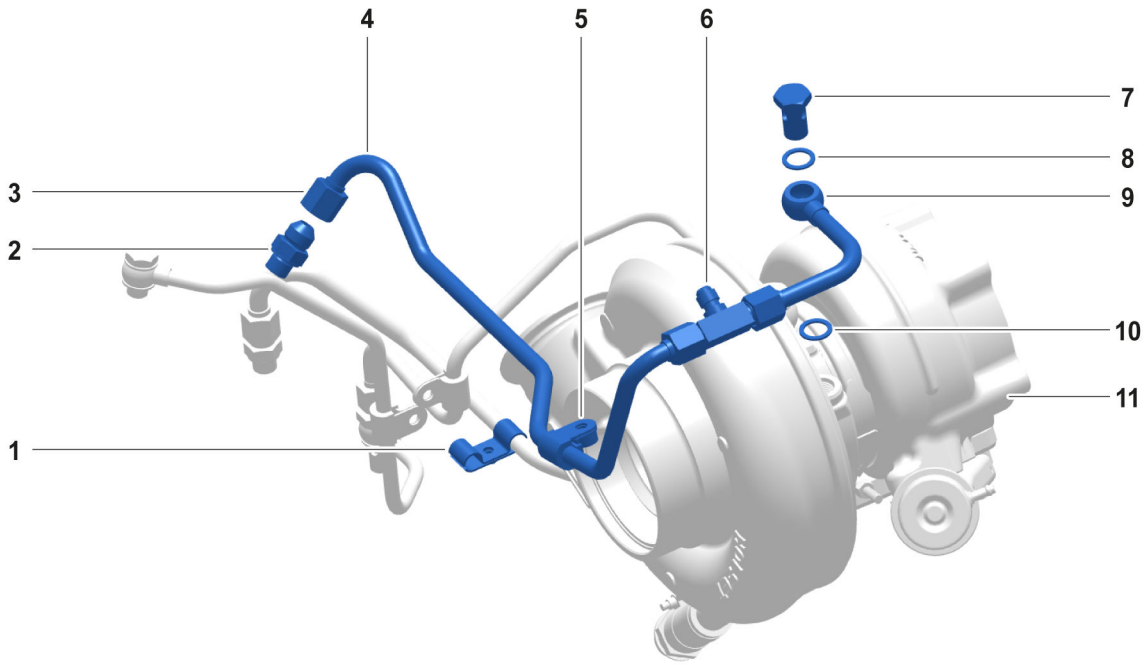

Fig. 422: Coolant return line

1 Holding clamp
2 Screw fitting
3 Box nut
4 Coolant return line
5 Holding clamp
6 Screw fitting
7 Banjo bolt
8 Sealing ring
9 Coolant return line
10 Sealing ring
11 Exhaust gas turbocharger

- ▶ Remove holding clamp **1**.
- ▶ Remove holding clamp **5**.
- ▶ Unscrew box nut **3** on coolant manifold.
- ▶ Unscrew banjo bolt **7**.
- ▶ Remove sealing ring **8**.
- ▶ Remove coolant return line **4** and coolant return line **9**.
- ▶ Seal openings of coolant return line **4** and coolant return line **9**.
- ▶ Remove sealing ring **10**.
- ▶ Seal opening of exhaust gas turbocharger **11**.
- ▶ If necessary, unscrew screw fitting **2**.
- ▶ Seal opening of coolant manifold.
- ▶ If necessary, remove screw **6**.

Cleaning the right coolant return line

- ▶ Clean sealing surface of exhaust gas turbocharger **11**.
- ▶ Clean sealing surface of coolant manifold.

Installing the right coolant return line

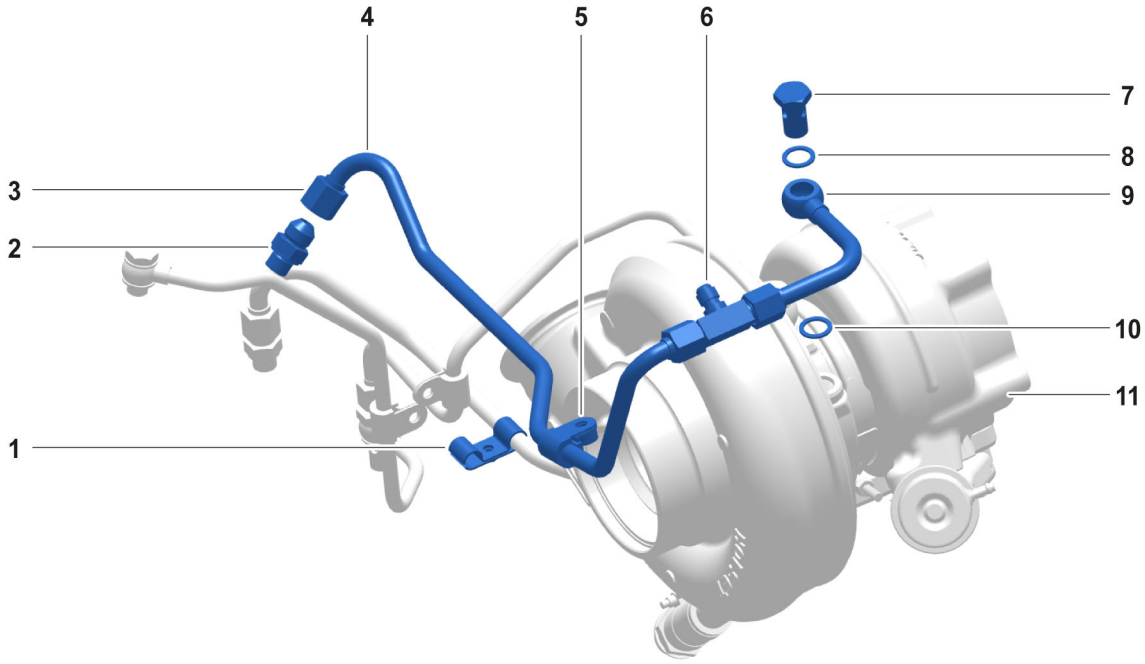

Fig. 423: Coolant return line

1 Holding clamp
2 Screw fitting
3 Box nut
4 Coolant return line
5 Holding clamp
6 Screw fitting
7 Banjo bolt
8 Sealing ring
9 Coolant return line
10 Sealing ring
11 Exhaust gas turbocharger

- ▶ Install screw fitting **6**.
- ▶ Remove closure from coolant manifold.
- ▶ Tighten screw fitting **2**.
- ▶ Remove closure from exhaust gas turbocharger **11**.
- ▶ Install new sealing ring **10**.
- ▶ Remove closures from coolant return line **4** and coolant return line **9**.
- ▶ Install coolant return line **4** and coolant return line **9**.
- ▶ Install new sealing ring **8**.
- ▶ Tighten banjo bolt **7**.
- ▶ Tighten box nut **3** on coolant manifold.
- ▶ Install holding clamp **5**.
- ▶ Install holding clamp **1**.

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Removing and installing the left exhaust gas turbocharger

Removing the left exhaust gas turbocharger

Make sure that the following prerequisites are met:

- ❑ Left charge air pipe is removed from left exhaust gas turbocharger. (For more information see: Removing the charge air pipe, page 291.)
- ❑ Left exhaust gas stub from exhaust gas turbocharger to device is removed from left exhaust gas turbocharger. (For more information see: Removing the left exhaust gas stub from the exhaust gas turbocharger to the device, page 306.)
- ❑ Left intake manifold is removed from left exhaust gas turbocharger. (For more information see: Removing the left intake manifold, page 286.)
- ❑ Oil supply line is removed from left exhaust gas turbocharger. (For more information see: Removing the left oil supply line, page 318.)
- ❑ Oil return line is removed from left exhaust gas turbocharger. (For more information see: Removing the left oil return line, page 322.)
- ❑ Coolant supply line is removed from left exhaust gas turbocharger. (For more information see: Removing the left coolant supply line, page 326.)
- ❑ Coolant return line is removed from left exhaust gas turbocharger. (For more information see: Removing the left coolant return line, page 330.)
- ❑ Charging pressure regulation is removed from left exhaust gas turbocharger. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)

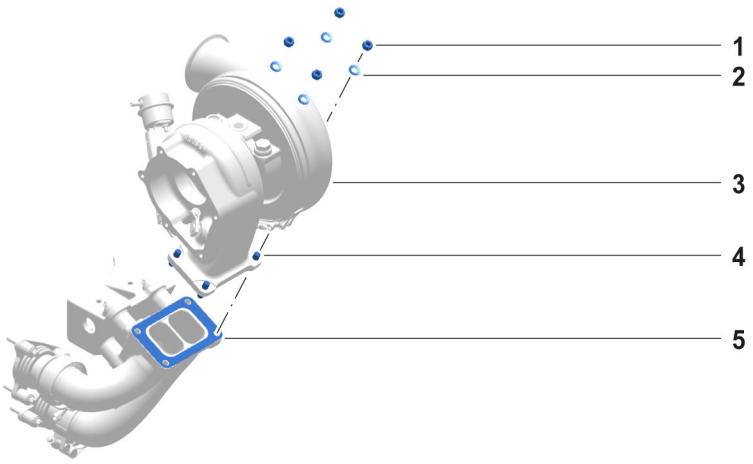


Fig. 424: Exhaust gas turbocharger

1 Hex nut (4x)
2 Washer (4x)
3 Exhaust gas turbocharger
4 Double-ended stud (4x)
5 Seal

▶ Unscrew hex nuts **1**.

▶ Remove washers **2**.

▶ Remove exhaust gas turbocharger **3**.

▶ Remove seal **5**.

▶ If necessary, unscrew stud bolts **4**.

Cleaning the exhaust gas turbocharger

- ▶ Clean sealing surface of exhaust gas turbocharger **3**.
- ▶ Clean sealing surface of exhaust gas stub.

Installing the left exhaust gas turbocharger

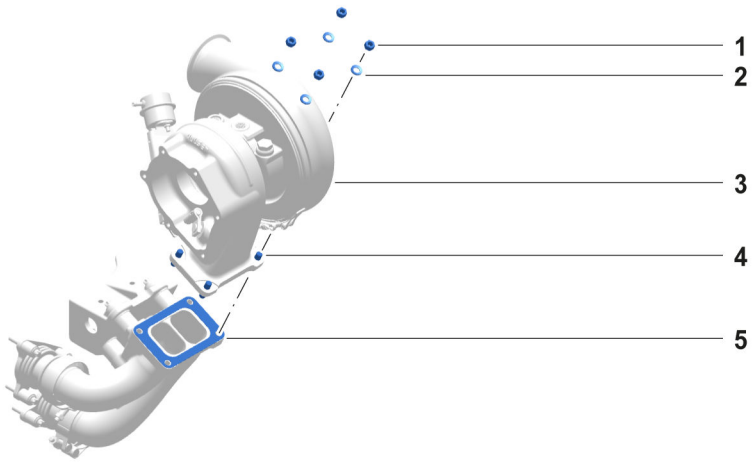
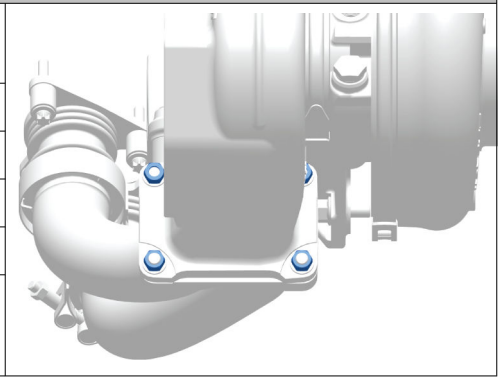


Fig. 425: Exhaust gas turbocharger

1 Hex nut (4x)
2 Washer (4x)
3 Exhaust gas turbocharger
4 Double-ended stud (4x)
5 Seal

- ▶ Tighten stud bolts **4**.
- ▶ Install new seal **5**.
- ▶ Install exhaust gas turbocharger **3**.
- ▶ Install washers **2**.

Tightening instruction for hex nut		
Lubricant (thread and head contact surface)	MOTOREX 14	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	20 Nm	
2.	44 Nm	

Tab. 90: Tightening instruction 10134830-000

- ▶ Lubricate hex nuts **1** according to tightening instruction.
- ▶ Tighten hex nuts **1** according to tightening instruction.

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Removing and installing the right exhaust gas turbocharger

Removing the right exhaust gas turbocharger

Make sure that the following prerequisites are met:

- ❑ Right charge air pipe is removed from right exhaust gas turbocharger. (For more information see: Removing the charge air pipe, page 291.)
- ❑ Right exhaust gas stub from exhaust gas turbocharger to device is removed from right exhaust gas turbocharger. (For more information see: Removing the right exhaust gas stub from the exhaust gas turbocharger to the device, page 311.)
- ❑ Right intake manifold is removed from right exhaust gas turbocharger. (For more information see: Removing the right intake manifold, page 289.)
- ❑ Oil supply line is removed from right exhaust gas turbocharger. (For more information see: Removing the right oil supply line, page 320.)
- ❑ Oil return line is removed from right exhaust gas turbocharger. (For more information see: Removing the right oil return line, page 324.)
- ❑ Coolant supply line is removed from right exhaust gas turbocharger. (For more information see: Removing the right coolant supply line, page 328.)
- ❑ Coolant return line is removed from right exhaust gas turbocharger. (For more information see: Removing the right coolant return line, page 332.)
- ❑ Charging pressure regulation is removed from right exhaust gas turbocharger. (For more information see: Removing the pipeline from the cycle valve to the vacuum actuator, page 300.)

▶ Procedure according to description for left exhaust gas turbocharger. (For more information see: Removing the left exhaust gas turbocharger, page 335.)

Cleaning the right exhaust gas turbocharger

▶ Procedure according to description for left exhaust gas turbocharger. (For more information see: Cleaning the exhaust gas turbocharger, page 336.)

Installing the right exhaust gas turbocharger

▶ Procedure according to description for left exhaust gas turbocharger. (For more information see: Installing the left exhaust gas turbocharger, page 336.)

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3.8.3 Exhaust manifold

Removing and installing the left heat protection

Removing the left heat protection

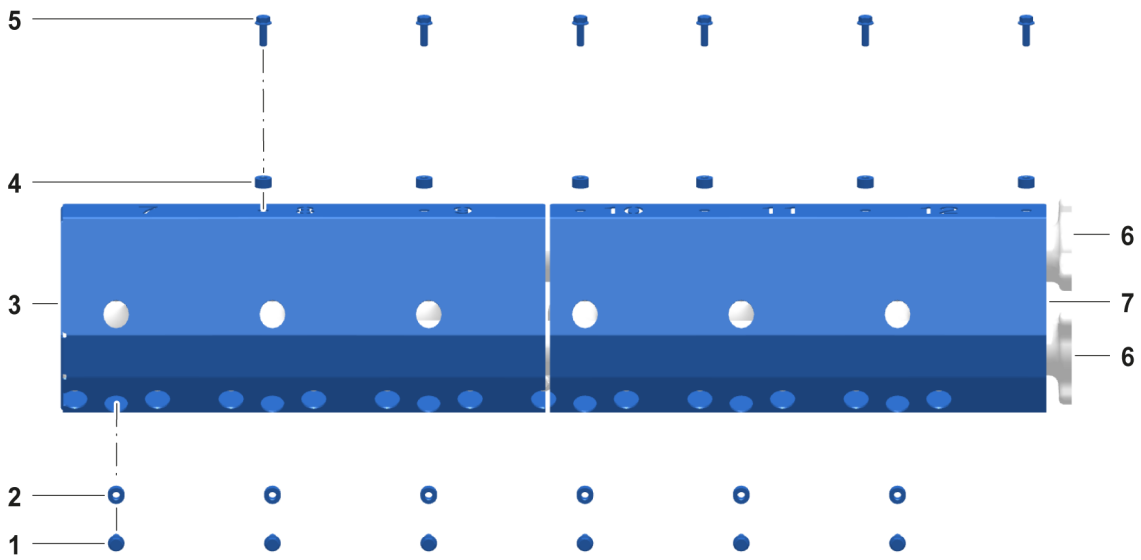

Fig. 427: Left heat protection

1 Hex head screw (6x)
2 Spacer sleeve (6x)
3 Heat protection
4 Spacer sleeve (6x)
5 Hex head screw (6x)
6 Exhaust manifold (2x)
7 Heat protection

▶ Unscrew hex head screws **1**.

▶ Remove spacer sleeves **2**.

▶ Unscrew hex head screws **5**.

▶ Remove spacer sleeves **4**.

▶ Remove heat protection **3**.

▶ Remove heat protection **7**.

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Installing the left heat protection

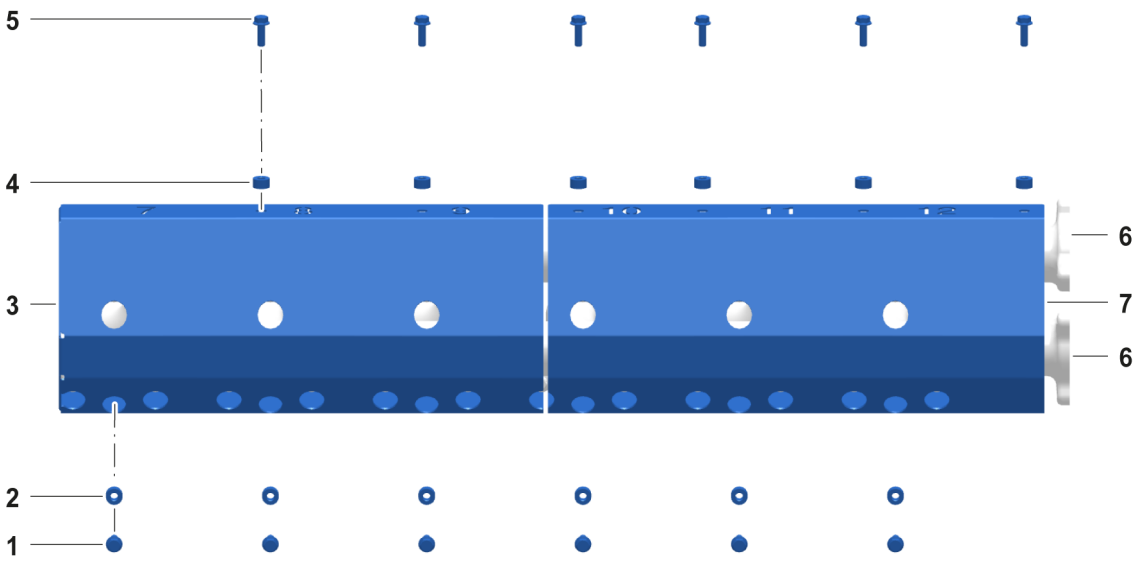

Fig. 428: Left heat protection

1 Hex head screw (6x)
2 Spacer sleeve (6x)
3 Heat protection
4 Spacer sleeve (6x)
5 Hex head screw (6x)
6 Exhaust manifold (2x)
7 Heat protection

- ▶ Install heat protection **7**.
- ▶ Install heat protection **3**.
- ▶ Install spacer sleeves **4** on exhaust manifolds **6**.
- ▶ Tighten hex head screws **5**.
- ▶ Tighten spacer sleeves **2** with hex head screws **1**.

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Removing and installing the right heat protection

Removing the right heat protection

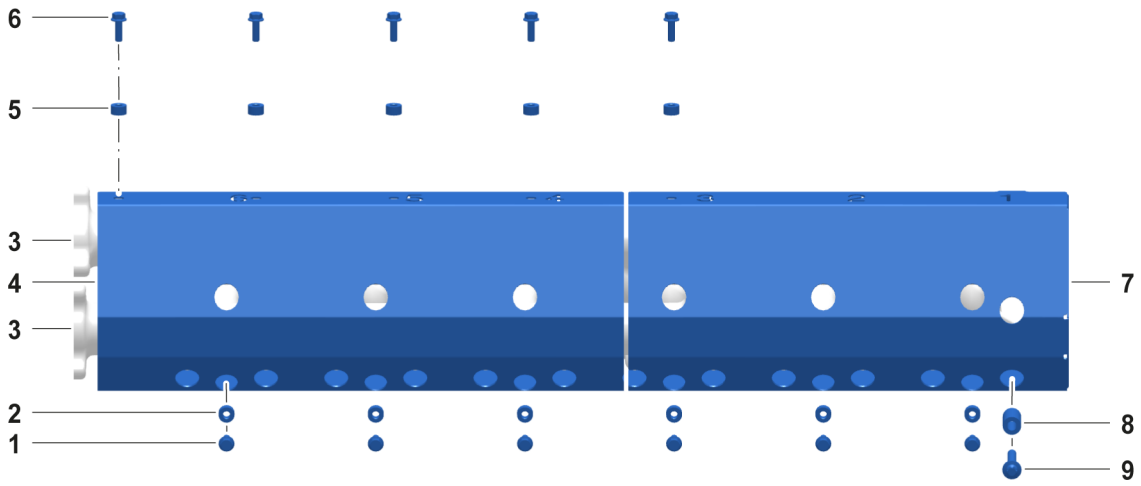

Fig. 429: Right heat protection

1 Hex head screw (6x)
2 Spacer sleeve (6x)
3 Exhaust manifold (2x)
4 Heat protection
5 Spacer sleeve (5x)
6 Hex head screw (5x)
7 Heat protection
8 Spacer sleeve
9 Hex head screw

▶ Unscrew hex head screws **1**.

▶ Remove spacer sleeves **2**.

▶ Unscrew hex head screw **9**.

▶ Remove spacer sleeve **8**.

▶ Unscrew hex head screws **6**.

▶ Remove spacer sleeves **5**.

▶ Remove heat protection **4**.

▶ Remove heat protection **7**.

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Installing the right heat protection

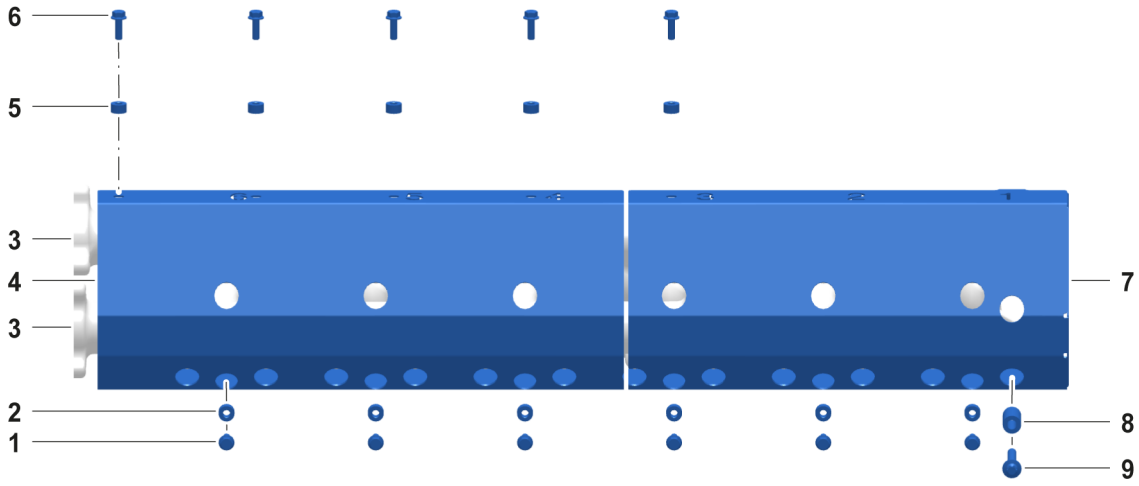

Fig. 430: Right heat protection

1 Hex head screw (6x)
2 Spacer sleeve (6x)
3 Exhaust manifold (2x)
4 Heat protection
5 Spacer sleeve (5x)
6 Hex head screw (5x)
7 Heat protection
8 Spacer sleeve
9 Hex head screw

▶ Install heat protection **7**.

▶ Install heat protection **4**.

▶ Install spacer sleeves **5** on exhaust manifolds **3**.

▶ Tighten hex head screws **6**.

▶ Tighten spacer sleeve **8** with hex head screw **9**.

▶ Tighten spacer sleeves **2** with hex head screws **1**.

Removing and installing the left exhaust manifold

Removing the left exhaust manifold

Make sure that the following prerequisites are met:
❑ Left exhaust gas stub from exhaust manifold to exhaust gas turbocharger is removed from exhaust manifold. (For more information see: Removing the left exhaust gas stub from the exhaust manifold to the exhaust gas turbocharger, page 307.)
❑ Left heat protection is removed. (For more information see: Removing the left heat protection, page 338.)

WARNING
Hot components!
Serious burns possible.

▶ Let the diesel engine cool down to below 50 °C.

▶ Wear heat-resistant safety gloves and heat-resistant work clothes.

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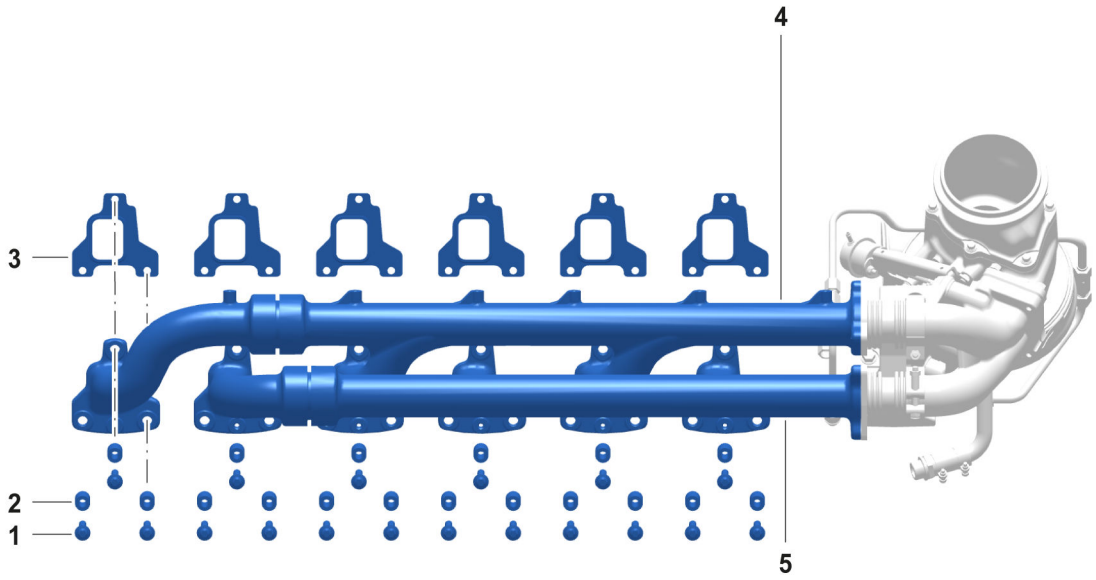

Fig. 431: Exhaust manifold

1 Hex head screw (18x)
2 Spacer sleeve (18x)
3 Seal (6x)
4 Exhaust manifold
5 Exhaust manifold

▶ Unscrew hex head screws **1**.

▶ Remove spacer sleeves **2**.

▶ Remove exhaust manifold **4**.

▶ Remove exhaust manifold **5**.

▶ Remove seals **3**.

Checking and cleaning the left exhaust manifold

▶ Check exhaust manifold **4** and exhaust manifold **5** for leaks.

If exhaust manifold **4** or exhaust manifold **5** is leaking:
▶ Do not start engine.

▶ Replace leaking exhaust manifold.

▶ Check exhaust manifold **4** and exhaust manifold **5** for damage.

If exhaust manifold **4** or exhaust manifold **5** is damaged:
▶ Do not start engine.

▶ Replace damaged exhaust manifold.

▶ Clean sealing surfaces of exhaust manifold **4** and exhaust manifold **5**.

▶ Clean sealing surfaces of cylinder heads.

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Installing the left exhaust manifold

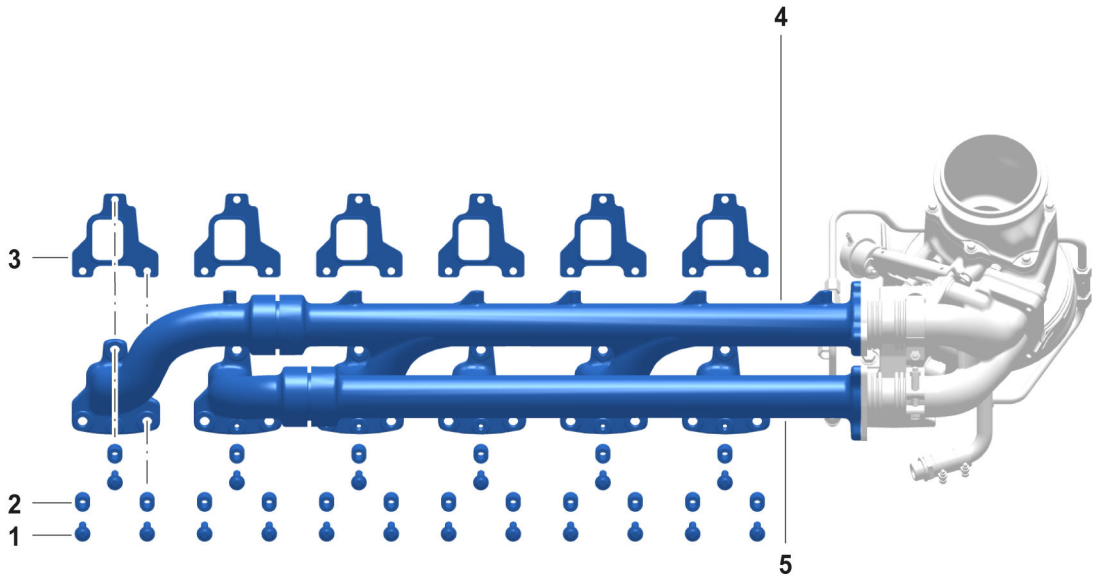


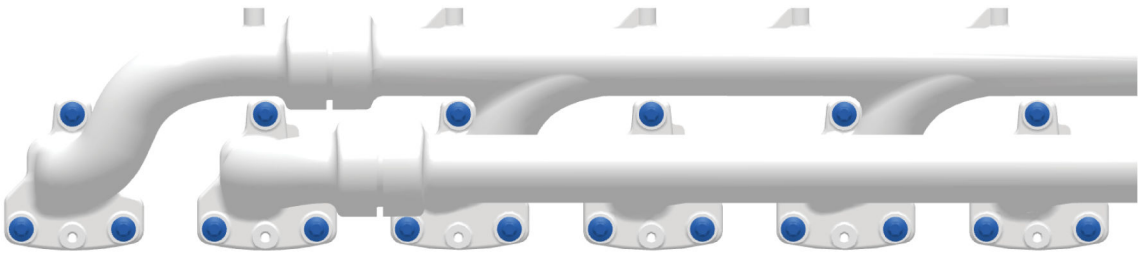
Fig. 432: Exhaust manifold

1 Hex head screw (18x)
2 Spacer sleeve (18x)
3 Seal (6x)
4 Exhaust manifold
5 Exhaust manifold

▶ Install new seals **3**.

▶ Install exhaust manifold **5**.

▶ Install exhaust manifold **4**.

Tightening instruction for hex head screws	
	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	38 Nm

Tab. 91: Tightening instruction 12439138-000

▶ Tighten spacer sleeves **2** with hex head screws **1** according to tightening instruction.

Removing and installing the right exhaust manifold

Removing the right exhaust manifold

Make sure that the following prerequisites are met:

- ❑ Right exhaust gas stub from exhaust manifold to exhaust gas turbocharger is removed from exhaust manifold. (For more information see: Removing the right exhaust gas stub from the exhaust gas turbocharger to the device, page 311.)
- ❑ Right heat protection is removed. (For more information see: Removing the right heat protection, page 340.)

▶ Procedure according to description for left exhaust manifold. (For more information see: Removing the left exhaust manifold, page 341.)

Checking and cleaning the left exhaust manifold

▶ Procedure according to description for left exhaust manifold. (For more information see: Checking and cleaning the left exhaust manifold, page 342.)

Installing the right exhaust manifold

▶ Procedure according to description for left exhaust manifold. (For more information see: Installing the left exhaust manifold, page 343.)

Dismantling and assembling the left exhaust manifold

Dismantling the left exhaust manifold

Make sure that the following prerequisite is met:

- ❑ Left exhaust manifold is removed. (For more information see: Removing the left exhaust manifold, page 341.)

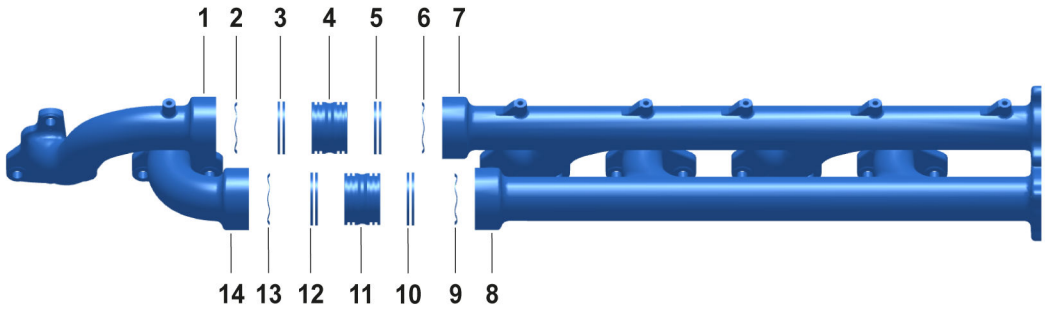


Fig. 434: Exhaust manifold

1	Exhaust pipe	**8**	Exhaust pipe
2	Ondular washer	**9**	Ondular washer
3	Laminar ring set	**10**	Laminar ring set
4	Intermediate section	**11**	Intermediate section
5	Laminar ring set	**12**	Laminar ring set
6	Ondular washer	**13**	Ondular washer
7	Exhaust pipe	**14**	Exhaust pipe

▶ Remove exhaust pipe **1**.

▶ Remove ondular washer **2**.

▶ Remove laminar ring set **3**.

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- ▶ Remove intermediate section **4**.
- ▶ Remove laminar ring set **5**.
- ▶ Remove ondular washer **6**.
- ▶ Remove exhaust pipe **14**.
- ▶ Remove ondular washer **13**.
- ▶ Remove laminar ring set **12**.
- ▶ Remove intermediate section **11**.
- ▶ Remove laminar ring set **10**.
- ▶ Remove ondular washer **9**.

Checking and cleaning the left exhaust manifold

- ▶ Check exhaust pipes for damage and replace if necessary.
- ▶ Check intermediate sections for damage and replace if necessary.
- ▶ Check ondular washers for damage and replace if necessary.
- ▶ Check laminar ring sets for damage and replace if necessary.
- ▶ Clean exhaust pipes.
- ▶ Clean intermediate sections.
- ▶ Clean ondular washers.
- ▶ Clean laminar ring sets.

Assembling the left exhaust manifold

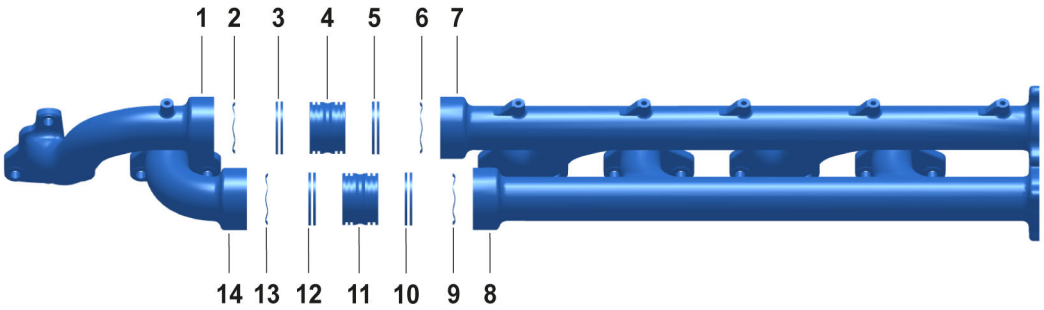

Fig. 435: Exhaust manifold

1	Exhaust pipe	**8**	Exhaust pipe
2	Ondular washer	**9**	Ondular washer
3	Laminar ring set	**10**	Laminar ring set
4	Intermediate section	**11**	Intermediate section
5	Laminar ring set	**12**	Laminar ring set
6	Ondular washer	**13**	Ondular washer
7	Exhaust pipe	**14**	Exhaust pipe

- ▶ Install ondular washer **9** in exhaust pipe **8**.
- ▶ Install laminar ring set **10** with openings offset by 180°.
- ▶ Install intermediate section **11** in exhaust pipe **8**.
- ▶ Install laminar ring set **12** with openings offset by 180°.
- ▶ Install ondular washer **13** in exhaust pipe **14**.

- ▶ Install exhaust pipe **14**.
- ▶ Install ondular washer **6** in exhaust pipe **7**.
- ▶ Install laminar ring set **5** with openings offset by 180°.
- ▶ Install intermediate section **4** in exhaust pipe **7**.
- ▶ Install laminar ring set **3** with openings offset by 180°.
- ▶ Install ondular washer **2** in exhaust pipe **1**.
- ▶ Install exhaust pipe **1**.

Dismantling and assembling the right exhaust manifold

Dismantling the right exhaust manifold

Make sure that the following prerequisite is met:
- ❑ Right exhaust manifold is removed. (For more information see: Removing the right exhaust manifold, page 344.)

- ▶ Procedure according to description for left exhaust manifold. (For more information see: Dismantling the left exhaust manifold, page 344.)

Checking and cleaning the right exhaust manifold

- ▶ Procedure according to description for left exhaust manifold. (For more information see: Checking and cleaning the left exhaust manifold, page 345.)

Assembling the right exhaust manifold

- ▶ Procedure according to description for left exhaust manifold. (For more information see: Assembling the left exhaust manifold, page 345.)

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3.9 Engine oil system

3.9.1 Initial commissioning of the engine oil system

NOTICE
Oil pressure builds up too late!
Engine damage.

- ▶ During the initial commissioning of the engine (for example, after a repair to the engine oil system), 0.5 liters of engine oil must be filled into each oil channel on the side on the oil module/oil channel, in addition to the (standard) engine oil filling.

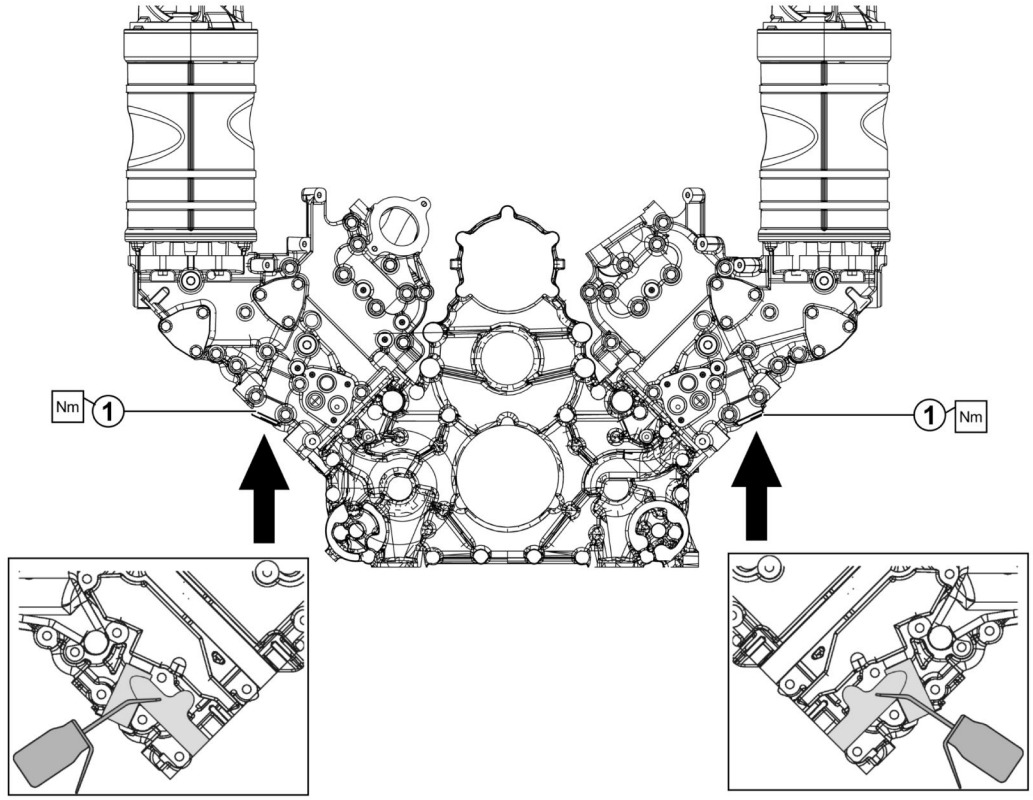

Fig. 436: Initial filling

1 Screw plug (2x)

Note

Always fill engine oil on both sides, even if an oil filter is only installed on one side.

- ▶ Unscrew screw plugs **1**.
- ▶ Fill at least 0.5 l of engine oil.
- ▶ Tighten screw plugs **1**.

3.9.2 Removing and installing the end control valve

Removing the end control valve pipeline

Make sure that the following prerequisites are met:
- ❑ A collection container for engine oil is available.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

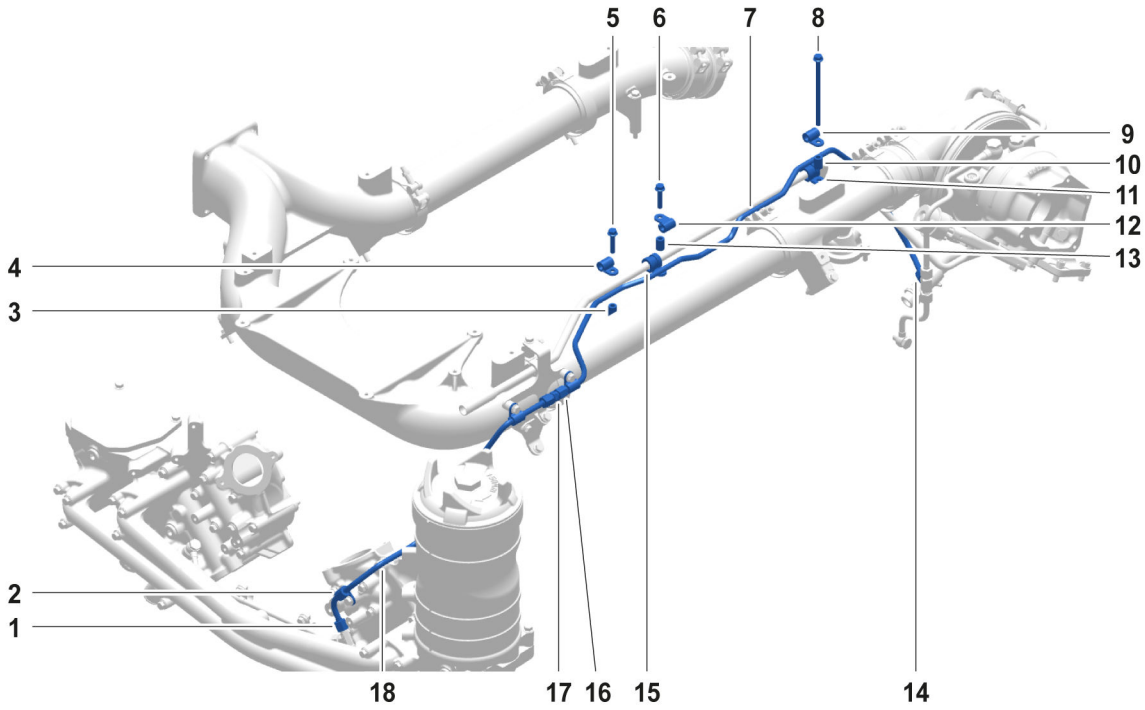

Fig. 437: Pipeline

1	Box nut
2	Holding clamp (3x)
3	Spacer sleeve
4	Holding clamp
5	Hex head screw
6	Hex head screw
7	Pipeline
8	Hex head screw
9	Holding clamp
10	Spacer sleeve
11	Holding clamp
12	Holding clamp
13	Spacer sleeve
14	Box nut
15	Holding clamp
16	Box nut (2x)
17	Screw fitting
18	Pipeline

- ▶ Remove holding clamps **2**.
- ▶ Unscrew hex head screw **5**.
- ▶ Remove holding clamp **4**.
- ▶ Remove spacer sleeve **3**.
- ▶ Unscrew hex head screw **6**.
- ▶ Remove holding clamp **12**.
- ▶ Remove spacer sleeve **13**.
- ▶ Unscrew hex head screw **8**.
- ▶ Remove holding clamp **9**.
- ▶ Remove spacer sleeve **10**.

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- ▶ Unscrew box nut **1**.
- ▶ Unscrew box nut **14**.
- ▶ Remove pipeline **7** and pipeline **18**.
- ▶ If necessary, unscrew box nuts **16**.
- ▶ Remove screw fitting **17**.
- ▶ Seal openings of pipeline **7** and pipeline **18**.

Removing the left end control valve pipeline to the right end control valve

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

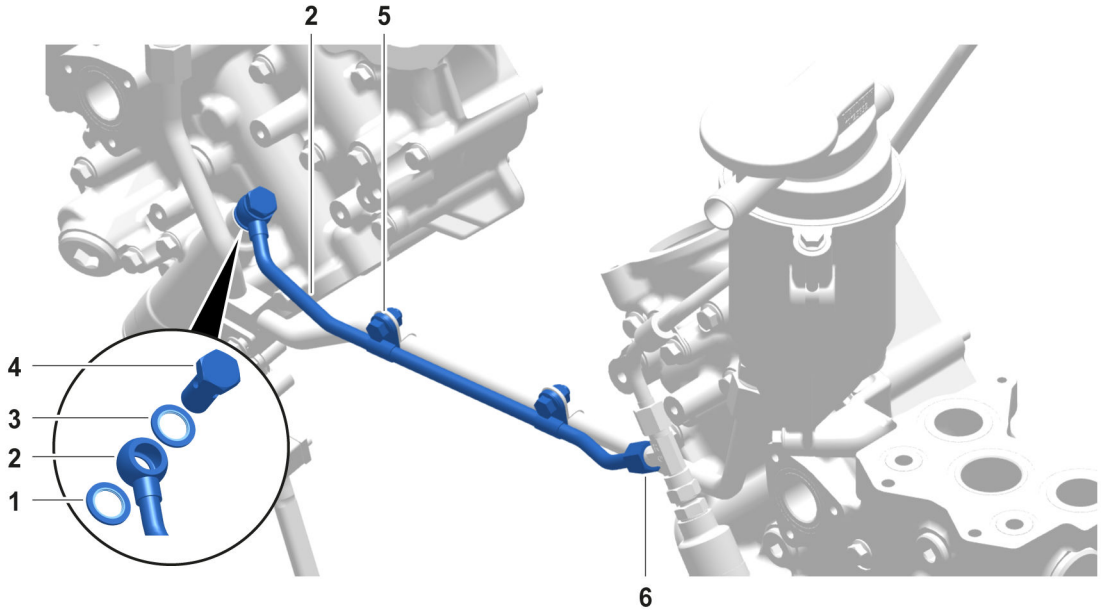

Fig. 438: Pipeline

1 Sealing ring
2 Pipeline
3 Sealing ring
4 Banjo bolt
5 Holding clamp (2x)
6 Box nut

- ▶ Remove holding clamps **5**.
- ▶ Unscrew banjo bolt **4**.
- ▶ Remove sealing ring **3**.
- ▶ Remove sealing ring **1**.
- ▶ Unscrew box nut **6**.
- ▶ Remove pipeline **2**.
- ▶ Seal openings of pipeline **2**.
- ▶ Seal openings of left end control valve and right end control valve.

Removing the left end control valve

Make sure that the following prerequisites are met:
❑ A collection container for engine oil is available.

- ❑ End control valve pipeline is removed. (For more information see: Removing the end control valve pipeline, page 348.)
- ❑ Left end control valve pipeline to right end control valve is removed. (For more information see: Removing the left end control valve pipeline to the right end control valve, page 349.)

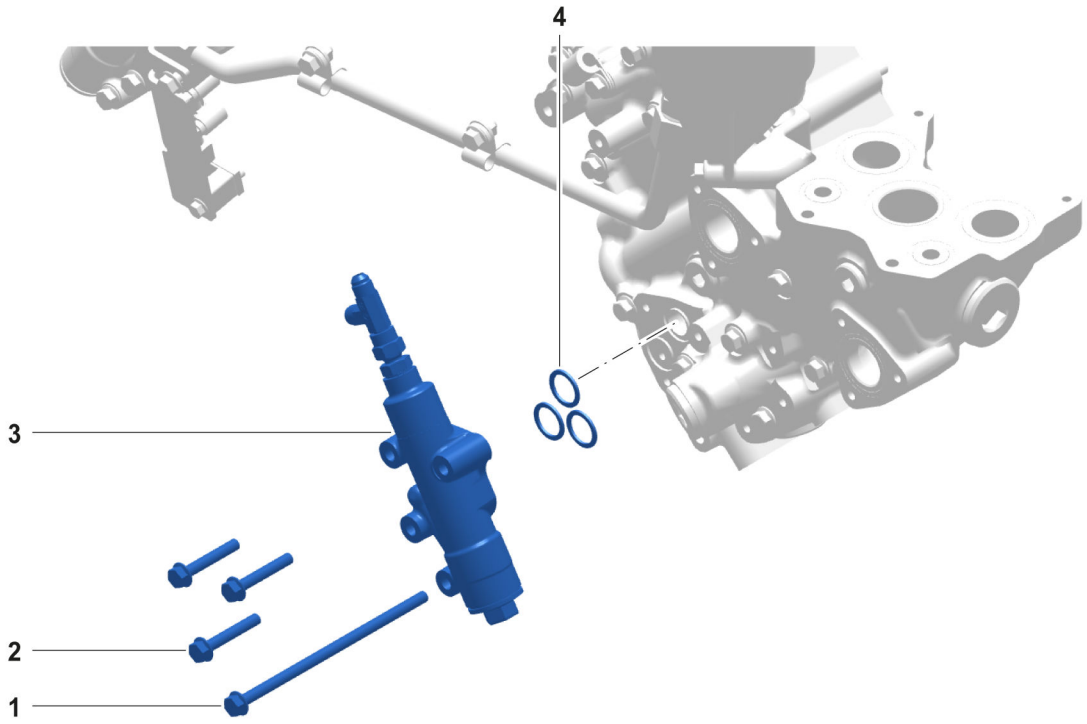

Fig. 439: Left end control valve

1 Hex head screw
2 Hex head screw (3x)
3 End control valve
4 O-ring (3x)

▶ Unscrew hex head screw **1**.

▶ Unscrew hex head screws **2**.

▶ Remove end control valve **3**.

▶ Remove o-rings **4**.

Removing the right end control valve

Make sure that the following prerequisites are met:
- ❑ A collection container for engine oil is available.
- ❑ Tension pulley (self-tensioning) is removed. (For more information see: Removing the tension pulley (self-tensioning), page 267.)
- ❑ Console of oil return line is removed. (For more information see: Removing the oil return line, page 366.)
- ❑ Banjo bolt of left end control valve pipeline to right end control valve is removed. (For more information see: Removing the left end control valve pipeline to the right end control valve, page 349.)

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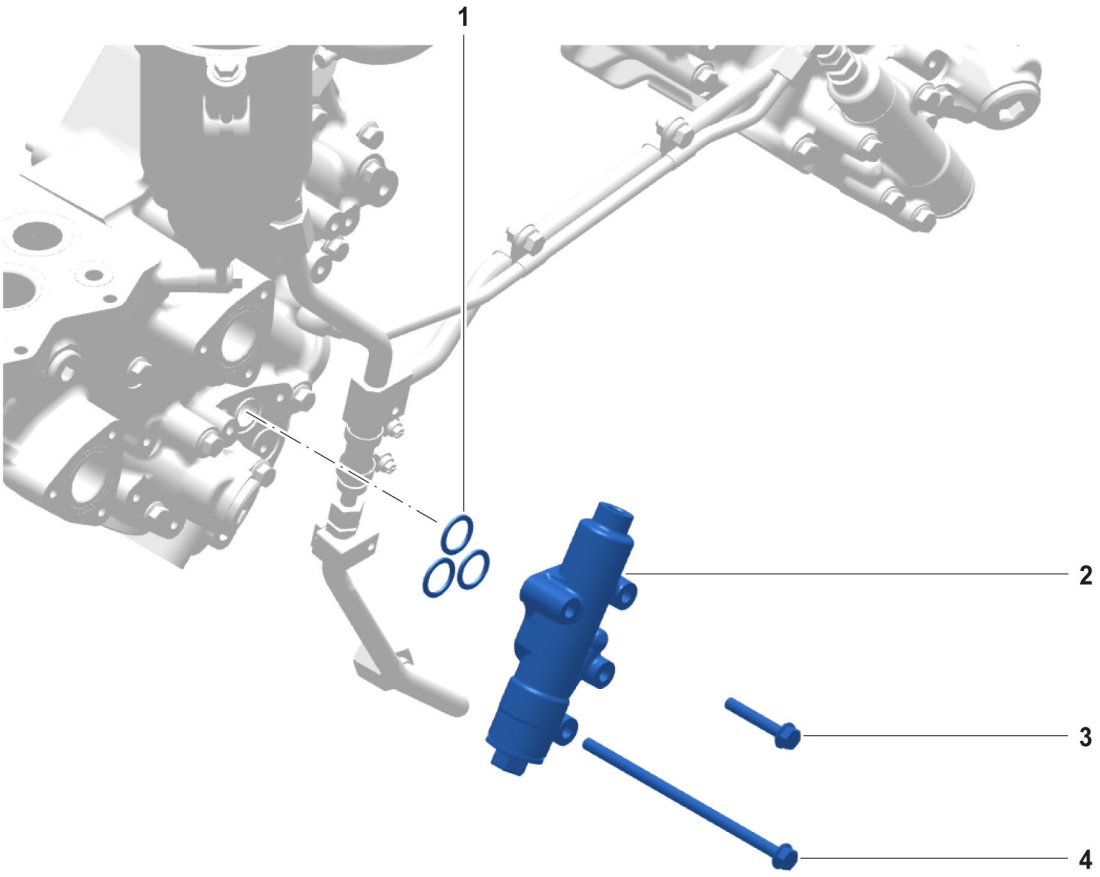

Fig. 440: Right end control valve

1 O-ring (3x)
2 End control valve
3 Hex head screw
4 Hex head screw

▶ Unscrew hex head screw **3**.

▶ Unscrew hex head screw **4**.

▶ Remove end control valve **2**.

▶ Remove o-rings **1**.

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Removing the bracket

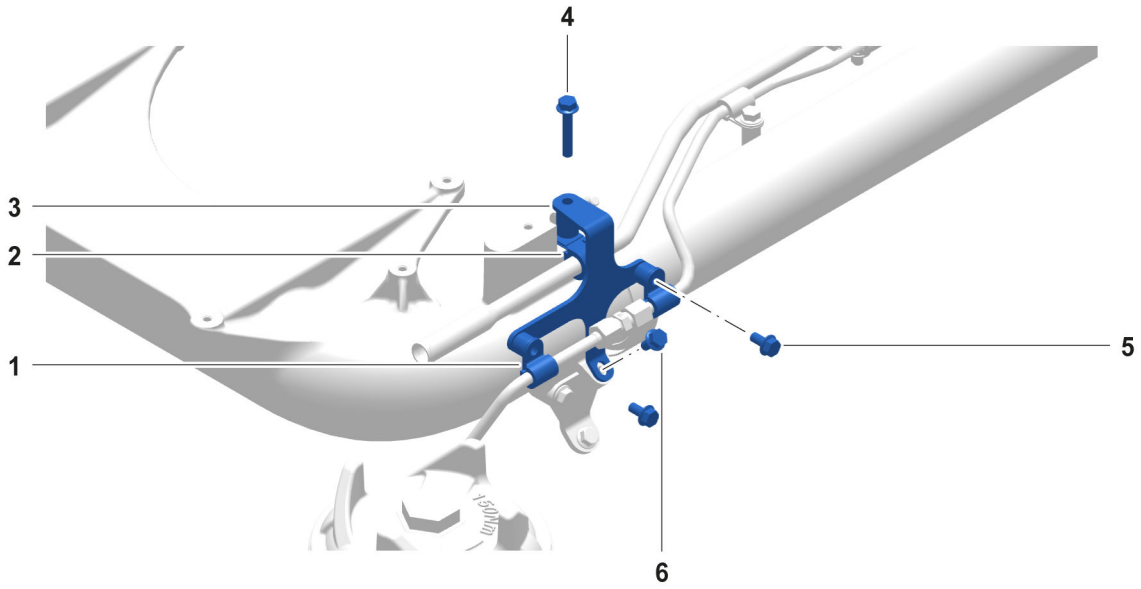

Fig. 441: Bracket

1 Holding clamp (2x)
2 Holding clamp
3 Bracket
4 Hex head screw
5 Hex head screw (2x)
6 Hex head screw

▶ Unscrew hex head screws **5**.

▶ Unscrew hex head screw **6**.

▶ Unscrew hex head screw **4**.

▶ Remove bracket **3**.

Cleaning the end control valve

▶ Clean sealing surfaces of left end control valve.

▶ Clean sealing surface of left oil module.

▶ Clean grooves of o-rings.

▶ Clean sealing surfaces of right end control valve.

▶ Clean sealing surface of right oil module.

▶ Clean grooves of o-rings.

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Installing the bracket

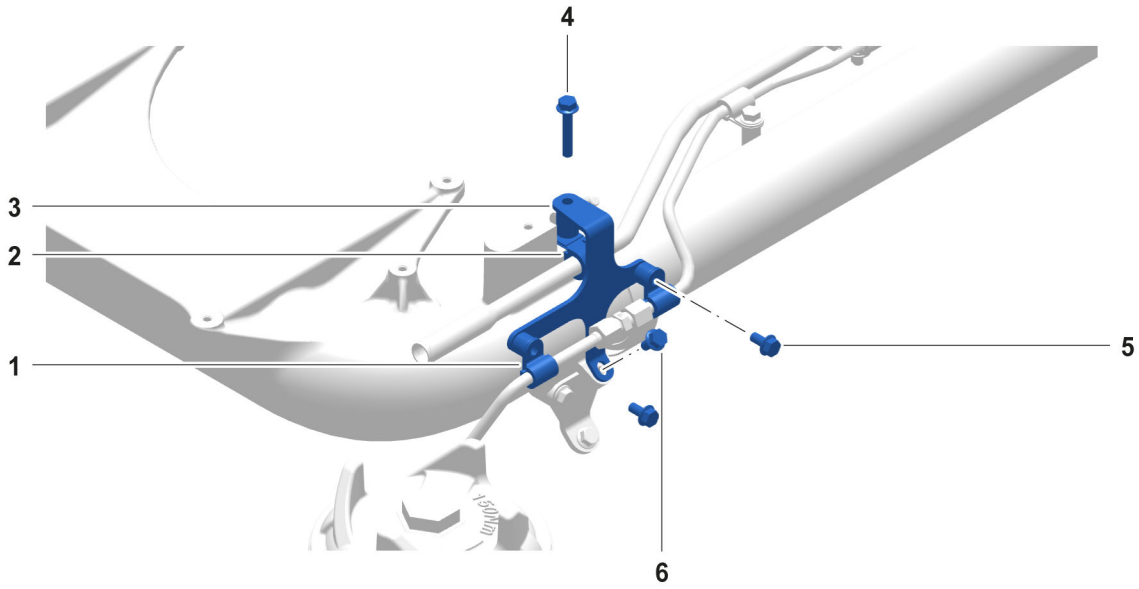

Fig. 442: Bracket

1 Holding clamp (2x)
2 Holding clamp
3 Bracket
4 Hex head screw
5 Hex head screw (2x)
6 Hex head screw

- ▶ Install bracket **3**.
- ▶ Install holding clamp **2**.
- ▶ Tighten hex head screw **4**.
- ▶ Tighten hex head screw **6**.
- ▶ Install holding clamps **1**.
- ▶ Tighten hex head screws **5**.

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Installing the right end control valve

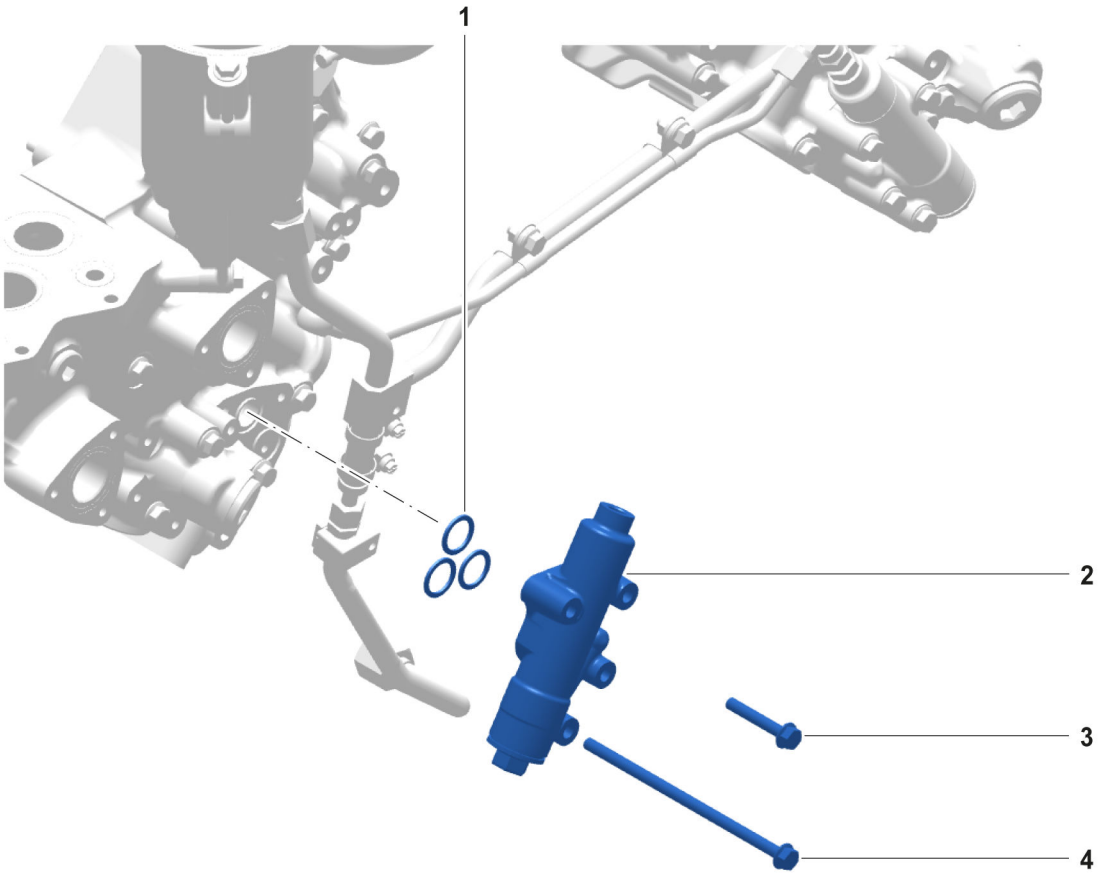


Fig. 443: Right end control valve

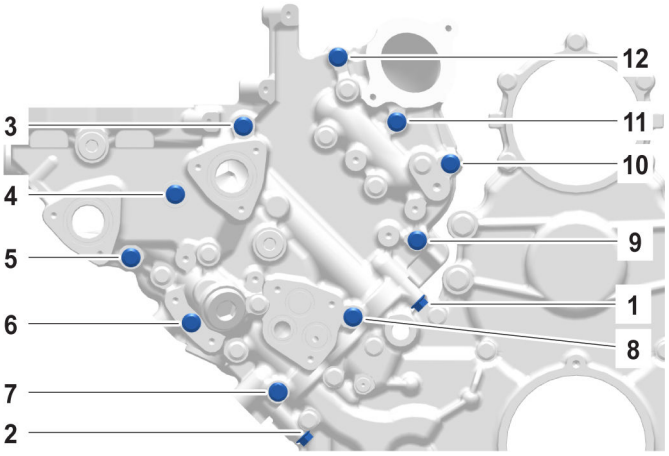
1 O-ring (3x)
2 End control valve
3 Hex head screw
4 Hex head screw

▶ Lubricate new o-rings **1** with NBU 30 grease.

▶ Install o-rings **1**.

▶ Install end control valve **2**.

▶ Tighten hex head screw **3**.

Tightening instruction for hex head screw	
Tightening sequence  	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	19 Nm
2.	25 Nm

Tab. 92: Tightening instruction 12960298-000

▶ Tighten hex head screw **4** according to tightening instruction.

Installing the left end control valve

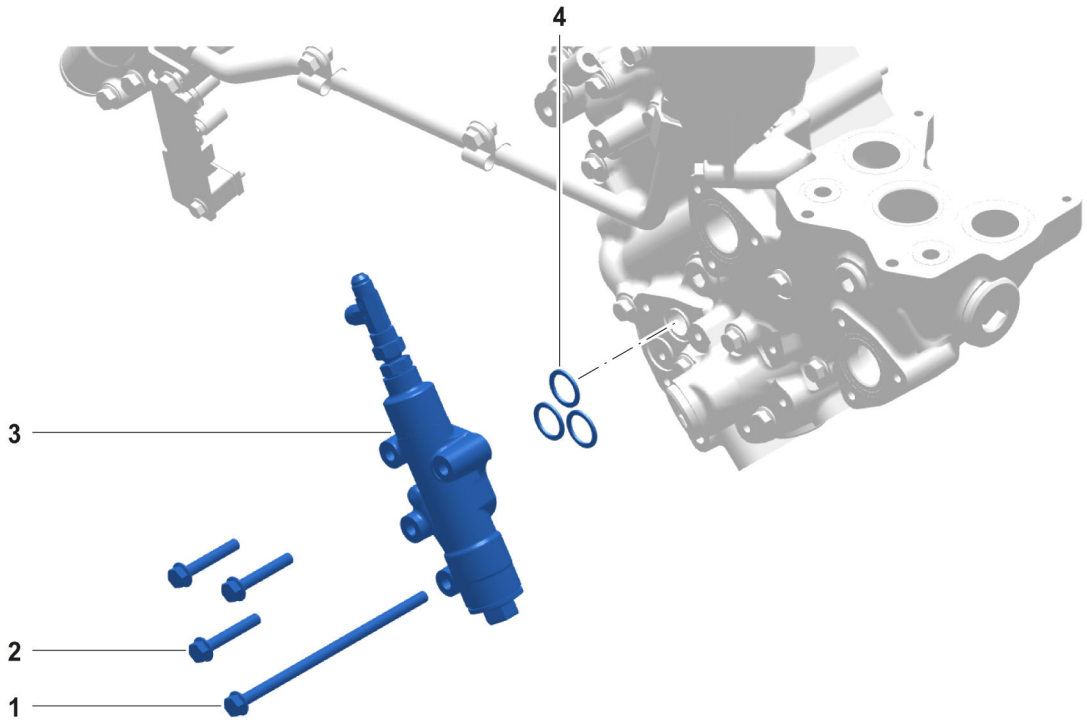


Fig. 445: Left end control valve

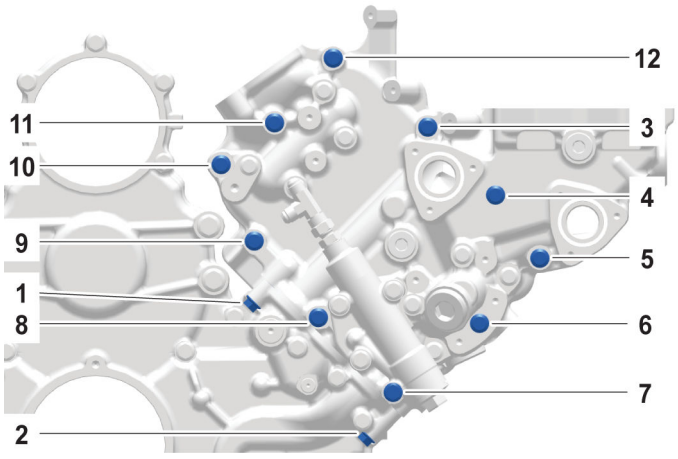
1 Hex head screw
2 Hex head screw (3x)
3 End control valve
4 O-ring (3x)

▶ Lubricate new o-rings **4** with NBU 30 grease.

▶ Install o-rings **4**.

▶ Install end control valve **3**.

▶ Tighten hex head screws **2**.

Tightening instruction for hex head screw	
Tightening sequence 	
Lubricant (thread and head contact surface)	-

Tightening instruction for hex head screw	
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	19 Nm
2.	25 Nm

Tab. 93: Tightening instruction 12960298-000

▶ Tighten hex head screw **1** according to tightening instruction.

Installing the left end control valve pipeline to the right end control valve

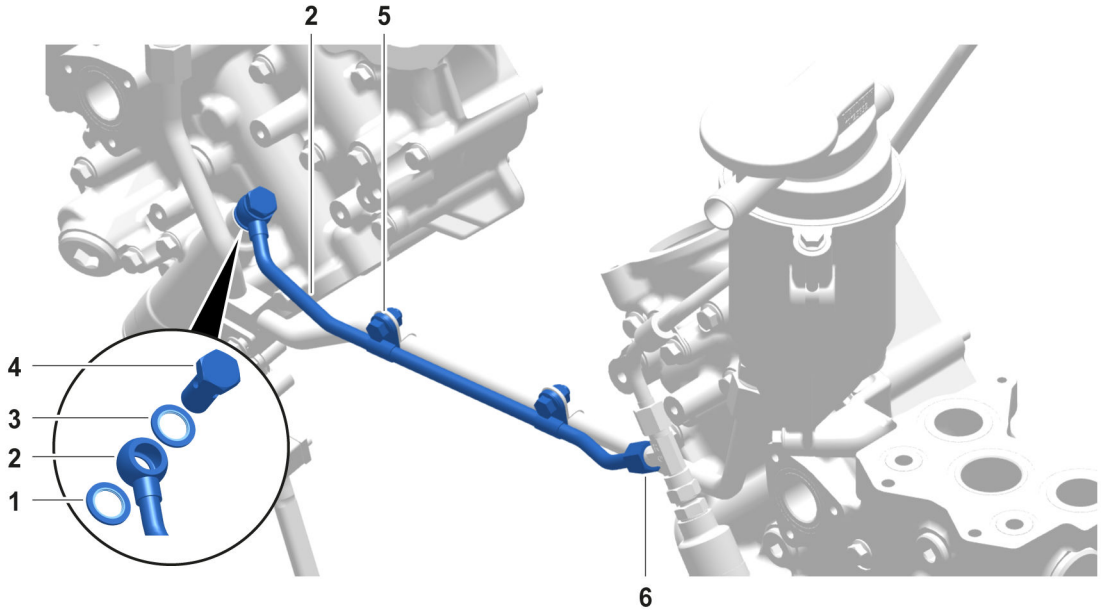


Fig. 447: Pipeline

1 Sealing ring
2 Pipeline
3 Sealing ring
4 Banjo bolt
5 Holding clamp (2x)
6 Box nut

▶ Remove closures from left end control valve and right end control valve.

▶ Remove closures from pipeline **2**.

▶ Install pipeline **2**.

▶ Tighten box nut **6**.

▶ Install sealing ring **3**.

▶ Install sealing ring **1**.

▶ Tighten banjo bolt **4**.

▶ Install holding clamps **5**.

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Installing the end control valve pipeline

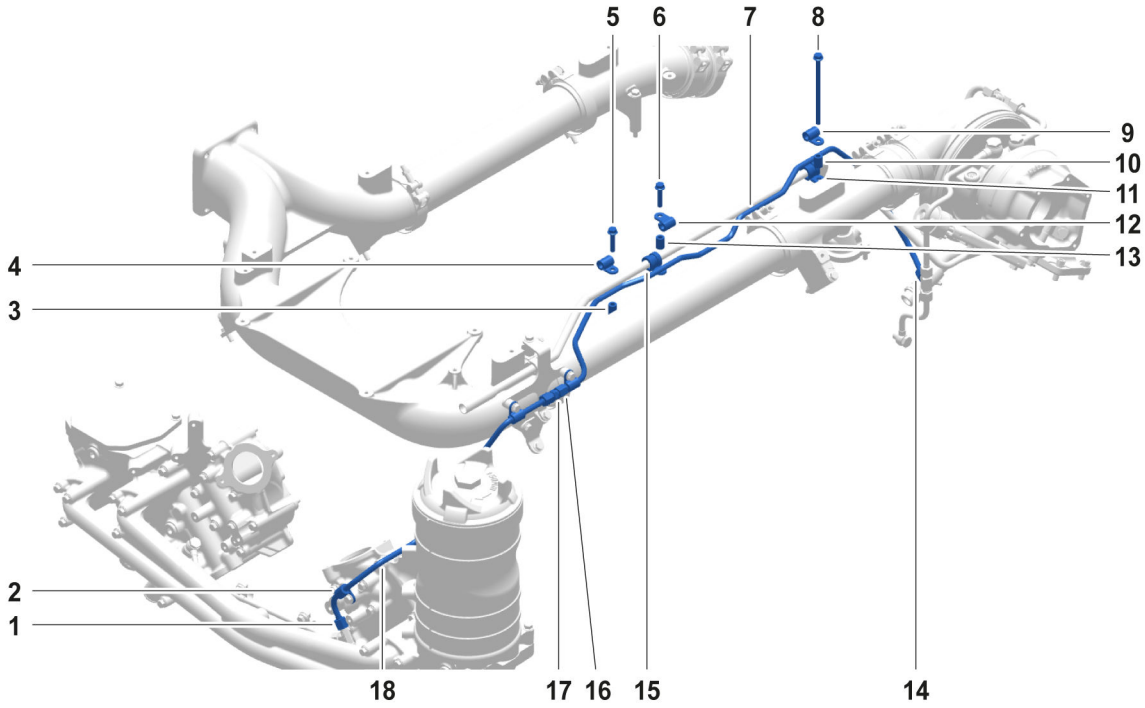

Fig. 448: Pipeline

1	Box nut	**10**	Spacer sleeve
2	Holding clamp (3x)	**11**	Holding clamp
3	Spacer sleeve	**12**	Holding clamp
4	Holding clamp	**13**	Spacer sleeve
5	Hex head screw	**14**	Box nut
6	Hex head screw	**15**	Holding clamp
7	Pipeline	**16**	Box nut (2x)
8	Hex head screw	**17**	Screw fitting
9	Holding clamp	**18**	Pipeline

- ▶ Remove closures from pipeline **7** and pipeline **18**.
- ▶ Install screw fitting **17**.
- ▶ Tighten box nuts **16**.
- ▶ Install pipeline **7** and pipeline **18**.
- ▶ Tighten box nut **14**.
- ▶ Tighten box nut **1**.
- ▶ Install holding clamp **11**.
- ▶ Install spacer sleeve **10**.
- ▶ Install holding clamp **9**.
- ▶ Tighten hex head screw **8**.
- ▶ Install holding clamp **15**.
- ▶ Install spacer sleeve **13**.
- ▶ Install holding clamp **12**.
- ▶ Tighten hex head screw **6**.

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- ▶ Install spacer sleeve **3**.
- ▶ Install holding clamp **4**.
- ▶ Tighten hex head screw **5**.
- ▶ Install holding clamps **2**.

3.9.3 Crankcase ventilation

Removing and installing the left pipelines

Removing the cylinder head cover pipeline to the left oil mist separator

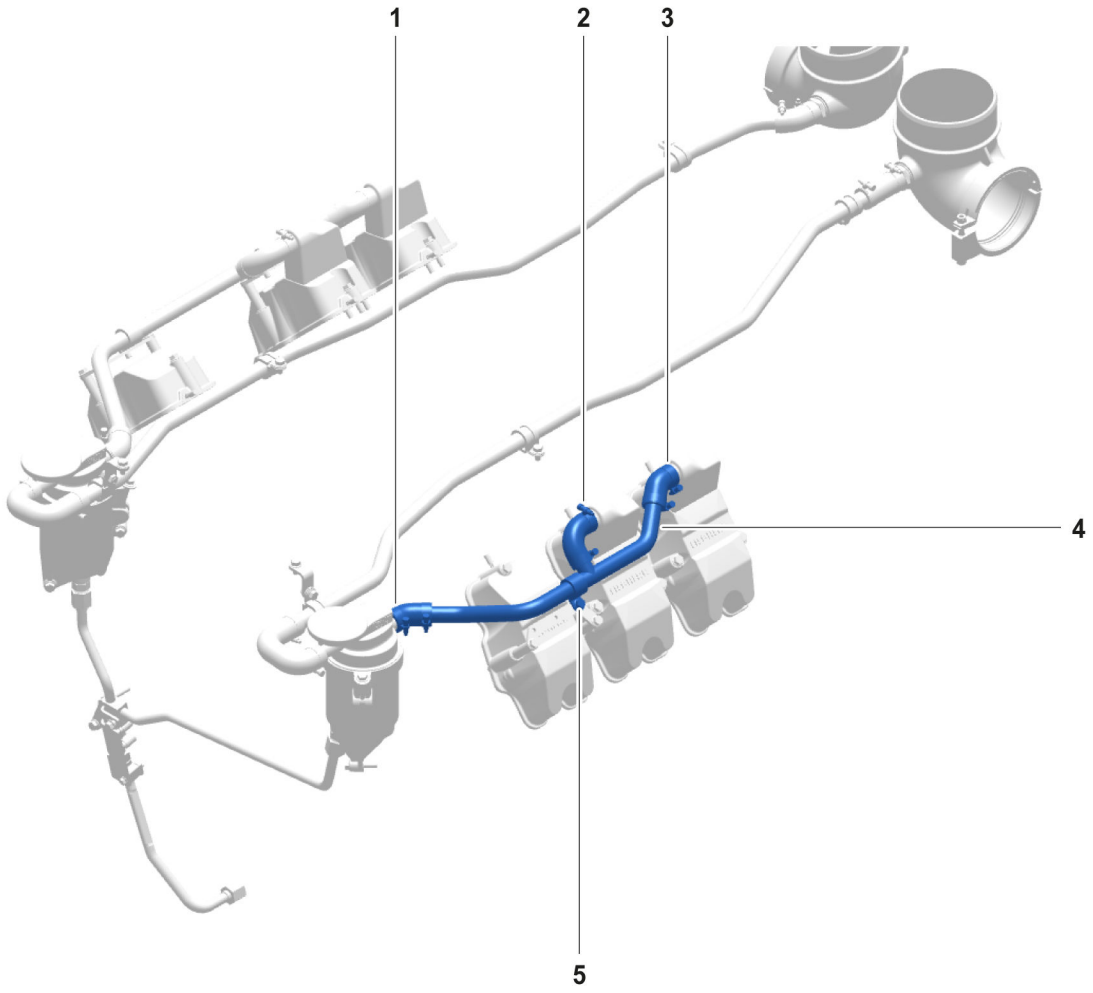

Fig. 449: Crankcase ventilation

1 Hose clamp
2 Hose clamp
3 Hose clamp
4 Pipeline
5 Holding clamp

- ▶ Remove hose clamp **1**.
- ▶ Remove hose clamp **2**.
- ▶ Remove hose clamp **3**.
- ▶ Remove holding clamp **5**.
- ▶ Remove pipeline **4**.

Removing the left oil mist separator pipeline to the intake manifold

Make sure that the following prerequisites are met:
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

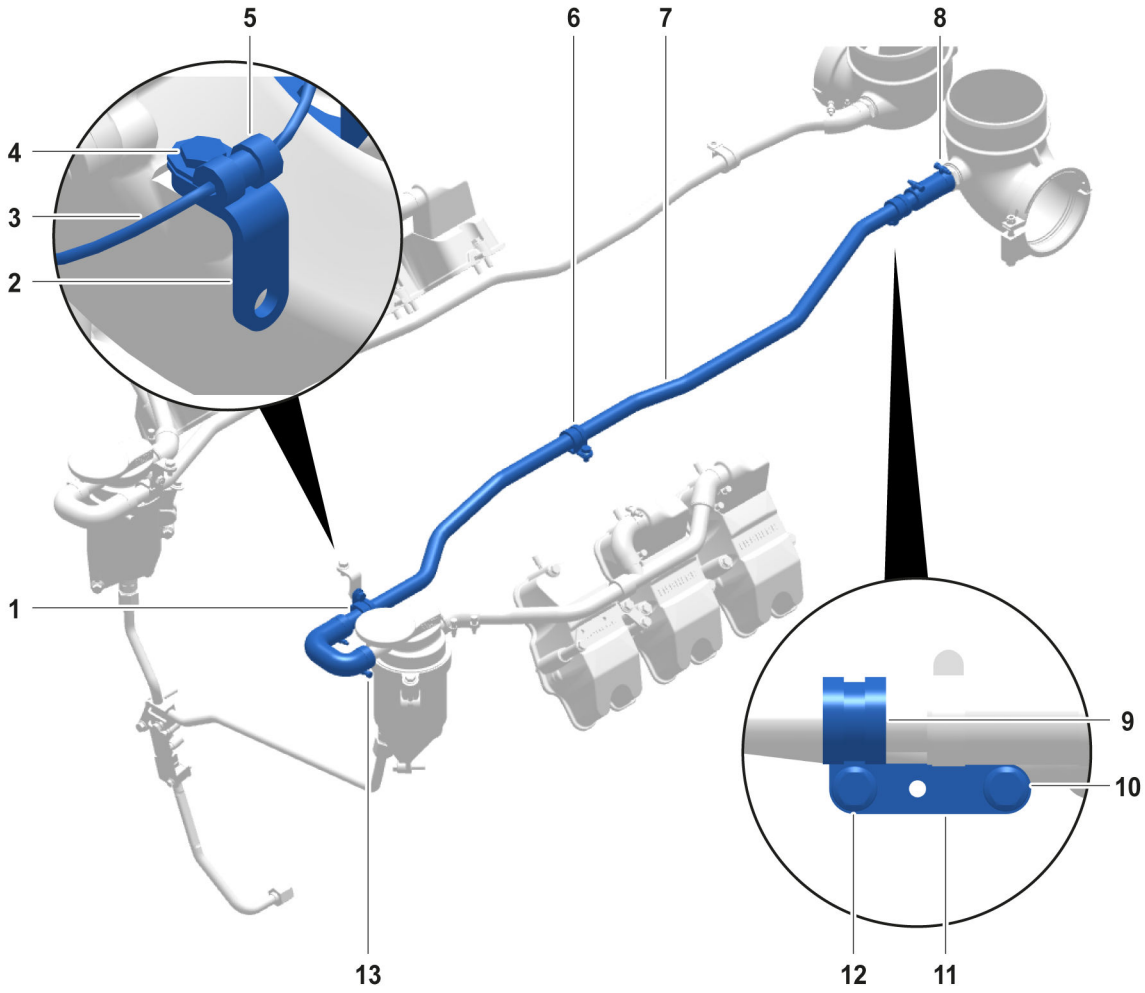

Fig. 450: Crankcase ventilation

1 Holding clamp
2 Bracket
3 Electrical line
4 Hex head screw
5 Holding clamp
6 Holding clamp
7 Pipeline
8 Hose clamp
9 Holding clamp
10 Hex head screw
11 Bracket
12 Hex head screw
13 Hose clamp

▶ Remove hose clamp **13**.
▶ Remove holding clamp **1**.
▶ Remove holding clamp **6**.
▶ Remove hose clamp **8**.
▶ Unscrew hex head screw **12**.
▶ Remove holding clamp **9**.
▶ Remove pipeline **7**.
▶ If necessary, unscrew hex head screw **4**.

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▶ Remove bracket **2**.

▶ If necessary, unscrew hex head screw **10**.

▶ Remove bracket **11**.

Checking the left pipelines

▶ Check all rubber sleeves for damage.

If rubber sleeves are damaged:

▶ Replace rubber sleeves.

Installing the left oil mist separator pipeline to the intake manifold

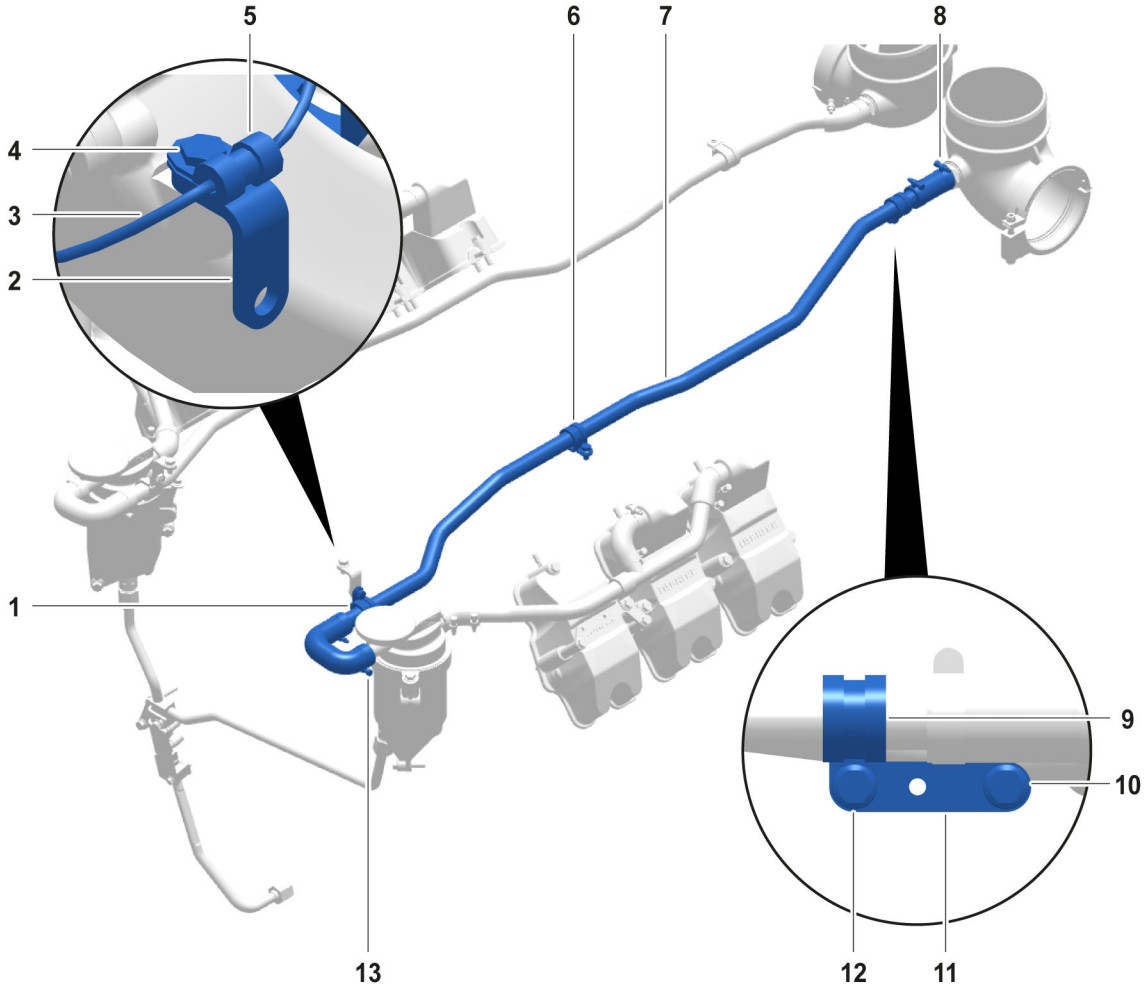

Fig. 451: Crankcase ventilation

1 Holding clamp
2 Bracket
3 Electrical line
4 Hex head screw
5 Holding clamp
6 Holding clamp
7 Pipeline
8 Hose clamp
9 Holding clamp
10 Hex head screw
11 Bracket
12 Hex head screw
13 Hose clamp

▶ Install bracket **11**.

▶ Tighten hex head screw **10**.

- ▶ Install bracket **2**.
- ▶ Align electrical line **3** with holding clamp **5**.
- ▶ Tighten hex head screw **4**.
- ▶ Install pipeline **7**.
- ▶ Install holding clamp **9**.
- ▶ Tighten hex head screw **12**.
- ▶ Install hose clamp **8**.
- ▶ Install holding clamp **6**.
- ▶ Install holding clamp **1**.
- ▶ Install hose clamp **13**.

Installing the cylinder head cover pipeline to the left oil mist separator

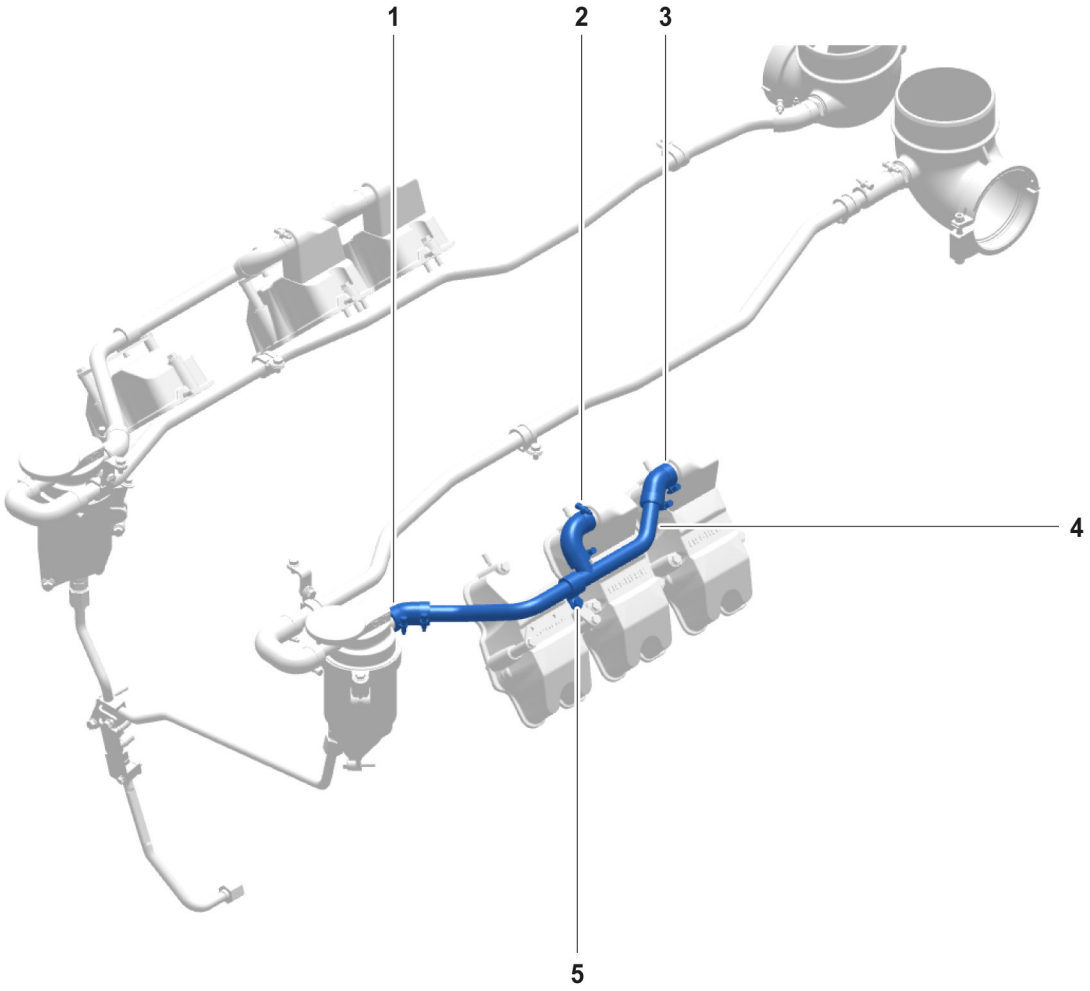

Fig. 452: Crankcase ventilation

1 Hose clamp
2 Hose clamp
3 Hose clamp
4 Pipeline
5 Holding clamp

- ▶ Install pipeline **4**.
- ▶ Install holding clamp **5**.

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- ▶ Install hose clamp **3**.
- ▶ Install hose clamp **2**.
- ▶ Install hose clamp **1**.

Removing and installing the right pipelines

Removing the cylinder head cover pipeline to the right oil mist separator

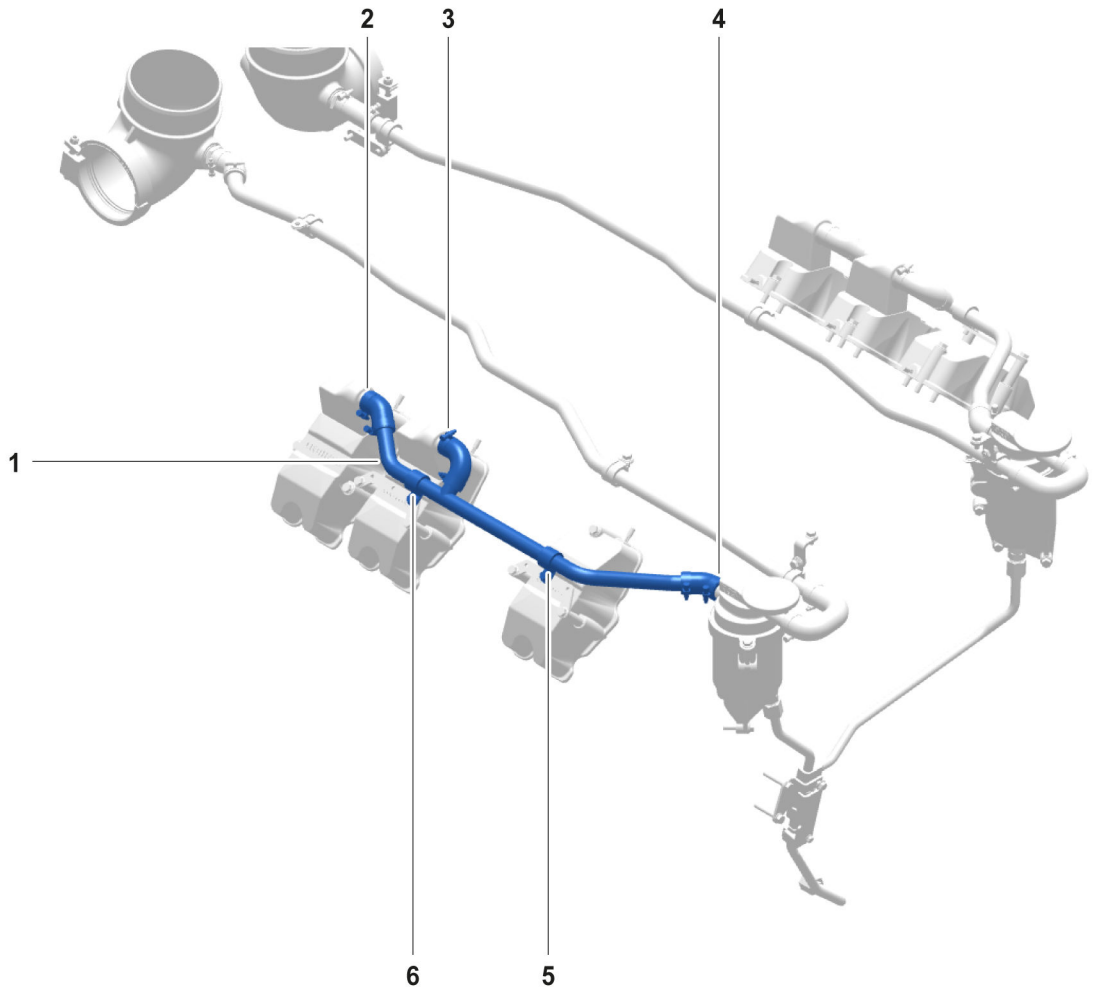

Fig. 453: Crankcase ventilation

1 Pipeline
2 Hose clamp
3 Hose clamp
4 Hose clamp
5 Holding clamp
6 Hose clamp

- ▶ Remove hose clamp **2**.
- ▶ Remove hose clamp **3**.
- ▶ Remove hose clamp **4**.
- ▶ Remove holding clamp **5**.
- ▶ Remove hose clamp **6**.
- ▶ Remove pipeline **1**.

Removing the right oil mist separator pipeline to the intake manifold

Make sure that the following prerequisites are met:
❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)

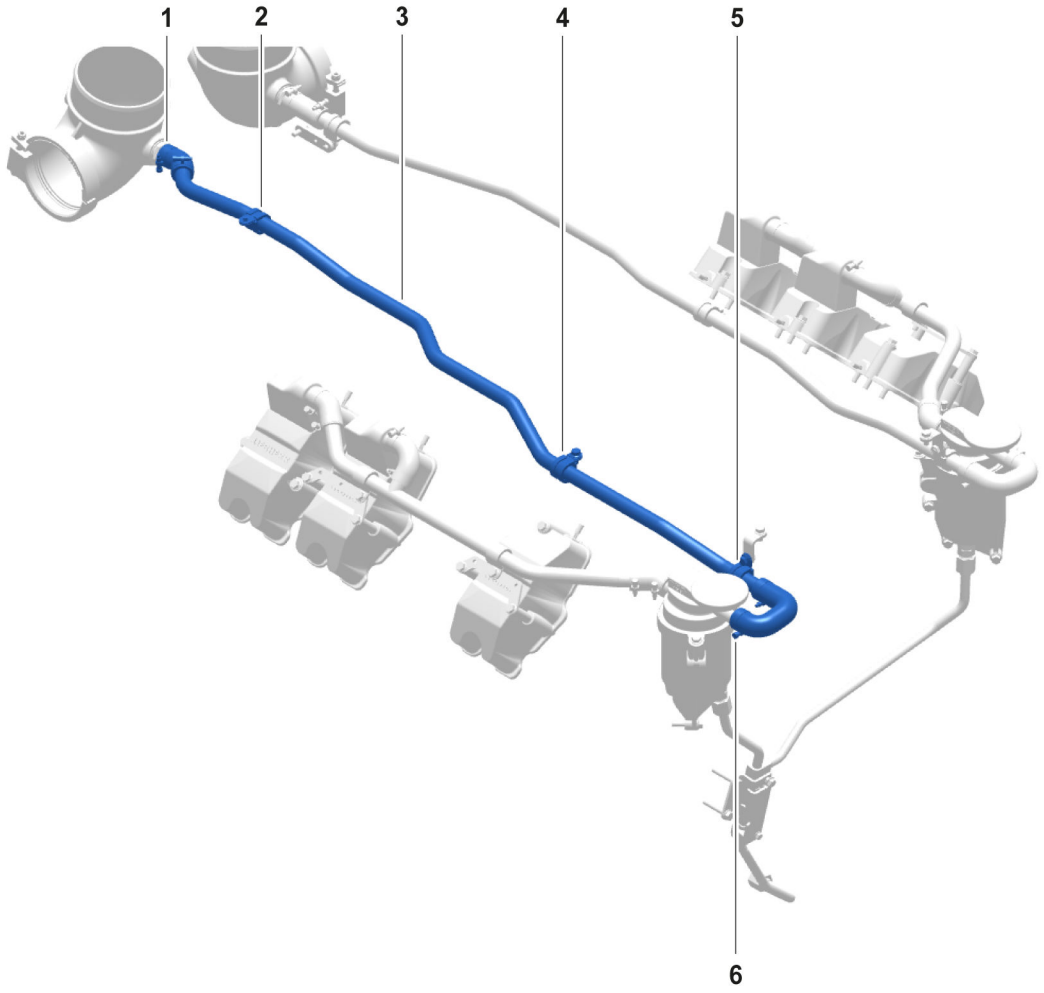

Fig. 454: Crankcase ventilation

1 Hose clamp
2 Holding clamp
3 Pipeline
4 Holding clamp
5 Holding clamp
6 Hose clamp

▶ Remove hose clamp **1**.

▶ Remove holding clamp **2**.

▶ Remove holding clamp **4**.

▶ Remove holding clamp **5**.

▶ Remove hose clamp **6**.

▶ Remove pipeline **3**.

Checking the right pipelines

▶ Check all rubber sleeves for damage.

If rubber sleeves are damaged:
▶ Replace rubber sleeves.

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Installing the right oil mist separator pipeline to the intake manifold

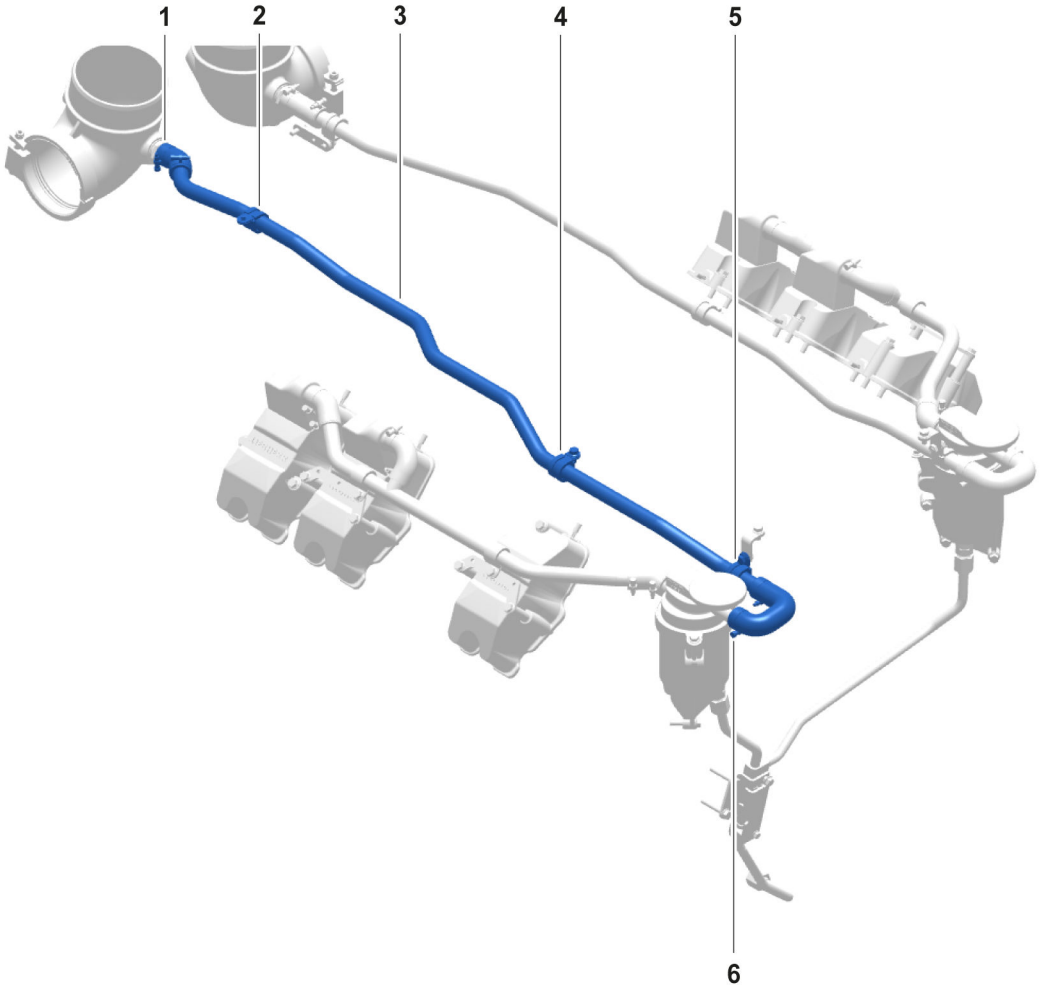

Fig. 455: Crankcase ventilation

1 Hose clamp
2 Holding clamp
3 Pipeline
4 Holding clamp
5 Holding clamp
6 Hose clamp

- ▶ Install pipeline **3**.
- ▶ Install hose clamp **6**.
- ▶ Install holding clamp **5**.
- ▶ Install holding clamp **4**.
- ▶ Install holding clamp **2**.
- ▶ Install hose clamp **1**.

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Installing the cylinder head cover pipeline to the right oil mist separator

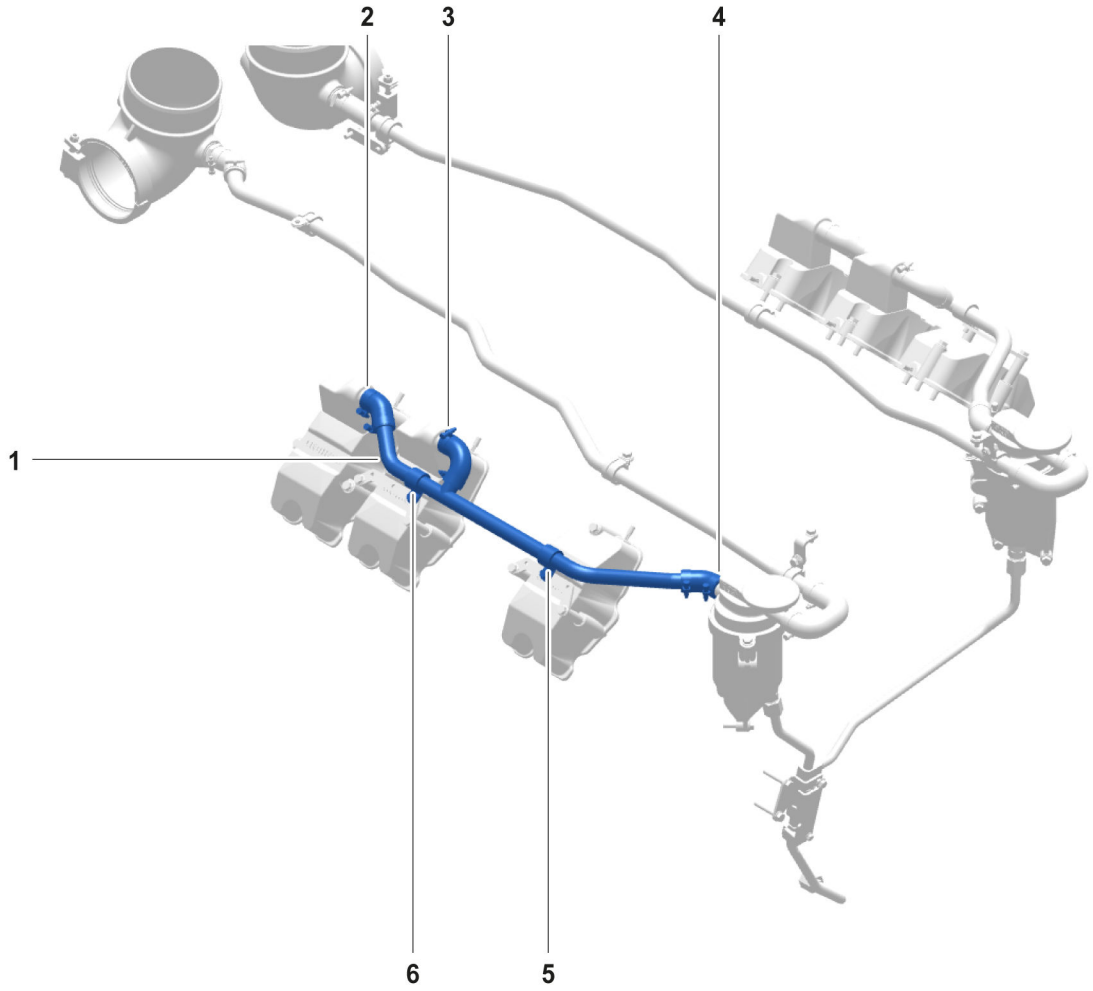

Fig. 456: Crankcase ventilation

1 Pipeline
2 Hose clamp
3 Hose clamp
4 Hose clamp
5 Holding clamp
6 Holding clamp

▶ Install pipeline **1**.

▶ Install holding clamp **6**.

▶ Install holding clamp **5**.

▶ Install hose clamp **4**.

▶ Install hose clamp **3**.

▶ Install hose clamp **2**.

Removing and installing the oil return line

Removing the oil return line

Make sure that the following prerequisite is met:
❑ Deflection pulley bracket is removed. (For more information see: Removing the bracket, page 271.)

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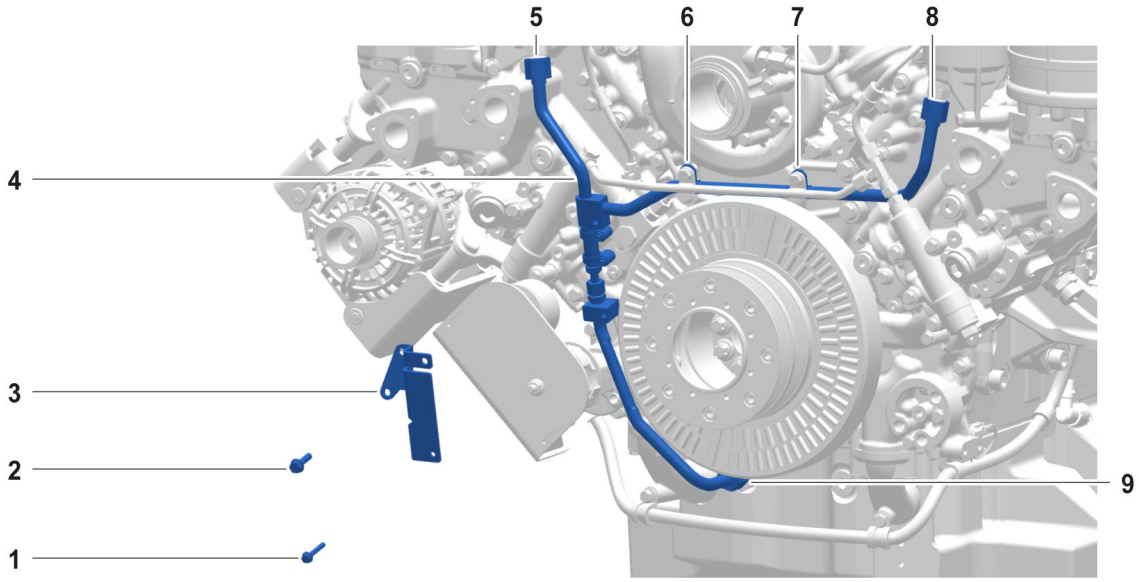

Fig. 457: Crankcase ventilation oil return line

1 Hex head screw
2 Hex head screw
3 Console
4 Oil return line
5 Box nut
6 Holding clamp
7 Holding clamp
8 Box nut
9 Box nut

- ▶ Unscrew hex head screw **1**.
- ▶ Unscrew hex head screw **2**.
- ▶ Remove console **3**.
- ▶ Remove holding clamp **6**.
- ▶ Remove holding clamp **7**.
- ▶ Unscrew box nut **5**.
- ▶ Unscrew box nut **8**.
- ▶ Unscrew box nut **9**.
- ▶ Remove oil return line **4**.
- ▶ Seal openings of oil return line **4**.
- ▶ Seal openings of oil pan and oil mist separator.

Checking the oil return line

- ▶ Check all rubber sleeves for damage.

If rubber sleeves are damaged:

- ▶ Replace rubber sleeves.

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Installing the oil return line

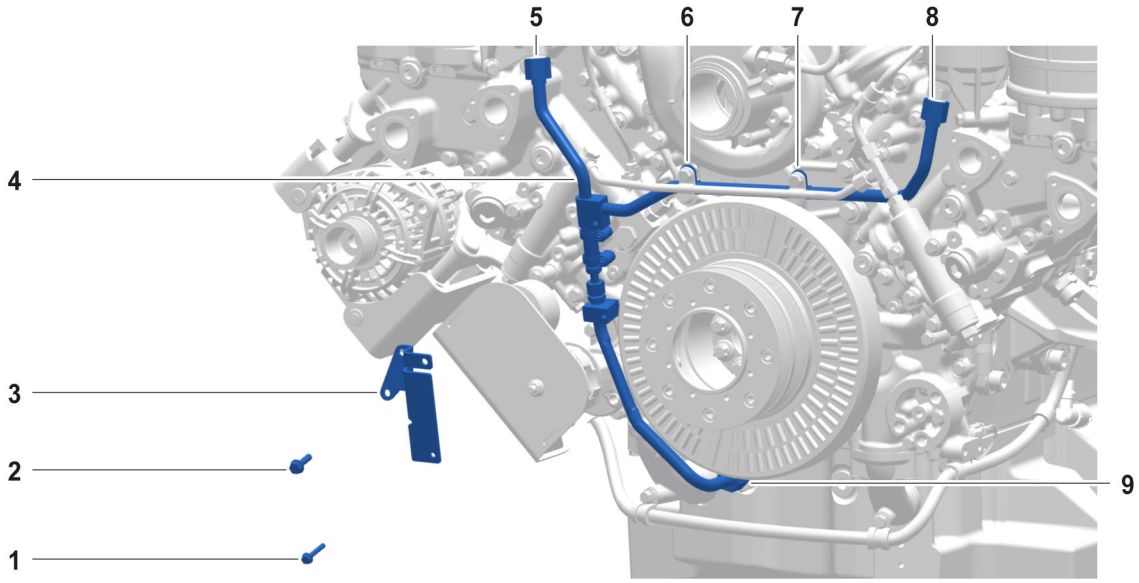

Fig. 458: Crankcase ventilation oil return line

1	Hex head screw	**6**	Holding clamp
2	Hex head screw	**7**	Holding clamp
3	Console	**8**	Box nut
4	Oil return line	**9**	Box nut
5	Box nut		

▶ Remove closures from oil pan and oil mist separator.

▶ Remove closures from oil return line **4**.

▶ Install oil return line **4**.

▶ Tighten box nut **9**.

▶ Tighten box nut **8**.

▶ Tighten box nut **5**.

▶ Install holding clamp **7**.

▶ Install holding clamp **6**.

▶ Install console **3**.

▶ Tighten hex head screw **2**.

▶ Tighten hex head screw **1**.

Removing and installing the left oil mist separator

Removing the left oil mist separator

Make sure that the following prerequisites are met:

❑ Cylinder head cover pipeline to left oil mist separator is removed from oil mist separator. (For more information see: Removing the cylinder head cover pipeline to the left oil mist separator, page 359.)

❑ Left oil mist separator pipeline to intake manifold is removed from oil mist separator. (For more information see: Removing the left oil mist separator pipeline to the intake manifold, page 360.)

❑ Oil return line is removed from oil mist separator. (For more information see: Removing the oil return line, page 366.)

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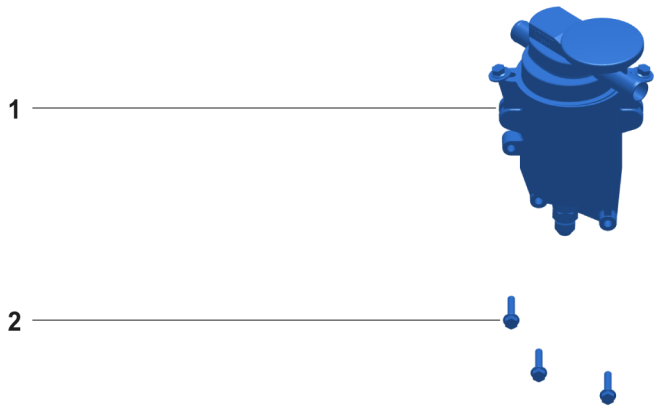

Fig. 459: Oil mist separator

1 Oil mist separator **2** Hex head screw (3x)

▶ Unscrew hex head screws **2**.

▶ Remove oil mist separator **1**.

Installing the left oil mist separator

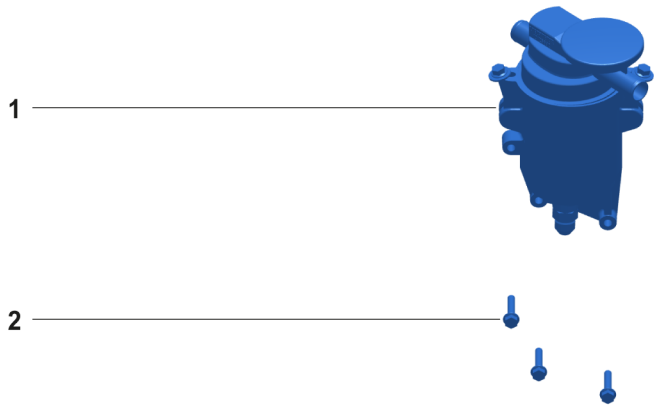

Fig. 460: Oil mist separator

1 Oil mist separator **2** Hex head screw (3x)

▶ Install oil mist separator **1**.

▶ Tighten hex head screws **2**.

Removing and installing the right oil mist separator

Removing the right oil mist separator

Make sure that the following prerequisites are met:

❑ Cylinder head cover pipeline to right oil mist separator is removed from oil mist separator. (For more information see: Removing the cylinder head cover pipeline to the right oil mist separator, page 363.)

- ❑ Right oil mist separator pipeline to intake manifold is removed from oil mist separator. (For more information see: Removing the right oil mist separator pipeline to the intake manifold, page 364.)
- ❑ Oil return line is removed from oil mist separator. (For more information see: Removing the oil return line, page 366.)

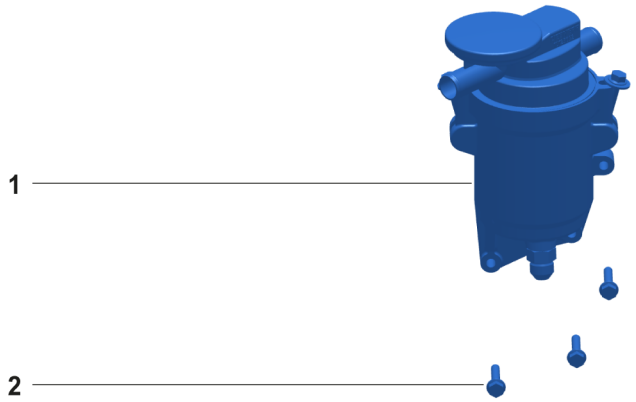

Fig. 461: Oil mist separator

1 Oil mist separator **2** Hex head screw (3x)

▶ Unscrew hex head screws **2**.

▶ Remove oil mist separator **1**.

Installing the right oil mist separator

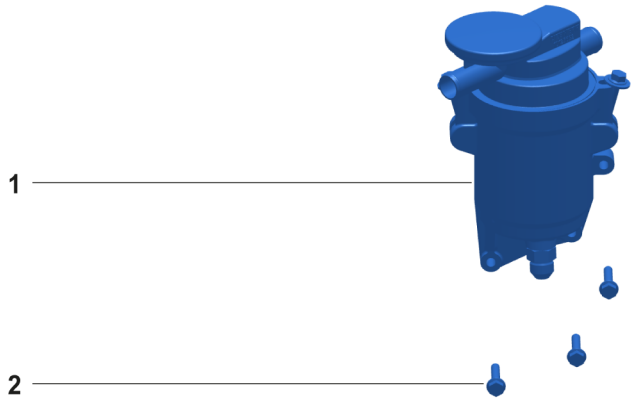

Fig. 462: Oil mist separator

1 Oil mist separator **2** Hex head screw (3x)

▶ Install oil mist separator **1**.

▶ Tighten hex head screws **2**.

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Removing and installing the bracket

Removing the left bracket

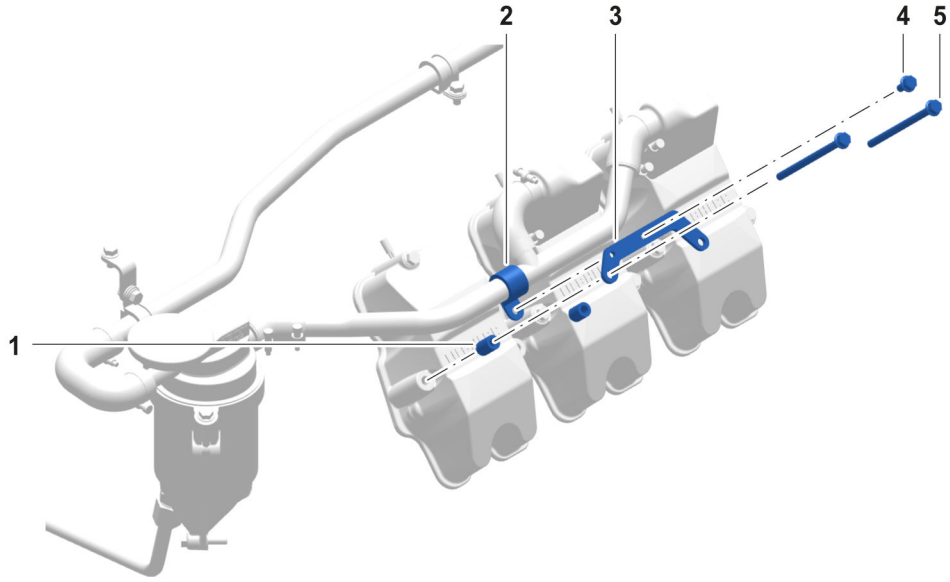

Fig. 463: Bracket

1 Spacer sleeve (2x)
2 Holding clamp
3 Bracket (3x)
4 Hex head screw
5 Hex head screw (2x)

▶ Unscrew hex head screw **4**.

▶ Unscrew hex head screws **5**.

▶ Remove bracket **3**.

▶ Remove spacer sleeves **1**.

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Removing the right bracket

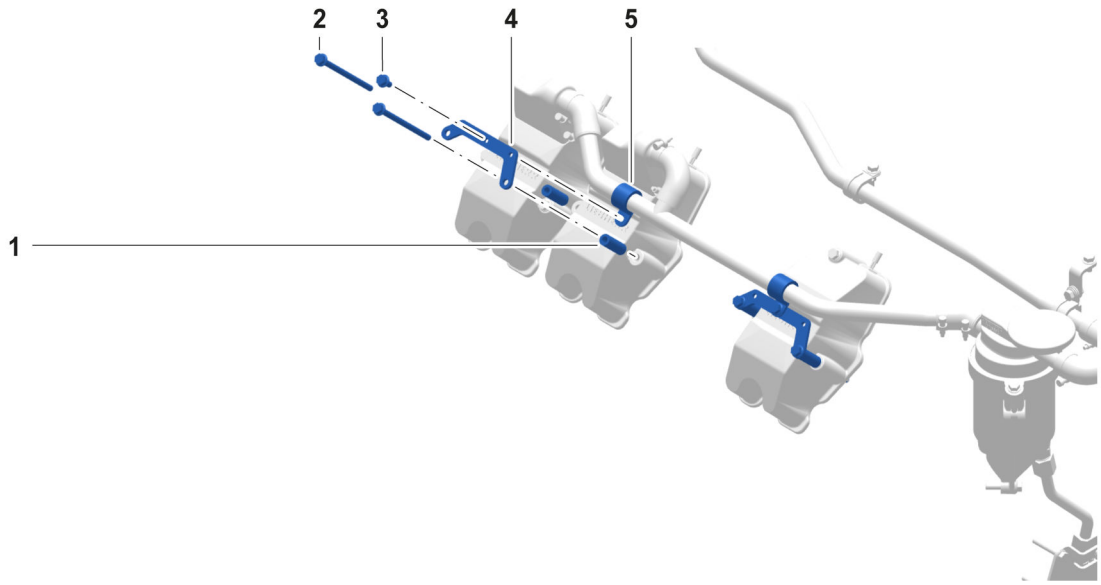

Fig. 464: Bracket

1 Spacer sleeve (4x)
2 Hex head screw (4x)
3 Hex head screw (2x)
4 Bracket (2x)
5 Holding clamp (2x)

▶ Unscrew hex head screws **3**.

▶ Remove holding clamps **5**.

▶ Unscrew hex head screws **2**.

▶ Remove bracket **4**.

▶ Remove spacer sleeves **1**.

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Installing the right bracket

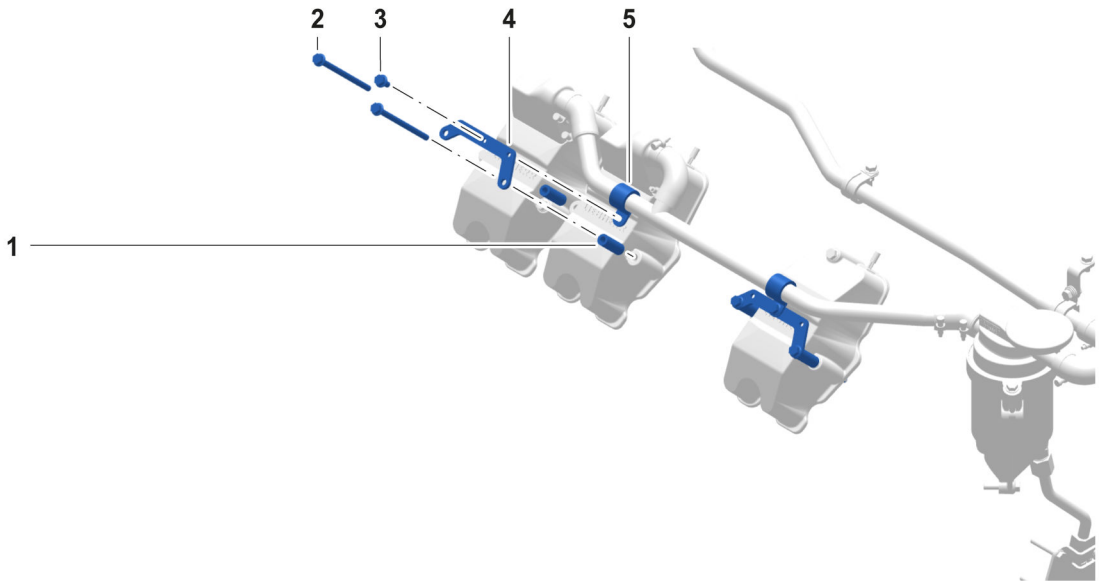

Fig. 465: Bracket

1 Spacer sleeve (4x)
2 Hex head screw (4x)
3 Hex head screw (2x)
4 Bracket (2x)
5 Holding clamp (2x)

- ▶ Install spacer sleeves **1**.
- ▶ Install bracket **4**.
- ▶ Tighten hex head screws **2**.
- ▶ Install holding clamps **5**.
- ▶ Tighten hex head screws **3**.

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Installing the left bracket

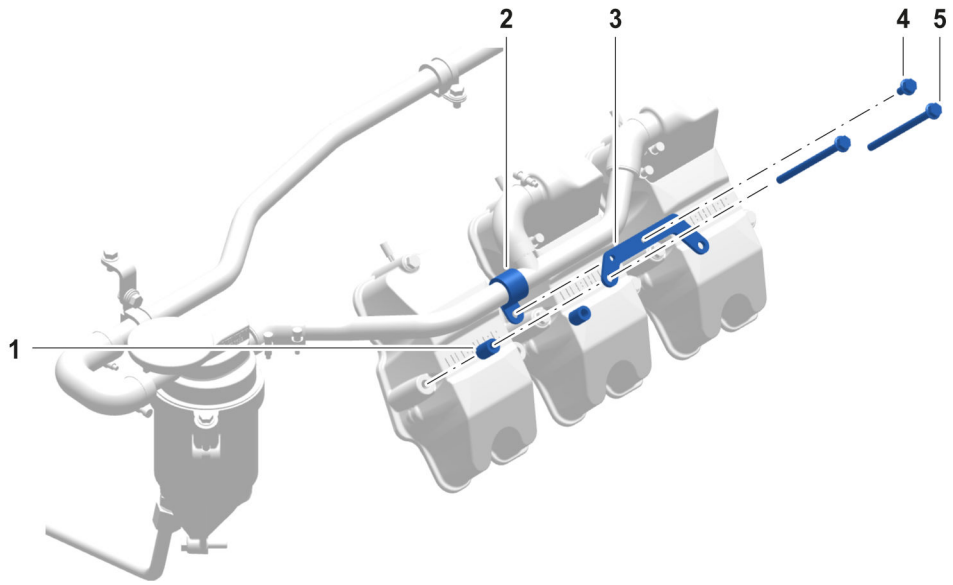

Fig. 466: Bracket

1 Spacer sleeve (2x)
2 Holding clamp
3 Bracket (3x)
4 Hex head screw
5 Hex head screw (2x)

▶ Install spacer sleeves **1**.

▶ Install bracket **3**.

▶ Tighten hex head screws **5**.

▶ Install holding clamp **2**.

▶ Tighten hex head screw **4**.

3.9.4 Oil module

Removing and installing the oil line

Removing the oil line

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

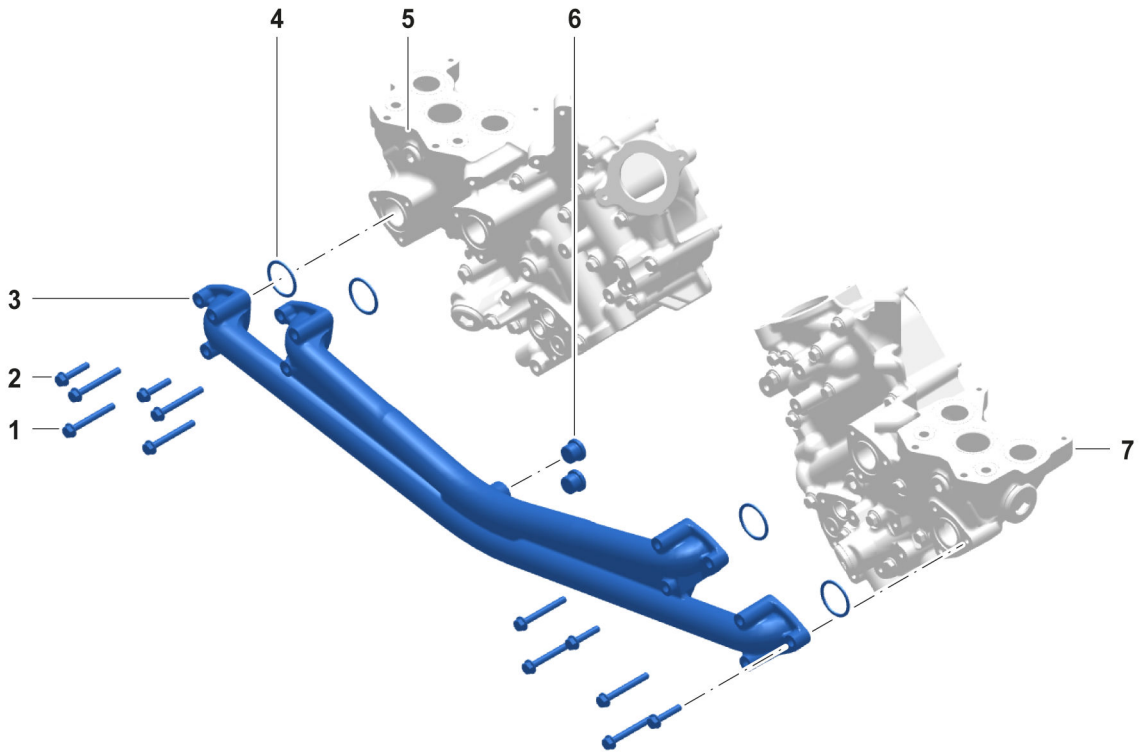

Fig. 467: Oil line

1 Hex head screw (8x)
2 Hex head screw (4x)
3 Oil line
4 O-ring (4x)
5 Right oil module
6 Screw plug (2x)
7 Left oil module

- ▶ Unscrew screw plugs **6** and collect escaping engine oil.
- ▶ Unscrew hex head screws **1**.
- ▶ Unscrew hex head screws **2**.
- ▶ Remove oil line **3**.
- ▶ Remove o-rings **4**.

Cleaning the oil line

- ▶ Clean sealing surfaces of oil line **3**.
- ▶ Clean sealing surfaces of right oil module **5**.
- ▶ Clean sealing surfaces of left oil module **7**.
- ▶ Clean grooves of o-rings **4**.

Installing the oil line

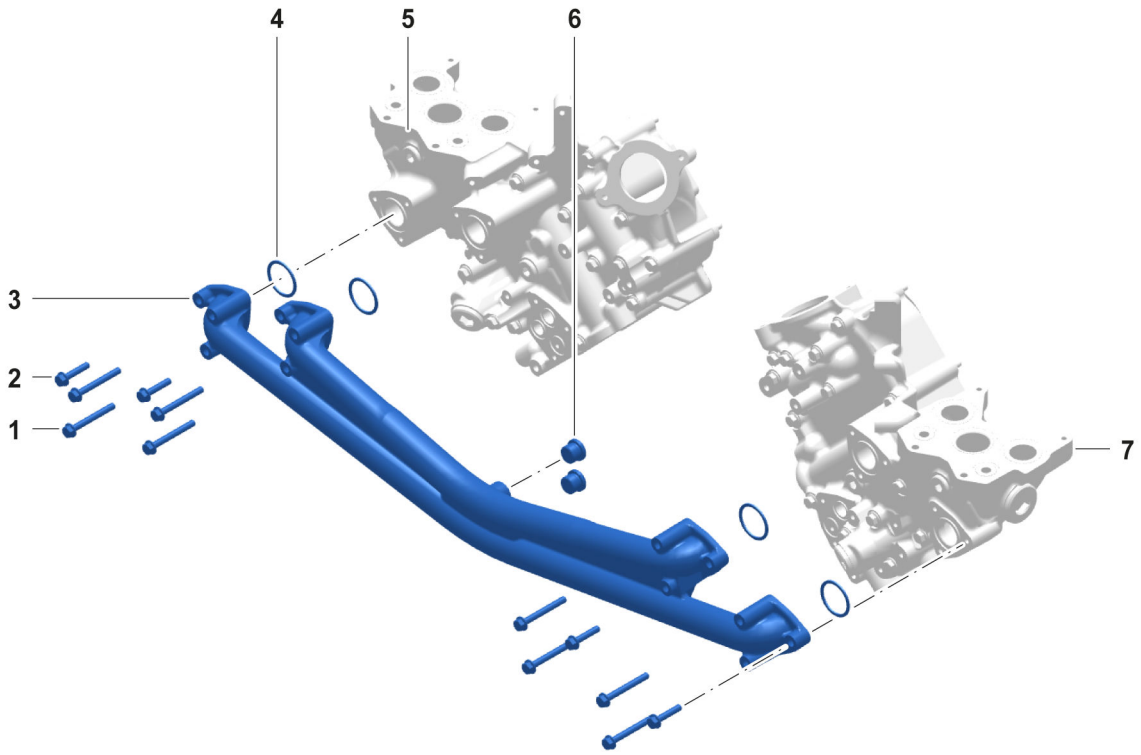

Fig. 468: Oil line

1 Hex head screw (8x)
2 Hex head screw (4x)
3 Oil line
4 O-ring (4x)
5 Right oil module
6 Screw plug (2x)
7 Left oil module

▶ Lubricate screw plugs **6** with Loctite 243 thread locker.

▶ Tighten screw plugs **6**.

▶ Lubricate new o-rings **4** with NBU 30 grease.

▶ Install o-rings **4**.

▶ Install oil line **3**.

▶ Tighten hex head screws **2**.

▶ Tighten hex head screws **1**.

Removing and installing the left oil module

Removing the left oil module

Make sure that the following prerequisites are met:
❑ A collection container for engine oil is available.
❑ Viscous damper is removed. (For more information see: Removing the crankshaft attachments, page 133.)
❑ Oil line is removed. (For more information see: Removing the oil line, page 374.)
❑ Left oil mist separator is removed. (For more information see: Removing the left oil mist separator, page 368.)

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- ❑ End control valve pipeline, left end control valve pipeline to right end control valve and left end control valve are removed. (For more information see: 3.9.2 Removing and installing the end control valve, page 348.)
- ❑ Coolant pump is removed from left oil module. (For more information see: Removing the coolant pump, page 429.)
- ❑ If necessary, filter housing is removed. (For more information see: Removing the filter housing, page 383.)

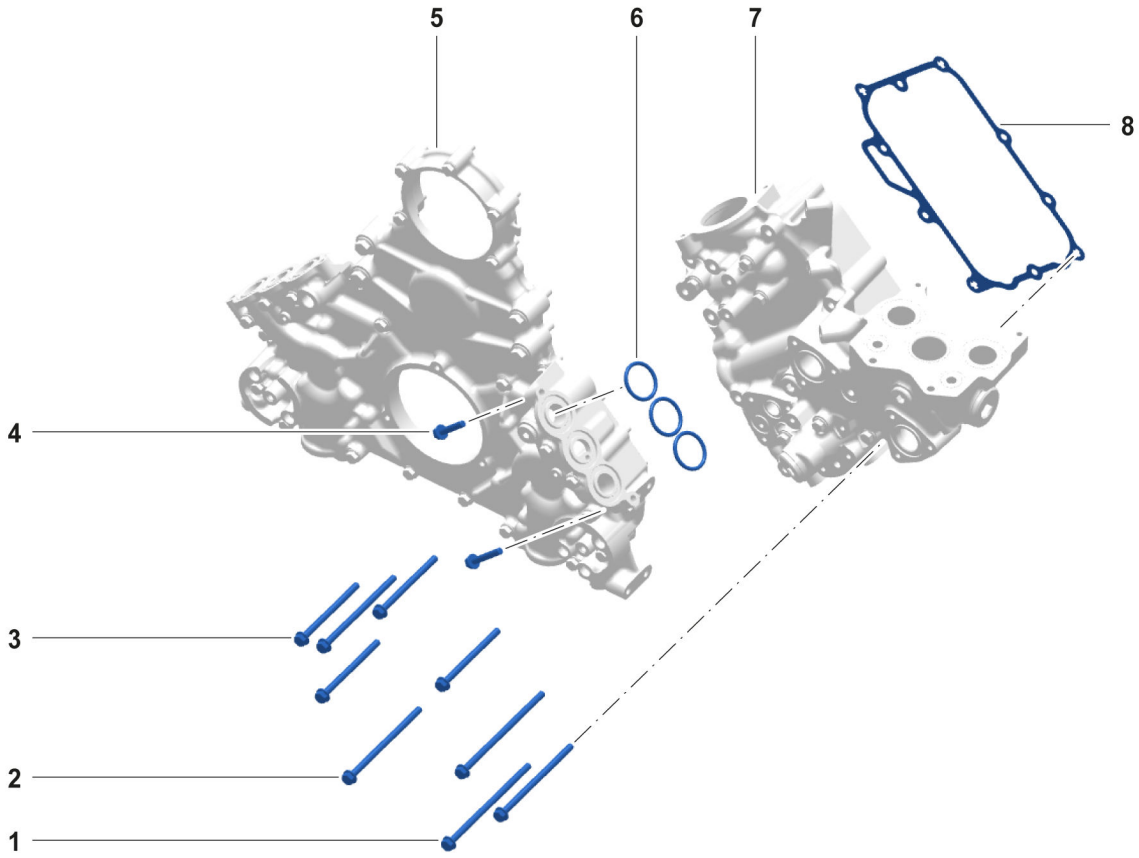


Fig. 469: Oil module

1 Hex head screw (2x)
2 Hex head screw (3x)
3 Hex head screw (4x)
4 Hex head screw (2x)
5 Ancillary support housing
6 O-ring (3x)
7 Oil module
8 Seal

▶ Unscrew hex head screws **1**.

▶ Unscrew hex head screws **2**.

▶ Unscrew hex head screws **3**.

▶ Unscrew hex head screws **4**.

▶ Remove oil module **7**.

▶ Remove seal **8**.

▶ Remove o-rings **6**.

Cleaning the left oil module

▶ Clean sealing surfaces of oil module **7**.

▶ Clean sealing surface of ancillary support housing **5**.

▶ Clean grooves of o-rings **6**.

Installing the left oil module

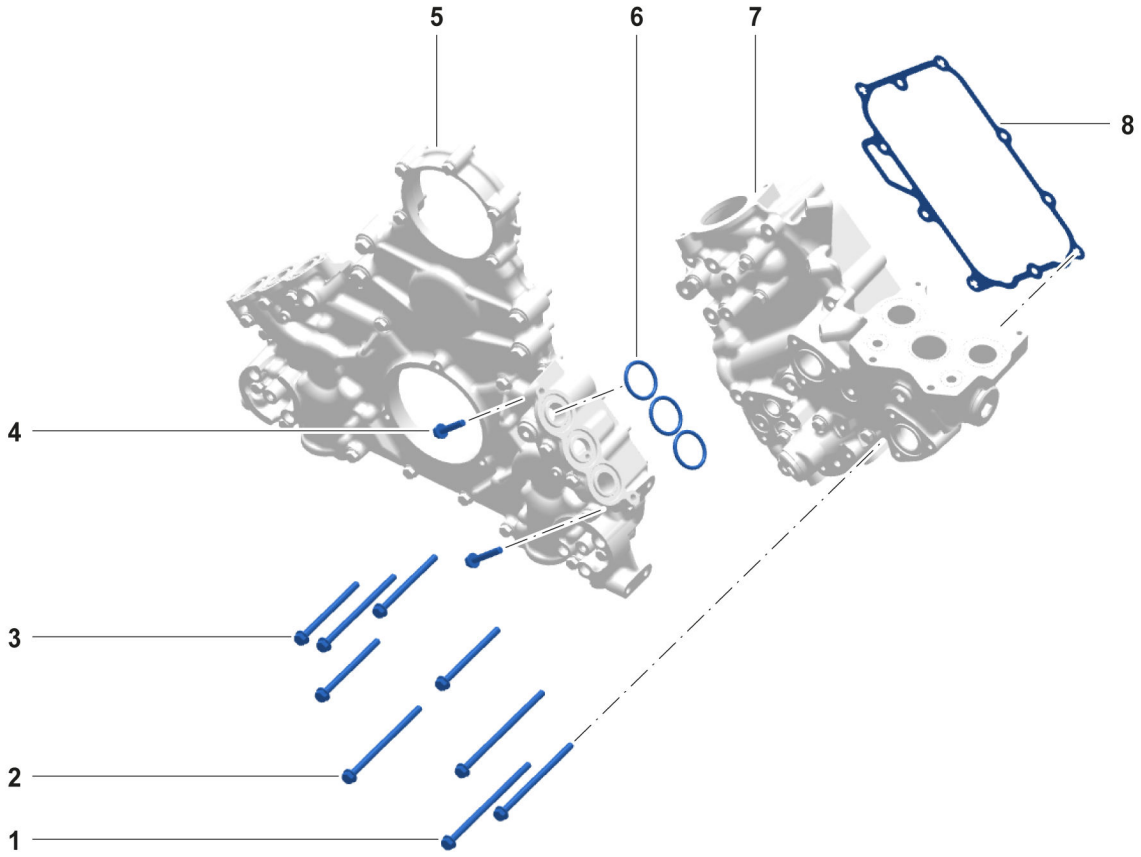


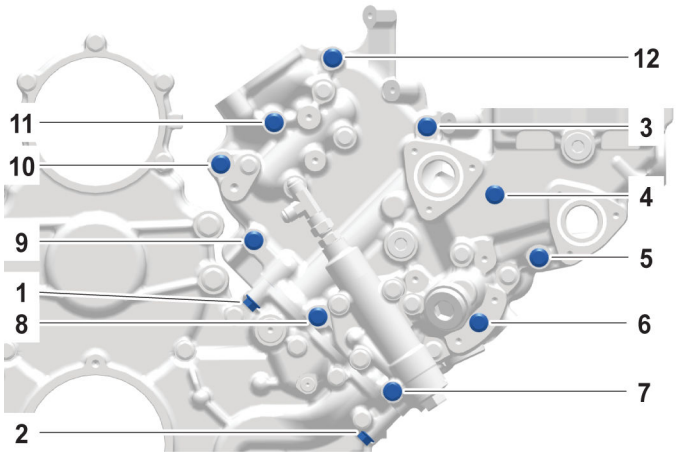
Fig. 470: Oil module

1 Hex head screw (2x)
2 Hex head screw (3x)
3 Hex head screw (4x)
4 Hex head screw (2x)
5 Ancillary support housing
6 O-ring (3x)
7 Oil module
8 Seal

▶ Install new o-rings **6**.

▶ Install new seal **8**.

▶ Install oil module **7**.

Tightening instruction for hex head screw	
Tightening sequence 	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	19 Nm
2.	25 Nm

Tab. 94: Tightening instruction 12960298-000

▶ Tighten hex head screws **1**, hex head screws **2**, hex head screws **3**, and hex head screws **4** according to tightening instruction.

Removing and installing the right oil module

Removing the right oil module

Make sure that the following prerequisites are met:
- ❑ A collection container for engine oil is available.
- ❑ Viscous damper is removed. (For more information see: Removing the crankshaft attachments, page 133.)
- ❑ Oil line is removed. (For more information see: Removing the oil line, page 374.)
- ❑ Oil return line is removed. (For more information see: Removing and installing the oil return line, page 366.)
- ❑ Right oil mist separator is removed. (For more information see: Removing the left oil mist separator, page 368.)
- ❑ Left end control valve pipeline to right end control valve and right end control valve are removed. (For more information see: 3.9.2 Removing and installing the end control valve, page 348.)
- ❑ Coolant pump is removed from right oil module. (For more information see: Removing the coolant pump, page 429.)
- ❑ Coolant pump coolant line to air compressor is removed. (For more information see: Removing the coolant pump coolant line to the air compressor , page 443.)
- ❑ Alternator bracket is removed. (For more information see: Removing the alternator bracket, page 464.)

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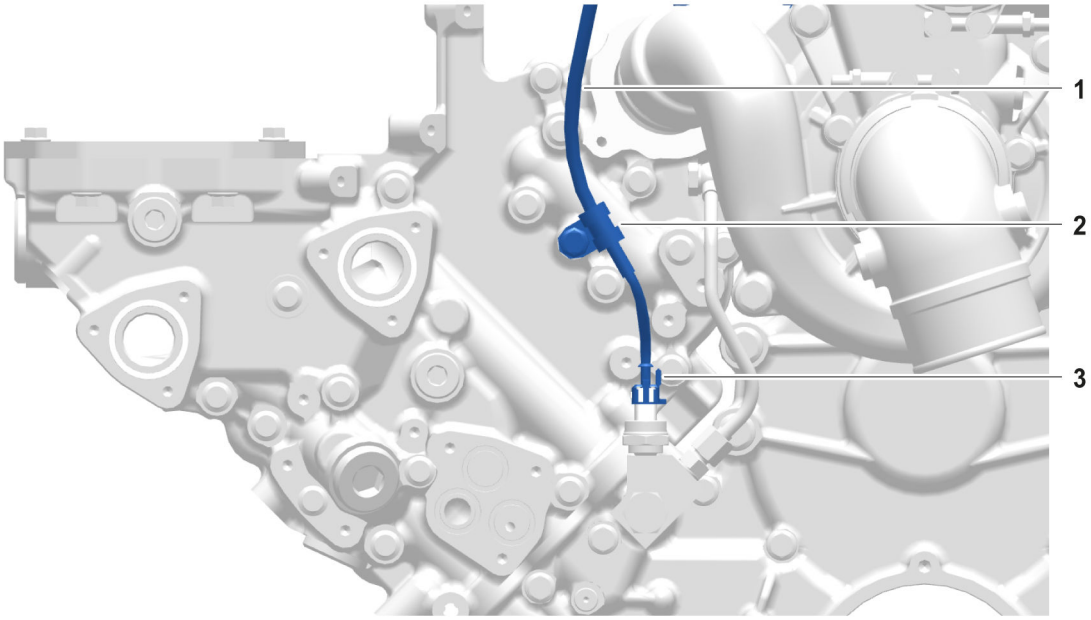

Fig. 472: Electrical line

1 Electrical line
2 Holding clamp
3 Electrical plug connection

▶ Remove holding clamp **2**.

▶ Disconnect electrical plug connection **3**.

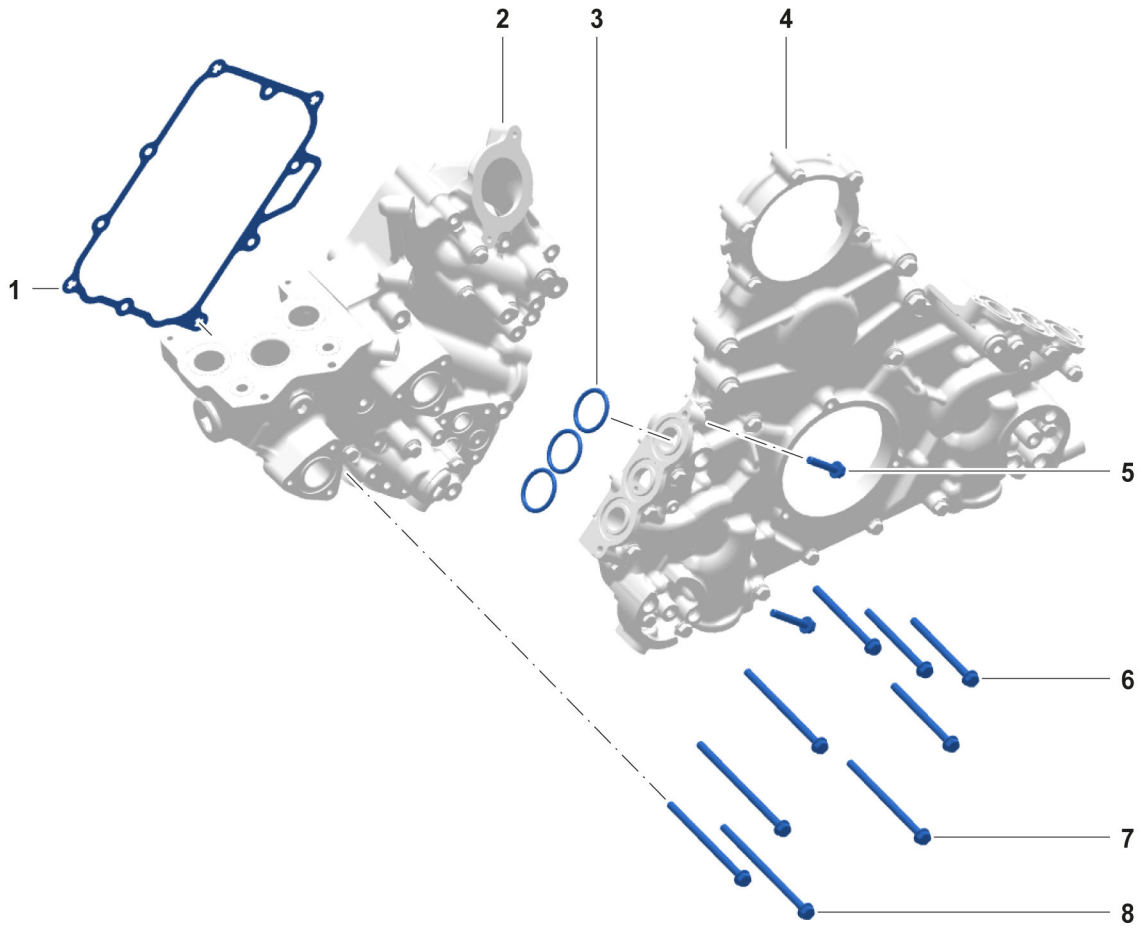

Fig. 473: Oil module

1 Seal
2 Oil module
3 O-ring (3x)
4 Ancillary support housing
5 Hex head screw (2x)
6 Hex head screw (4x)
7 Hex head screw (3x)
8 Hex head screw (2x)

- ▶ Unscrew hex head screws **8**.
- ▶ Unscrew hex head screws **7**.
- ▶ Unscrew hex head screws **6**.
- ▶ Unscrew hex head screws **5**.
- ▶ Remove oil module **2**.
- ▶ Remove seal **1**.
- ▶ Remove o-rings **3**.

Cleaning the right oil module

- ▶ Clean sealing surfaces on oil module **2**.
- ▶ Clean sealing surface on ancillary support housing **4**.
- ▶ Clean grooves of o-rings **3**.

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Installing the right oil module

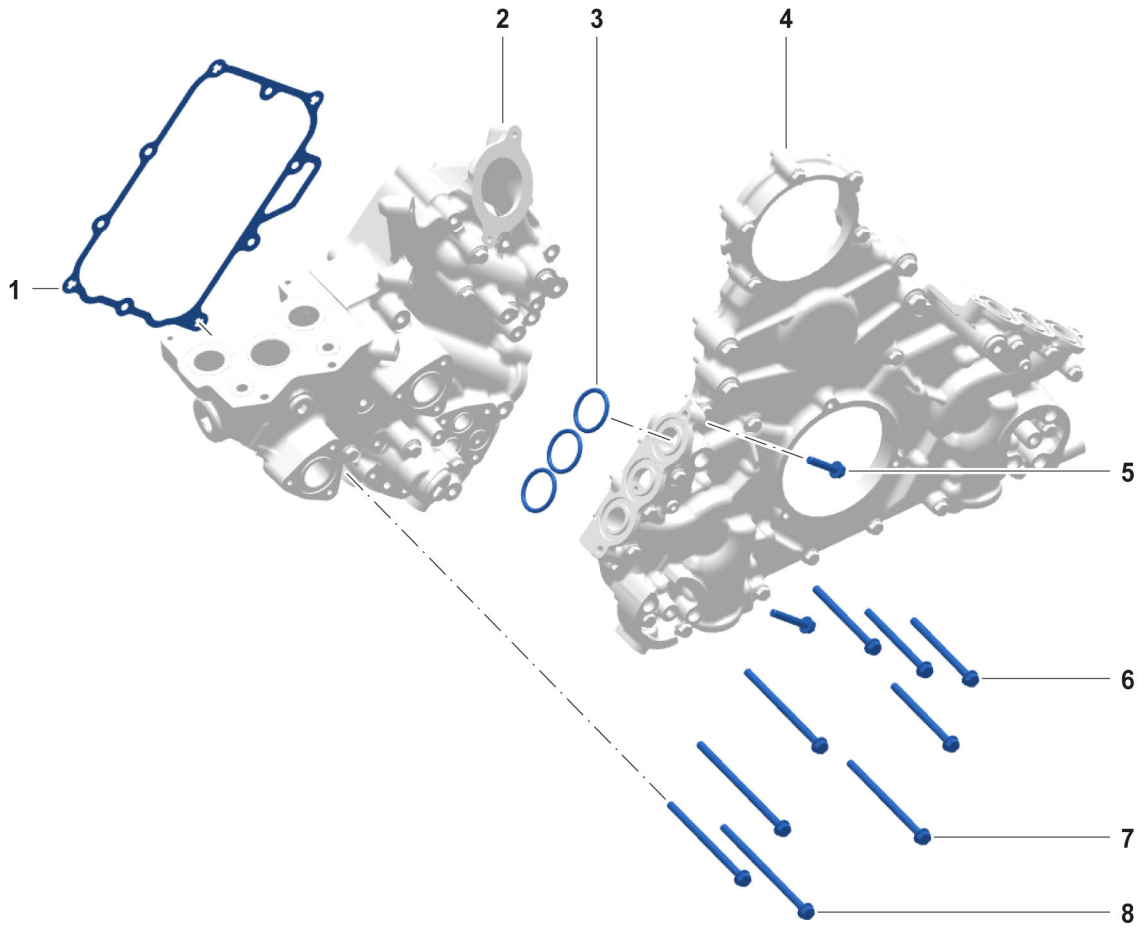


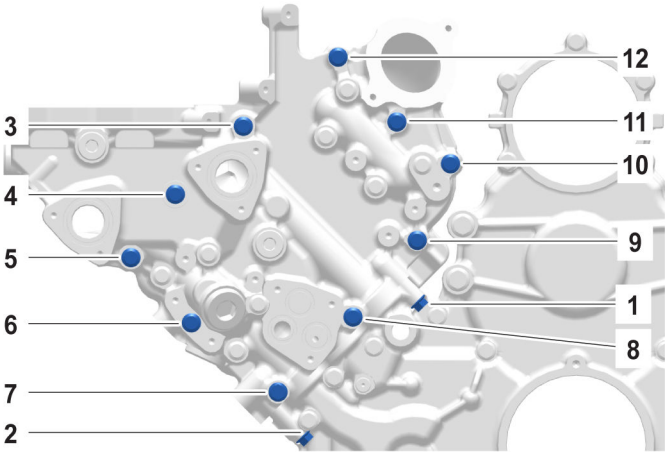
Fig. 474: Oil module

1 Seal
2 Oil module
3 O-ring (3x)
4 Ancillary support housing
5 Hex head screw (2x)
6 Hex head screw (4x)
7 Hex head screw (3x)
8 Hex head screw (2x)

▶ Install new o-rings **3**.

▶ Install new seal **1**.

▶ Install oil module **2**.

Tightening instruction for hex head screw	
Tightening sequence 	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	19 Nm
2.	25 Nm

Tab. 95: Tightening instruction 12960298-000

▶ Tighten hex head screws **5**, hex head screws **6**, hex head screws **7**, and hex head screws **8** according to tightening instruction.

Removing and installing the filter housing

Removing the filter housing

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

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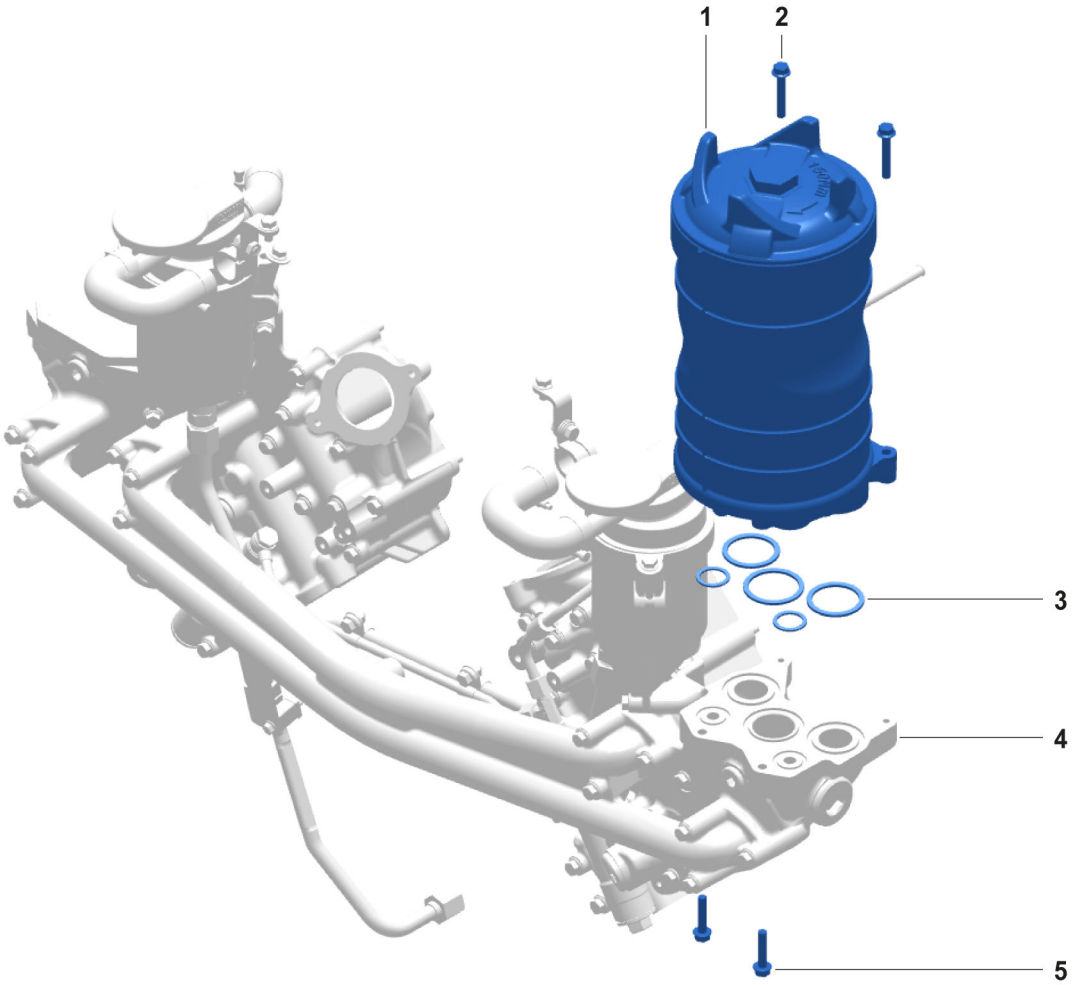

Fig. 476: Filter housing

1 Filter housing
2 Hex head screw (2x)
3 O-ring (5x)
4 Oil module
5 Hex head screw (2x)

▶ Unscrew hex head screws **2**.

▶ Unscrew hex head screws **5**.

▶ Remove filter housing **1**.

▶ Remove o-rings **3**.

Cleaning the filter housing

▶ Clean sealing surface on filter housing **1**.

▶ Clean sealing surface on oil module **4**.

▶ Clean grooves of o-rings **3**.

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Installing the filter housing

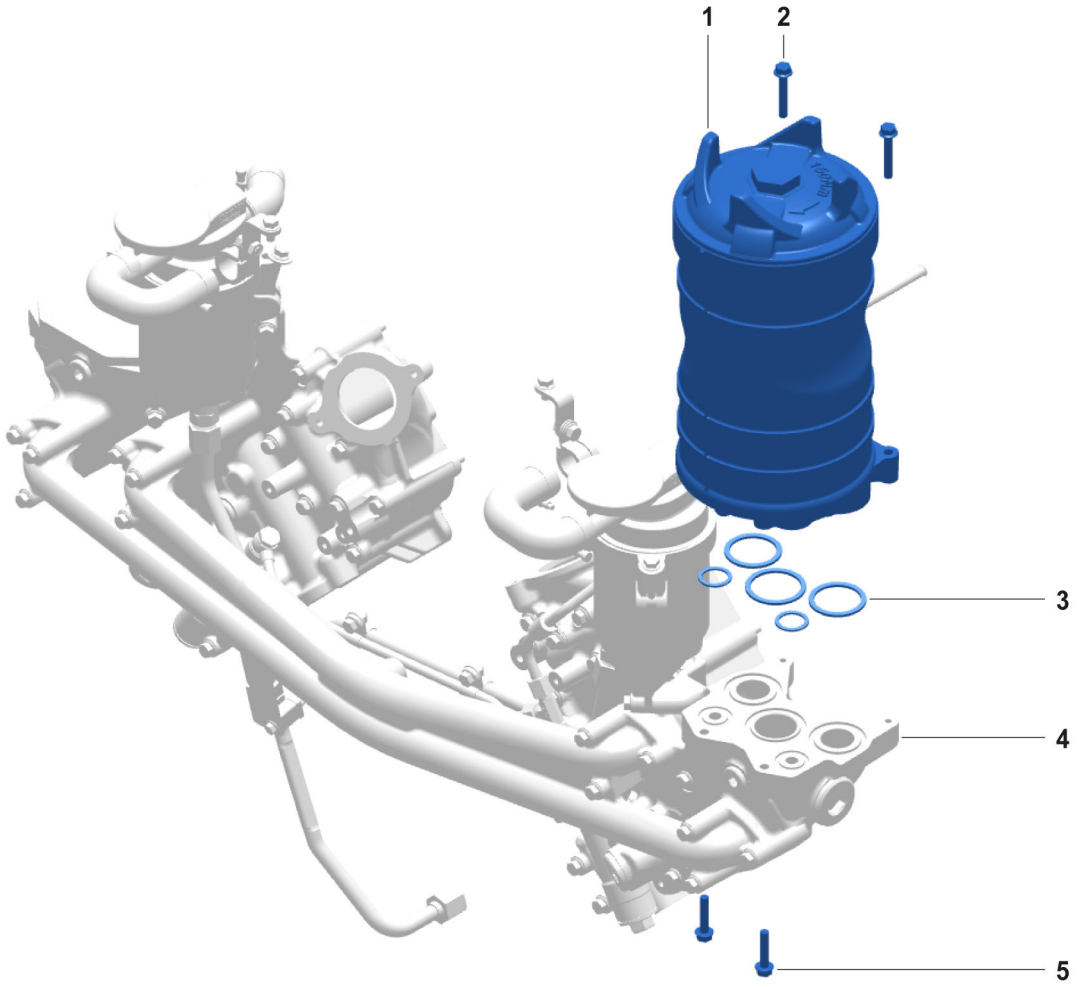

Fig. 477: Filter housing

1 Filter housing
2 Hex head screw (2x)
3 O-ring (5x)
4 Oil module
5 Hex head screw (2x)

▶ Lubricate new o-rings **3** with NBU 30 grease.

▶ Install o-rings **3**.

▶ Install filter housing **1**.

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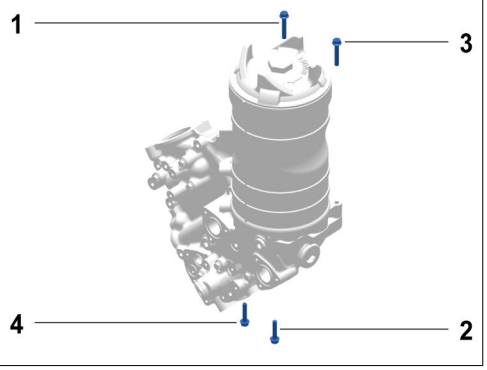
Tightening instruction for hex head screws		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	23 Nm	
2.	28 Nm	

Tab. 96: Tightening instruction 12960299-000

▶ Tighten hex head screws **2** and hex head screws **5** according to tightening instruction.

Dismantling and assembling the filter housing

Dismantling the filter housing

Make sure that the following prerequisite is met:
❑ Filter housing is removed. (For more information see: Removing the filter housing, page 383.)

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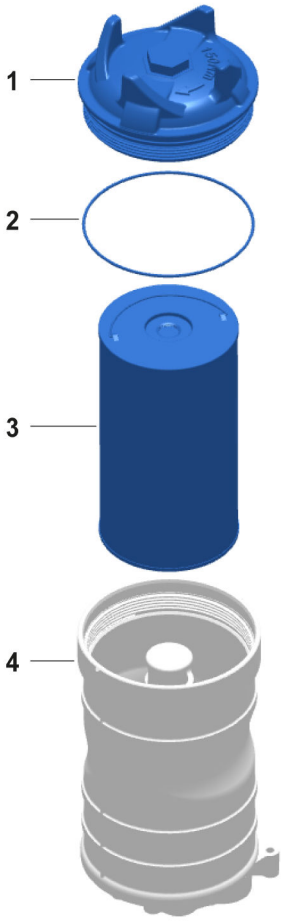

Fig. 479: Filter housing

1 Cover
2 O-ring
3 Filter insert
4 Housing

▶ Unscrew cover **1**.

▶ Remove o-ring **2**.

▶ Remove filter insert **3**.

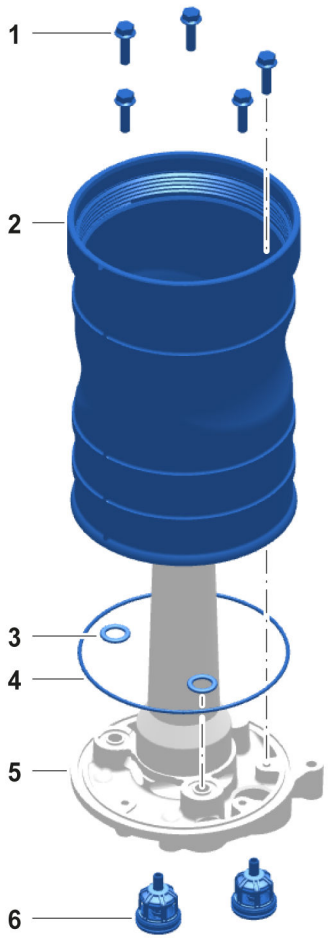

Fig. 480: Filter housing

1 Hex head screw (5x)
2 Housing
3 O-ring (2x)
4 O-ring
5 Filter holder
6 Non-return valve (2x)

- ▶ Unscrew hex head screws **1**.
- ▶ Remove housing **2**.
- ▶ Remove o-ring **4**.
- ▶ Remove o-rings **3**.
- ▶ Unscrew non-return valve **6**.

Cleaning the filter housing

- ▶ Clean grooves of o-rings.
- ▶ Clean housing **2**.
- ▶ Clean filter holder **5**.
- ▶ Check filter insert for contamination and damage and replace if necessary.

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Assembling the filter housing

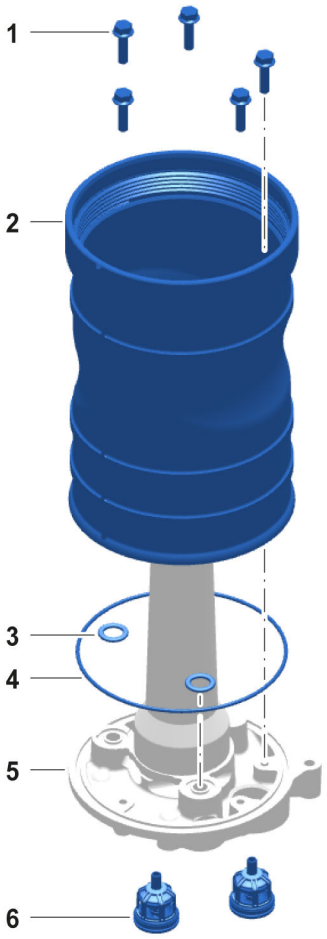

Fig. 481: Filter housing

1 Hex head screw (5x)
2 Housing
3 O-ring (2x)
4 O-ring
5 Filter holder
6 Non-return valve (2x)

- ▶ Lubricate thread of non-return valve **6** with new engine oil.
- ▶ Tighten non-return valves **6**.
- ▶ Lubricate new o-rings **3** with NBU 30 grease.
- ▶ Install o-rings **3**.
- ▶ Lubricate new o-ring **4** with NBU 30 grease.
- ▶ Install o-ring **4**.
- ▶ Install housing **2**.
- ▶ Tighten hex head screws **1**.

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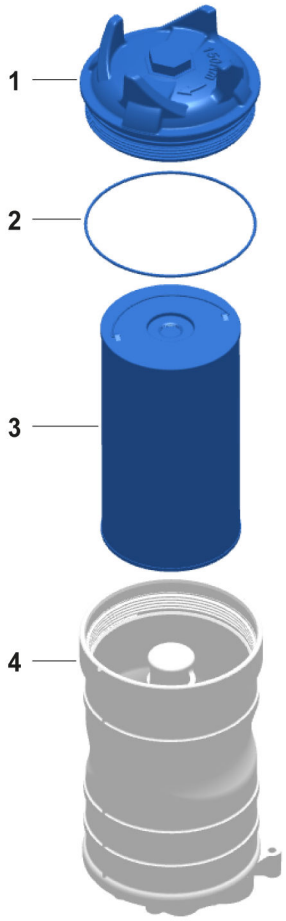

Fig. 482: Filter housing

1 Cover
2 O-ring
3 Filter insert
4 Housing

▶ Install filter insert **3**.

▶ Lubricate new o-ring **2** with NBU 30 grease.

▶ Install o-ring **2**.

Tightening instruction for cover		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	150 Nm	

Tab. 97: Tightening instruction 10127113-007

▶ Tighten cover **1** according to tightening instruction.

3.9.5 Oil cooler

Removing and installing the left oil cooler

Removing the left oil cooler

Make sure that the following prerequisite is met:
❑ Left oil module is removed. (For more information see: Removing the left oil module, page 376.)

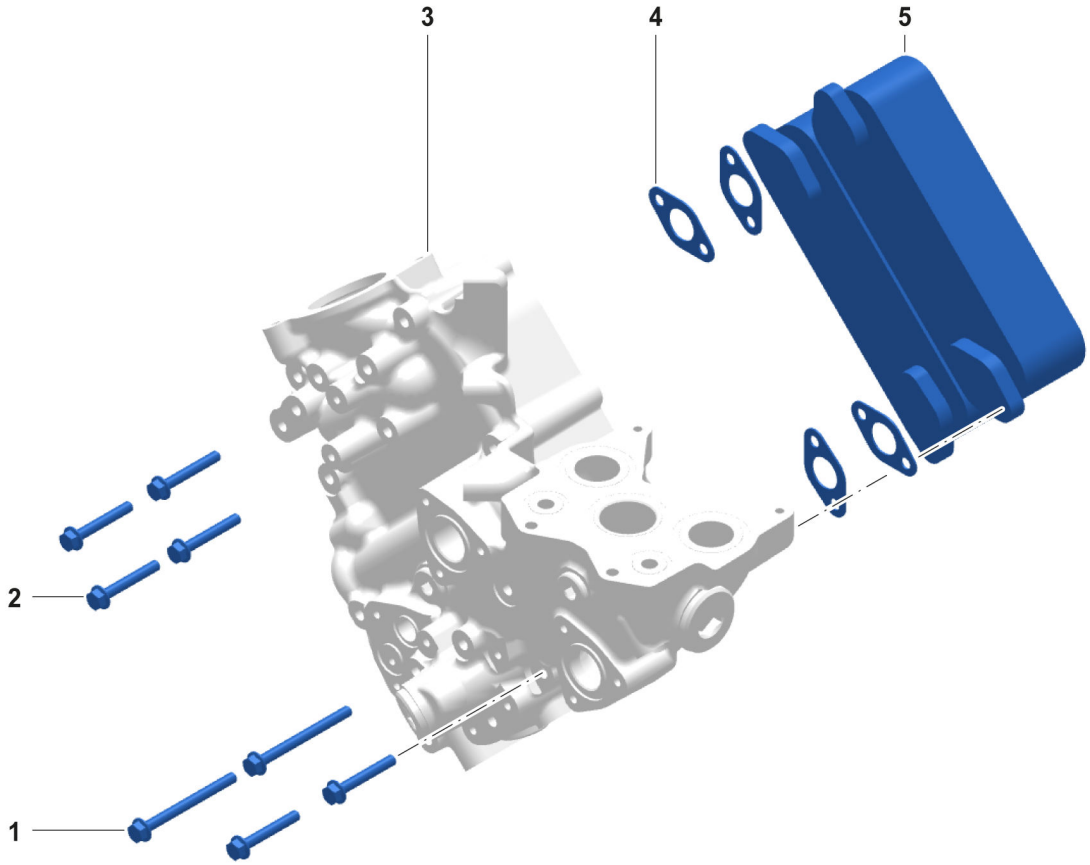

Fig. 484: Oil cooler

1 Hex head screw (2x)
2 Hex head screw (6x)
3 Oil module
4 Seal (4x)
5 Oil cooler (2x)

▶ Unscrew hex head screws **1**.

▶ Unscrew hex head screws **2**.

▶ Remove oil cooler **5**.

▶ Remove seals **4**.

Cleaning the left oil cooler

▶ Clean sealing surfaces of oil modules **3**.

▶ Clean sealing surfaces of oil cooler **5**.

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Installing the left oil cooler

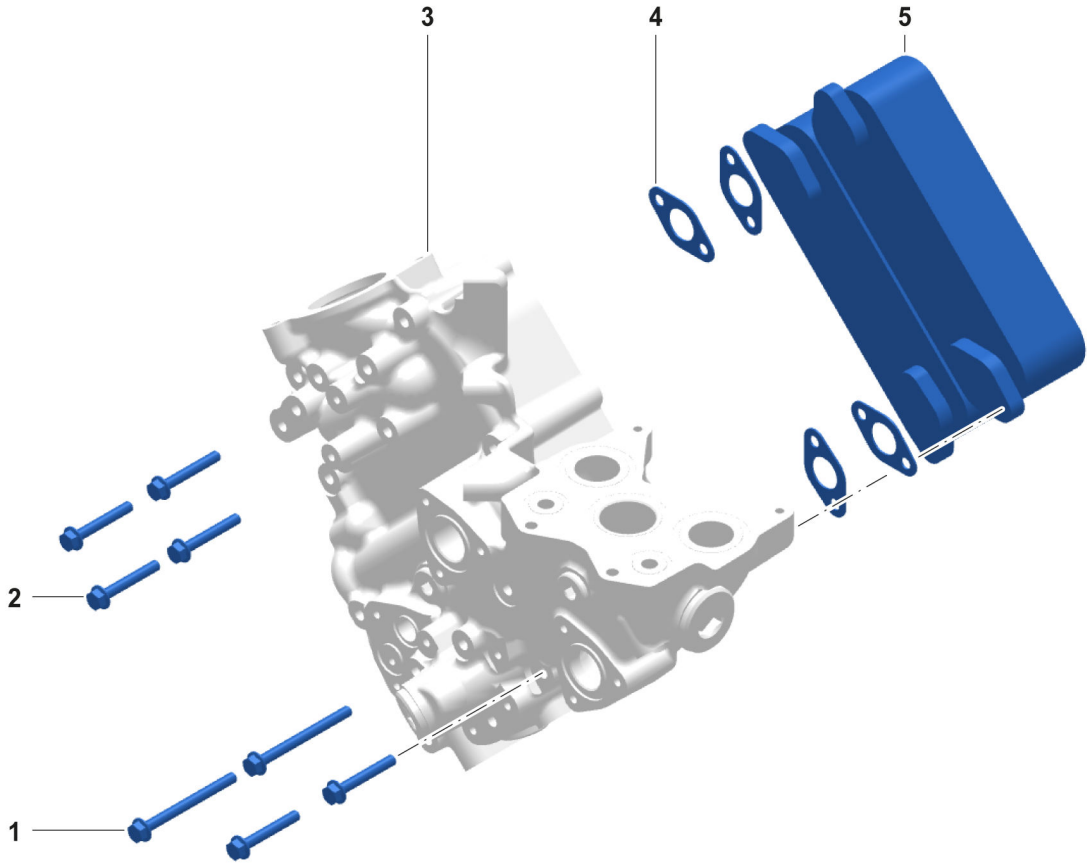
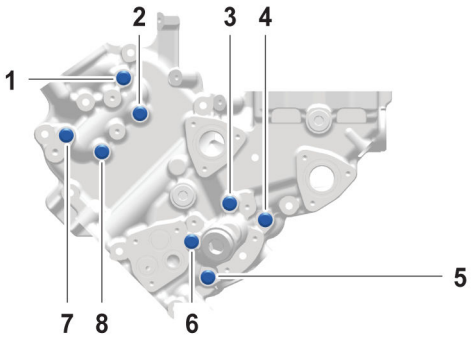


Fig. 485: Oil cooler

1 Hex head screw (2x)
2 Hex head screw (6x)
3 Oil module
4 Seal (4x)
5 Oil cooler (2x)

▶ Install new seals **4**.

▶ Install oil cooler **5**.

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	**Tightening sequence** 
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	19 Nm	
2.	25 Nm	

Tab. 98: Tightening instruction 12960300-000

▶ Tighten hex head screws **2** and hex head screws **1** according to tightening instruction.

Removing and installing the right oil cooler

Removing the right oil cooler

Make sure that the following prerequisite is met:
- ❑ Right oil module is removed. (For more information see: Removing the right oil module, page 379.)

▶ Procedure according to description for left oil cooler. (For more information see: Removing the left oil cooler, page 391.)

Cleaning the right oil cooler

▶ Procedure according to description for left oil cooler. (For more information see: Cleaning the left oil cooler, page 391.)

Installing the right oil cooler

▶ Procedure according to description for left oil cooler. (For more information see: Installing the left oil cooler, page 392.)

Removing and installing the pressure limiting valves

Removing the pressure limiting valves

Make sure that the following prerequisites are met:
- ❑ A collection container for engine oil is available.
- ❑ For right pressure limiting valve removal, the alternator bracket is removed. (For more information see: Removing the alternator bracket, page 464.)

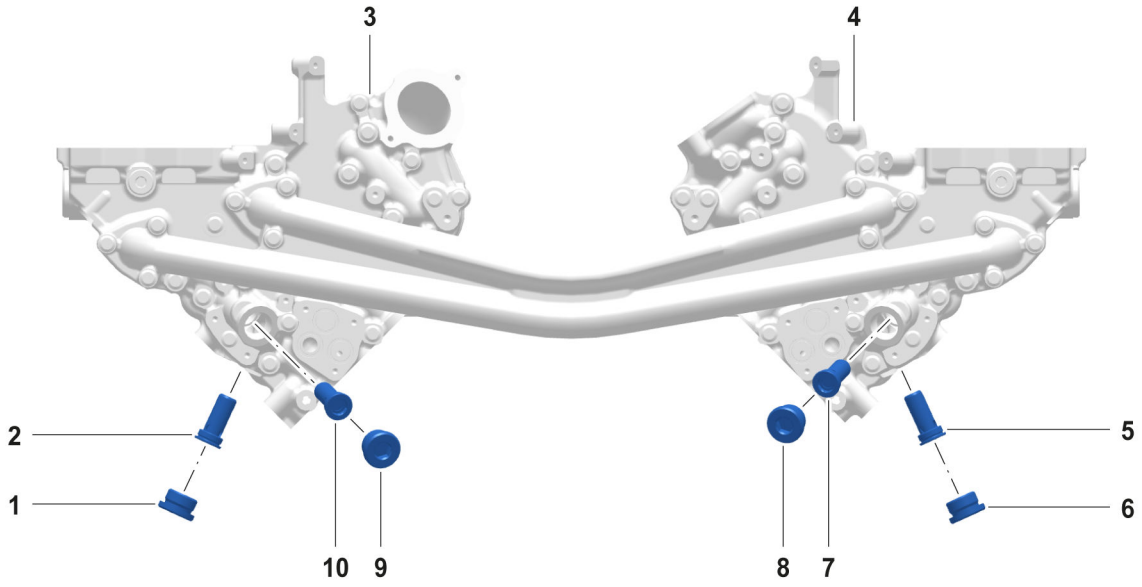


Fig. 487: Pressure limiting valves

1 Screw plug
2 Pressure limiting valve
3 Right oil module
4 Left oil module
5 Pressure limiting valve
6 Screw plug
7 Pressure limiting valve
8 Screw plug
9 Screw plug
10 Pressure limiting valve

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- ▶ Unscrew screw plug **1**.
- ▶ Unscrew pressure limiting valve **2**.
- ▶ Unscrew screw plug **6**.
- ▶ Unscrew pressure limiting valve **5**.
- ▶ Unscrew screw plug **8**.
- ▶ Unscrew pressure limiting valve **7**.
- ▶ Unscrew screw plug **9**.
- ▶ Unscrew pressure limiting valve **10**.

Installing the pressure limiting valves

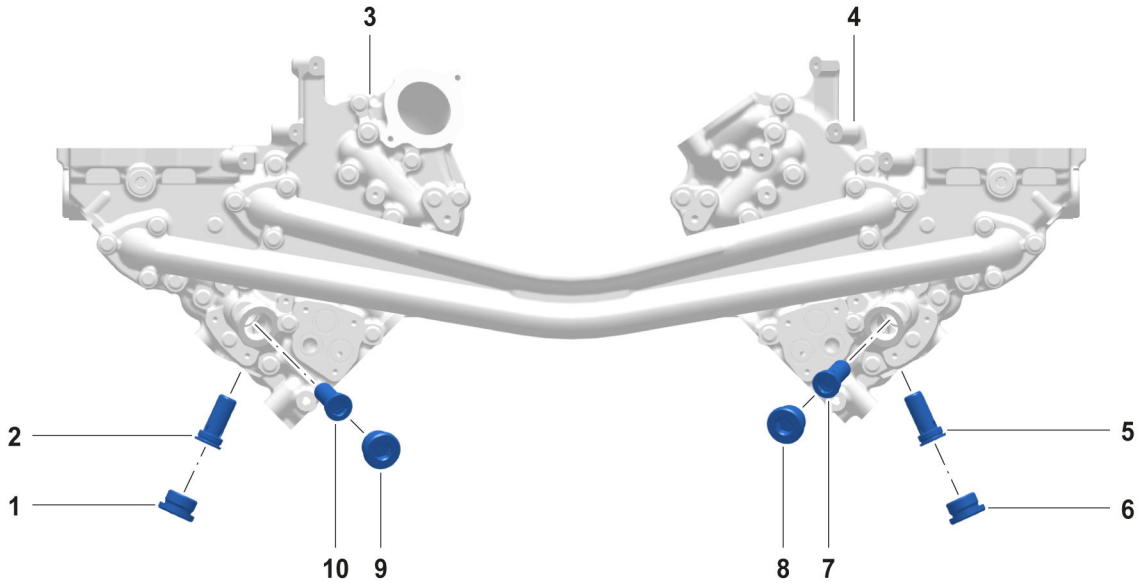

Fig. 488: Pressure limiting valves

1 Screw plug
2 Pressure limiting valve
3 Right oil module
4 Left oil module
5 Pressure limiting valve
6 Screw plug
7 Pressure limiting valve
8 Screw plug
9 Screw plug
10 Pressure limiting valve

Tightening instruction for pressure limiting valve		
Lubricant (thread and head contact surface)	Loctite® 577	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	110 Nm	

Tab. 99: Tightening instruction 11365192-001

- ▶ Lubricate pressure limiting valve **2**, pressure limiting valve **5**, pressure limiting valve **7** and pressure limiting valve **10** according to tightening instruction.

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- ▶ Tighten pressure limiting valve **2**, pressure limiting valve **5**, pressure limiting valve **7** and pressure limiting valve **10** according to tightening instruction.
- ▶ Tighten screw plug **9**.
- ▶ Tighten screw plug **8**.
- ▶ Tighten screw plug **6**.
- ▶ Tighten screw plug **1**.

3.9.6 Oil pan

Removing and installing the oil pan

Removing the oil pan

Make sure that the following prerequisites are met:
- ❑ Engine oil has been drained, see operator's manual.
- ❑ Cable harness is removed from oil pan.
- ❑ Oil return line is removed from oil pan. (For more information see: Removing the oil return line, page 452.)
- ❑ Oil return line from crankcase ventilation is removed from oil pan. (For more information see: Removing the oil return line, page 366.)
- ❑ Oil dipstick with guiding pipe is removed. (For more information see: Removing the oil dipstick with guiding pipe, page 402.)
- ❑ If necessary, oil filler neck is removed. (For more information see: Removing the oil filler neck, page 404.)

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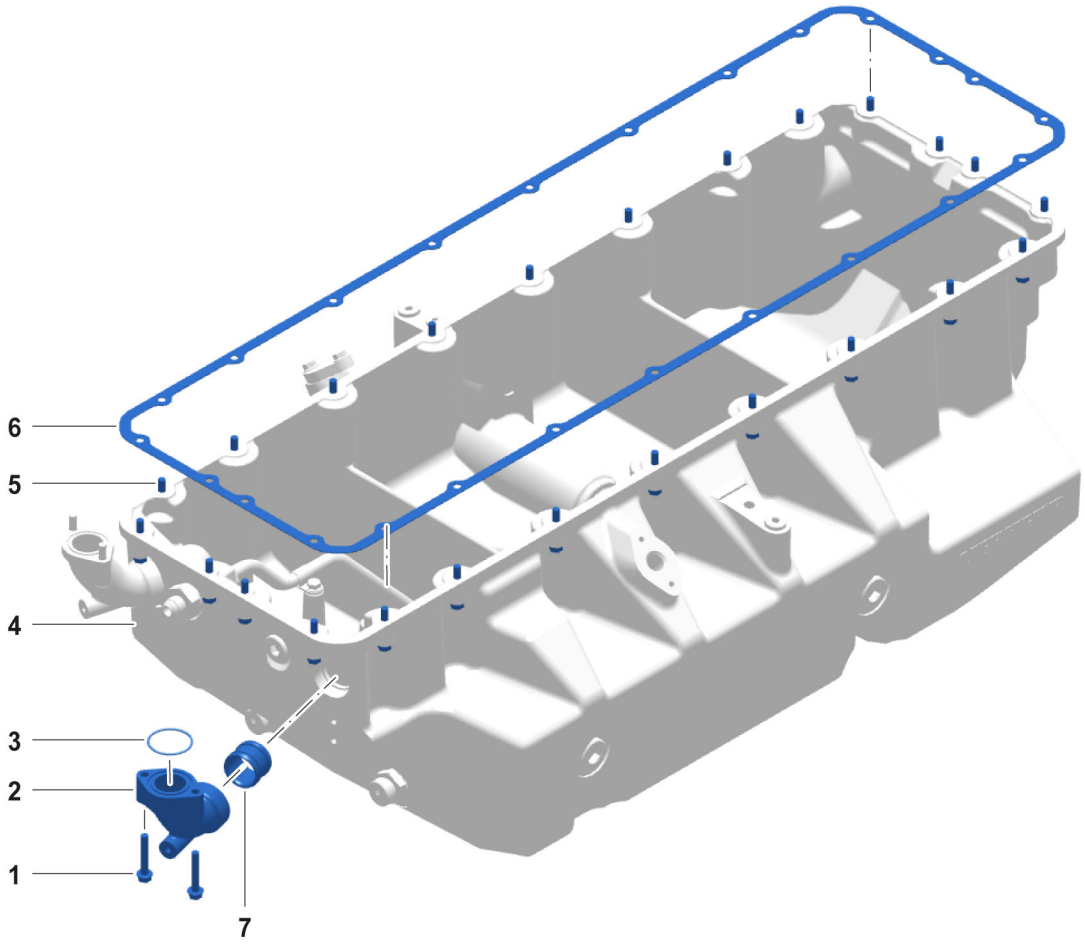

Fig. 490: Oil pan

1 Hex head screw (4x)
2 Elbow (2x)
3 O-ring (2x)
4 Oil pan
5 Hex head screw (24x)
6 Seal
7 Plug-in tube (2x)

▶ Unscrew hex head screws **1**.

▶ Unscrew hex head screws **5**.

▶ Remove oil pan **4**.

▶ Remove seal **6**.

▶ Remove o-rings **3**.

▶ If necessary, remove elbow **2**.

▶ Remove plug-in tubes **7**.

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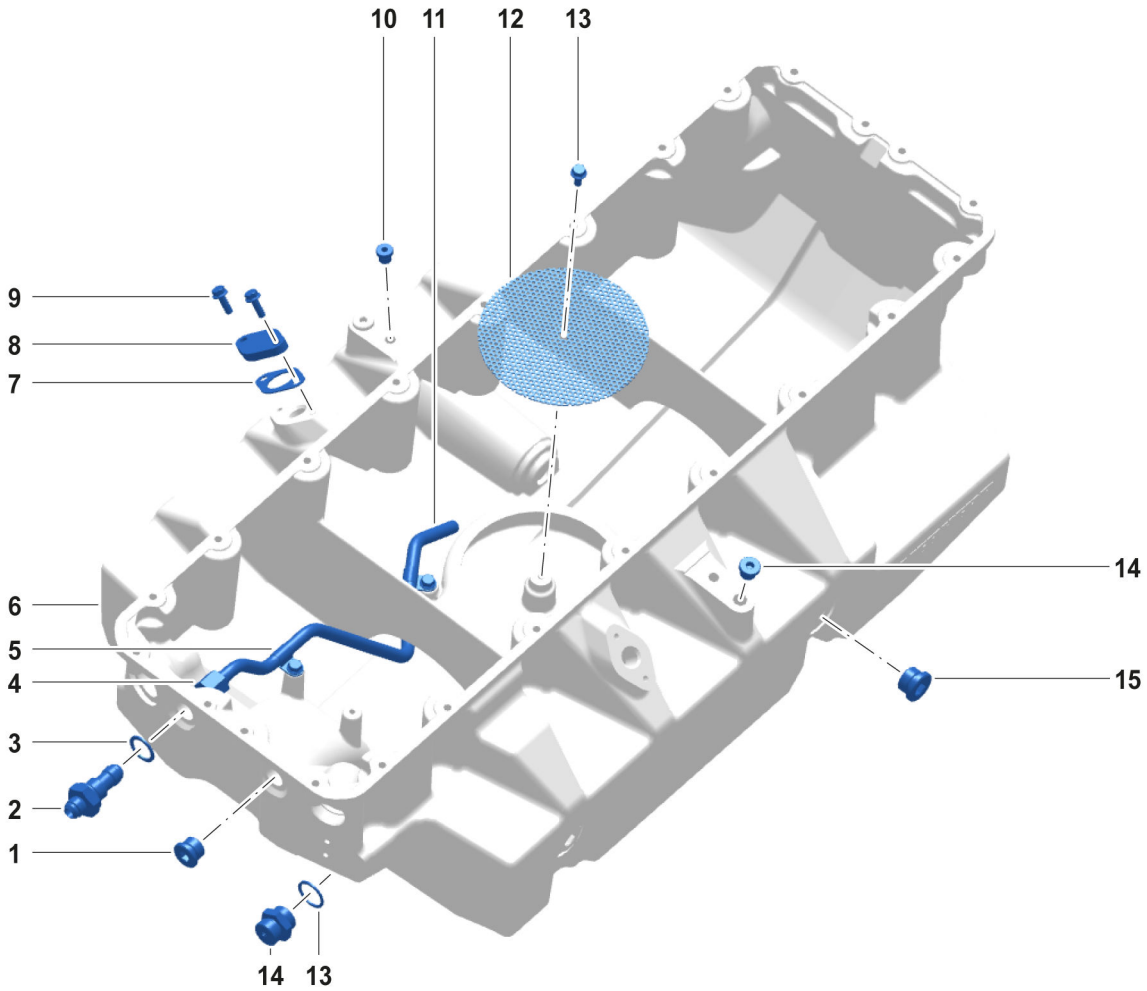

Fig. 491: Oil pan

1 Screw plug
2 Nozzle
3 Sealing ring
4 Box nut
5 Holding clamp (2x)
6 Oil pan
7 Seal
8 Cover
9 Hex head screw (2x)
10 Screw plug
11 Oil return line
12 Sieve
13 Hex head screw
14 Screw plug (2x)
15 Screw plug (5x)

- ▶ If necessary, unscrew screw plug **1**.
- ▶ If necessary, unscrew box nut **4**.
- ▶ Remove holding clamps **5**.
- ▶ Remove oil return line **11**.
- ▶ If necessary, unscrew nozzle **2**.
- ▶ Remove sealing ring **3**.
- ▶ If necessary, unscrew hex head screws **9**.
- ▶ Remove cover **8**.
- ▶ Remove seal **7**.
- ▶ If necessary, unscrew screw plug **10**.
- ▶ If necessary, unscrew hex head screw **13**.

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- ▶ Remove sieve **12**.
- ▶ If necessary, unscrew screw plugs **14**.
- ▶ If necessary, unscrew screw plugs **15**.

Cleaning and checking the oil pan

- ▶ Clean sealing surface of oil pan **4**.
- ▶ Clean sealing surface of crankcase.
- ▶ Clean oil pan **4**.
- ▶ Clean sieve **12**.
- ▶ Clean grooves of o-rings.
- ▶ Check oil return line **11** for damage and replace if necessary.

Installing the oil pan

Graphic representation	Description	Required number	Part number
	M8 assembly pin	2	0524059

Tab. 100: Special tool

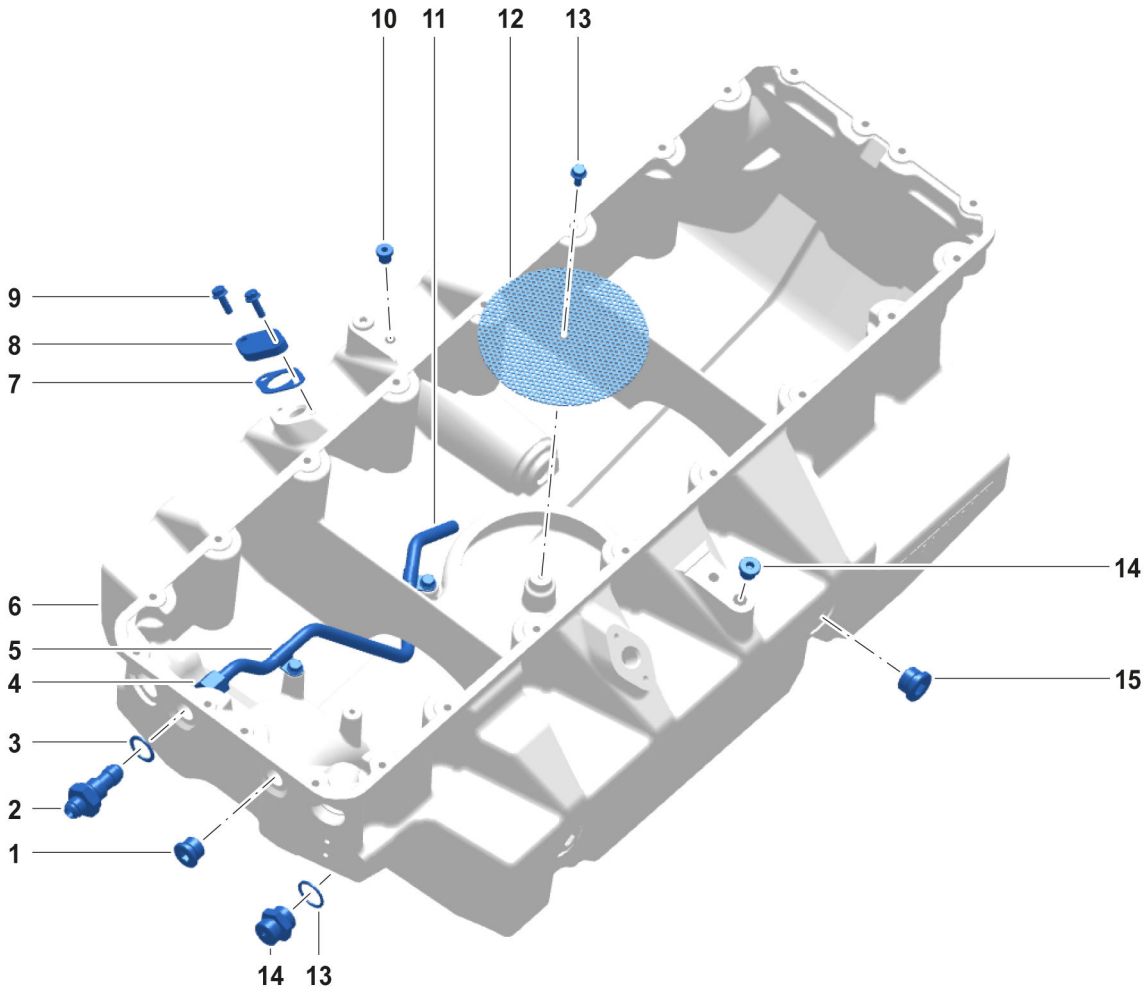

Fig. 493: Oil pan

1 Screw plug
2 Nozzle
3 Sealing ring
4 Box nut
5 Holding clamp (2x)
6 Oil pan
7 Seal
8 Cover
9 Hex head screw (2x)
10 Screw plug
11 Lubricating oil return line
12 Sieve
13 Hex head screw
14 Screw plug (2x)
15 Screw plug (5x)

- ▶ Tighten screw plugs **15**.
- ▶ Lubricate screw plugs **14** with Loctite 243.
- ▶ Tighten screw plugs **14**.
- ▶ Install sieve **12**.
- ▶ Lubricate hex head screw **13** with Loctite 243.
- ▶ Tighten hex head screw **13**.
- ▶ Tighten screw plug **10**.
- ▶ Install new seal **7**.
- ▶ Install cover **8**.
- ▶ Tighten hex head screws **9**.
- ▶ Install new sealing ring **3**.

- ▶ Tighten nozzle **2**.
- ▶ Install oil return line **11**.
- ▶ Tighten box nut **4**.
- ▶ Install holding clamps **5**.
- ▶ Tighten screw plug **1**.

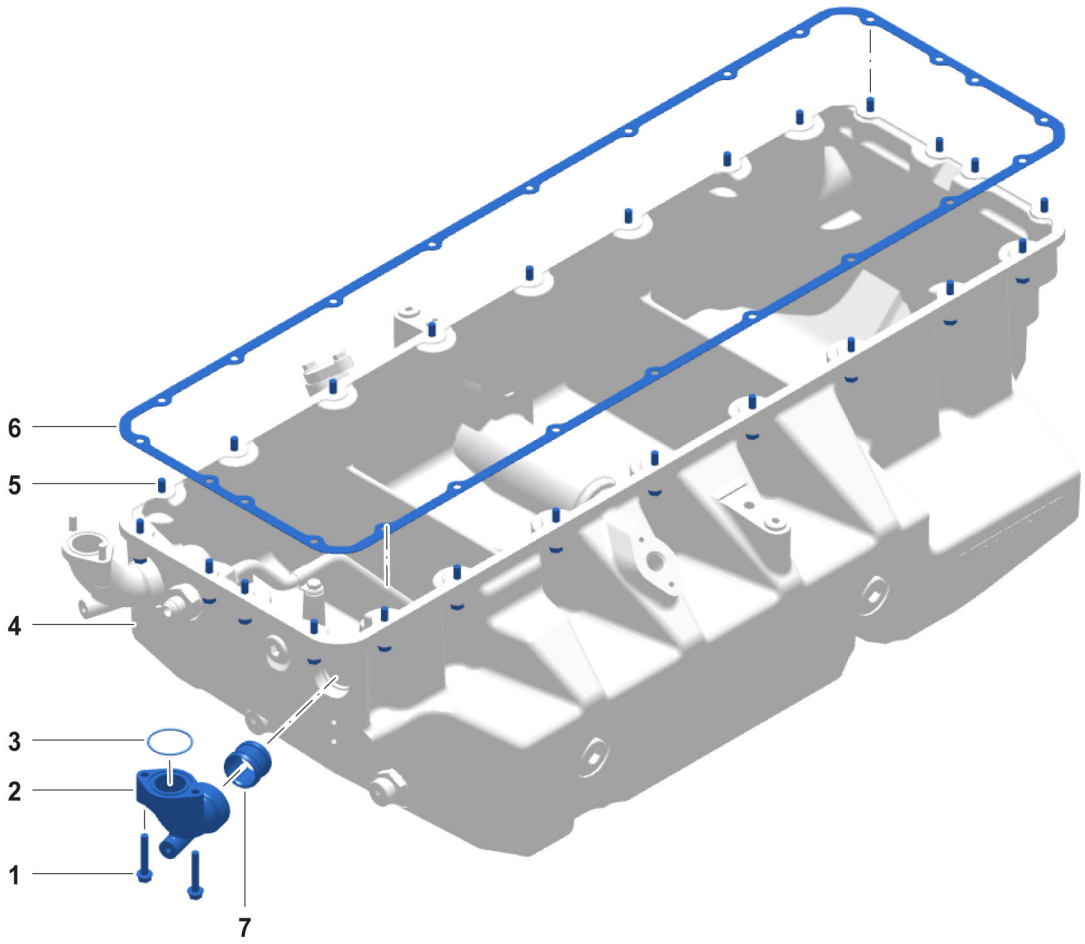

Fig. 494: Oil pan

1 Hex head screw (4x)
2 Elbow (2x)
3 O-ring (2x)
4 Oil pan
5 Hex head screw (24x)
6 Seal
7 Plug-in tube (2x)

- ▶ Install plug-in tubes **7**.
- ▶ Install elbow **2**.
- ▶ Install new o-rings **3**.
- ▶ Install new seal **6**.
- ▶ Screw assembly pins at two opposing holes into crankcase.
- ▶ Install oil pan **4**.
- ▶ Screw in hex head screws **5**.
- ▶ Unscrew two assembly pins.

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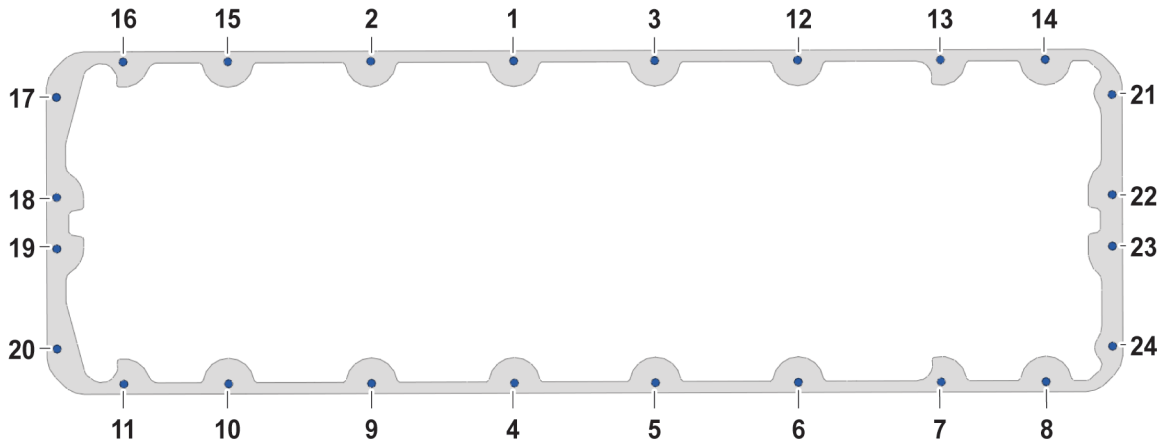
▶ Screw in remaining hex head screws **5**.

Tightening instruction for hex head screw	
Tightening sequence 	
Lubricant (thread and head contact surface)	-
Locking agent (thread)	-
Screws	Reusable
Stage	**Tightening torque**
1.	20 Nm
2.	28 Nm

Tab. 101: Tightening instruction 12871170-001

▶ Tighten hex head screws **5** according to tightening instruction.

▶ Tighten hex head screws **1**.

Removing and installing the oil dipstick with guiding pipe

Removing the oil dipstick with guiding pipe

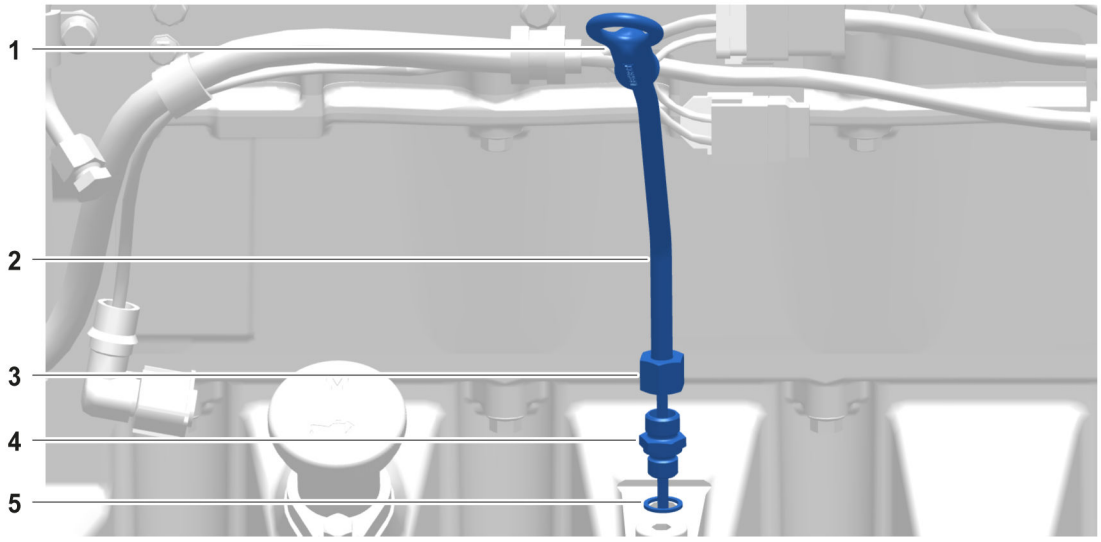


Fig. 496: Oil dipstick with guiding pipe

1 Oil dipstick
2 Guiding pipe
3 Box nut
4 Screw fitting
5 Sealing ring

▶ Remove oil dipstick **1**.

▶ Release box nut **3** and simultaneously remove guiding pipe **2**.

▶ If necessary, unscrew screw fitting **4**.

▶ Remove sealing ring **5**.

▶ Seal opening of oil pan.

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Installing the oil dipstick with guiding pipe

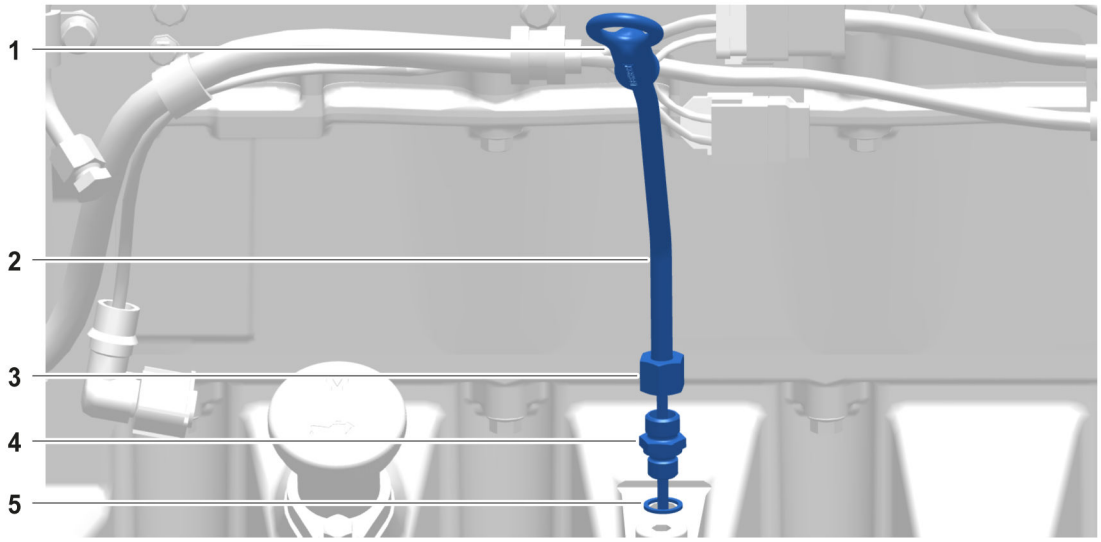

Fig. 497: Oil dipstick with guiding pipe

1 Oil dipstick
2 Guiding pipe
3 Box nut
4 Screw fitting
5 Sealing ring

▶ Remove closure from oil pan.

▶ Install new sealing ring **5**.

▶ Tighten screw fitting **4**.

Tightening instruction for box nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	26 Nm	

Tab. 102: Tightening instruction 13439438-000

▶ Install guiding pipe **2**.

▶ Tighten box nut **3** according to tightening instruction.

▶ Install oil dipstick **1**.

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Removing and installing the oil filler neck

Removing the oil filler neck

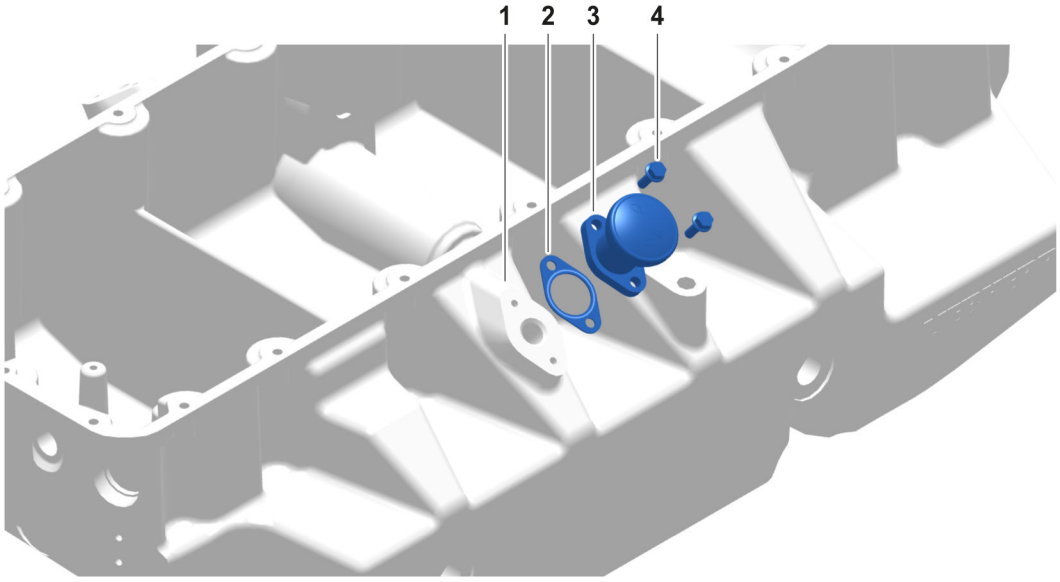

Fig. 499: Oil filler neck

1 Oil pan
2 Seal
3 Oil filler neck with sealing cover
4 Hex head screw (2x)

▶ Unscrew hex head screws **4**.

▶ Remove oil filler neck with sealing cover **3**.

▶ Remove seal **2**.

Cleaning the oil filler neck

▶ Clean sealing surface of oil pan **1**.

▶ Clean sealing surface of oil filler neck **3**.

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Installing the oil filler neck

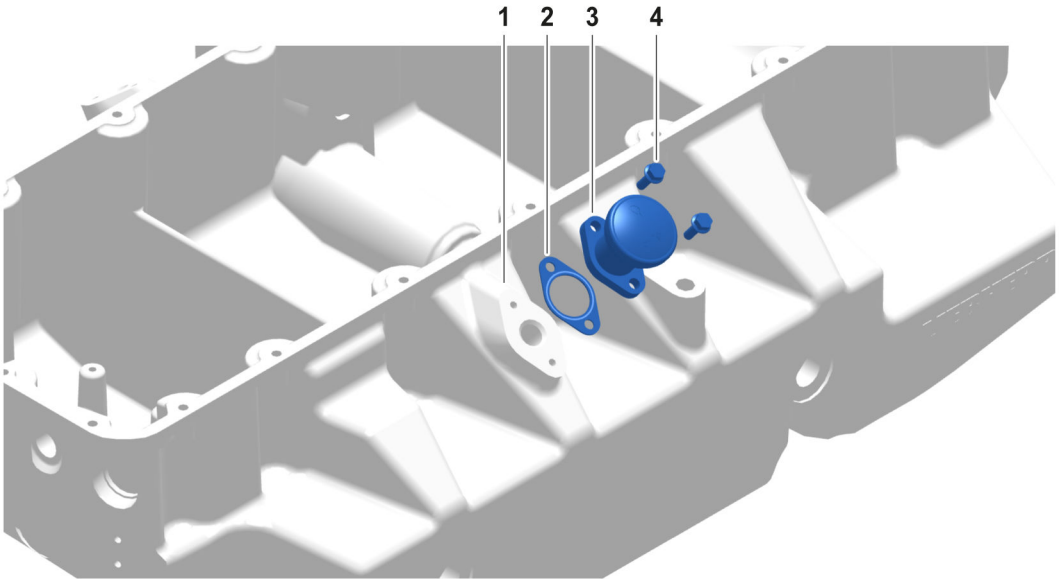

Fig. 500: Oil filler neck

1 Oil pan
2 Seal
3 Oil filler neck with sealing cover
4 Hex head screw (2x)

▶ Install new seal **2**.

▶ Install oil filler neck with sealing cover **3**.

▶ Tighten hex head screws **4**.

3.9.7 Engine oil pump

Removing and installing the left oil pump

Removing the left oil pump

Make sure that the following prerequisite is met:
❑ Ancillary support housing is removed. (For more information see: Removing the ancillary support housing, page 141.)

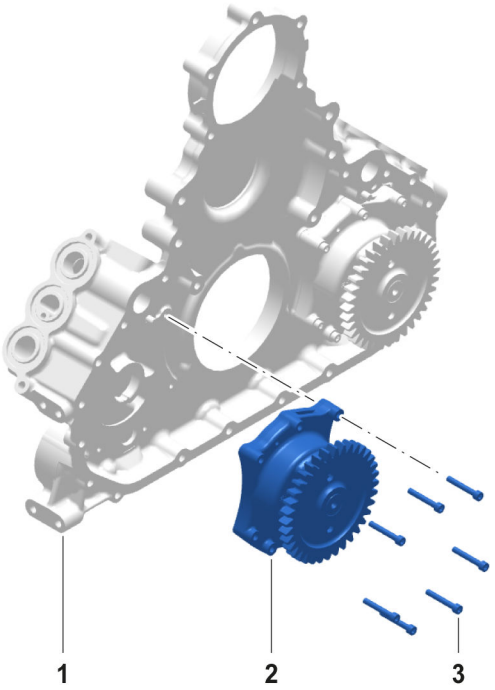

Fig. 501: Oil pump

1 Ancillary support housing
2 Oil pump
3 Hexagon socket screw (7x)

▶ Unscrew hexagon socket screws **3**.

▶ Remove oil pump **2**.

Checking and cleaning the left oil pump

▶ Check gear wheel of oil pump **2** for damage.

If gear wheel of oil pump **2** is damaged:
▶ Replace oil pump **2**.

▶ Clean contact surface of oil pump **2**.

▶ Clean the contact surface of ancillary support housing **1**.

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Installing the left oil pump

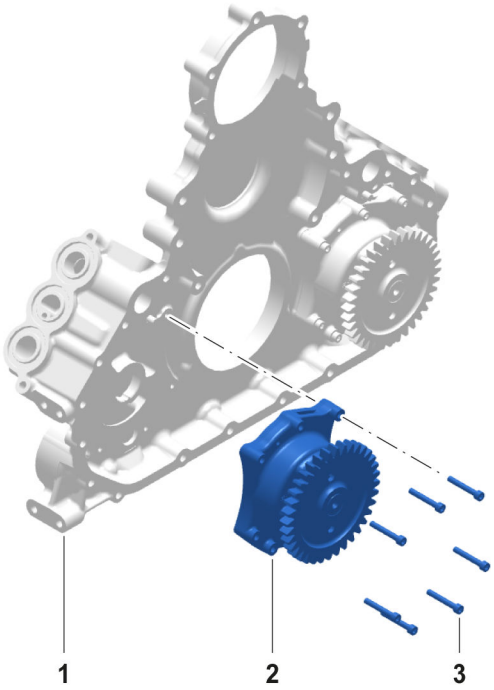

Fig. 502: Oil pump

1 Ancillary support housing
2 Oil pump
3 Hexagon socket screw (7x)

▶ Install oil pump **2**.

▶ Tighten hexagon socket screws **3**.

Removing and installing the right oil pump

Removing the right oil pump

Make sure that the following prerequisite is met:
❑ Ancillary support housing is removed. (For more information see: Removing the ancillary support housing, page 141.)

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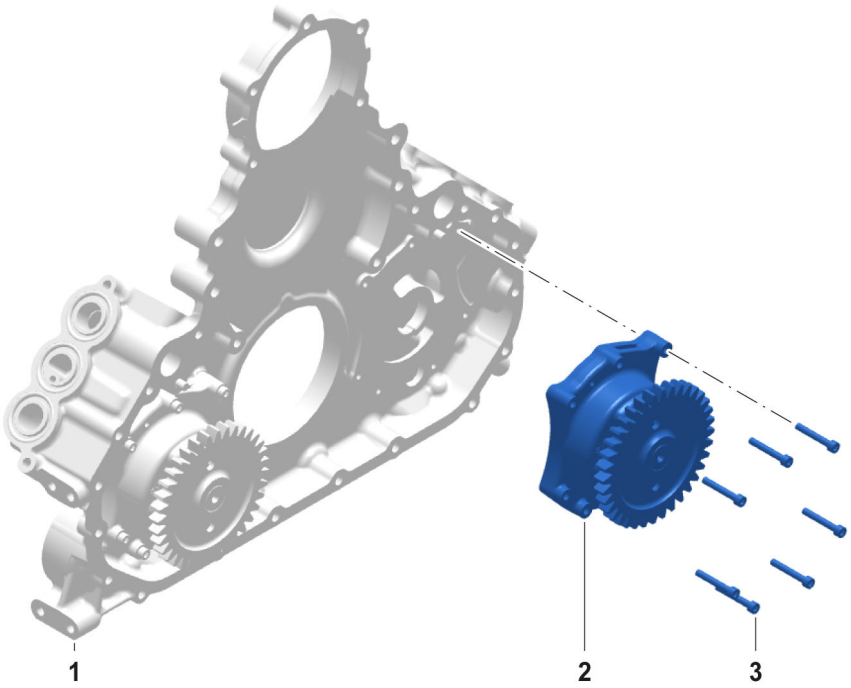

Fig. 503: Oil pump

1 Ancillary support housing
2 Oil pump
3 Hexagon socket screw (7x)

▶ Unscrew hexagon socket screws **3**.

▶ Remove oil pump **2**.

Checking and cleaning the right oil pump

▶ Check gear wheel of oil pump **2** for damage.

If gear wheel of oil pump **2** is damaged:
▶ Replace oil pump **2**.

▶ Clean contact surface of oil pump **2**.

▶ Clean the contact surface of ancillary support housing **1**.

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Installing the right oil pump

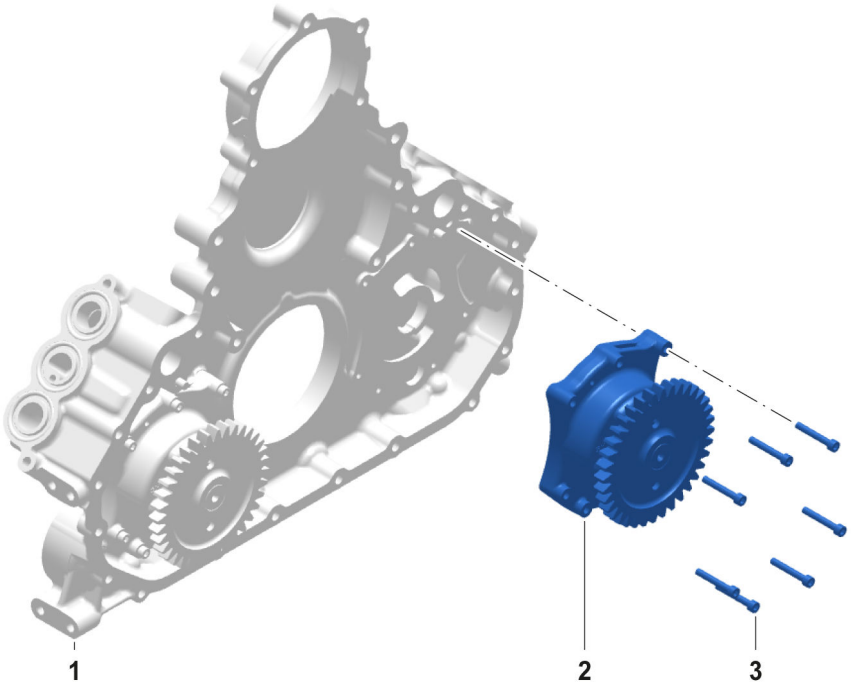

Fig. 504: Oil pump

1 Ancillary support housing
2 Oil pump
3 Hexagon socket screw (7x)

▶ Install oil pump **2**.

▶ Tighten hexagon socket screws **3**.

3.9.8 Removing and installing the piston cooling nozzle

Removing the piston cooling nozzle

Make sure that the following prerequisites are met:
❑ Oil pan is removed. (For more information see: Removing the oil pan, page 395.)
❑ Turning device is installed. (For more information see: Installing the turning device, page 67.)

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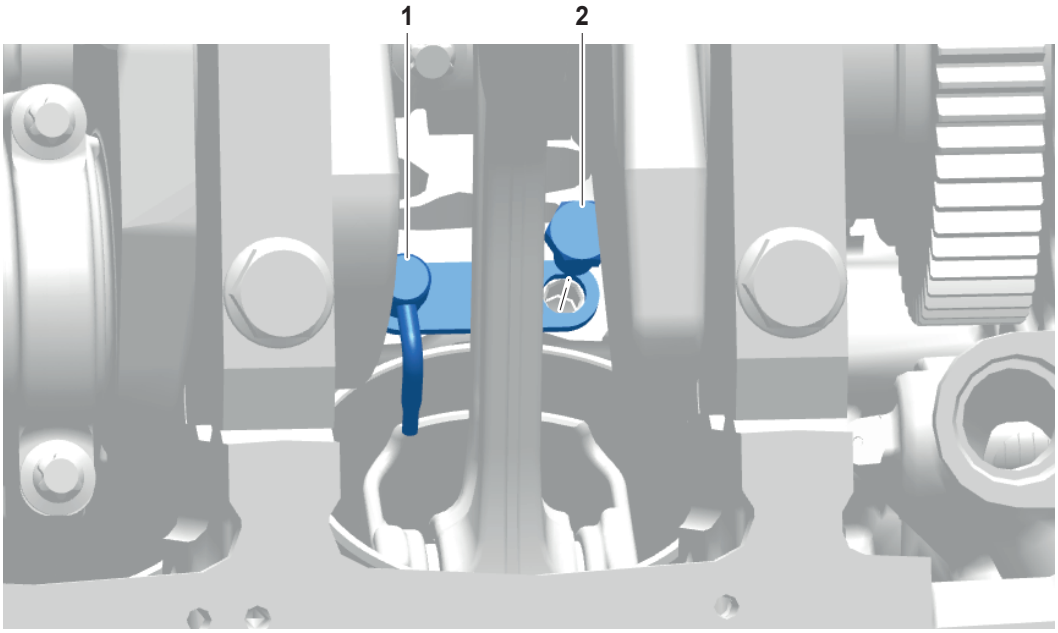

Fig. 505: Piston cooling nozzle

1 Piston cooling nozzle **2** Hex head screw

▶ Turn crankshaft with turning device until hex head screw **2** is accessible.

▶ Unscrew hex head screw **2**.

▶ Remove piston cooling nozzle **1**.

Installing the piston cooling nozzle

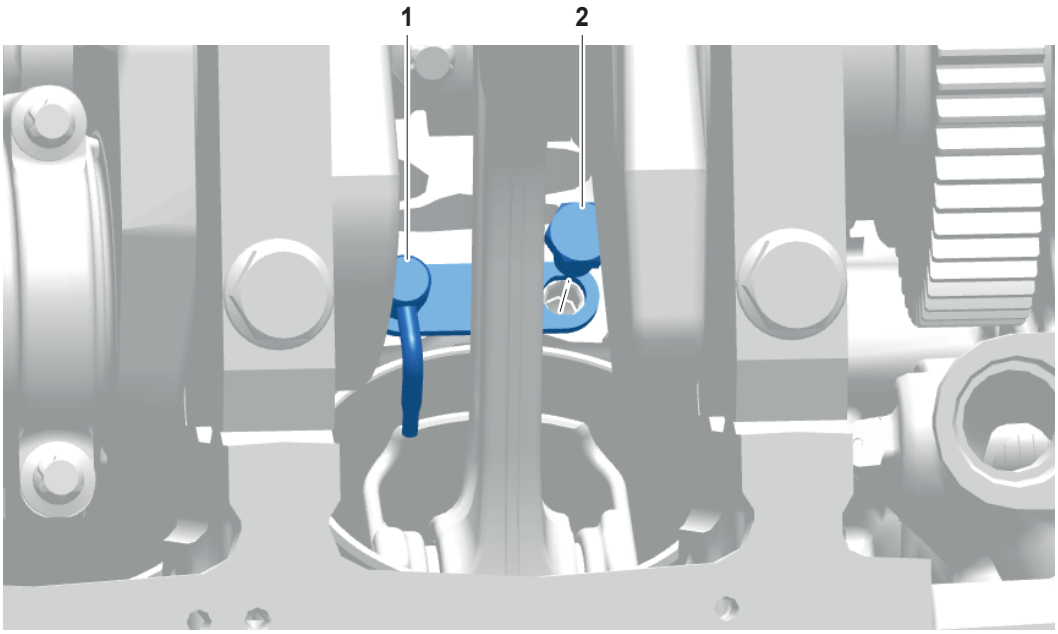

Fig. 506: Piston cooling nozzle

1 Piston cooling nozzle **2** Hex head screw

▶ Align piston cooling nozzle **1**.

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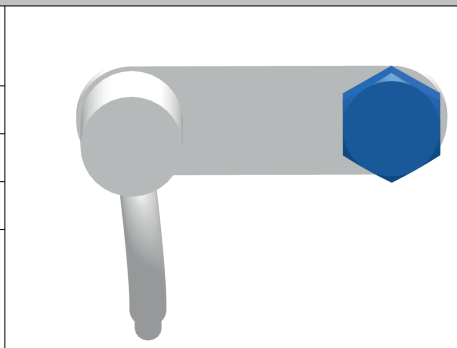
Tightening instruction for hexalobular flange head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	120 Nm	

Tab. 103: Tightening instruction 10146571-001

▶ Tighten hex head screw **2** according to tightening instruction.

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3.10 Cooling system

3.10.1 Removing and installing the ventilation line

Removing the ventilation line from the exhaust gas turbocharger to the expansion tank

Make sure that the following prerequisites are met:
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)
- ❑ Device side line is removed from the ventilation line, see documentation from the device manufacturer.

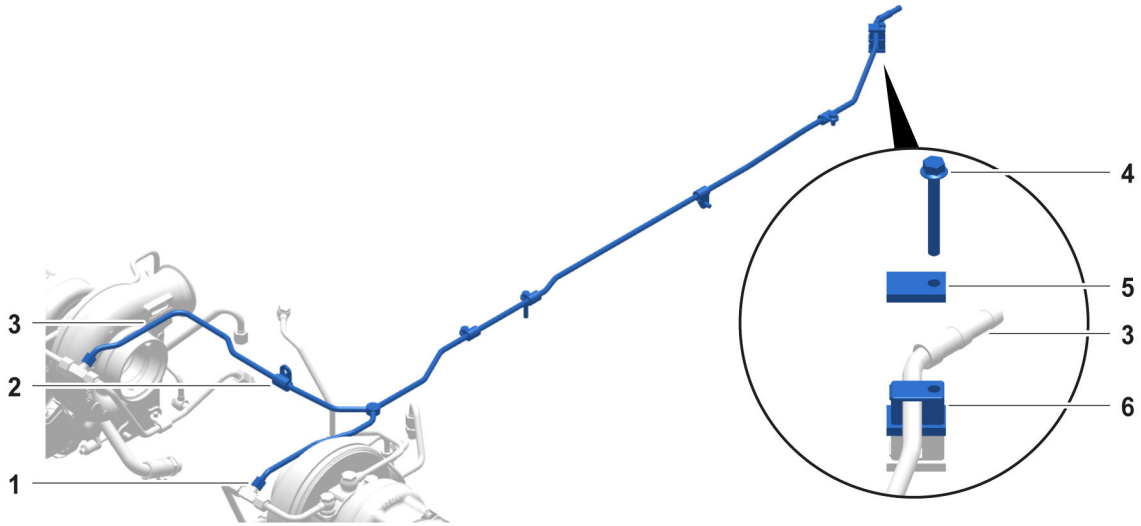

Fig. 508: Ventilation line

1 Box nut (2x)
2 Holding clamp (5x)
3 Ventilation line
4 Hex head screw
5 Support plate
6 Holding clamp

▶ Remove holding clamps **2**.

▶ Unscrew hex head screw **4**.

▶ Remove support plate **5**.

▶ Open holding clamp **6**.

▶ Unscrew box nuts **1**.

▶ Remove ventilation line **3**.

Removing the ventilation line from the cylinder banks to the expansion tank

Make sure that the following prerequisite is met:
- ❑ Device side line is removed from the ventilation line, see documentation from the device manufacturer.

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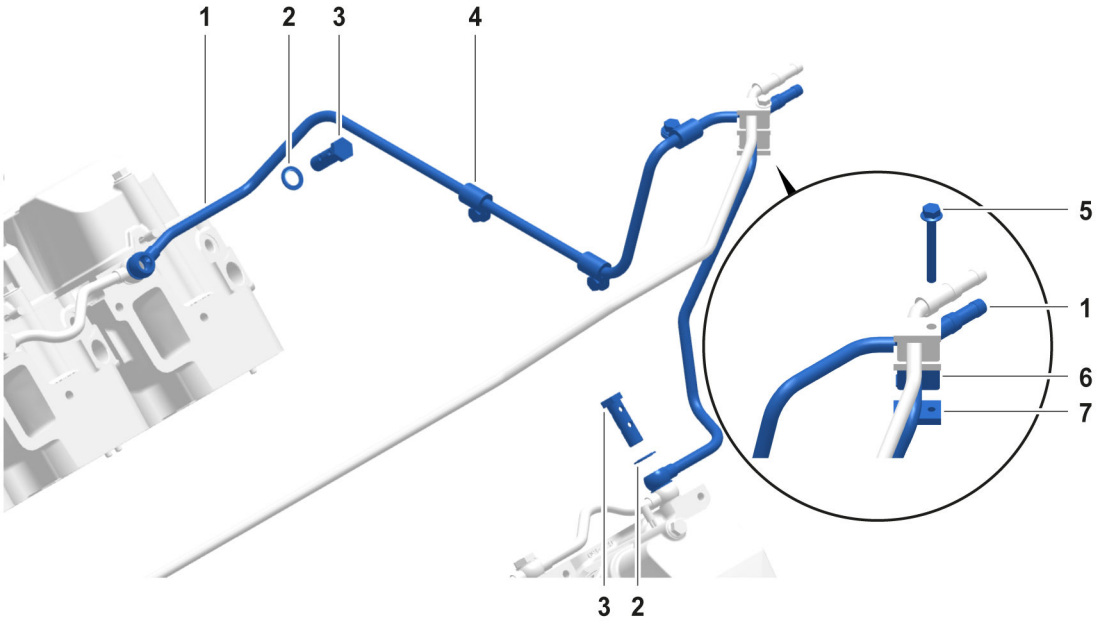

Fig. 509: Ventilation line

1 Ventilation line
2 Sealing ring (2x)
3 Double banjo bolt (2x)
4 Holding clamp (3x)
5 Hex head screw
6 Holding clamp
7 Support plate

- ▶ Remove holding clamps **4**.
- ▶ Unscrew hex head screw **5**.
- ▶ Remove support plate **7**.
- ▶ Open holding clamp **6**.
- ▶ Unscrew double banjo bolts **3**.
- ▶ Remove sealing rings **2**.
- ▶ Remove ventilation line **1**.
- ▶ Remove sealing rings under ventilation line **1**.

Removing the ventilation lines from the cylinder banks

Make sure that the following prerequisite is met:
- ❑ Ventilation line from cylinder banks to expansion tank is removed. (For more information see: Removing the ventilation line from the cylinder banks to the expansion tank, page 412.)

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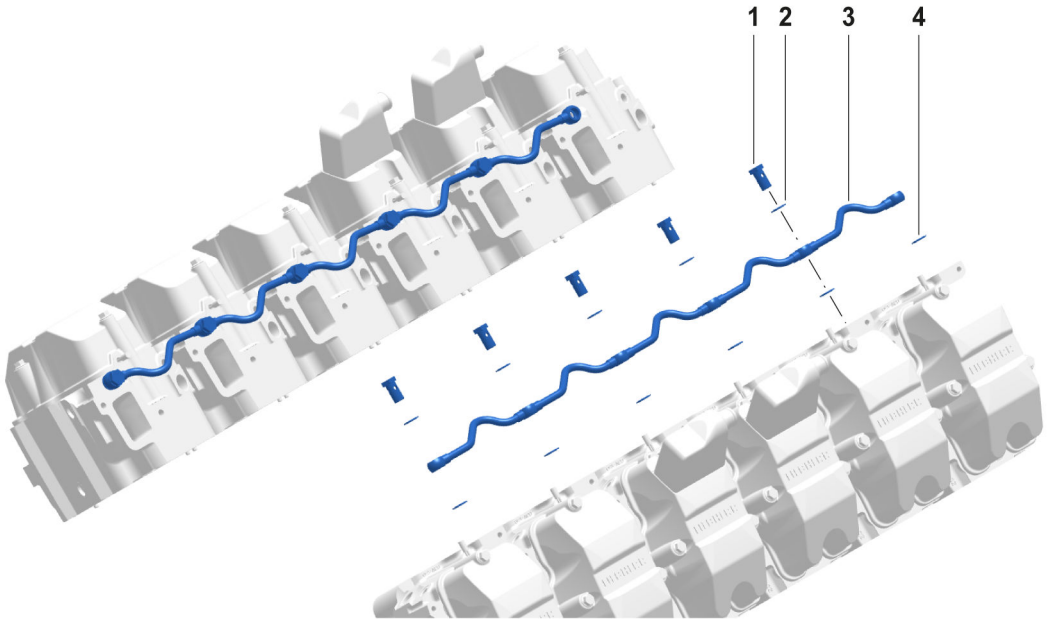

Fig. 510: Ventilation lines

1 Banjo bolt (10x)
2 Sealing ring (10x)
3 Ventilation line (2x)
4 Sealing ring (12x)

▶ Unscrew banjo bolts **1**.

▶ Remove sealing rings **2**.

▶ Remove ventilation lines **3**.

▶ Remove sealing rings **4**.

Checking the ventilation line

▶ Check ventilation lines for damage and replace if necessary.

Installing the ventilation lines from the cylinder banks

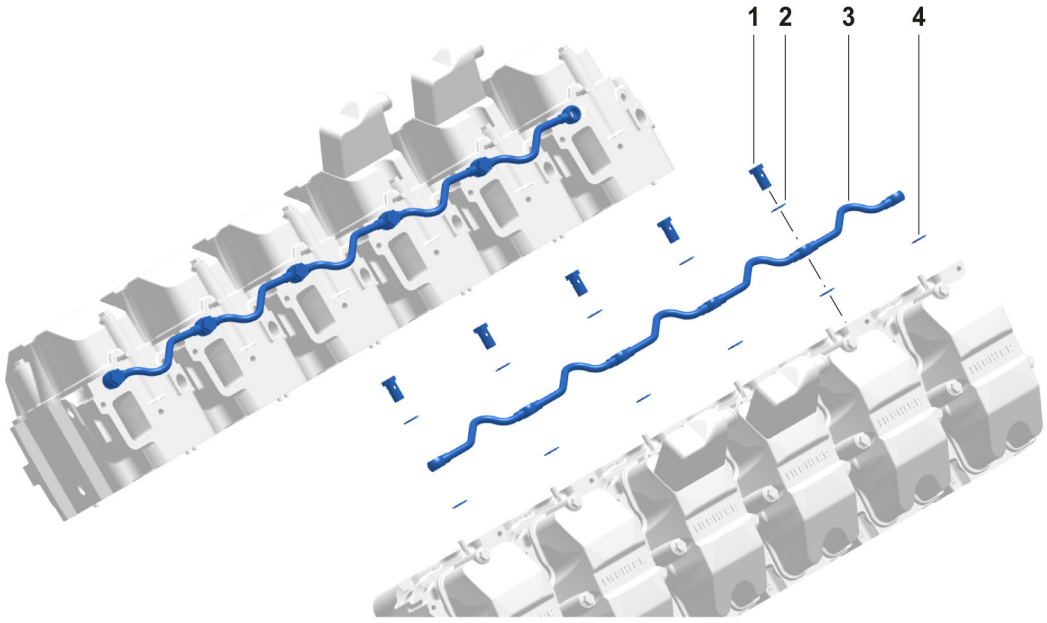

Fig. 511: Ventilation lines

1 Banjo bolt (10x)
2 Sealing ring (10x)
3 Ventilation line (2x)
4 Sealing ring (12x)

- ▶ Install new sealing rings **4**.
- ▶ Install ventilation lines **3**.
- ▶ Install new sealing rings **2**.
- ▶ Tighten banjo bolts **1**.

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Installing the ventilation line from the cylinder banks to the expansion tank

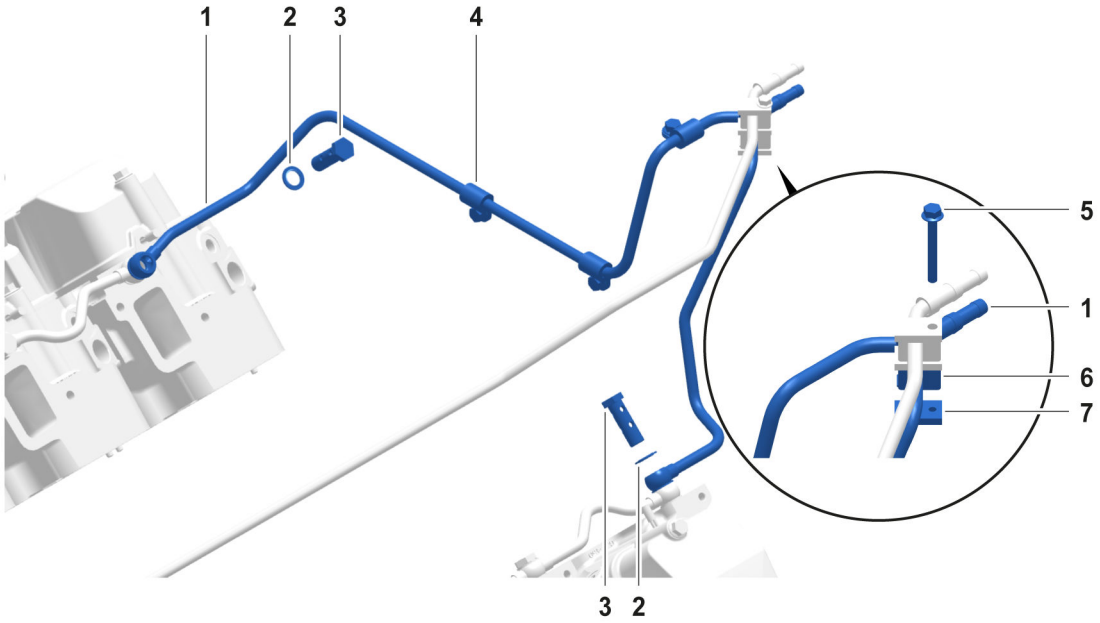

Fig. 512: Ventilation line

1 Ventilation line
2 Sealing ring (2x)
3 Double banjo bolt (2x)
4 Holding clamp (3x)
5 Hex head screw
6 Holding clamp
7 Support plate

- ▶ Install new sealing rings on cylinder bank ventilation lines.
- ▶ Install ventilation line **1**.
- ▶ Install new sealing rings **2**.
- ▶ Tighten double banjo bolts **3**.
- ▶ Install holding clamp **6**.
- ▶ Install support plate **7**.
- ▶ Tighten hex head screw **5**.
- ▶ Install holding clamps **4**.

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Installing the ventilation line from the exhaust gas turbocharger to the expansion tank

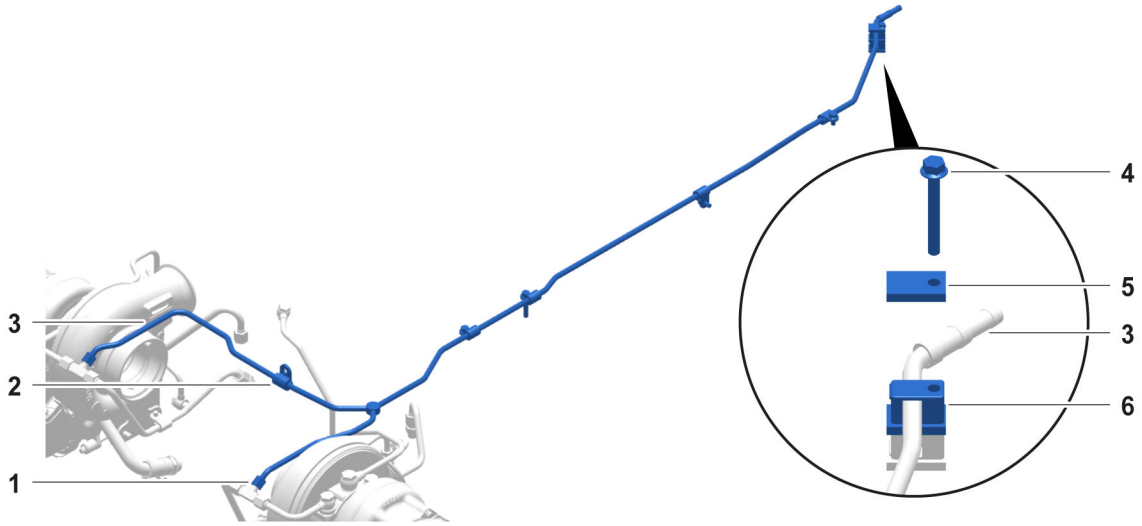

Fig. 513: Ventilation line

1 Box nut (2x)
2 Holding clamp (5x)
3 Ventilation line
4 Hex head screw
5 Support plate
6 Holding clamp

- ▶ Install ventilation line **3**.
- ▶ Tighten box nuts **1**.
- ▶ Install holding clamp **6**.
- ▶ Install support plate **5**.
- ▶ Tighten hex head screw **4**.
- ▶ Install holding clamps **2**.

3.10.2 Coolant manifold

Removing and installing the coolant manifold

Removing the pipeline

Make sure that the following prerequisites are met:
- ❑ Device side pipeline is removed, see documentation from the device manufacturer.
- ❑ Cover plate is removed. (For more information see: 3.1.1 Removing the cover plate, page 53.)
- ❑ Coolant supply line is removed from left coolant manifold. (For more information see: Removing the left coolant supply line, page 326.)

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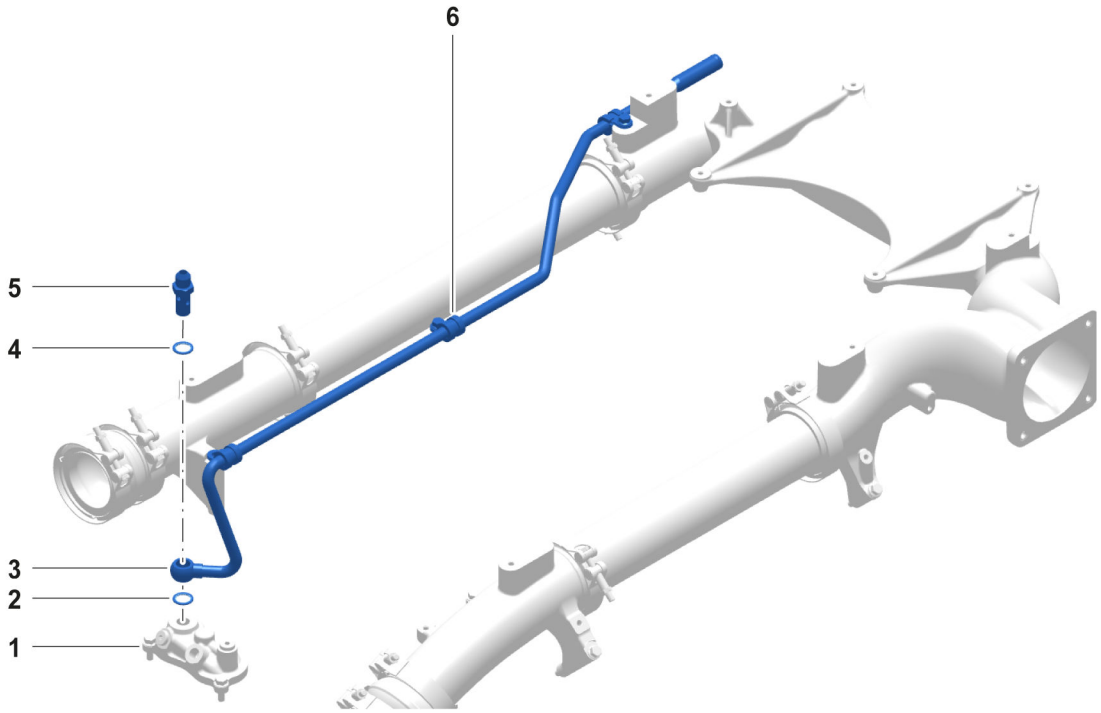

Fig. 514: Pipeline

1 Left coolant manifold
2 Sealing ring
3 Pipeline
4 Sealing ring
5 Nozzle
6 Holding clamp (3x)

▶ Remove holding clamps **6**.

▶ Unscrew nozzle **5**.

▶ Remove sealing ring **4**.

▶ Remove pipeline **3**.

▶ Seal openings on pipeline **3**.

▶ Remove sealing ring **2**.

▶ Seal opening on coolant manifold **1**.

Removing the coolant manifold

Make sure that the following prerequisites are met:
❑ For left coolant manifold removal, the device side pipeline is removed, see documentation from the device manufacturer.
❑ For left coolant manifold removal, the pipeline is removed. (For more information see: Removing the pipeline, page 417.)
❑ For left coolant manifold removal, the coolant supply line is removed. (For more information see: Removing the left coolant supply line, page 326.)
❑ For left coolant manifold removal, the coolant return line is removed. (For more information see: Removing the left coolant return line, page 330.)
❑ For right coolant manifold removal, the coolant supply line is removed. (For more information see: Removing and installing the right coolant supply line, page 328.)
❑ For right coolant manifold removal, the coolant return line is removed. (For more information see: Removing the right coolant return line, page 332.)

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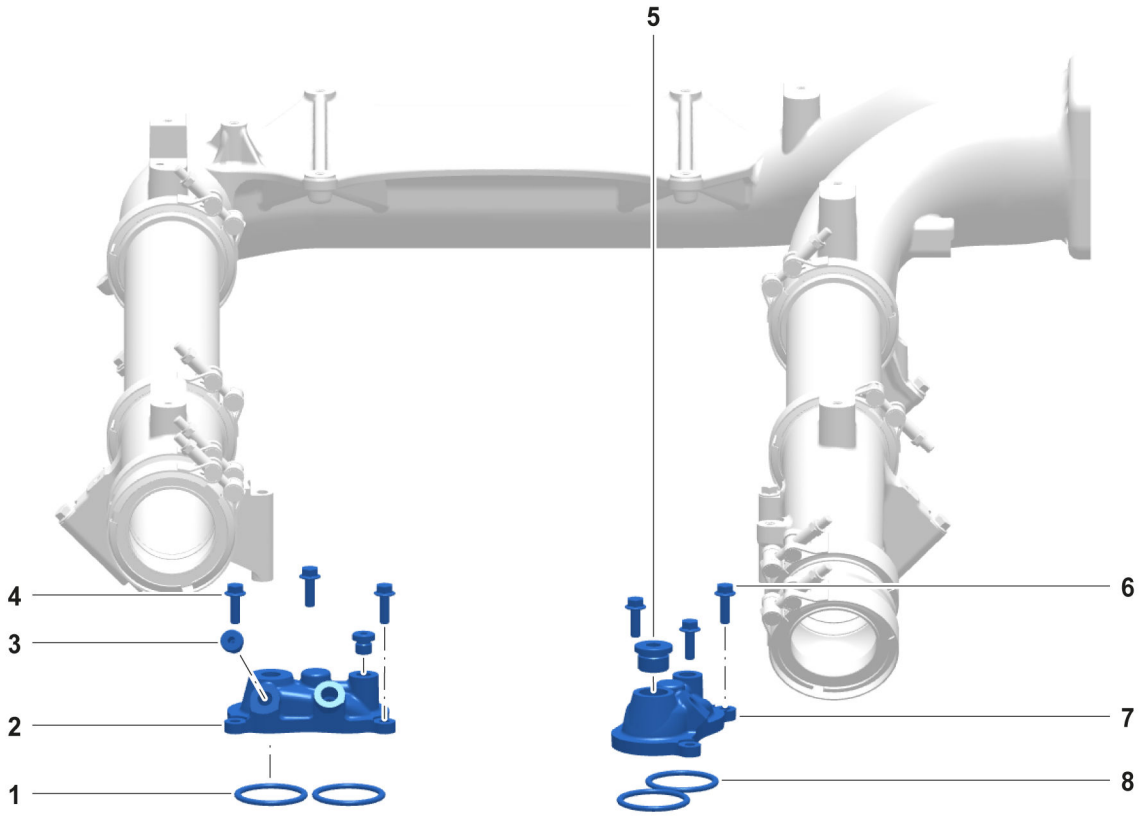

Fig. 515: Coolant manifold

1 O-ring (2x)
2 Left coolant manifold
3 Screw plug (2x)
4 Hex head screw (3x)
5 Screw plug
6 Hex head screw (3x)
7 Right coolant manifold (3x)
8 O-ring (2x)

- ▶ Unscrew hex head screws **4**.
- ▶ Remove left coolant manifold **2**.
- ▶ Remove o-rings **1**.
- ▶ Seal openings on crankcase.
- ▶ If necessary, unscrew screw plugs **3**.
- ▶ Unscrew hex head screws **6**.
- ▶ Remove right coolant manifold **7**.
- ▶ Remove o-rings **8**.
- ▶ Seal openings on crankcase.
- ▶ If necessary, unscrew screw plug **5**.

Cleaning the coolant manifold

- ▶ Clean sealing surfaces of left coolant manifold **2**.
- ▶ Clean sealing surfaces of right coolant manifold **7**.
- ▶ Clean sealing surfaces of crankcase.
- ▶ Clean nozzle.

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Installing the coolant manifold

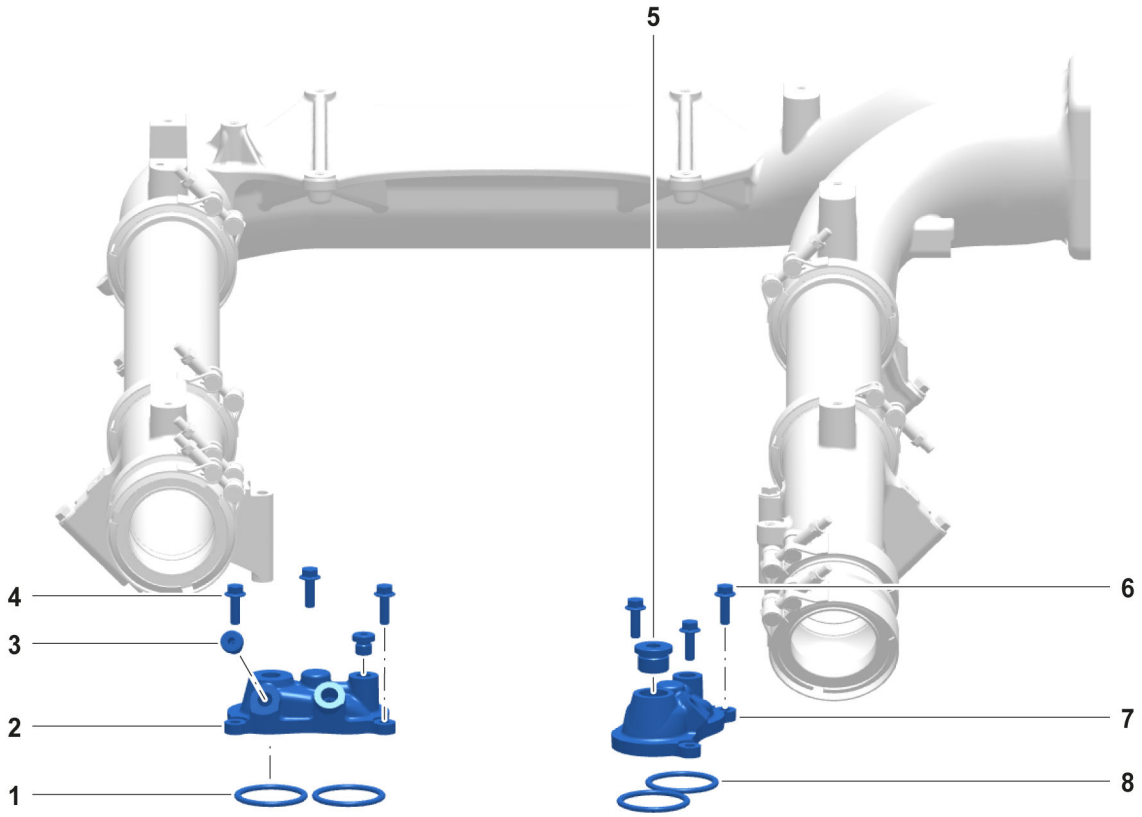

Fig. 516: Coolant manifold

1 O-ring (2x)
2 Left coolant manifold
3 Screw plug (2x)
4 Hex head screw (3x)
5 Screw plug
6 Hex head screw (3x)
7 Right coolant manifold (3x)
8 O-ring (2x)

- ▶ Tighten screw plug **5**.
- ▶ Remove closures from crankcase.
- ▶ Install new o-rings **8**.
- ▶ Install right coolant manifold **7**.
- ▶ Tighten hex head screws **6**.
- ▶ Tighten screw plugs **3**.
- ▶ Remove closures from crankcase.
- ▶ Install new o-rings **1**.
- ▶ Install left coolant manifold **2**.
- ▶ Tighten hex head screws **4**.

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Installing the pipeline

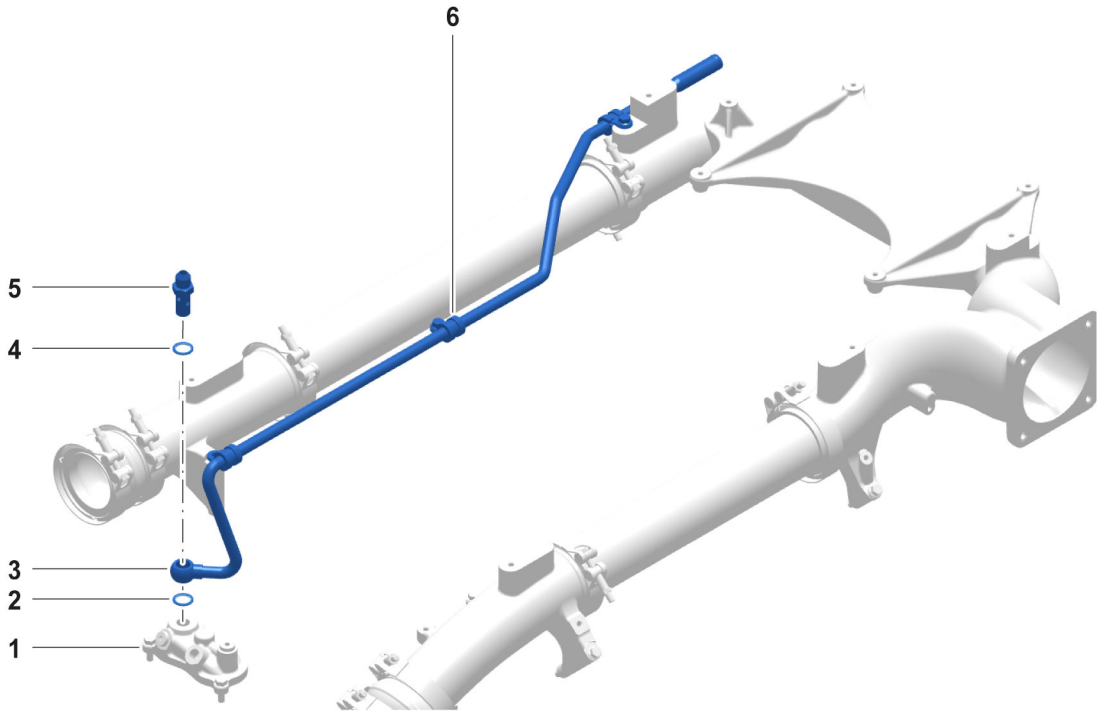

Fig. 517: Pipeline

1 Left coolant manifold
2 Sealing ring
3 Pipeline
4 Sealing ring
5 Nozzle
6 Holding clamp (3x)

- ▶ Remove closure from coolant manifold **1**.
- ▶ Install new sealing ring **2**.
- ▶ Remove closures from pipeline **3**.
- ▶ Align pipeline **3**.
- ▶ Install new sealing ring **4**.
- ▶ Lubricate nozzle **5** with Loctite® 577.
- ▶ Tighten nozzle **5**.
- ▶ Install holding clamps **6**.

3.10.3 Removing and installing the water line connections

Removing the water line connections

Make sure that the following prerequisite is met:
- ❑ Corresponding device side water line is removed, see documentation from the device manufacturer.

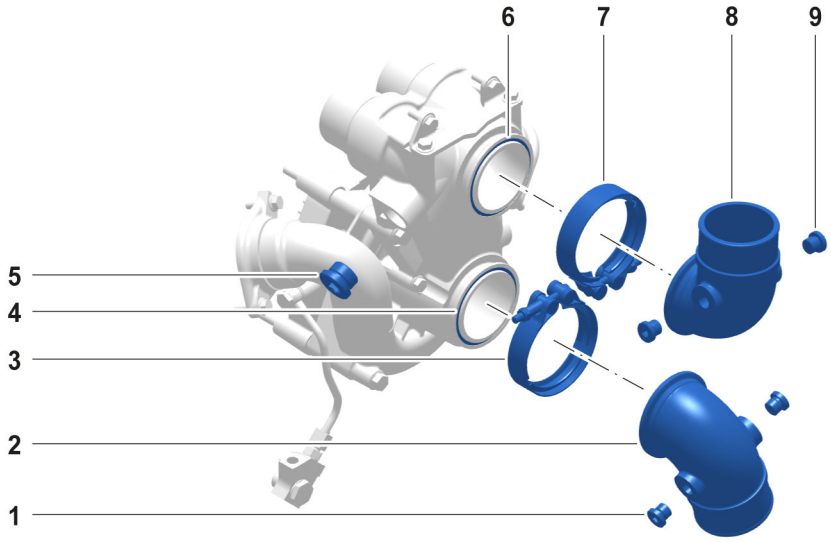

Fig. 518: Water line connections

1 Screw plug (2x)
2 Connecting elbow
3 V-band clamp
4 O-ring
5 Screw plug
6 O-ring
7 V-band clamp
8 Connecting elbow
9 Screw plug (2x)

- ▶ Remove V-band clamp **3**.
- ▶ Remove connecting elbow **2**.
- ▶ If necessary, unscrew screw plugs **1**.
- ▶ Remove o-ring **4**.
- ▶ Remove V-band clamp **7**.
- ▶ Remove connecting elbow **8**.
- ▶ If necessary, unscrew screw plugs **9**.
- ▶ Remove o-ring **6**.
- ▶ If necessary, unscrew screw plug **5**.

Cleaning the water line connections

- ▶ Clean sealing surface of connecting elbow **2**.
- ▶ Clean sealing surface of connecting elbow **8**.
- ▶ Clean sealing surface of coolant pump.
- ▶ Clean groove of o-ring **4**.
- ▶ Clean groove of o-ring **6**.

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Installing the water line connections

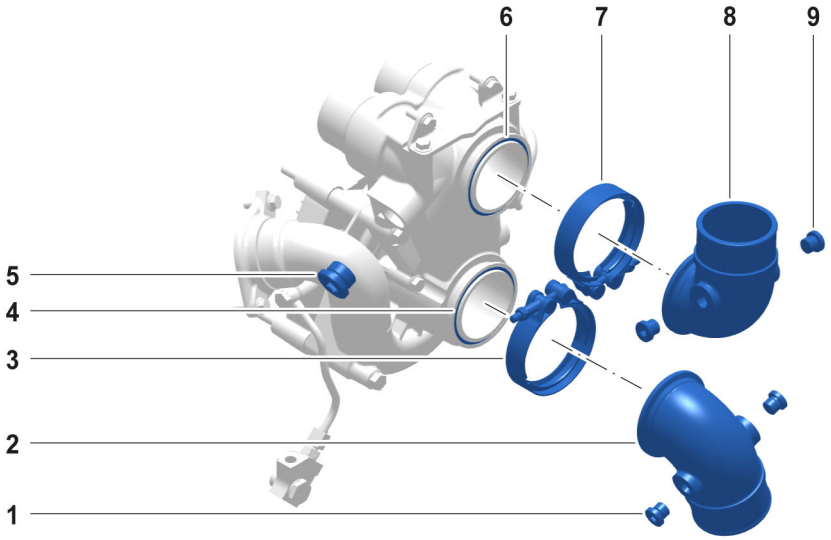

Fig. 519: Water line connections

1 Screw plug (2x)
2 Connecting elbow
3 V-band clamp
4 O-ring
5 Screw plug
6 O-ring
7 V-band clamp
8 Connecting elbow
9 Screw plug (2x)

▶ Tighten screw plug **5**.
▶ Install new o-ring **6**.
▶ Tighten screw plugs **9**.
▶ Install connecting elbow **8**.
▶ Install V-band clamp **7**.
▶ Install new o-ring **4**.
▶ Tighten screw plugs **1**.
▶ Install connecting elbow **2**.
▶ Install V-band clamp **3**.

3.10.4 Removing and installing the coolant connection

Removing the coolant connection

Make sure that the following prerequisite is met:
❑ A collection container for coolant is available.

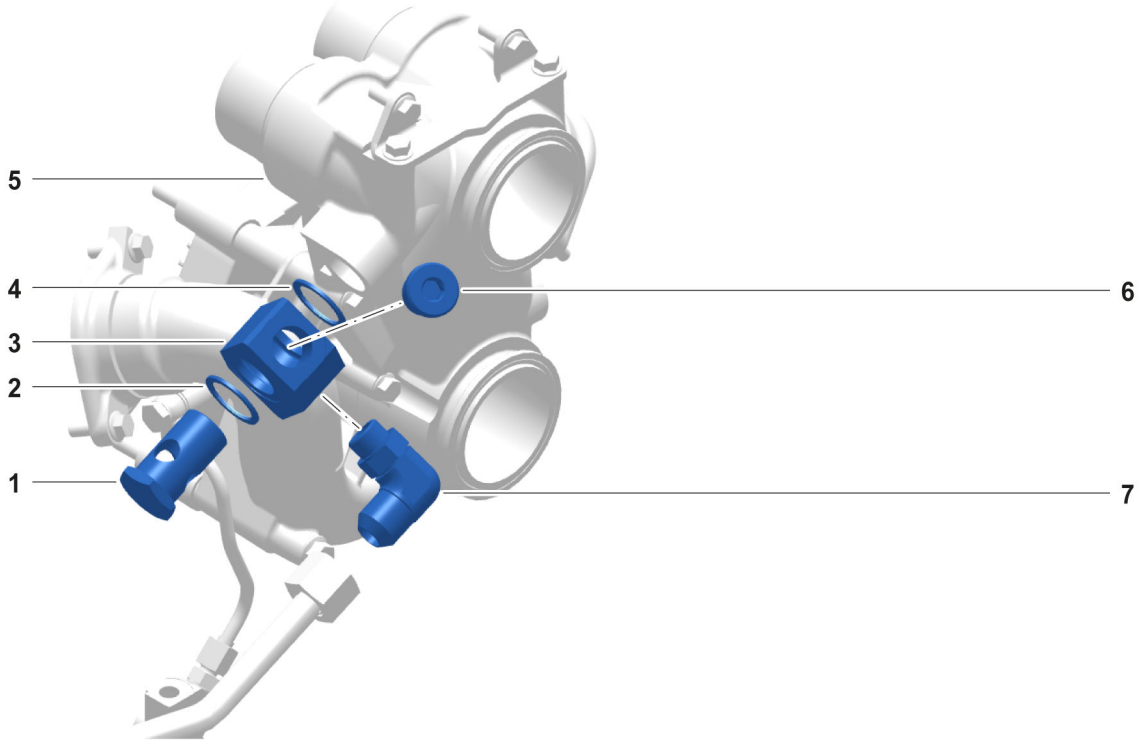

Fig. 520: Coolant connection

1 Banjo bolt
2 Sealing ring
3 Connection piece
4 Sealing ring
5 Coolant pump
6 Screw plug
7 Screw fitting

▶ Unscrew banjo bolt **1**.

▶ Remove sealing ring **2**.

▶ Remove sealing ring **4**.

▶ Unscrew box nut on screw fitting **7**.

▶ Remove connection piece **3**.

▶ Seal opening of coolant pump **5**.

▶ If necessary, unscrew screw fitting **7**.

▶ If necessary, unscrew screw plug **6**.

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Installing the coolant connection

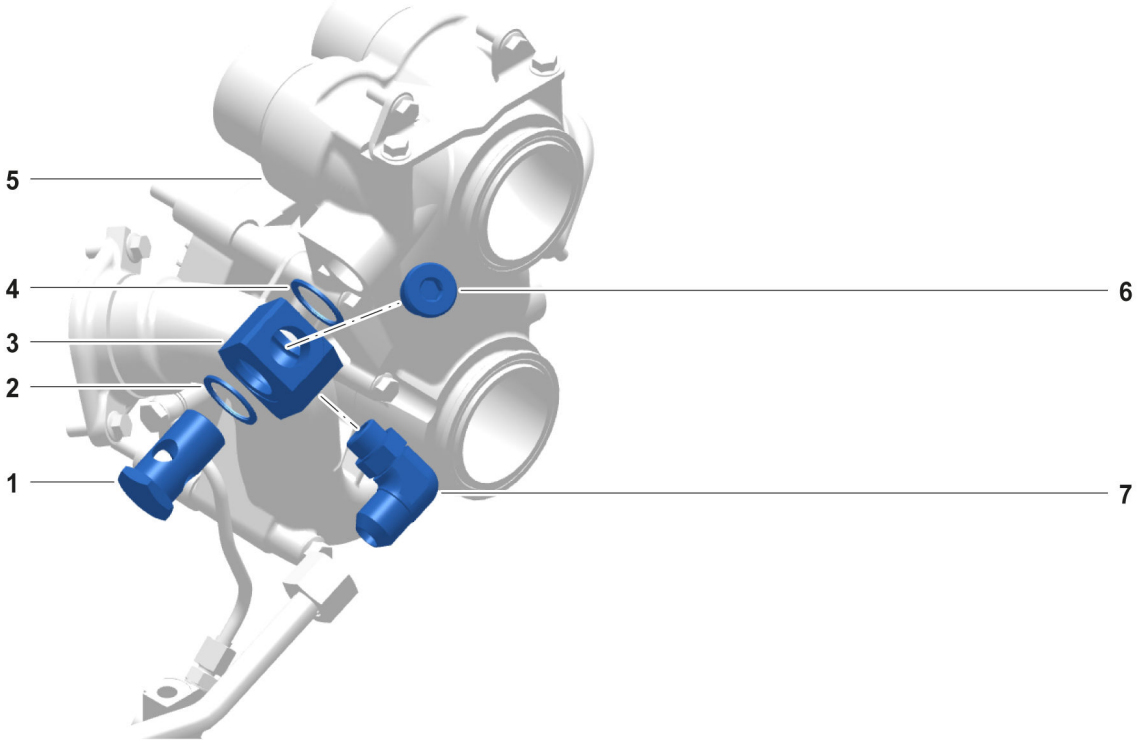

Fig. 521: Coolant connection

1 Banjo bolt
2 Sealing ring
3 Connection piece
4 Sealing ring
5 Coolant pump
6 Screw plug
7 Screw fitting

- ▶ Tighten screw plug **6**.
- ▶ Tighten screw fitting **7**.
- ▶ Remove closure from coolant pump **5**.
- ▶ Install connection piece **3**.
- ▶ Tighten box nut on screw fitting **7**.
- ▶ Install sealing ring **4**.
- ▶ Install sealing ring **2**.
- ▶ Tighten banjo bolt **1**.

3.10.5 Coolant pump

Removing and installing the coolant manifold

Removing the coolant manifold

Make sure that the following prerequisites are met:
❑ Coolant has been drained, see operator's manual.

- ❑ Water line connections are removed. (For more information see: Removing the water line connections, page 421.)
- ❑ Coolant connection is removed. (For more information see: Removing the coolant connection, page 423.)

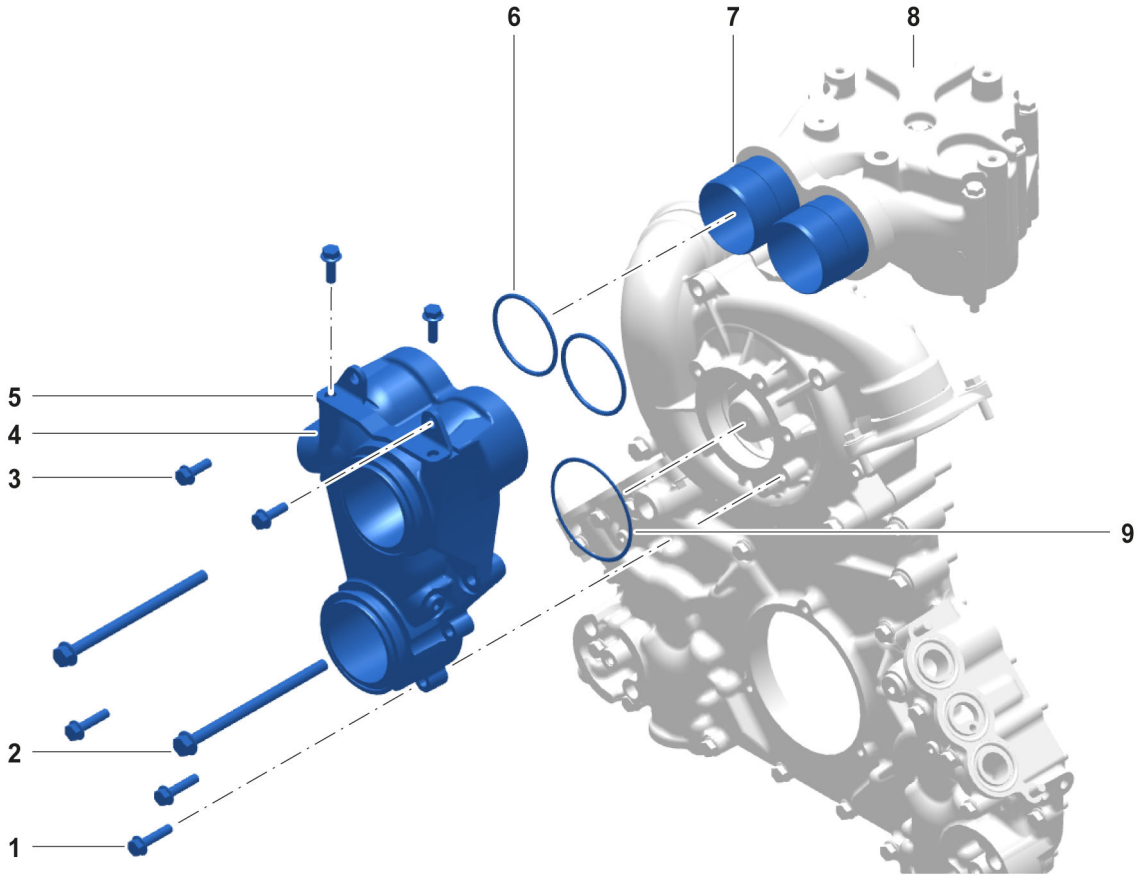

Fig. 522: Coolant manifold

1	Hex head screw (3x)	**6**	O-ring (2x)
2	Hex head screw (2x)	**7**	Plug-in tube (2x)
3	Hex head screw (4x)	**8**	Thermostat housing
4	Coolant manifold	**9**	O-ring
5	Bracket		

- ▶ Unscrew two hex head screws **3** from bracket on charge air pipe.
- ▶ If necessary, unscrew remaining hex head screws **3**.
- ▶ Remove bracket **5**.
- ▶ Unscrew hex head screws **1**.
- ▶ Unscrew hex head screws **2**.
- ▶ Remove coolant manifold **4**.
- ▶ Remove o-rings **6**.
- ▶ Remove o-ring **9**.
- ▶ If necessary, remove plug-in tubes **7**. (For more information see: Removing the thermostat housing, page 433.)

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Cleaning the coolant manifold

- ▶ Clean sealing surfaces of coolant manifold **4**.
- ▶ Clean sealing surface of coolant pump.
- ▶ Clean sealing surfaces of plug-in tubes **7**.
- ▶ Clean grooves of o-rings **6**.
- ▶ Clean groove of o-ring **9**.

Installing the coolant manifold

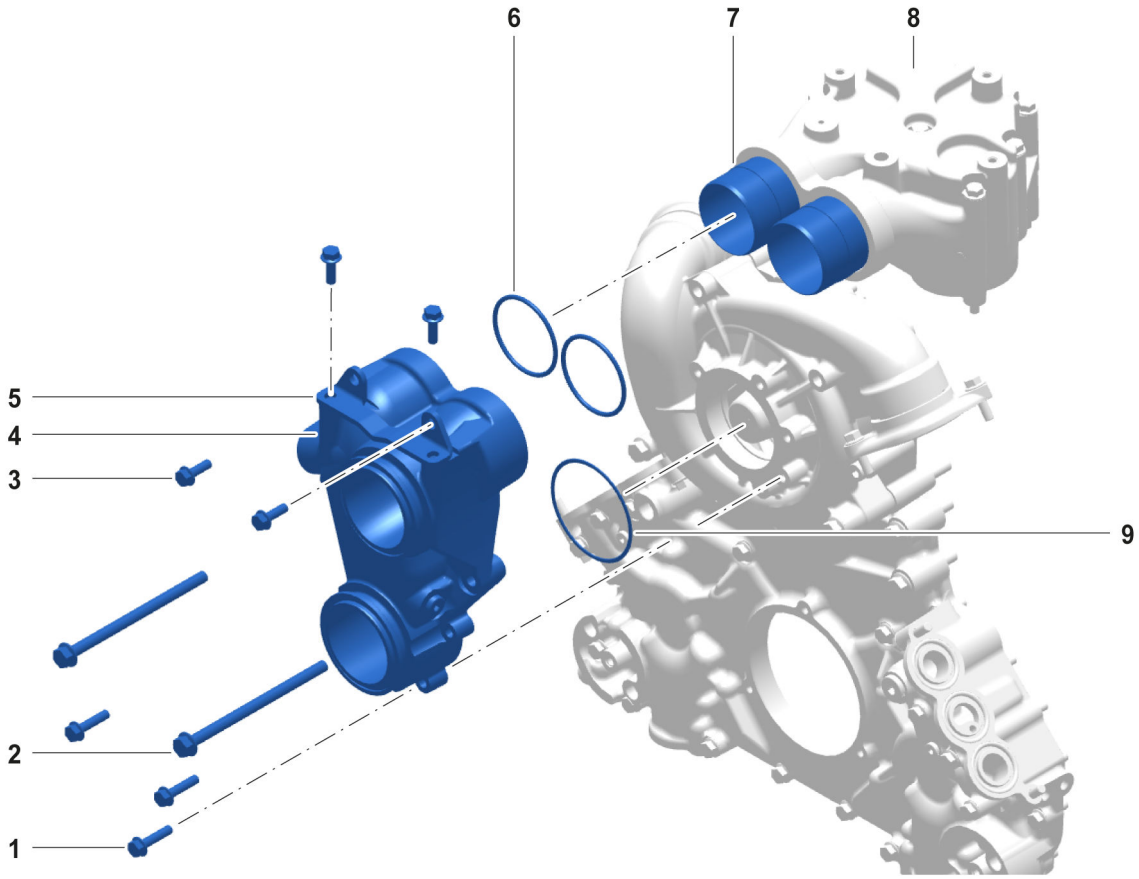

Fig. 523: Coolant manifold

1	Hex head screw (3x)	**6**	O-ring (2x)
2	Hex head screw (2x)	**7**	Plug-in tube (2x)
3	Hex head screw (4x)	**8**	Thermostat housing
4	Coolant manifold	**9**	O-ring
5	Bracket		

- ▶ Install plug-in tubes **7**. (For more information see: Installing the thermostat housing, page 435.)
- ▶ Lubricate new o-ring **9** with NBU 30 grease.
- ▶ Install o-ring **9**.
- ▶ Lubricate new o-rings **6** with NBU 30 grease.
- ▶ Install o-rings **6**.
- ▶ Install coolant manifold **4**.
- ▶ Tighten hex head screws **2**.

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▶ Tighten hex head screws **1**.

▶ Install bracket **5**.

▶ Tighten hex head screws **3**.

Removing and installing the coolant pump

Removing the oil line

Make sure that the following prerequisite is met:
❑ A collection container for engine oil is available.

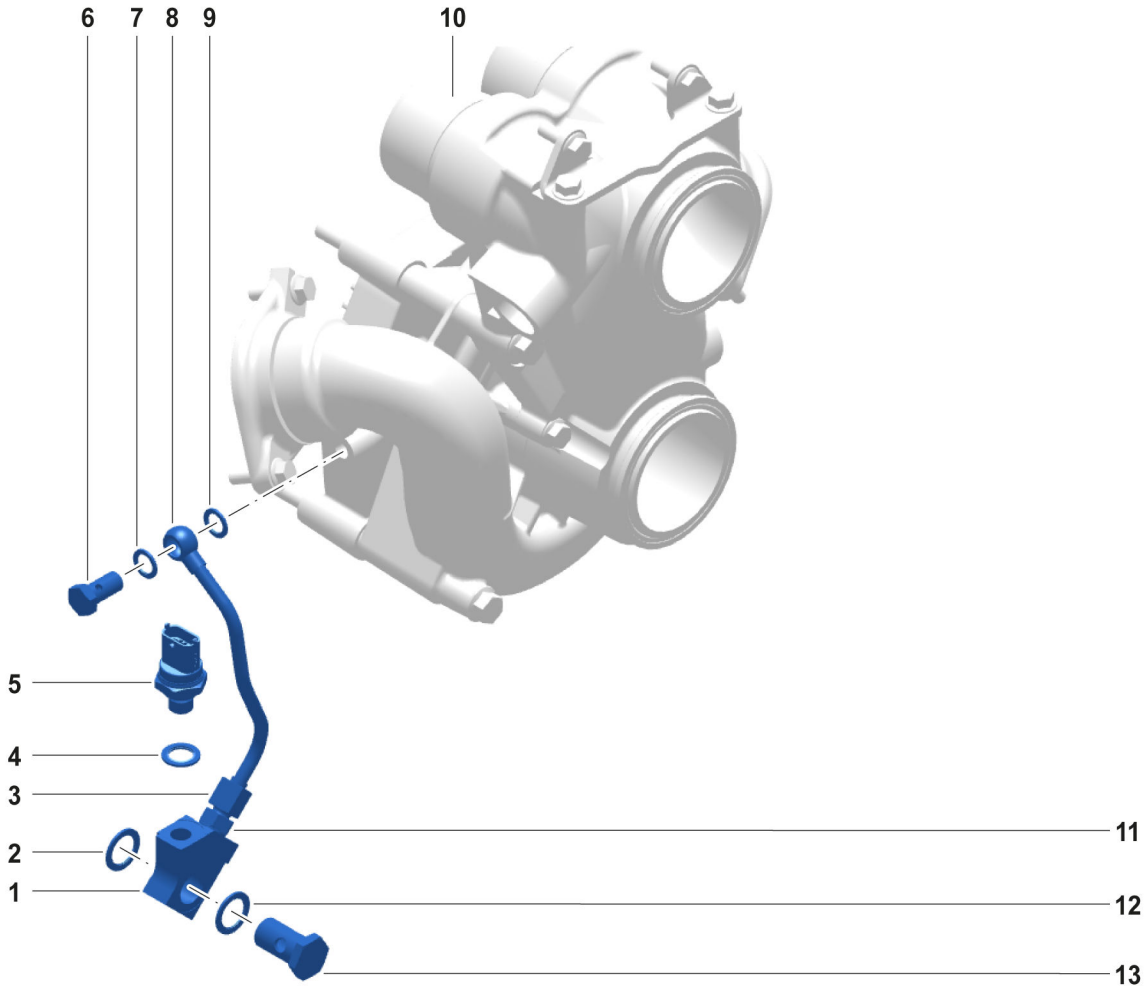

Fig. 524: Oil line

1 Connection piece
2 Sealing ring
3 Box nut
4 Sealing ring
5 Pressure sensor
6 Banjo bolt
7 Sealing ring
8 Oil line
9 Sealing ring
10 Coolant pump
11 Screw fitting
12 Sealing ring
13 Banjo bolt

▶ Unscrew banjo bolt **6**.

▶ Remove sealing ring **7**.

▶ Remove sealing ring **9**.

- ▶ Unscrew box nut **3**.
- ▶ Remove oil line **8**.
- ▶ Seal openings of oil line **8**.
- ▶ If necessary, unscrew screw fitting **11**.
- ▶ Seal openings of coolant pump **10** and connection piece **1**.
- ▶ If necessary, disconnect electrical plug connection on pressure sensor **5**.
- ▶ Unscrew pressure sensor **5**.
- ▶ Unscrew banjo bolt **13**.
- ▶ Remove sealing ring **12**.
- ▶ Remove connection piece **1**.
- ▶ Remove sealing ring **2**.
- ▶ Seal opening of ancillary support housing.

Removing the coolant pump

Make sure that the following prerequisites are met:
- ❑ Coolant has been drained, see operator's manual.
- ❑ Oil line is removed from coolant pump. (For more information see: Removing the oil line, page 428.)
- ❑ Coolant connection is removed. (For more information see: Removing the coolant connection, page 423.)
- ❑ If necessary, coolant manifold is removed. (For more information see: Removing the coolant manifold, page 425.)

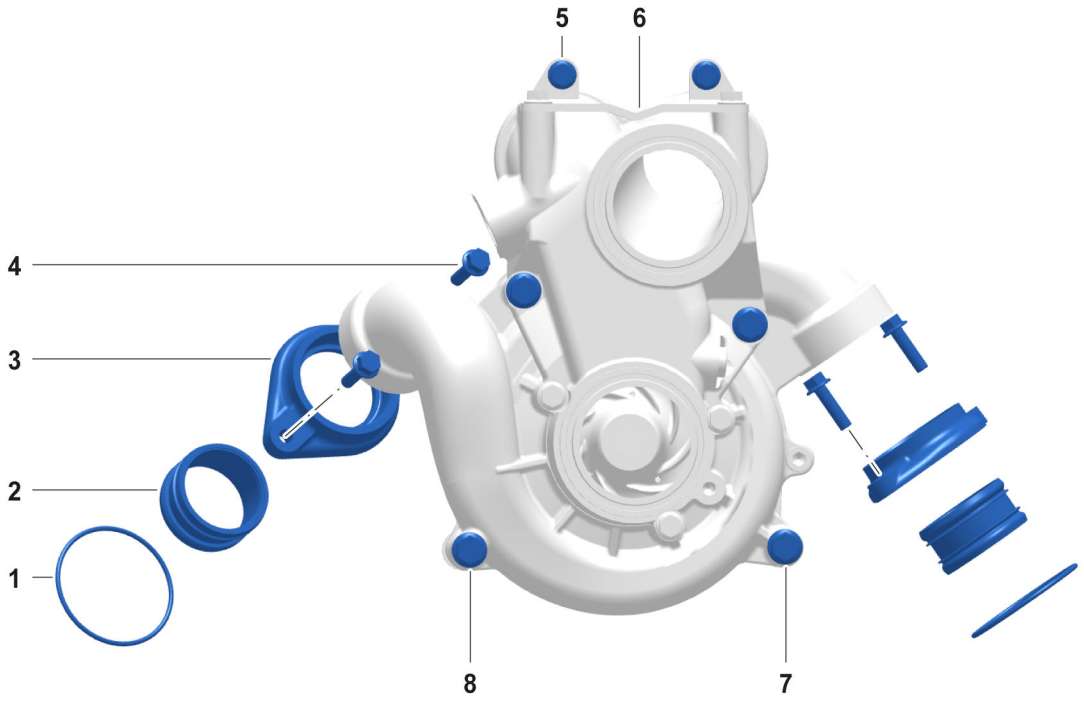

Fig. 525: Coolant pump

1 O-ring (2x)
2 Plug-in tube (2x)
3 Intermediate flange (2x)
4 Hex head screw (4x)
5 Hex head screw (2x)
6 Coolant pump
7 Hex head screw
8 Hex head screw (3x)

- ▶ Unscrew hex head screws **5**.
- ▶ Unscrew hex head screws **4**.
- ▶ Unscrew hex head screw **7**.
- ▶ Unscrew hex head screws **8**.
- ▶ Remove coolant pump **6**.
- ▶ Remove intermediate flanges **3**.
- ▶ Remove o-rings **1**.
- ▶ If necessary, remove plug-in tubes **2**.

Cleaning the coolant pump

- ▶ Clean sealing surfaces of coolant pump **6**.
- ▶ Clean sealing surfaces of oil modules.

Installing the coolant pump

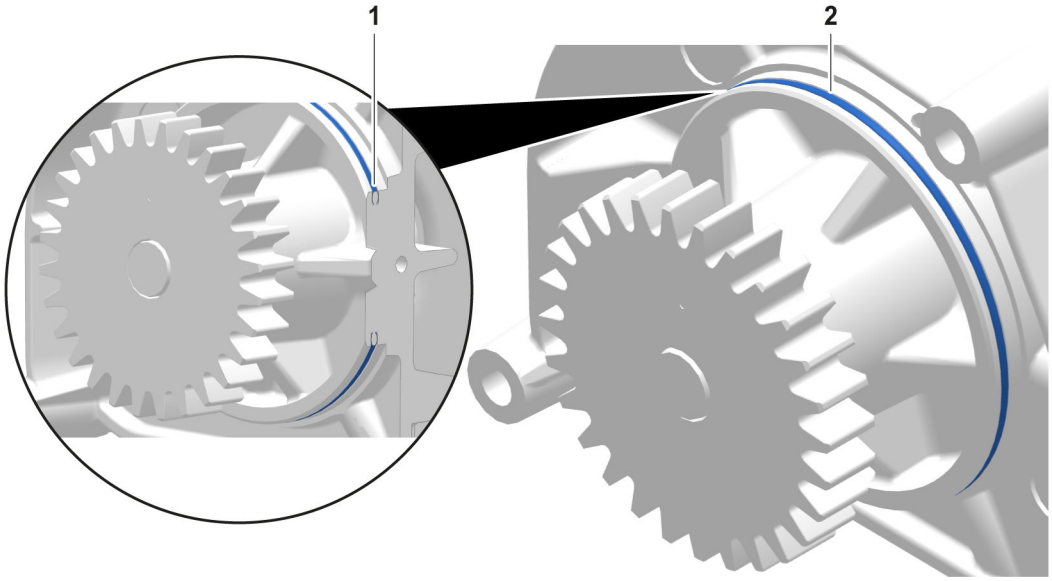

Fig. 526: Groove on coolant pump

1 Grease **2** Groove

- ▶ Lubricate groove **2** with NBU 30 grease **1**.

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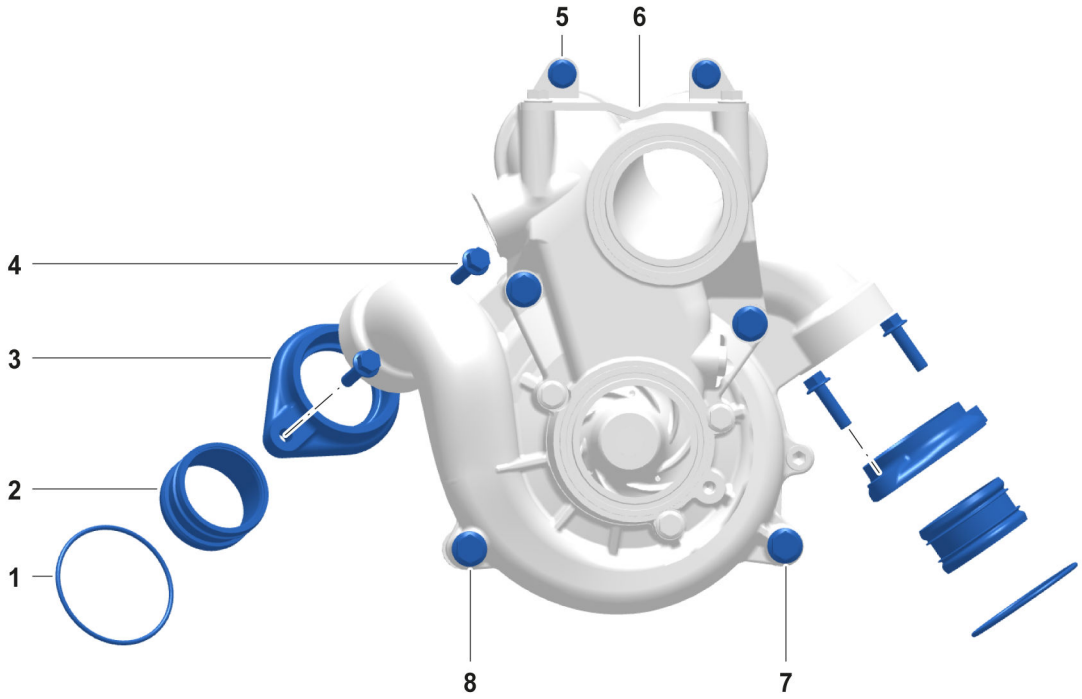

Fig. 527: Coolant pump

1 O-ring (2x)
2 Plug-in tube (2x)
3 Intermediate flange (2x)
4 Hex head screw (4x)
5 Hex head screw (2x)
6 Coolant pump
7 Hex head screw
8 Hex head screw (3x)

- ▶ Install plug-in tubes **2**.
- ▶ Lubricate new o-rings **1** with NBU 30 grease.
- ▶ Install o-rings **1**.
- ▶ Install intermediate flanges **3**.
- ▶ Install coolant pump **6**.
- ▶ Tighten hex head screws **8**.
- ▶ Tighten hex head screw **7**.
- ▶ Tighten hex head screws **4**.
- ▶ Tighten hex head screws **5**.

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Installing the oil line

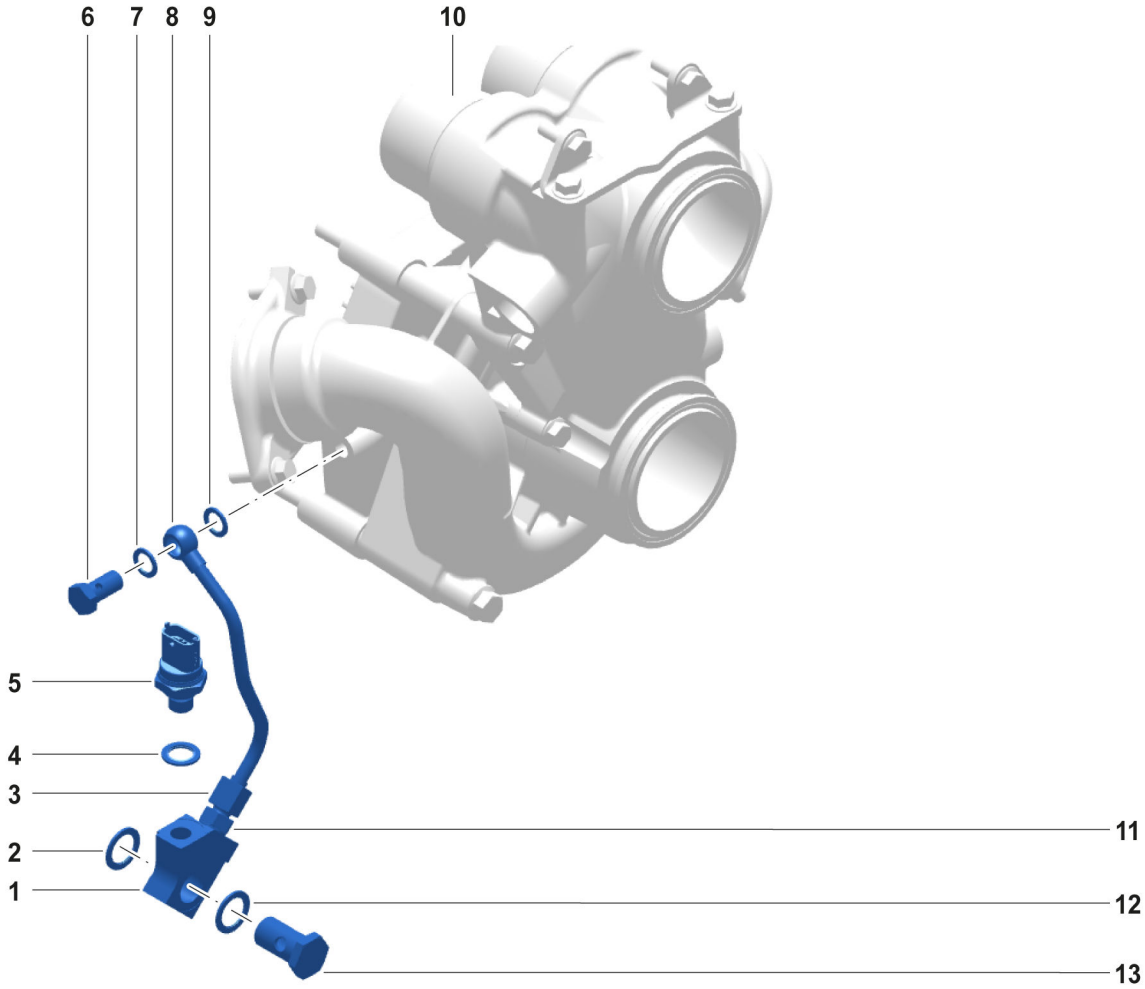

Fig. 528: Oil line

1	Connection piece	**8**	Oil line
2	Sealing ring	**9**	Sealing ring
3	Box nut	**10**	Coolant pump
4	Sealing ring	**11**	Screw fitting
5	Pressure sensor	**12**	Sealing ring
6	Banjo bolt	**13**	Banjo bolt
7	Sealing ring		

- ▶ Remove closure from ancillary support housing.
- ▶ Install new sealing ring **2**.
- ▶ Install connection piece **1**.
- ▶ Install new sealing ring **12**.
- ▶ Tighten banjo bolt **13**.
- ▶ Tighten pressure sensor **5** according to tightening instruction. (For more information see: Pressure sensor on coolant pump connection piece, page 473.)
- ▶ Connect electrical plug connection to pressure sensor **5**.
- ▶ Remove closures from coolant pump **10** and connection piece **1**.
- ▶ Tighten screw fitting **11**.

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- ▶ Remove closures from oil line **8**.
- ▶ Install oil line **8**.
- ▶ Tighten box nut **3**.
- ▶ Install new sealing ring **9**.
- ▶ Install new sealing ring **7**.
- ▶ Tighten banjo bolt **6**.

3.10.6 Thermostat

Removing and installing the thermostat housing

Removing the thermostat housing

Make sure that the following prerequisites are met:
- ❑ Coolant manifold is removed. (For more information see: Removing the coolant manifold, page 425.)
- ❑ Charge air pipe is removed. (For more information see: Removing the charge air pipe, page 291.)

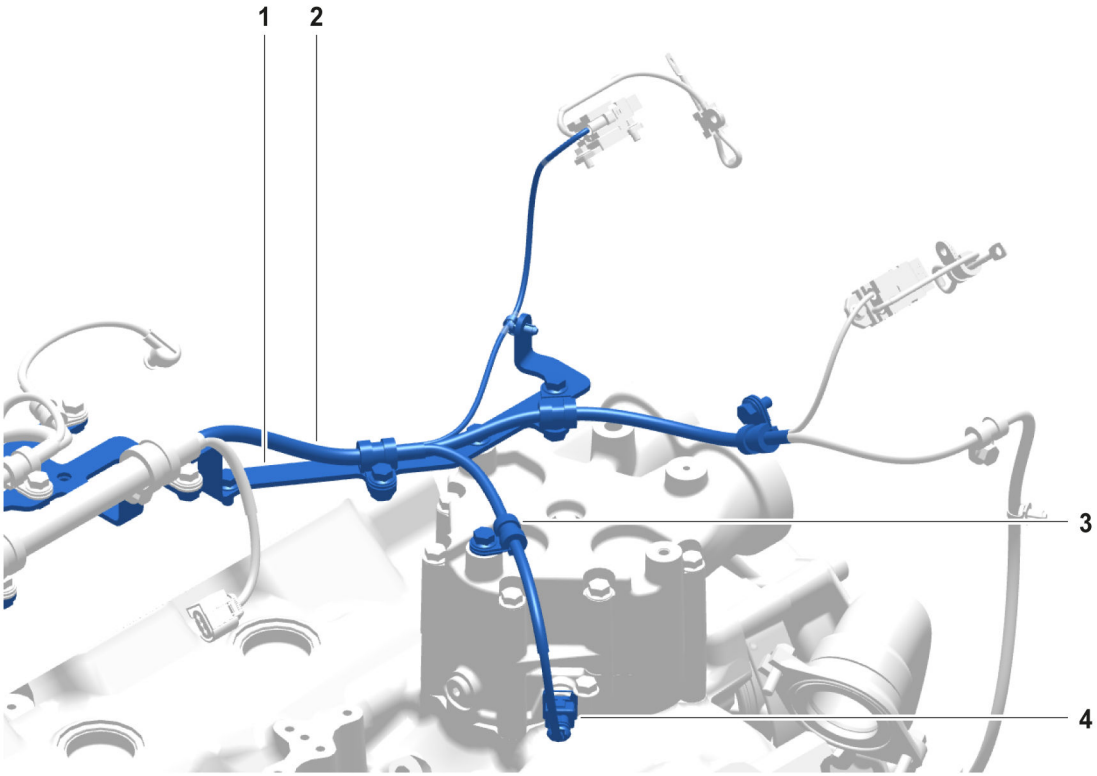

Fig. 529: Thermostat housing

1 Bracket
2 Cable harness
3 Holding clamp
4 Electrical plug connection

- ▶ Disconnect electrical plug connection **4**.
- ▶ Remove holding clamp **3**.
- ▶ Remove cable harness **2** as needed.
- ▶ Remove bracket **1**.

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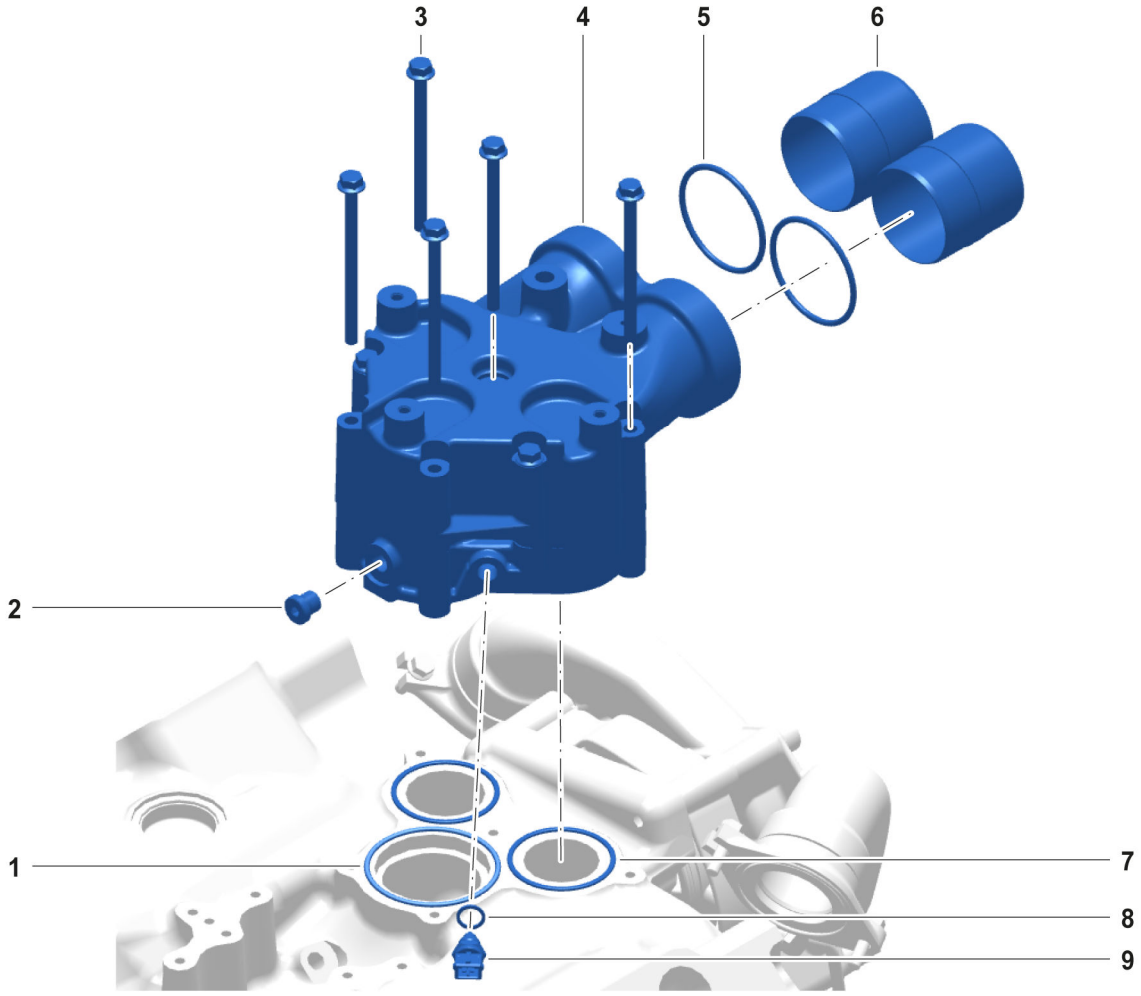

Fig. 530: Thermostat housing

1 O-ring
2 Screw plug
3 Hex head screw (5x)
4 Thermostat housing
5 O-ring (2x)
6 Plug-in tube (2x)
7 O-ring (2x)
8 Sealing ring
9 Temperature sensor

▶ Unscrew hex head screws **3**.

▶ Remove thermostat housing **4**.

▶ Remove o-ring **1**.

▶ Remove o-rings **7**.

▶ If necessary, unscrew screw plug **2**.

▶ If necessary, remove plug-in tubes **6**.

▶ Remove o-rings **5**.

▶ If necessary, unscrew temperature sensor **9**.

▶ Remove sealing ring **8**.

Checking and cleaning the thermostat housing

▶ Clean sealing surfaces of thermostat housing **4**.

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- ▶ Clean sealing surface of crankcase.
- ▶ Clean grooves of o-rings.

Installing the thermostat housing

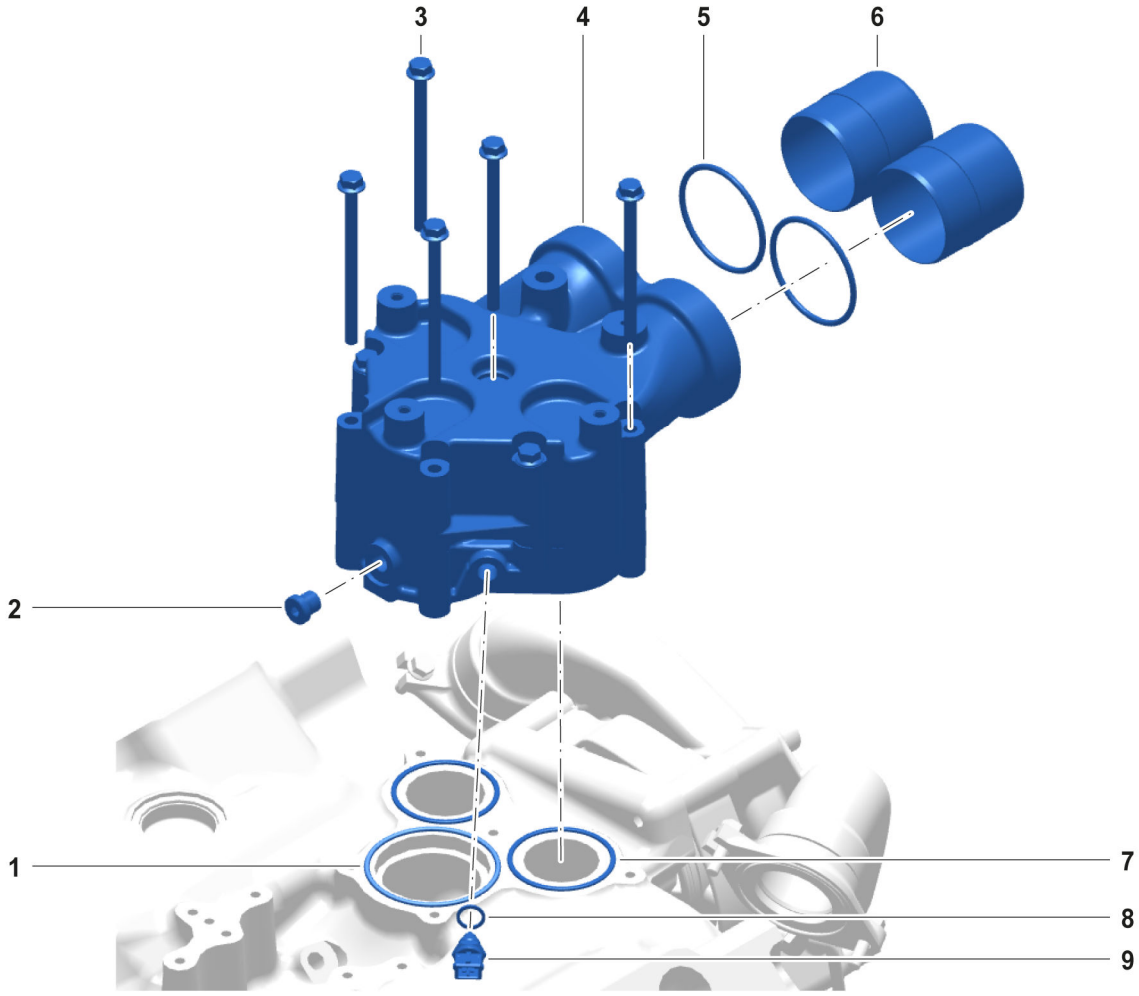

Fig. 531: Thermostat housing

1	O-ring	**6**	Plug-in tube (2x)
2	Screw plug	**7**	O-ring (2x)
3	Hex head screw (5x)	**8**	Sealing ring
4	Thermostat housing	**9**	Temperature sensor
5	O-ring (2x)		

- ▶ Install new sealing ring **8**.
- ▶ Tighten temperature sensor **9** according to tightening instruction. (see: tab. 111, page 473)
- ▶ Install new o-rings **5**.
- ▶ Install plug-in tubes **6**.
- ▶ Tighten screw plug **2**.
- ▶ Install new o-rings **7**.
- ▶ Install new o-ring **1**.
- ▶ Install thermostat housing **4**.
- ▶ Tighten hex head screws **3**.

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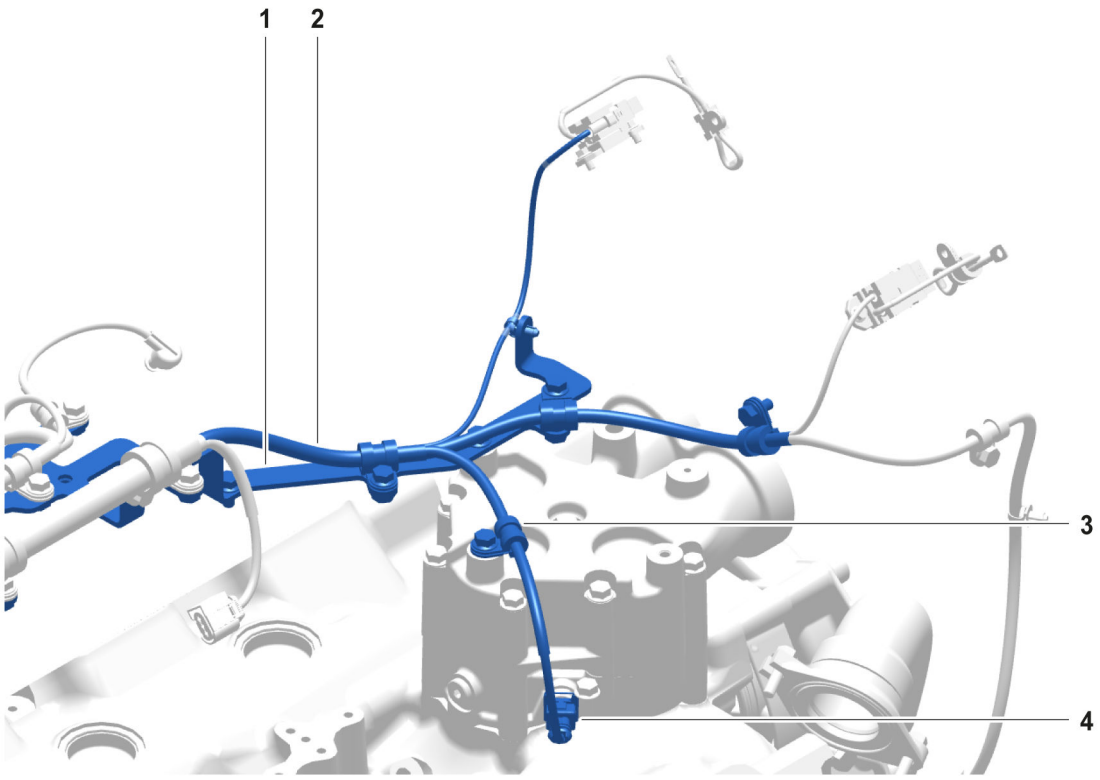

Fig. 532: Thermostat housing

1 Bracket
2 Cable harness
3 Holding clamp
4 Electrical plug connection

▶ Install bracket **1**.

▶ Install cable harness **2**.

▶ Install holding clamp **3**.

▶ Connect electrical plug connection **4**.

Removing and installing the thermostat

Removing the thermostat

Make sure that the following prerequisite is met:
❑ Thermostat housing is removed. (For more information see: Removing the thermostat housing, page 433.)

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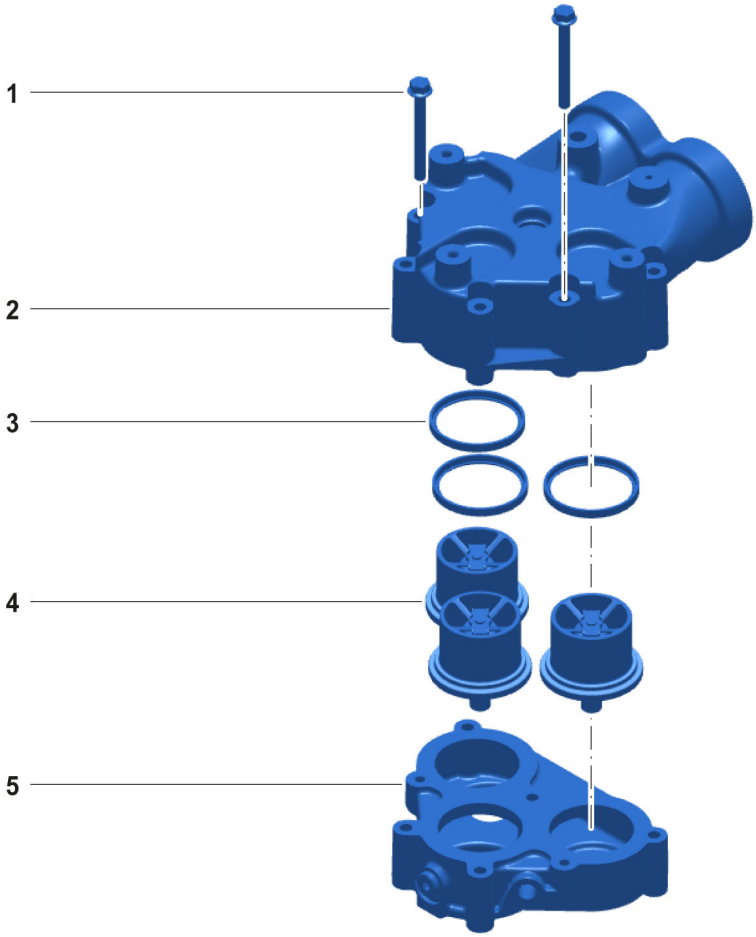

Fig. 533: Thermostats

1 Hex head screw (2x)
2 Thermostat housing upper part
3 Sealing ring (3x)
4 Thermostat (3x)
5 Thermostat housing lower part

- ▶ Unscrew hex head screws **1**.
- ▶ Remove thermostat housing upper part **2**.
- ▶ Remove sealing rings **3**.
- ▶ Remove thermostats **4**.

Checking and cleaning the thermostat

- ▶ If necessary, check thermostats. (For more information see: Checking the opening temperature of the thermostat in removed condition, page 439.)
- ▶ Clean sealing surface of thermostat housing upper part **2**.
- ▶ Clean sealing surface of thermostat housing lower part **5**.
- ▶ Clean grooves of sealing rings **3**.

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Installing the thermostat

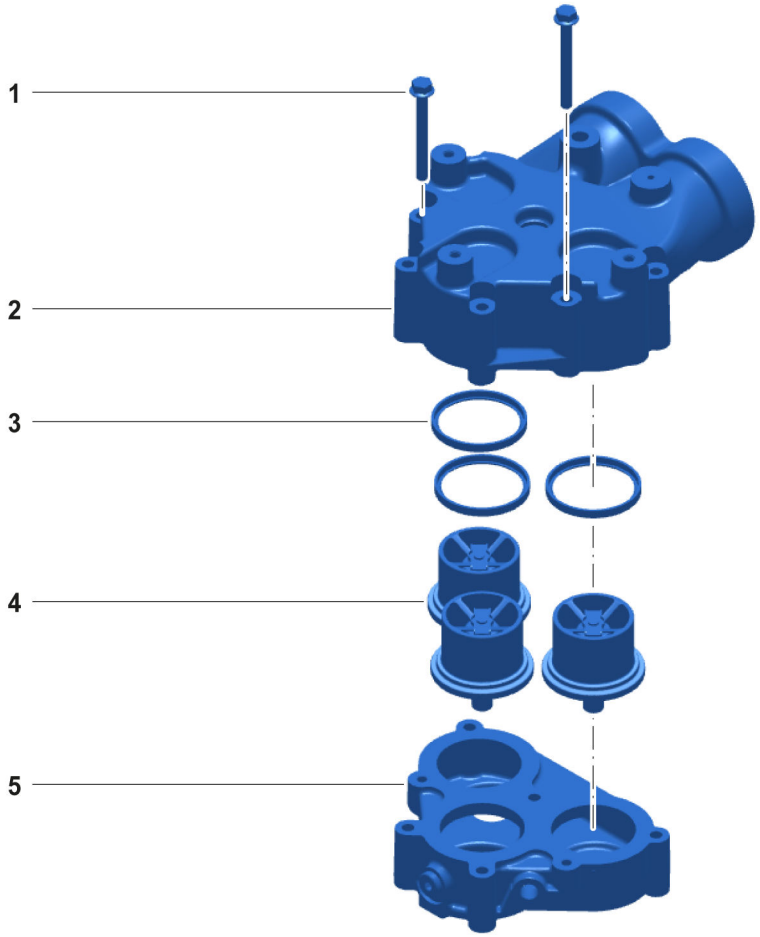

Fig. 534: Thermostats

1 Hex head screw (2x)
2 Thermostat housing upper part
3 Sealing ring (3x)
4 Thermostat (3x)
5 Thermostat housing lower part

▶ Install thermostats **4**.

▶ Install new sealing rings **3**.

▶ Install thermostat housing upper part **2**.

▶ Tighten hex head screws **1**.

Checking the thermostat

Checking the thermostat in installed condition

Make sure that the following prerequisite is met:
❑ Coolant level is correct, see documentation from the device manufacturer.

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WARNING
Hot water and hot parts!
Can lead to scalding and burns.

- ▶ Wear personal protective equipment.
- ▶ Avoid skin contact with hot water and hot components.

- ▶ Start engine.
- ▶ Bring engine to operating temperature.
- ▶ Turn off engine.
- ▶ Check temperature in secondary cooling circuit, see documentation from the device manufacturer.

If operating temperature is not reached in secondary cooling circuit:
- ▶ Check thermostat in removed condition. (For more information see: Checking the opening temperature of the thermostat in removed condition, page 439.)

If operating temperature is reached in secondary cooling circuit:
- ▶ End check.

Checking the opening temperature of the thermostat in removed condition

Make sure that the following prerequisite is met:
- ❑ Thermostat is removed. (For more information see: Removing the thermostat, page 436.)

WARNING
Hot water and hot parts!
Can lead to scalding and burns.

- ▶ Wear personal protective equipment.
- ▶ Avoid skin contact with hot water and hot components.

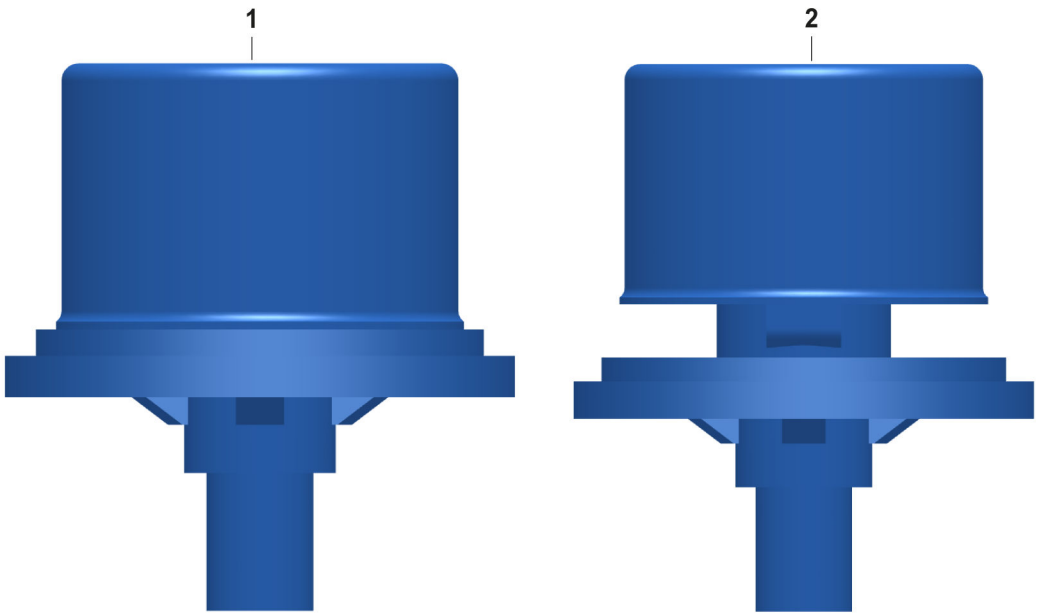

Fig. 535: Thermostat

1 Closed thermostat
2 Open thermostat

▶ Heat closed thermostat **1** in water bath.

▶ Measure water temperature on thermostat.

▶ Determine temperature at start of opening. (For more information see: 1.2.4 Thermostat, page 29.)

If the thermostat does not open within the tolerance:
▶ Replace thermostat.

If the thermostat opens within the tolerance:
▶ Check full opening of thermostat in removed condition. (For more information see: Checking the full opening of the thermostat in removed condition, page 440.)

Checking the full opening of the thermostat in removed condition

Make sure that the following prerequisite is met:
❑ Thermostat is removed. (For more information see: Removing the thermostat, page 436.)

WARNING
Hot water and hot parts!
Can lead to scalding and burns.

▶ Wear personal protective equipment.

▶ Avoid skin contact with hot water and hot components.

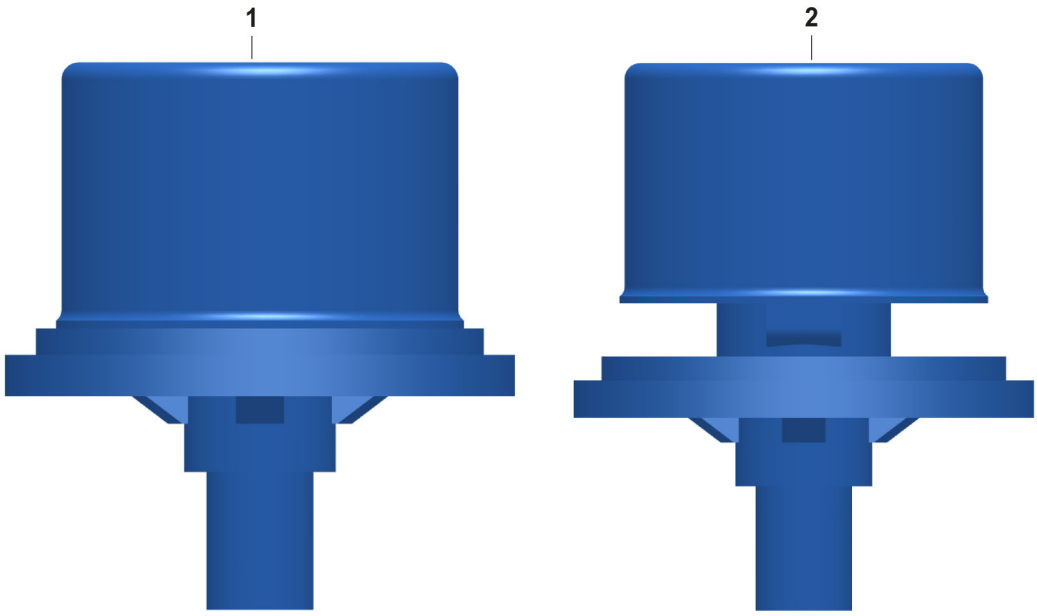

Fig. 536: Thermostat

1 Closed thermostat **2** Open thermostat

▶ Heat thermostat in water bath to temperature at full opening. (For more information see: 1.2.4 Thermostat, page 29.)

If the thermostat is not completely open (For more information see: 1.2.4 Thermostat, page 29.) :
▶ Replace thermostat.

If the thermostat is completely open **2**:
▶ End the check.

▶ Install thermostat. (For more information see: Installing the thermostat, page 438.)

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3.11 Auxiliary output

3.11.1 Removing and installing the cover

Removing the cover

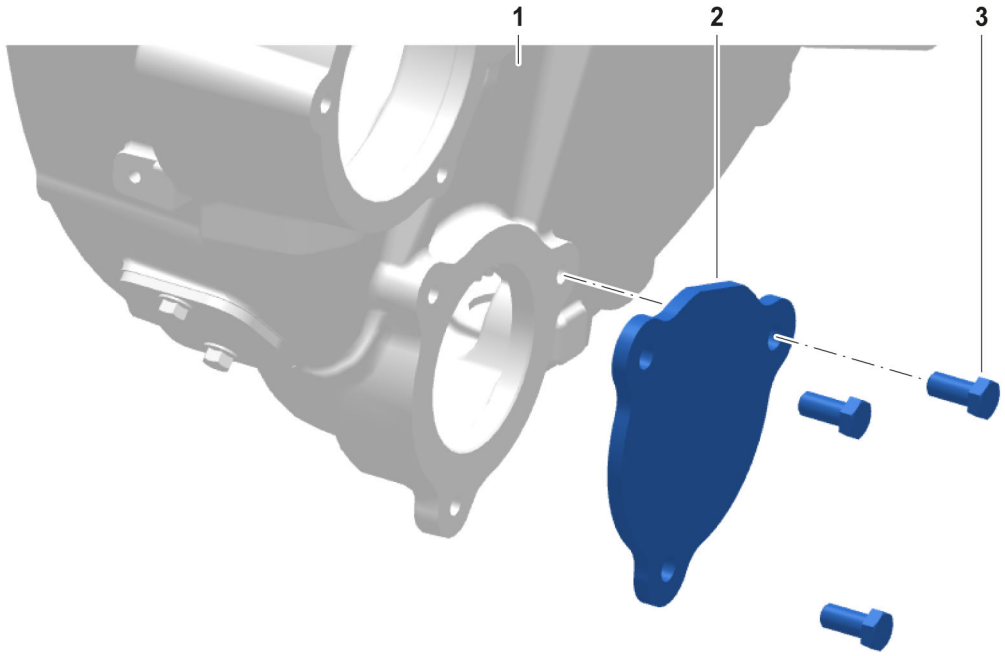

Fig. 537: Cover

1 Flywheel housing
2 Cover
3 Hex head screw (3x)

▶ Unscrew hex head screws **3**.

▶ Remove cover **2**.

Cleaning the cover

▶ Clean sealing surface of cover **2**.

▶ Clean sealing surface of flywheel housing **1**.

Installing the cover

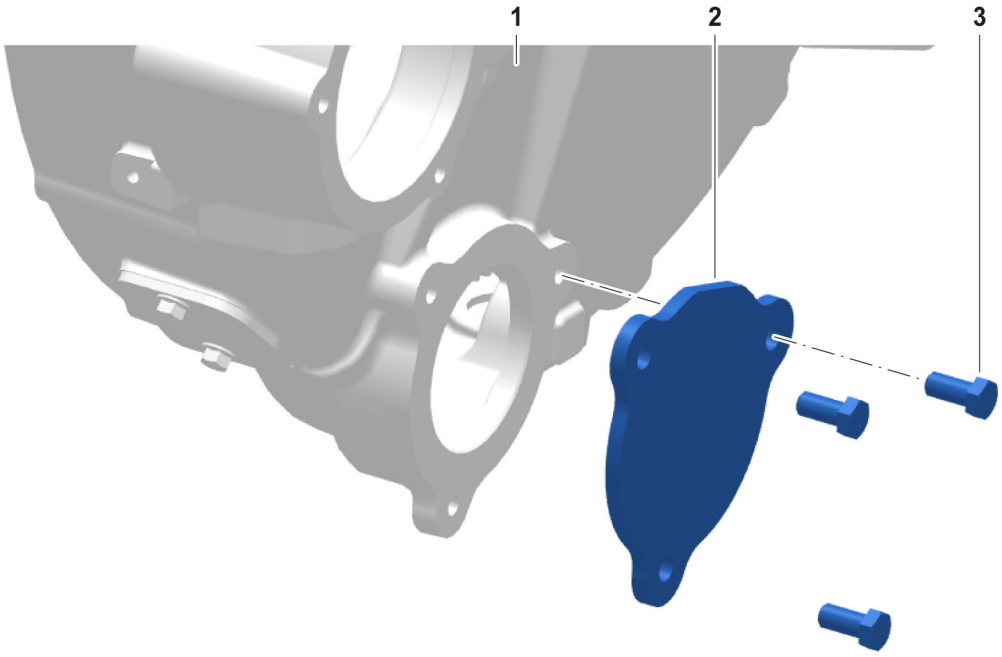

Fig. 538: Cover

1 Flywheel housing
2 Cover
3 Hex head screw (3x)

▶ Install cover **2**.

▶ Tighten hex head screws **3**.

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3.11.2 Air compressor (optional)

Removing and installing the coolant lines

Removing the coolant pump coolant line to the air compressor

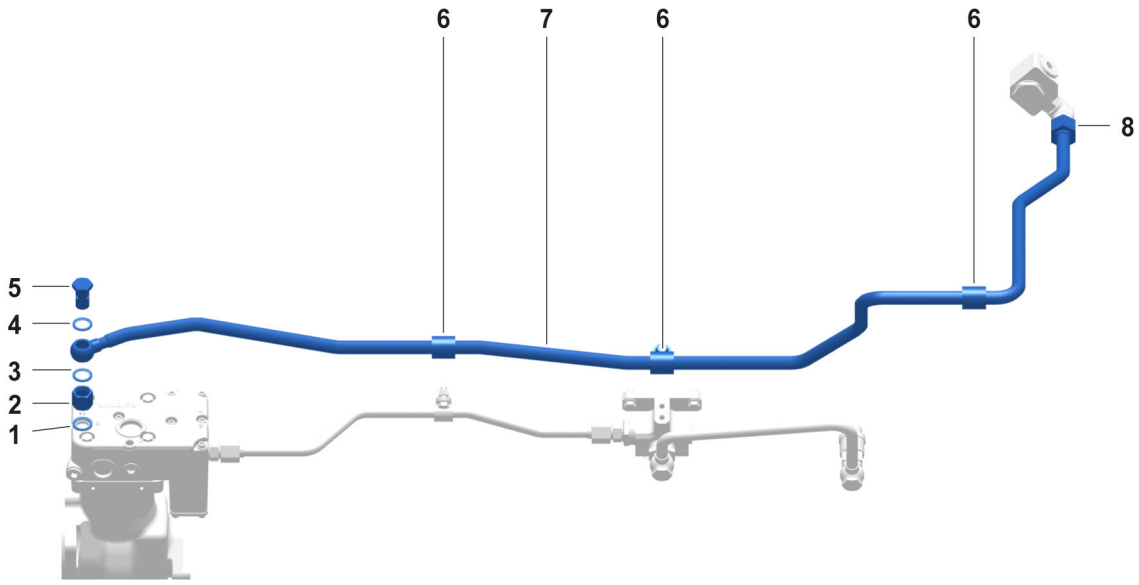

Fig. 539: Coolant line

1 Sealing ring
2 Nozzle
3 Sealing ring
4 Sealing ring
5 Banjo bolt
6 Holding clamp (3x)
7 Coolant line
8 Box nut

- ▶ Remove holding clamps **6**.
- ▶ Unscrew banjo bolt **5**.
- ▶ Remove sealing ring **4**.
- ▶ Remove sealing ring **3**.
- ▶ Remove nozzle **2**.
- ▶ Remove sealing ring **1**.
- ▶ Unscrew box nut **8**.
- ▶ Remove coolant line **7**.
- ▶ Seal openings on coolant line **7**.

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Removing the air compressor coolant line to the connection piece

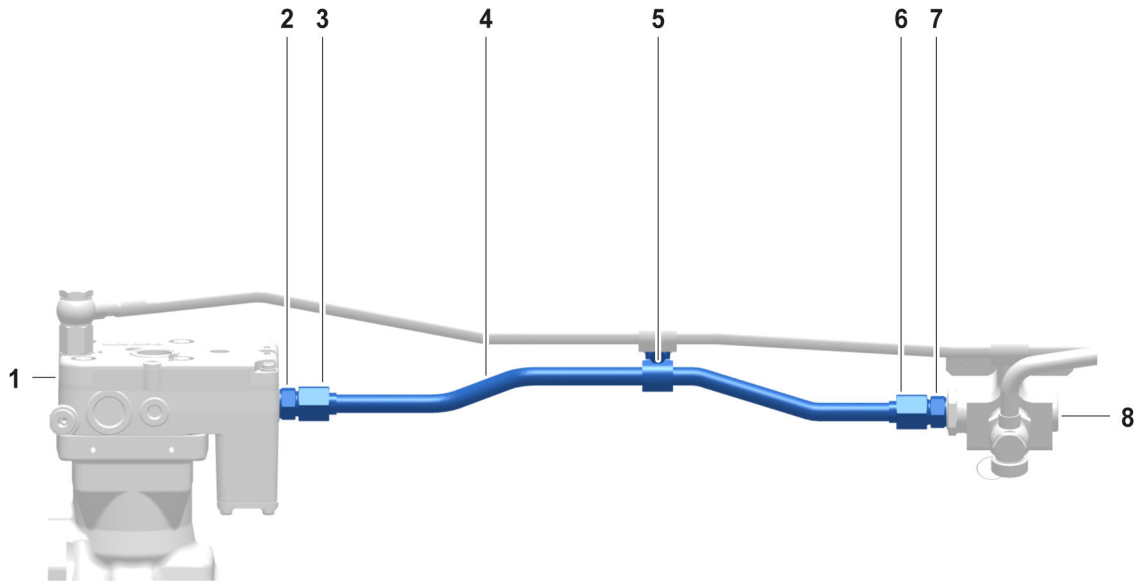

Fig. 540: Coolant line

1 Air compressor
2 Screw fitting
3 Box nut
4 Coolant line
5 Holding clamp
6 Box nut
7 Screw fitting
8 Connection piece

- ▶ Remove holding clamp **5**.
- ▶ Unscrew box nut **3**.
- ▶ Unscrew box nut **6**.
- ▶ Remove coolant line **4**.
- ▶ Seal openings of coolant line **4**.
- ▶ If necessary, unscrew screw fitting **2**.
- ▶ Seal opening of air compressor **1**.
- ▶ If necessary, unscrew screw fitting **7**.
- ▶ Seal opening of connection piece **8**.

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Removing the connection piece coolant line to the crankcase

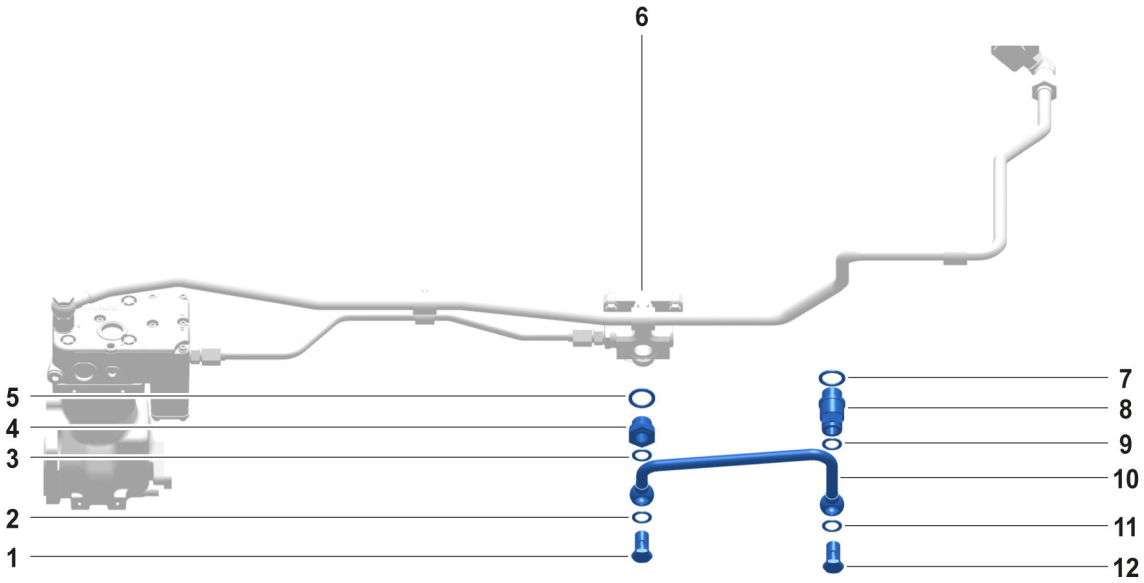

Fig. 541: Coolant line

1 Banjo bolt
2 Sealing ring
3 Sealing ring
4 Nozzle
5 Sealing ring
6 Connection piece
7 Sealing ring
8 Nozzle
9 Sealing ring
10 Coolant line
11 Sealing ring
12 Banjo bolt

- ▶ Unscrew banjo bolt **1**.
- ▶ Remove sealing ring **2**.
- ▶ Unscrew banjo bolt **12**.
- ▶ Remove sealing ring **11**.
- ▶ Remove coolant line **10**.
- ▶ Seal openings of coolant line **10**.
- ▶ Remove sealing ring **3**.
- ▶ Unscrew nozzle **4**.
- ▶ Remove sealing ring **5**.
- ▶ Seal opening of connection piece **6**.
- ▶ Remove sealing ring **9**.
- ▶ Unscrew nozzle **8**.
- ▶ Remove sealing ring **7**.
- ▶ Seal opening of crankcase.

Removing the connection piece

Make sure that the following prerequisites are met:
- ❑ Air compressor coolant line to connection piece is removed. (For more information see: Removing the air compressor coolant line to the connection piece, page 444.)
- ❑ Connection piece coolant line to crankcase is removed. (For more information see: Removing the connection piece coolant line to the crankcase, page 445.)

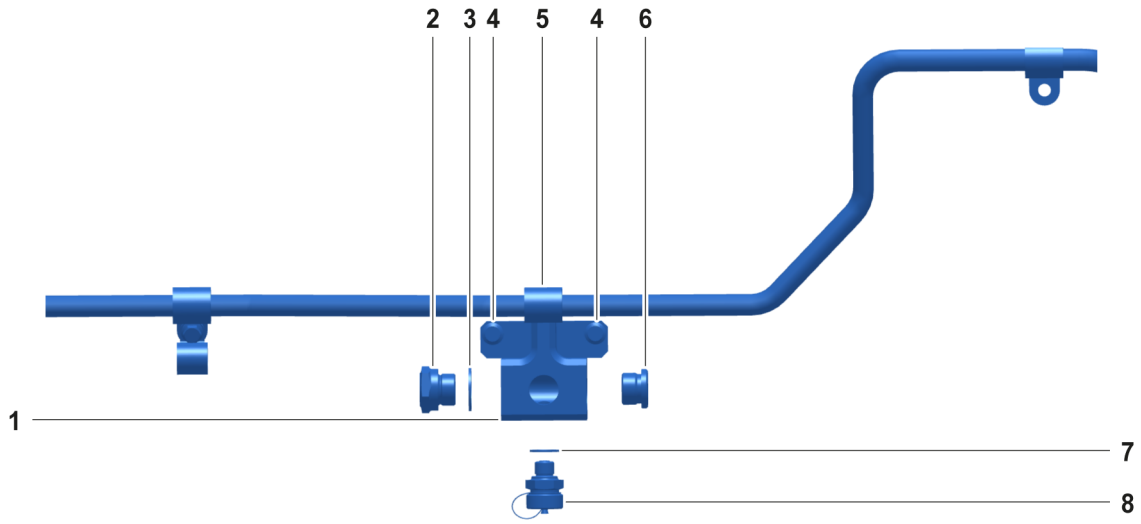

Fig. 542: Connection piece

1 Connection piece
2 Nozzle
3 Sealing ring
4 Hex head screw (2x)
5 Holding clamp
6 Screw plug
7 Sealing ring
8 Valve

- ▶ Remove holding clamp **5**.
- ▶ Unscrew hex head screws **4**.
- ▶ Remove connection piece **1**.
- ▶ If necessary, unscrew nozzle **2**.
- ▶ Remove sealing ring **3**.
- ▶ If necessary, unscrew screw plug **6**.
- ▶ If necessary, unscrew valve **8**.
- ▶ Remove sealing ring **7**.

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Installing the connection piece

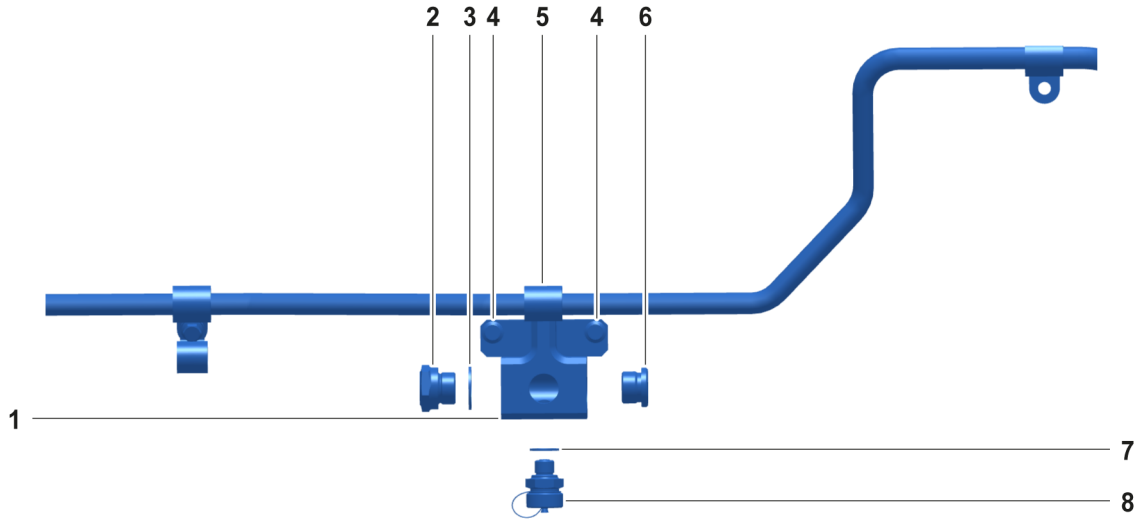

Fig. 543: Connection piece

1 Connection piece
2 Nozzle
3 Sealing ring
4 Hex head screw (2x)
5 Holding clamp
6 Screw plug
7 Sealing ring
8 Valve

- ▶ Install new sealing ring **7**.
- ▶ Tighten valve **8**.
- ▶ Tighten screw plug **6**.
- ▶ Install new sealing ring **3**.
- ▶ Tighten nozzle **2**.
- ▶ Install connection piece **1**.
- ▶ Tighten hex head screws **4**.
- ▶ Install holding clamp **5**.

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Installing the connection piece coolant line to the crankcase

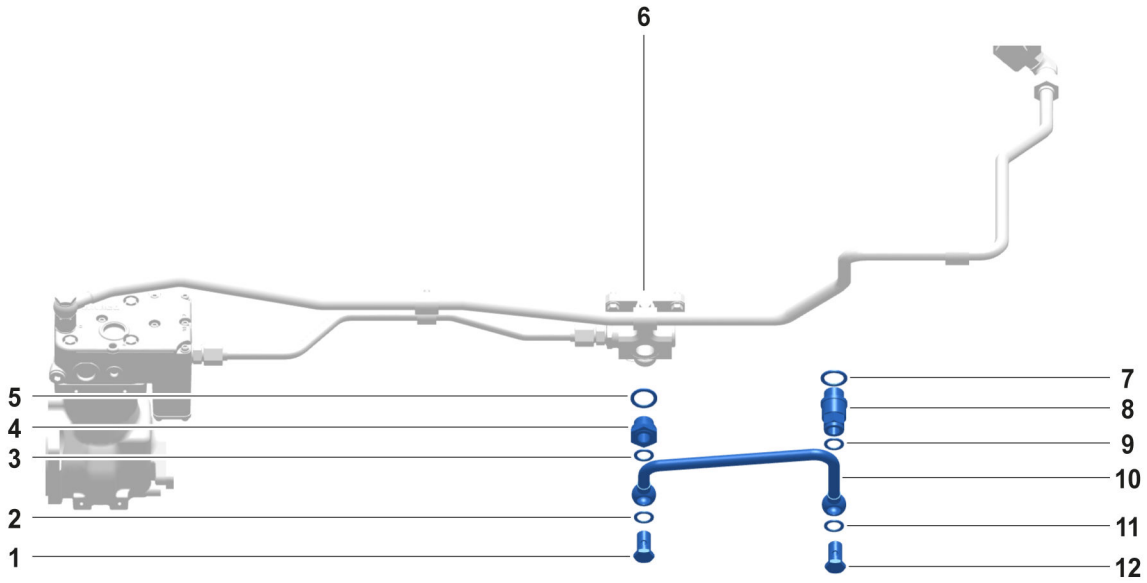

Fig. 544: Coolant line

1	Banjo bolt	**7**	Sealing ring
2	Sealing ring	**8**	Nozzle
3	Sealing ring	**9**	Sealing ring
4	Nozzle	**10**	Coolant line
5	Sealing ring	**11**	Sealing ring
6	Connection piece	**12**	Banjo bolt

- ▶ Remove closure from crankcase.
- ▶ Install new sealing ring **7**.
- ▶ Tighten nozzle **8**.
- ▶ Install new sealing ring **9**.
- ▶ Remove closure from connection piece **6**.
- ▶ Install new sealing ring **5**.
- ▶ Tighten nozzle **4**.
- ▶ Install new sealing ring **3**.
- ▶ Remove closures from coolant line **10**.
- ▶ Install coolant line **10**.
- ▶ Install new sealing ring **11**.
- ▶ Tighten banjo bolt **12**.
- ▶ Install new sealing ring **2**.
- ▶ Tighten banjo bolt **1**.

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Installing the air compressor coolant line to the connection piece

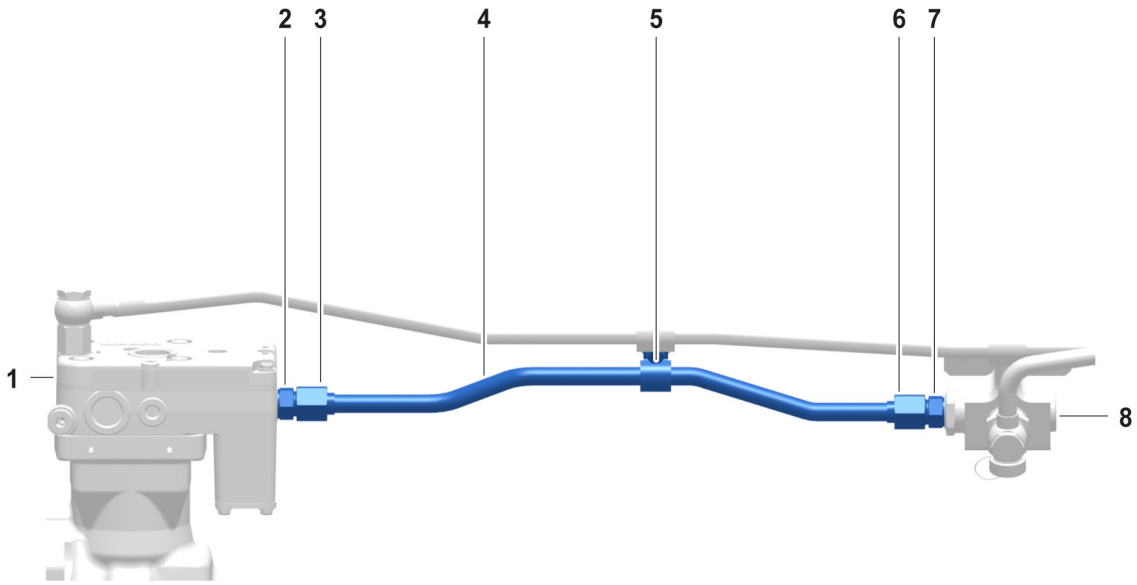

Fig. 545: Coolant line

1 Air compressor
2 Screw fitting
3 Box nut
4 Coolant line
5 Holding clamp
6 Box nut
7 Screw fitting
8 Connection piece

- ▶ Remove closures from connection piece **8**.
- ▶ Tighten screw fitting **7**.
- ▶ Remove closures from air compressor **1**.
- ▶ Tighten screw fitting **2**.
- ▶ Remove closures from coolant line **4**.
- ▶ Install coolant line **4**.
- ▶ Tighten box nut **6**.
- ▶ Tighten box nut **3**.
- ▶ Install holding clamp **5**.

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Installing the coolant pump coolant line to the air compressor

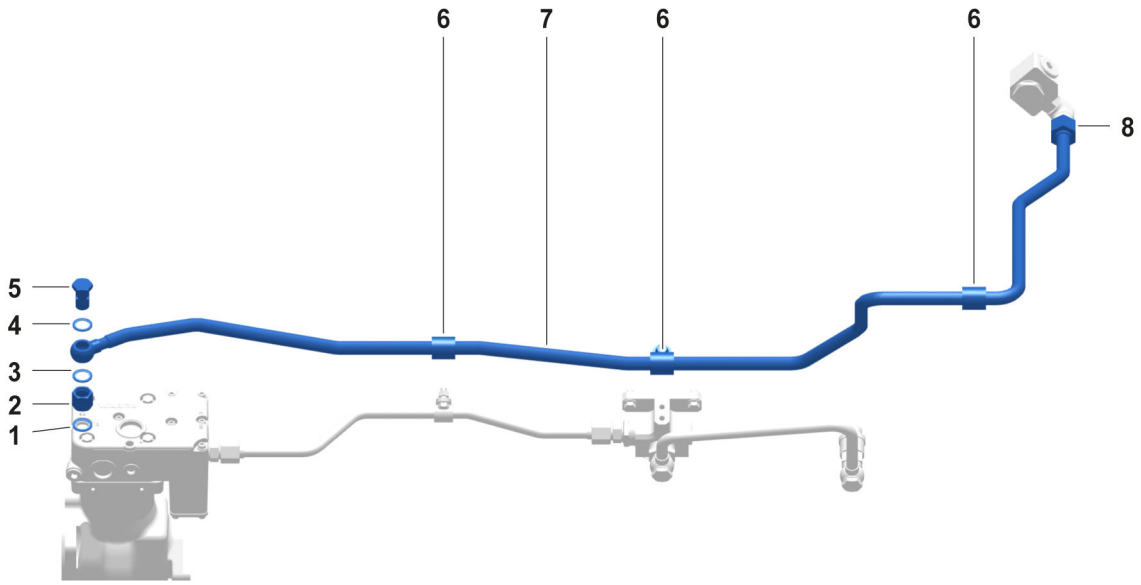

Fig. 546: Coolant line

1 Sealing ring
2 Nozzle
3 Sealing ring
4 Sealing ring
5 Banjo bolt
6 Holding clamp (3x)
7 Coolant line
8 Box nut

- ▶ Remove closures from coolant line **7**.
- ▶ Install coolant line **7**.
- ▶ Tighten box nut **8**.
- ▶ Install new sealing ring **1**.
- ▶ Install nozzle **2**.
- ▶ Install new sealing ring **3**.
- ▶ Install new sealing ring **4**.
- ▶ Tighten banjo bolt **5**.
- ▶ Install holding clamps **6**.

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Removing and installing the air compressor

Removing the pipeline

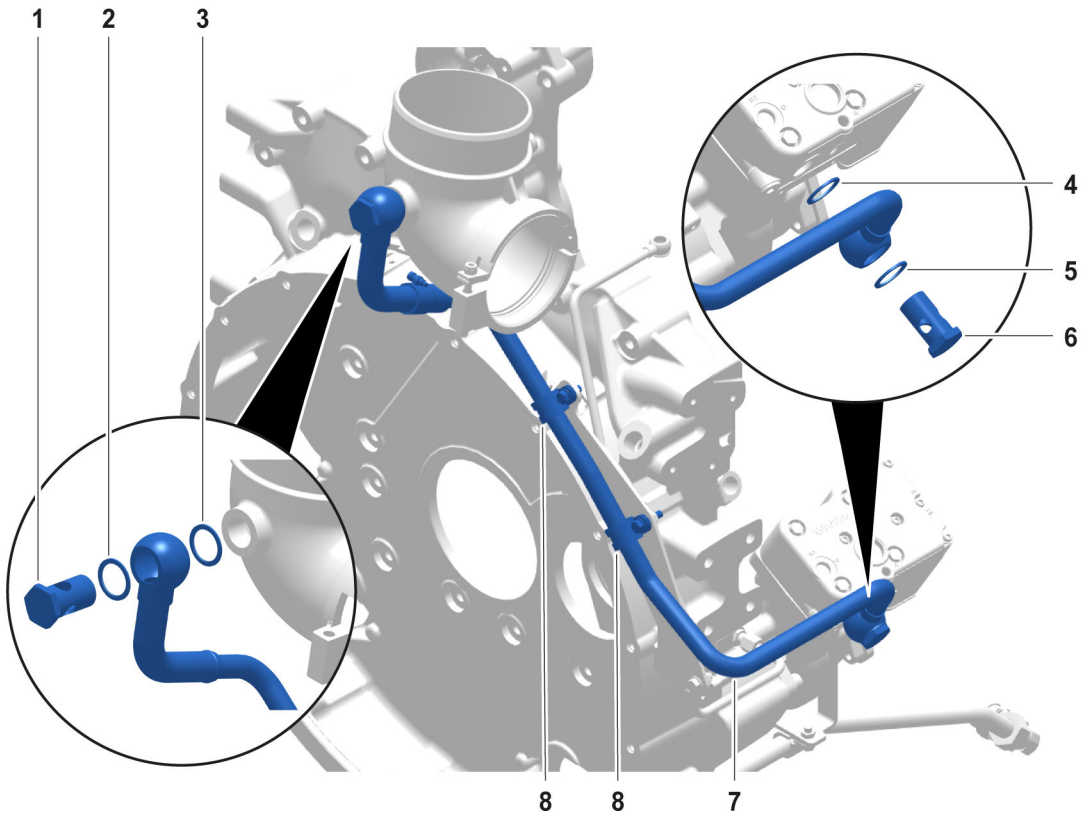

Fig. 547: Pipeline

1 Banjo bolt
2 Sealing ring
3 Sealing ring
4 Sealing ring
5 Sealing ring
6 Banjo bolt
7 Pipeline
8 Holding clamp (2x)

- ▶ Unscrew banjo bolt **1**.
- ▶ Remove sealing ring **2**.
- ▶ Unscrew banjo bolt **6**.
- ▶ Remove sealing ring **5**.
- ▶ Remove holding clamps **8**.
- ▶ Remove pipeline **7**.
- ▶ Seal openings on pipeline **7**.
- ▶ Remove sealing ring **3**.
- ▶ Remove sealing ring **4**.

Removing the oil supply line

Make sure that the following prerequisite is met:
- ❑ Right oil supply line is removed. (For more information see: Removing the right oil supply line, page 320.)

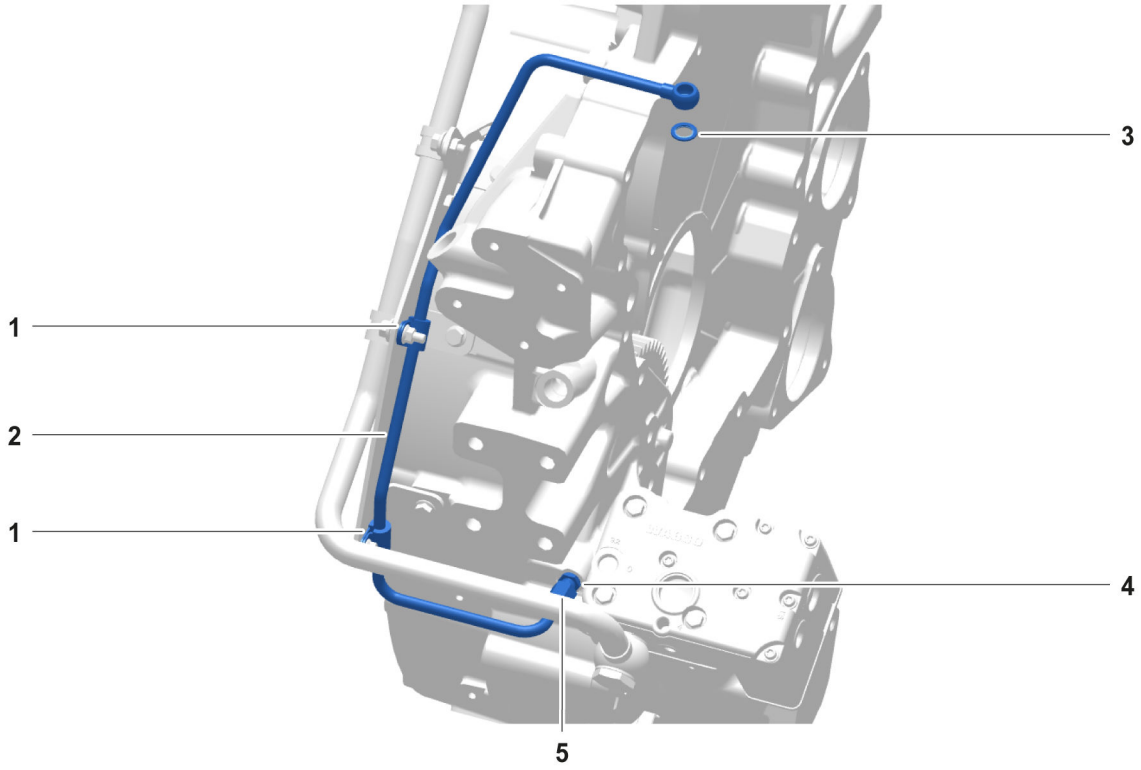

Fig. 548: Oil supply line

1 Holding clamp (2x)
2 Oil supply line
3 Sealing ring
4 Screw fitting
5 Box nut

▶ Remove holding clamps **1**.

▶ Unscrew box nut **5**.

▶ Remove oil supply line **2**.

▶ Seal openings on oil supply line **2**.

▶ Remove sealing ring **3**.

▶ If necessary, unscrew screw fitting **4**.

▶ Seal opening on flywheel housing.

Removing the oil return line

Make sure that the following prerequisite is met:
❑ Engine oil has been drained, see operator's manual.

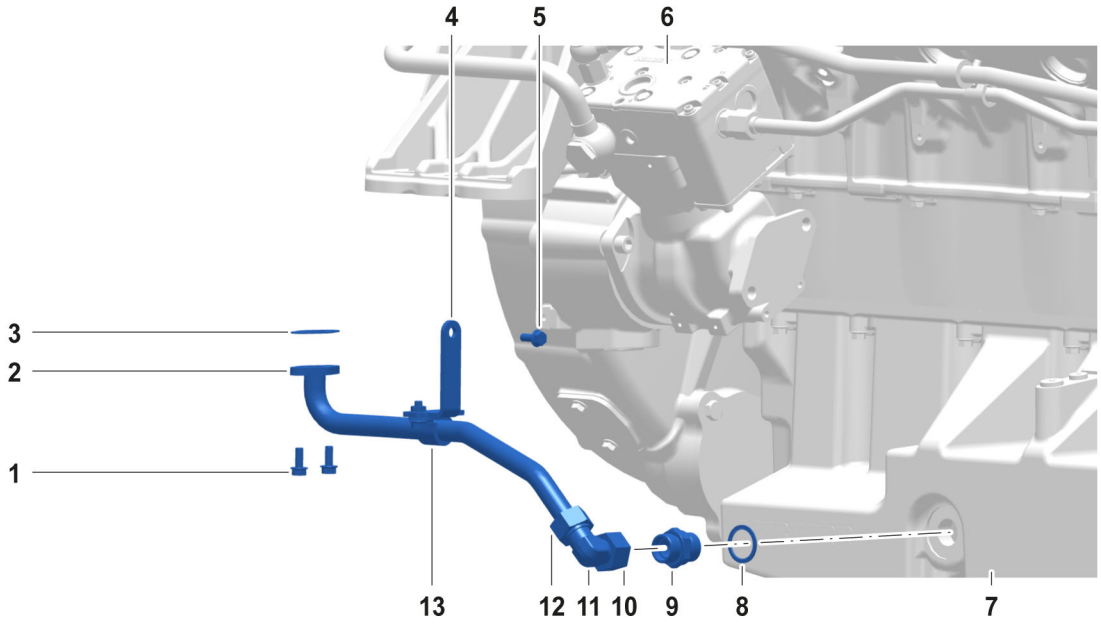

Fig. 549: Oil return line

1 Hex head screw (2x)
2 Oil return line
3 Seal
4 Bracket
5 Hex head screw
6 Air compressor
7 Oil pan
8 Sealing ring
9 Nozzle
10 Box nut
11 Screw fitting
12 Box nut
13 Holding clamp

- ▶ Remove holding clamp **13**.
- ▶ If necessary, unscrew hex head screw **5**.
- ▶ Remove bracket **4**.
- ▶ Unscrew hex head screws **1**.
- ▶ Remove seal **3**.
- ▶ Unscrew box nut **10**.
- ▶ Remove oil return line **2**.
- ▶ Seal openings on oil return line **2**.
- ▶ If necessary, unscrew nozzle **9**.
- ▶ Remove sealing ring **8**.
- ▶ Seal opening on oil pan **7**.
- ▶ If necessary, unscrew box nut **12**.
- ▶ Remove screw fitting **11**.

Removing the air compressor

Make sure that the following prerequisites are met:
- ❑ Coolant pump coolant line to air compressor is removed from air compressor. (For more information see: Removing the coolant pump coolant line to the air compressor , page 443.)
- ❑ Air compressor coolant line to connection piece is removed from air compressor. (For more information see: Removing the air compressor coolant line to the connection piece, page 444.)

- ❑ Pipeline is removed from air compressor. (For more information see: Removing the pipeline, page 451.)
- ❑ Oil return line is removed from air compressor. (For more information see: Removing the oil return line, page 452.)

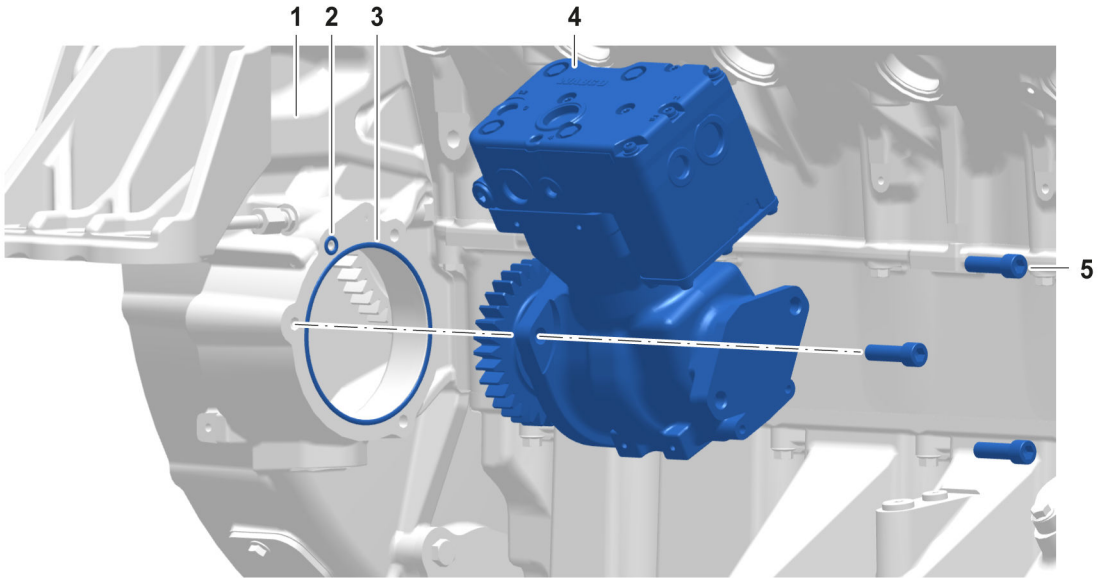

Fig. 550: Air compressor

1 Flywheel housing
2 O-ring
3 O-ring
4 Air compressor
5 Socket head screw (3x)

▶ Unscrew socket head screws **5**.

▶ Remove air compressor **4**.

▶ Remove o-ring **2**.

▶ Remove o-ring **3**.

Removing the bracket

Make sure that the following prerequisites are met:
- ❑ Pipeline is removed from bracket. (For more information see: Removing the pipeline, page 451.)
- ❑ Oil supply line is removed from air compressor. (For more information see: Removing the oil supply line, page 451.)

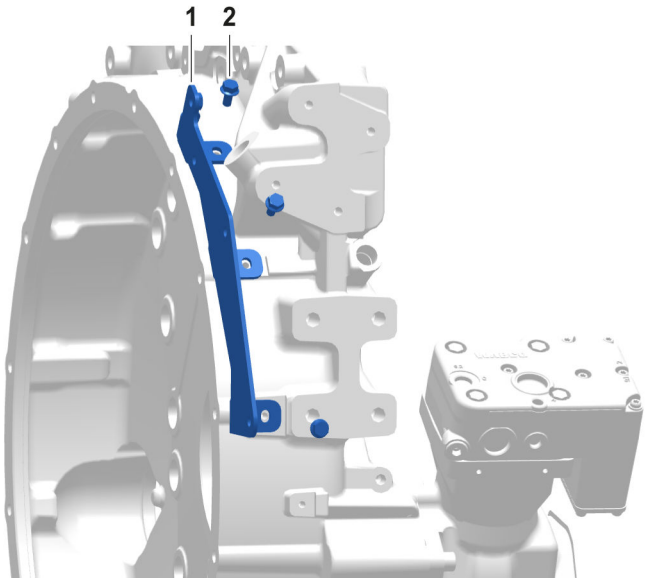

Fig. 551: Bracket

1 Bracket **2** Hex head screw (3x)

▶ Unscrew hex head screws **2**.

▶ Remove bracket **1**.

Installing the bracket

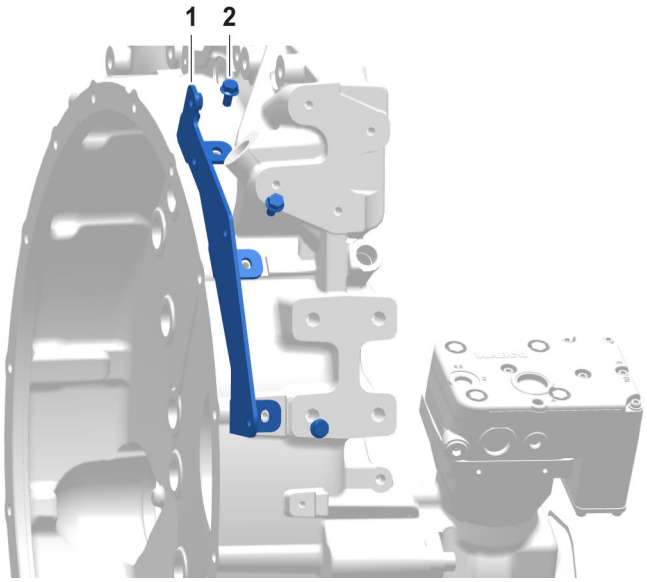

Fig. 552: Bracket

1 Bracket **2** Hex head screw (3x)

▶ Install bracket **1**.

▶ Tighten hex head screws **2**.

Installing the air compressor

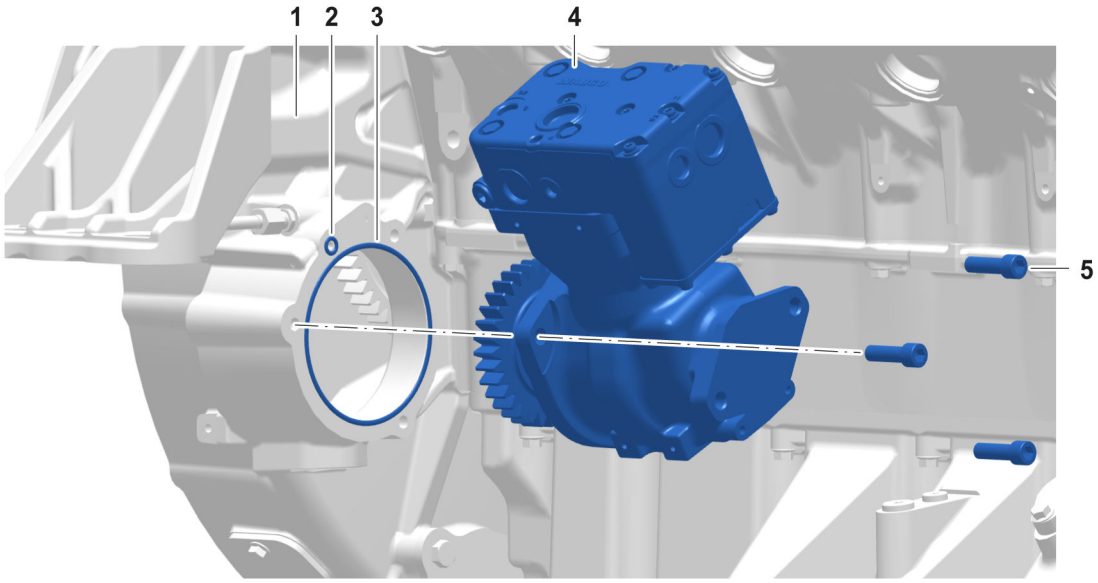

Fig. 553: Air compressor

1 Flywheel housing
2 O-ring
3 O-ring
4 Air compressor
5 Socket head screw (3x)

- ▶ Lubricate new o-ring **3** with NBU 30 grease.
- ▶ Install o-ring **3**.
- ▶ Lubricate new o-ring **2** with NBU 30 grease.
- ▶ Install o-ring **2**.
- ▶ Install air compressor **4**.
- ▶ Tighten socket head screws **5**.

Installing the oil return line

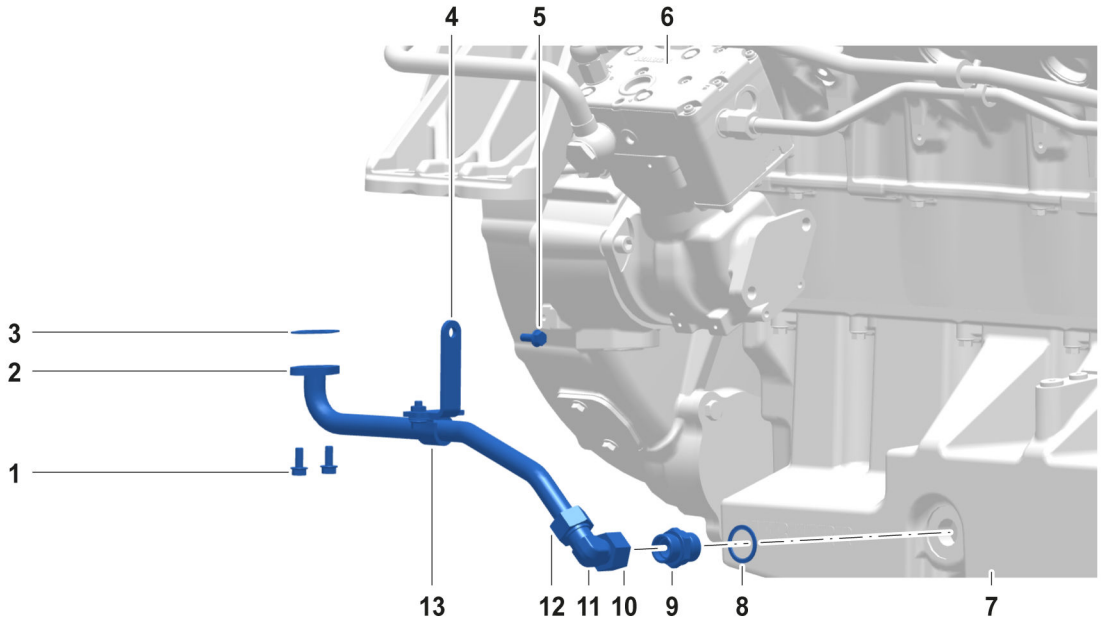

Fig. 554: Oil return line

1 Hex head screw (2x)
2 Oil return line
3 Seal
4 Bracket
5 Hex head screw
6 Air compressor
7 Oil pan
8 Sealing ring
9 Nozzle
10 Box nut
11 Screw fitting
12 Box nut
13 Holding clamp

- ▶ Install screw fitting **11**.
- ▶ Tighten box nut **12**.
- ▶ Remove closure from oil pan **7**.
- ▶ Install new sealing ring **8**.
- ▶ Tighten nozzle **9**.
- ▶ Remove closures from oil return line **2**.
- ▶ Install oil return line **2**.
- ▶ Tighten box nut **10**.
- ▶ Align new seal **3**.
- ▶ Tighten hex head screws **1**.
- ▶ Install bracket **4**.
- ▶ Tighten hex head screw **5**.
- ▶ Install holding clamp **13**.

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Installing the oil supply line

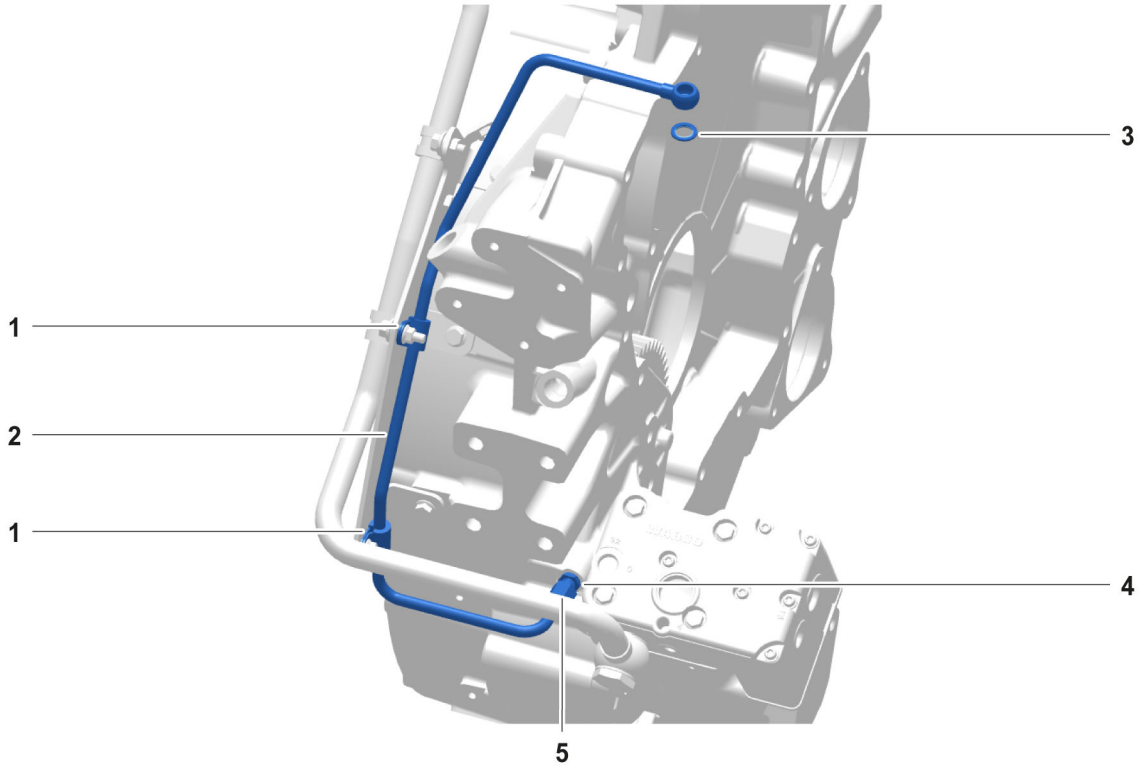

Fig. 555: Oil supply line

1 Holding clamp (2x)
2 Oil supply line
3 Sealing ring
4 Screw fitting
5 Box nut

▶ Remove closure from flywheel housing.

▶ Tighten screw fitting **4**.

▶ Install new sealing ring **3**.

▶ Remove closures from oil supply line **2**.

▶ Install oil supply line **2**.

▶ Tighten box nut **5**.

▶ Install holding clamps **1**.

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Installing the pipeline

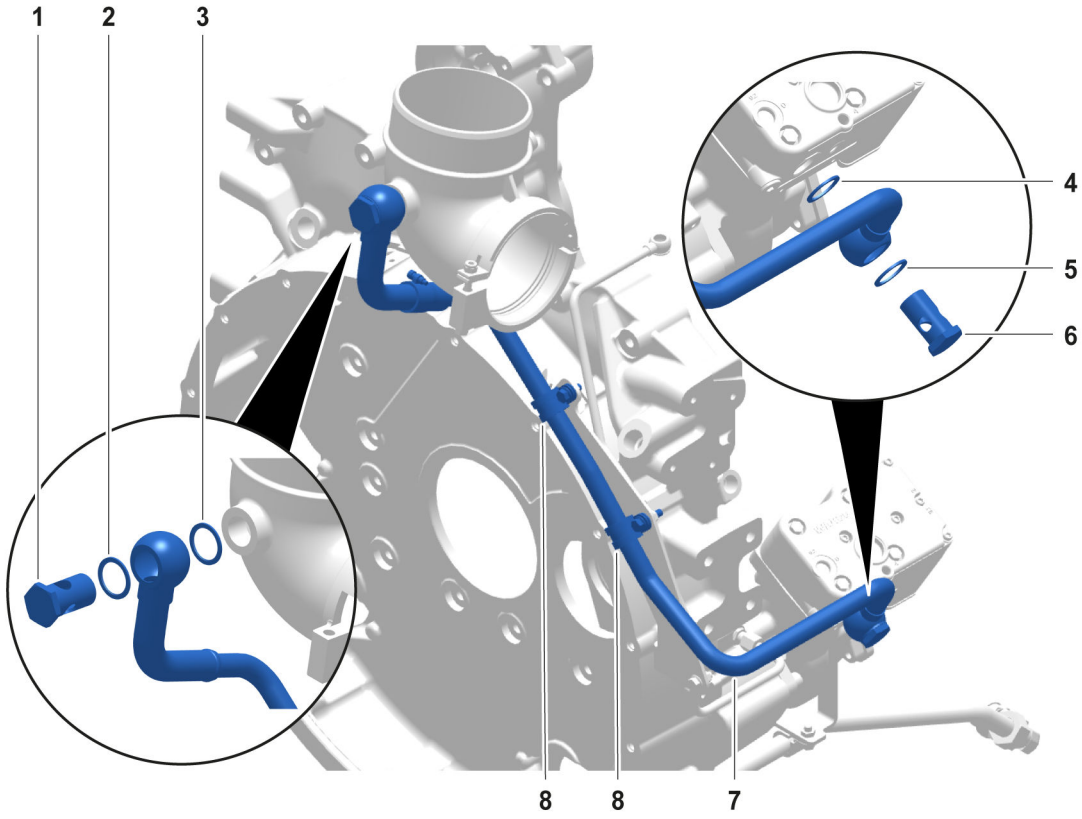

Fig. 556: Pipeline

1 Banjo bolt
2 Sealing ring
3 Sealing ring
4 Sealing ring
5 Sealing ring
6 Banjo bolt
7 Pipeline
8 Holding clamp (2x)

- ▶ Install new sealing ring **4**.
- ▶ Install new sealing ring **3**.
- ▶ Remove closures from pipeline **7**.
- ▶ Install pipeline **7**.
- ▶ Install holding clamps **8**.
- ▶ Install new sealing ring **5**.
- ▶ Tighten banjo bolt **6**.
- ▶ Install new sealing ring **2**.
- ▶ Tighten banjo bolt **1**.

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3.12 Electrical system

3.12.1 Removing and installing the left heating flange

Removing the left heating flange

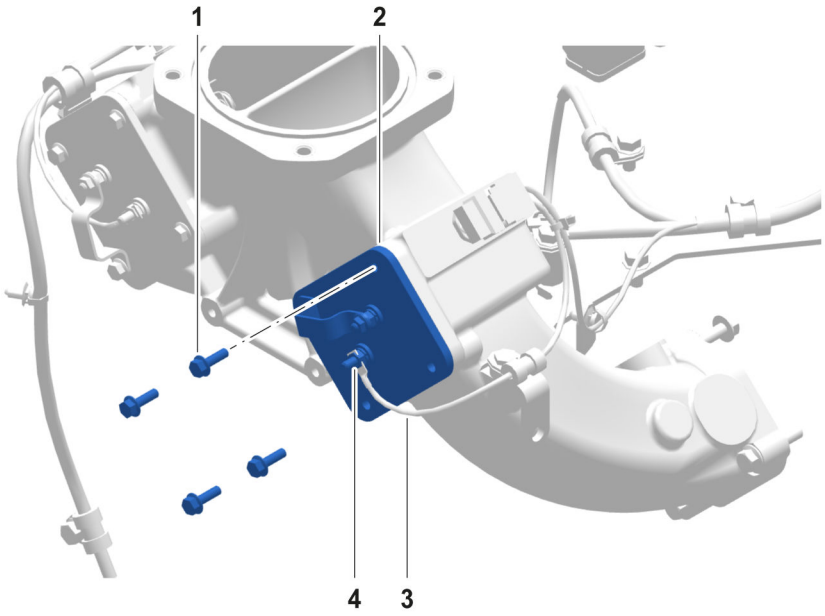


Fig. 557: Heating flange

1 Hex head screw (4x)
2 Heating flange
3 Electrical line
4 Hex nut

▶ Unscrew hex nut **4**.

▶ Remove electrical line **3** from heating flange **2**.

▶ Unscrew hex head screws **1**.

▶ Remove heating flange **2**.

Installing the left heating flange

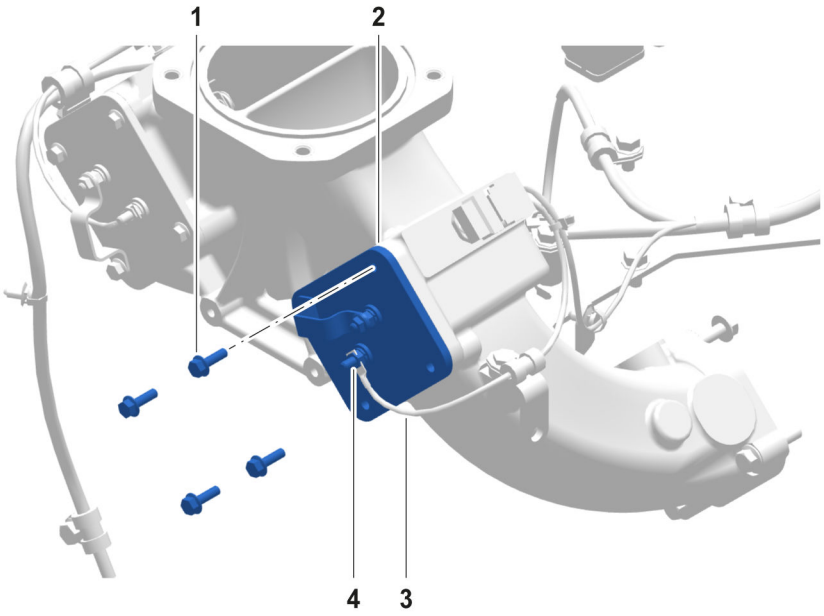


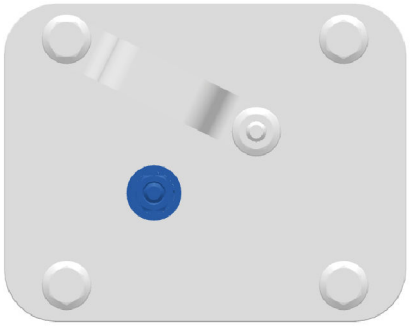
Fig. 558: Heating flange

1 Hex head screw (4x)
2 Heating flange
3 Electrical line
4 Hex nut

▶ Install heating flange **2**.

▶ Tighten hex head screws **1**.

▶ Install electrical line **3** on heating flange **2**.

Tightening instruction for hex nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	9 Nm	

Tab. 104: Tightening instruction 9080927-001

Note
Tightening the hex nut!

▶ Hold cable lugs and electrical line against each other when tightening the hex nut!

▶ Tighten hex nut **4** according to tightening instruction.

3.12.2 Removing and installing the right heating flange

The procedure corresponds to the description for the left heating flange. (For more information see: 3.12.1 Removing and installing the left heating flange, page 460.)

3.12.3 Alternator

Removing and installing the alternator

Removing the alternator

Make sure that the following prerequisites are met:
- ❑ Energy supply is disconnected, see documentation from the device manufacturer.
- ❑ V-ribbed belt is removed. (For more information see: Removing the V-ribbed belt, page 264.)

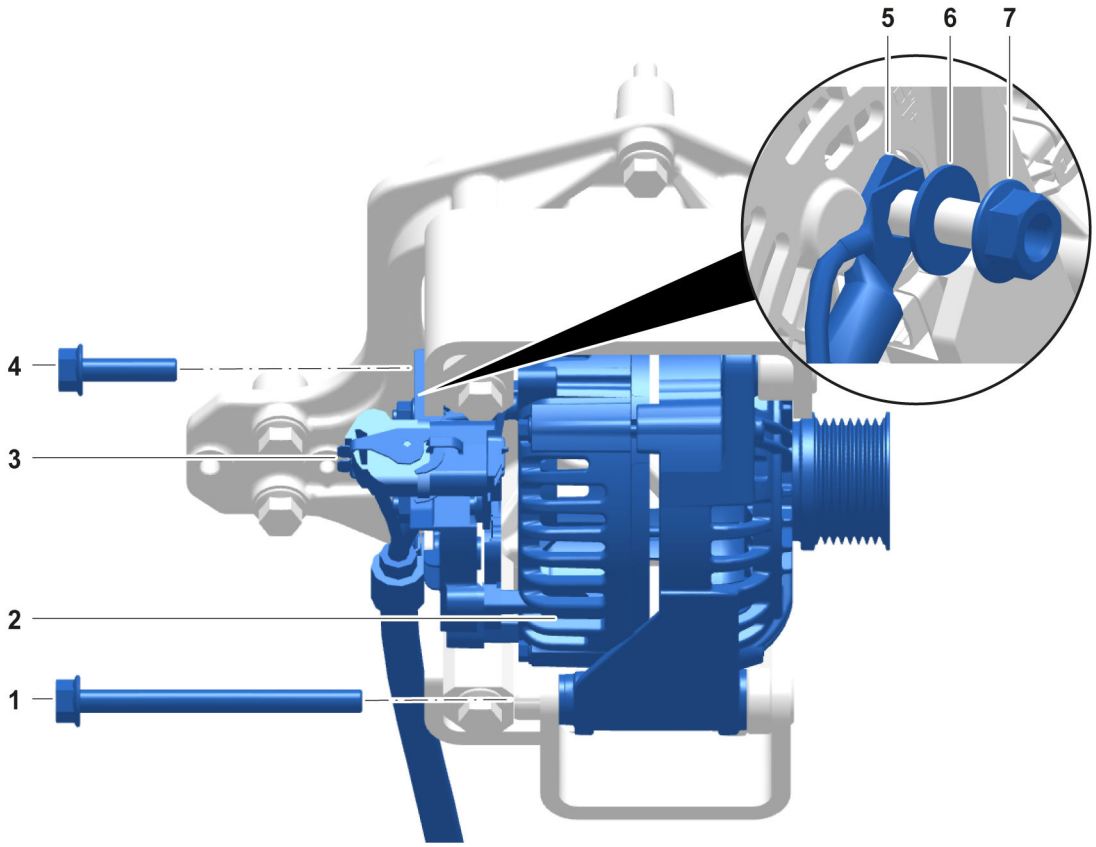


Fig. 560: Alternator

1 Hex head screw
2 Alternator
3 Electrical plug connection
4 Hex head screw
5 Electrical connection B1+
6 Washer
7 Hex nut

▶ Disconnect electrical plug connection **3**.

▶ Unscrew hex nut **7**.

▶ Remove washer **6**.

▶ Remove electrical connection B1+ **5**.

▶ Unscrew hex head screw **1**.

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- ▶ Unscrew hex head screw **4**.
- ▶ Remove alternator **2**.

Cleaning the alternator

- ▶ Clean contact surfaces of alternator **4**.
- ▶ Clean contact surfaces of bracket.

Installing the alternator

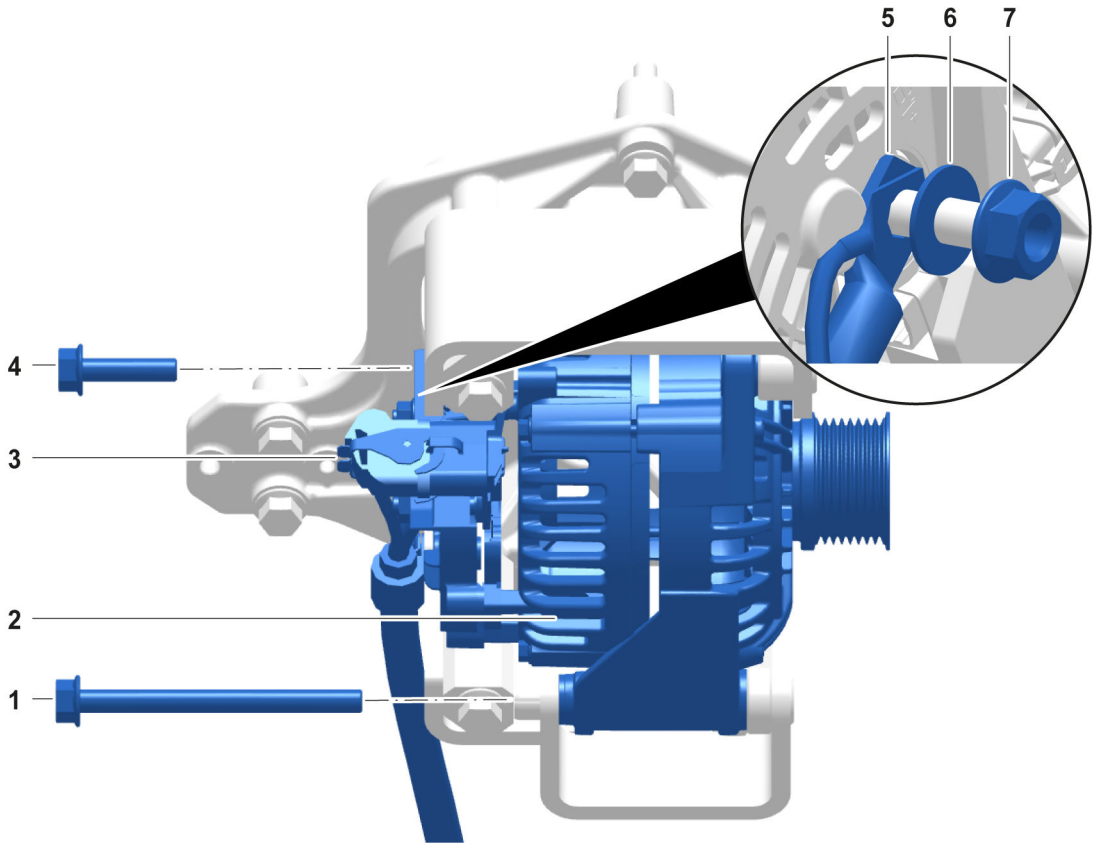

Fig. 561: Alternator

1 Hex head screw
2 Electrical connections B+, B-
3 Electrical plug connection
4 Alternator
5 Hex head screw

- ▶ Install alternator **2**.
- ▶ Tighten hex head screw **4**.
- ▶ Tighten hex head screw **1**.
- ▶ Install electrical connection B1+ **5**.
- ▶ Install washer **6**.

Tightening instruction for hex nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	14 Nm	

Tab. 105: Tightening instruction 10148088-100

▶ Tighten hex nut **7** according to tightening instruction.

▶ Connect electrical plug connection **3**.

Removing and installing the alternator bracket

Removing the alternator bracket

Make sure that the following prerequisites are met:
❑ Alternator is removed. (For more information see: Removing the alternator, page 462.)
❑ Connection piece coolant line to crankcase is removed. (For more information see: Removing the connection piece coolant line to the crankcase, page 445.)

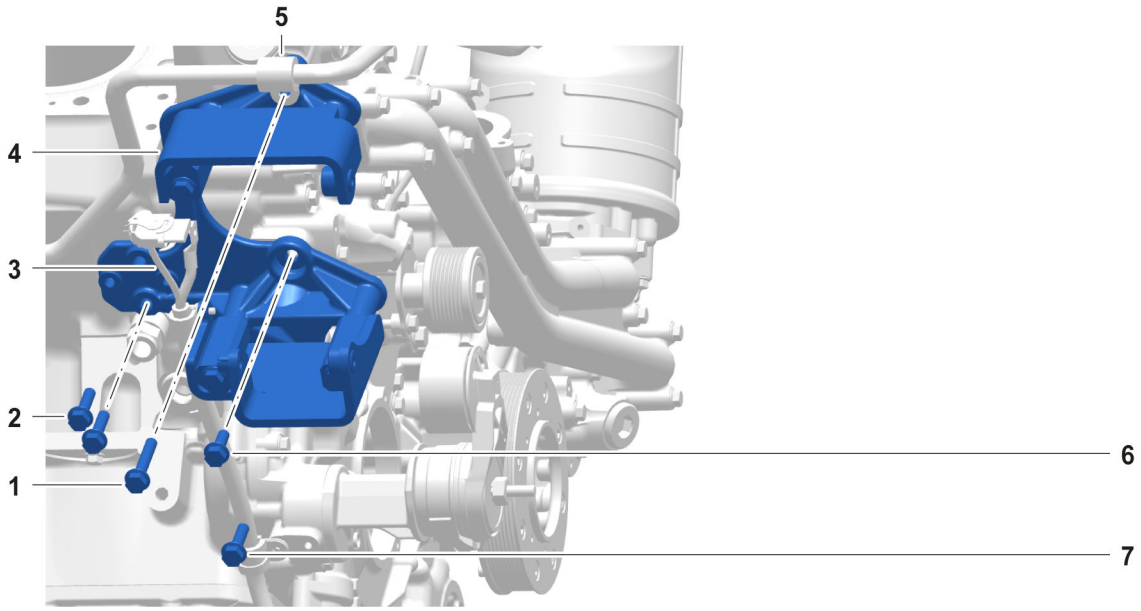

Fig. 563: Alternator bracket

1 Hex head screw
2 Hex head screw (2x)
3 Electrical line
4 Bracket
5 Holding clamp
6 Hex head screw
7 Hex head screw

▶ Remove electrical line **3** from bracket **4**.

▶ Unscrew hex head screw **1**.

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- ▶ Unscrew hex head screws **2**.
- ▶ Unscrew hex head screw **6**.
- ▶ Unscrew hex head screw **7**.
- ▶ Remove bracket **4**.

Installing the alternator bracket

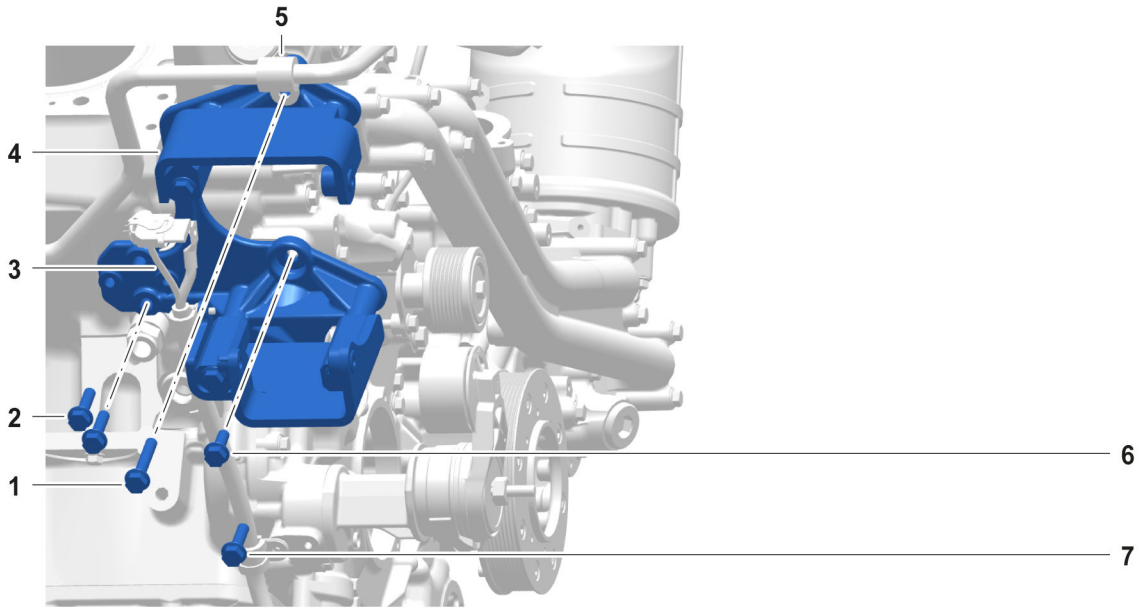

Fig. 564: Alternator bracket

1 Hex head screw
2 Hex head screw (2x)
3 Electrical line
4 Bracket
5 Holding clamp
6 Hex head screw
7 Hex head screw

- ▶ Install bracket **4**.
- ▶ Tighten hex head screw **7**.
- ▶ Tighten hex head screw **6**.
- ▶ Tighten hex head screws **2**.
- ▶ Install holding clamp **5**.
- ▶ Tighten hex head screw **1**.
- ▶ Install electrical line **3** on bracket **4**.

3.12.4 Removing and installing the starter motor

Removing the starter motor

Make sure that the following prerequisite is met:
❑ Energy supply is disconnected, see documentation from the device manufacturer.

WARNING
Unexpected movement!
Death or serious injuries possible.

▶ Never bypass the starter motor.

Note

Procedure applies for both starter motors.

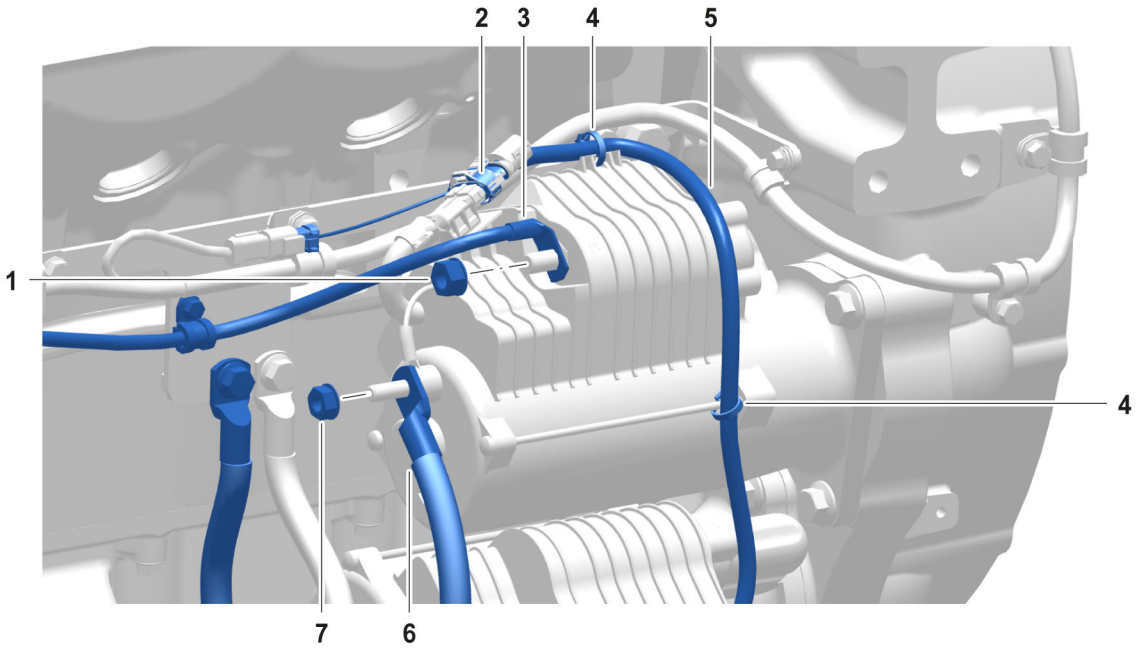

Fig. 565: Starter motor

1 Hex nut
2 Electrical plug connection
3 Electrical line
4 Cable tie
5 Electrical line
6 Electrical line
7 Hex nut

▶ Remove cable tie **4**.

▶ Disconnect electrical plug connection **2**.

▶ For upper starter motor removal, unscrew hex nut **1**.

▶ Remove electrical line **3**.

▶ Unscrew hex nut **7**.

▶ Remove electrical line **6**.

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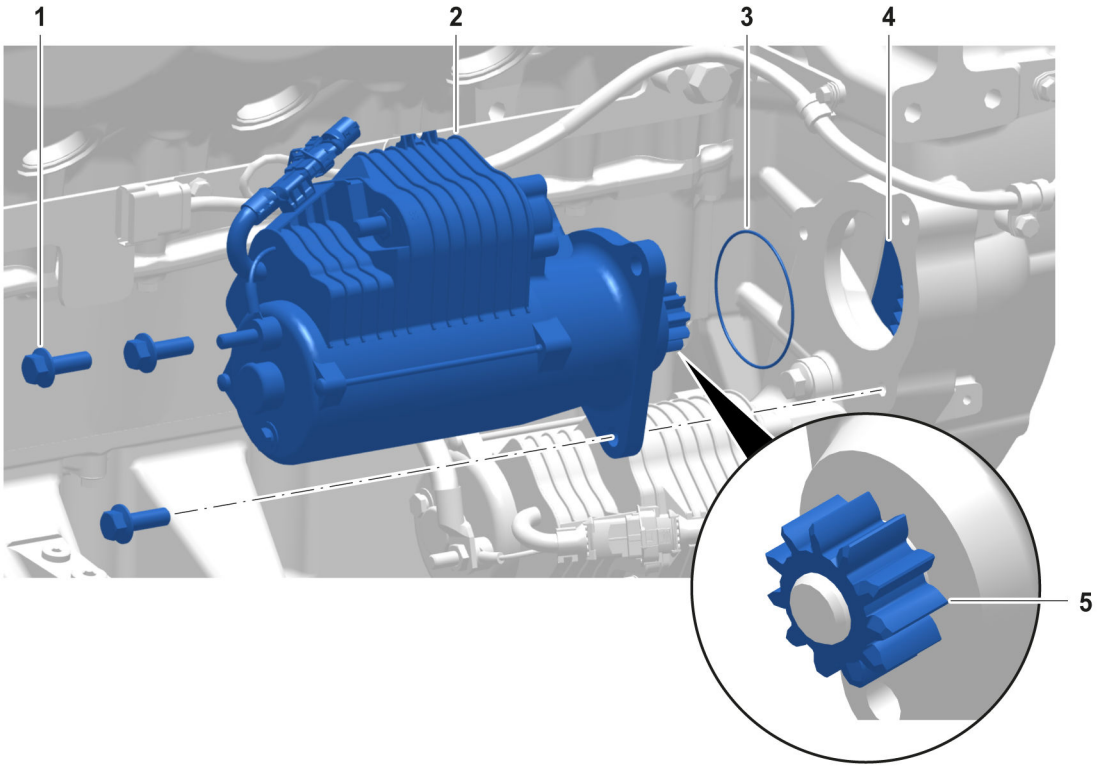

Fig. 566: Starter motor

1 Hex head screw (3x)
2 Starter motor
3 O-ring
4 Gear ring of flywheel
5 Starter pinion

▶ Unscrew hex head screws **1**.

▶ Remove starter motor **2**.

▶ Remove o-ring **3**.

Checking the starter motor

▶ Check starter pinion **5** for damage.

If the starter pinion **5** is damaged:
▶ Replace starter motor **2**.

▶ Check gear ring of flywheel **4** for damage.

If gear ring of flywheel **4** is damaged:
▶ Replace flywheel.

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Installing the starter motor

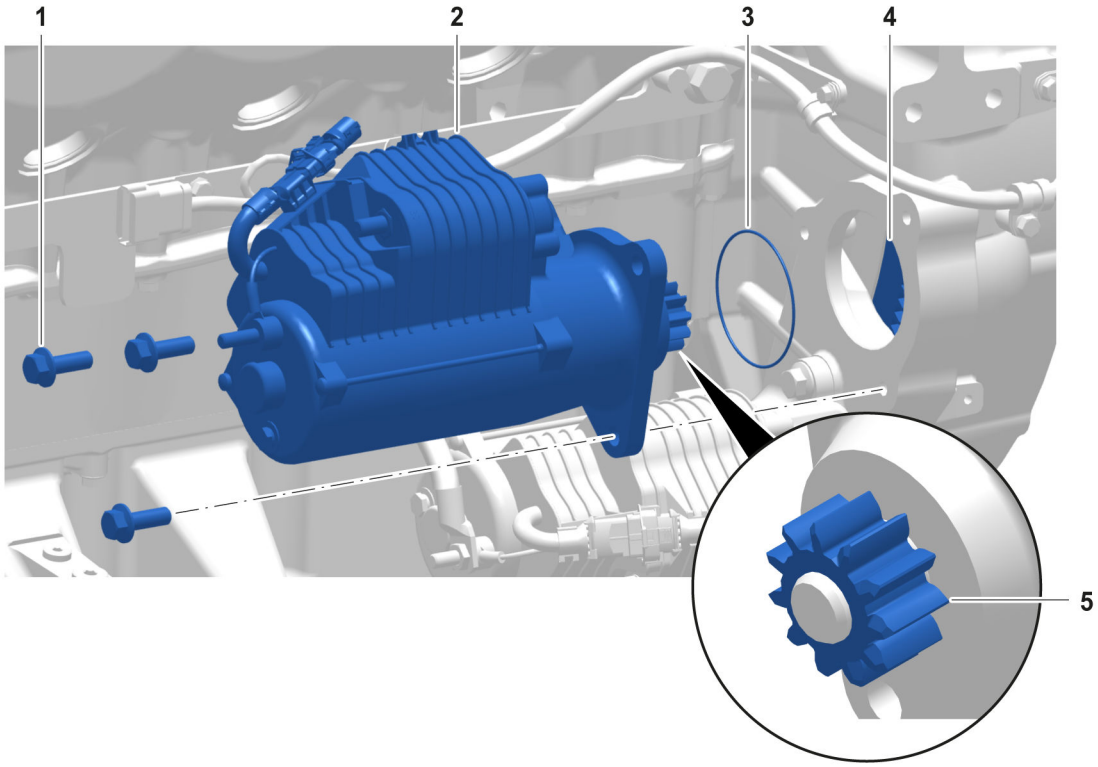

Fig. 567: Starter motor

1 Hex head screw (3x)
2 Starter motor
3 O-ring
4 Gear ring of flywheel
5 Starter pinion

▶ Install new o-ring **3**.

▶ Align starter motor **2** and starter pinion **5**.

▶ Install starter motor **2** and starter pinion **5**.

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	90 Nm	

Tab. 106: Tightening instruction 10120540-001

▶ Tighten hex head screws **1** according to tightening instruction.

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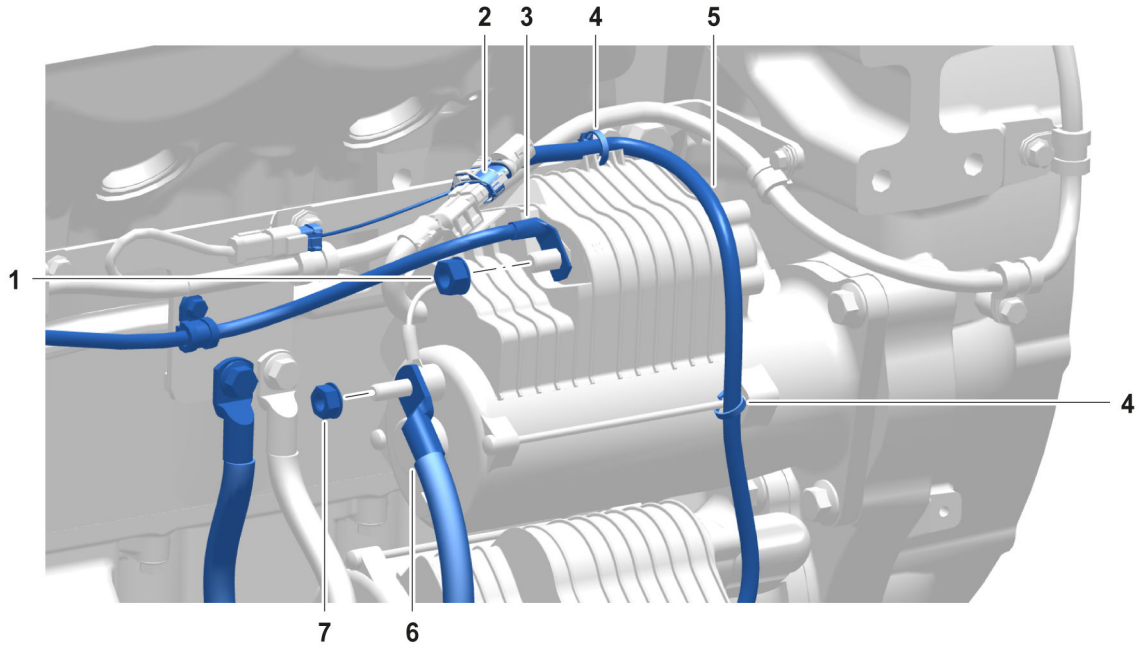

Fig. 569: Starter motor

1 Hex nut
2 Electrical plug connection
3 Electrical line
4 Cable tie
5 Electrical line
6 Electrical line
7 Hex nut

▶ Install electrical line **6**.

▶ Install electrical line **3**.

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	28 Nm	

Tab. 107: Tightening instruction 10120541-006

▶ Tighten hex nut **7** according to tightening instruction.

▶ Tighten hex nut **1** according to tightening instruction.

▶ Connect electrical plug connection **2**.

▶ Install new cable tie **4**.

3.12.5 Engine control unit

Removing and installing the engine control unit

Removing the engine control unit

Make sure that the following prerequisites are met:
- ❑ Energy supply is disconnected, see documentation from the device manufacturer.
- ❑ Device side plug connections are disconnected from the engine control unit, see documentation from the device manufacturer.
- ❑ Cable harness is disconnected from the engine control unit.
- ❑ Fuel high pressure pump fuel line to engine control unit is removed from engine control unit. (For more information see: Removing the fuel prefeeding pumps fuel line to the engine control unit, page 188.)
- ❑ Engine control unit fuel line to the fuel fine filter is removed from engine control unit. (For more information see: Removing the engine control unit fuel line to the fuel fine filter, page 189.)
- ❑ Engine control unit fuel return line to distributor block is removed. (For more information see: Removing the fuel return line from the engine control unit to the distributor block, page 197.)
- ❑ Fuel has been drained from engine control unit, see documentation from the device manufacturer.

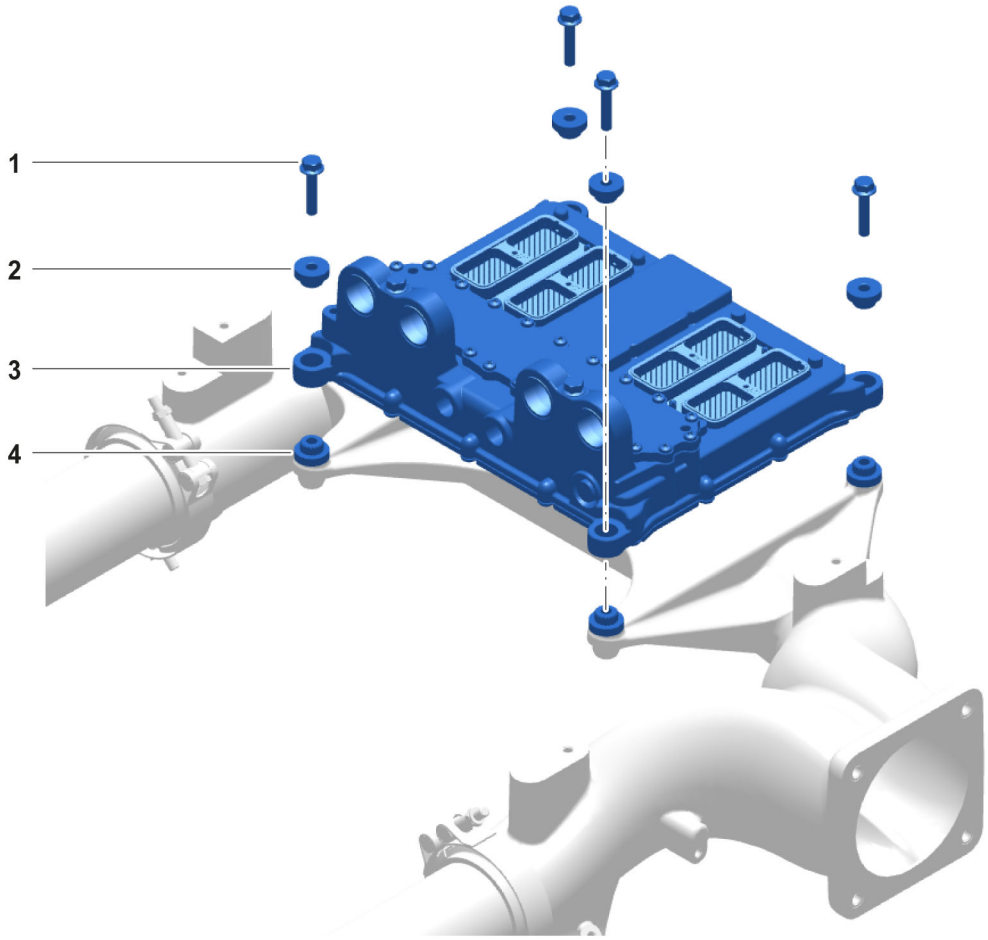

Fig. 571: Engine control unit

1 Hex head screw (4x)
2 Rubber buffer (4x)
3 Engine control unit
4 Rubber buffer (4x)

- ▶ Unscrew hex head screws **1**.
- ▶ Remove rubber buffer **2**.
- ▶ Remove engine control unit **3**.
- ▶ Remove rubber buffer **4**.

Installing the engine control unit

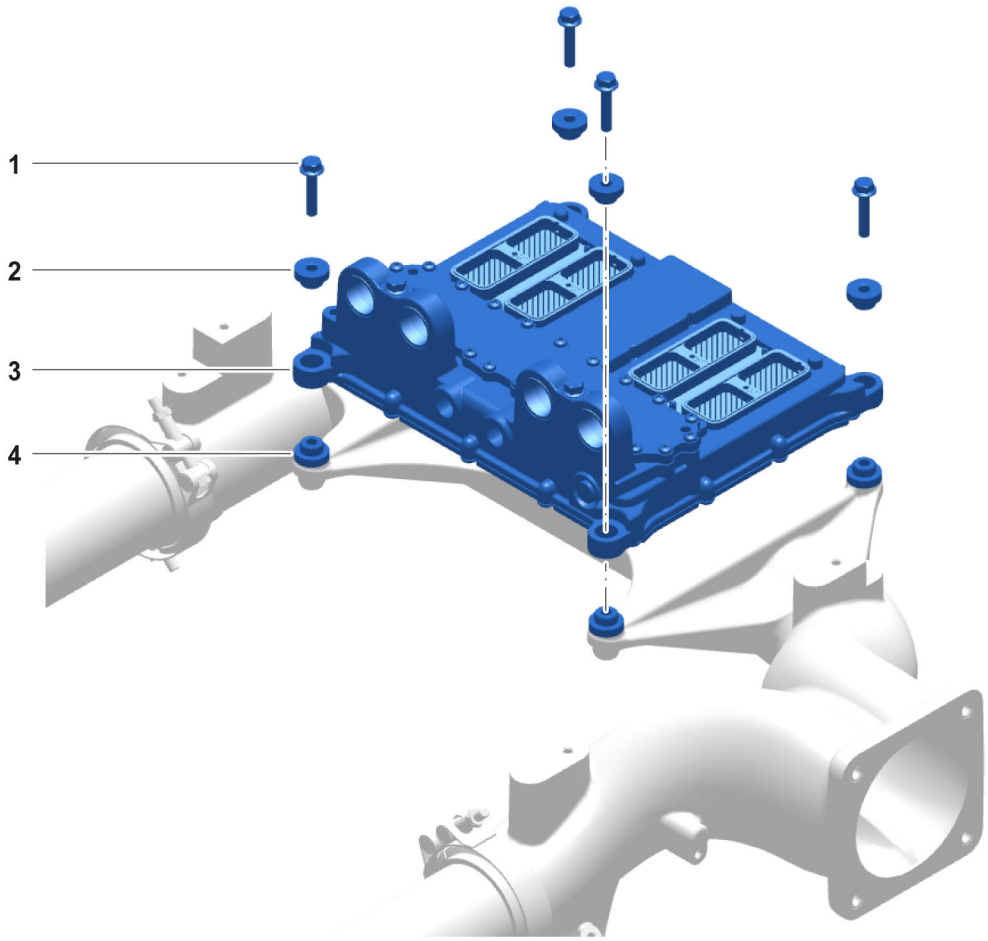

Fig. 572: Engine control unit

1 Hex head screw (4x)
2 Rubber buffer (4x)
3 Engine control unit
4 Rubber buffer (4x)

- ▶ Install new rubber buffer **4**.
- ▶ Install engine control unit **3**.
- ▶ Install new rubber buffer **2**.

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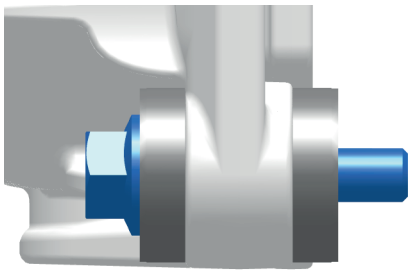
Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	Loctite® 243	
Screws	Reusable	
Stage	**Tightening torque**	
1.	10 Nm	

Tab. 108: Tightening instruction 9080731-000

- ▶ Lubricate hex head screws **1** according to tightening instruction.
- ▶ Tighten hex head screws **1** according to tightening instruction.
- ▶ Install engine control unit fuel return line to distributor block. (For more information see: Installing the fuel return line from the engine control unit to the distributor block, page 204.)
- ▶ Install engine control unit fuel line to fuel fine filter on engine control unit. (For more information see: Installing the engine control unit fuel line to the fuel fine filter, page 192.)
- ▶ Install fuel high pressure pump fuel line to engine control unit on engine control unit. (For more information see: Installing the fuel prefeeding pumps fuel line to the engine control unit, page 193.)
- ▶ Install cable harness on engine control unit **3**.
- ▶ Connect the device side plug connections to the engine control unit **3**, see documentation from the device manufacturer.
- ▶ Establish energy supply, see documentation from the device manufacturer.

If a new engine control unit **3** is installed:

- ▶ Make sure that the correct software is installed.
- ▶ If necessary, perform a software update.
- ▶ Start engine.
- ▶ Check engine for proper function.
- ▶ Turn off engine.

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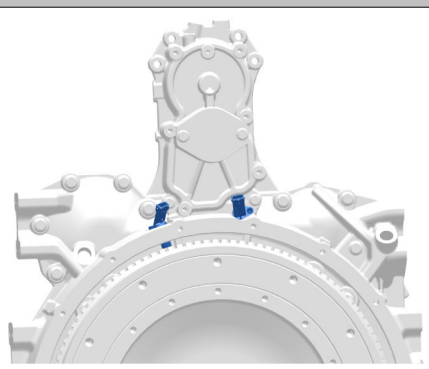
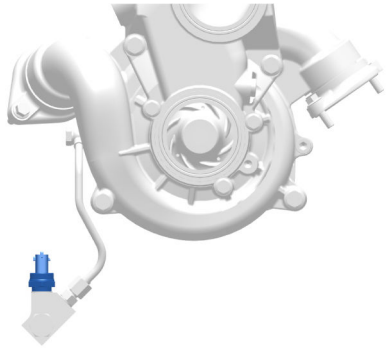
3.12.6 Sensors

Speed sensor on flywheel housing

Tightening instruction for socket head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	10 Nm	

Tab. 109: Tightening instruction 13410308-000

Pressure sensor on coolant pump connection piece

Tightening instruction for pressure sensor		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	32.5 Nm	

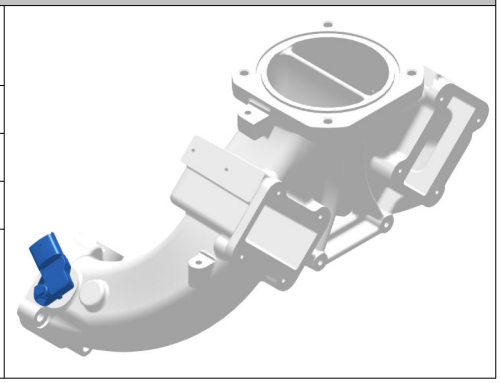
Tab. 110: Tightening instruction 13410304-000

Temperature sensor on thermostat housing

Tightening instruction for temperature sensor		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	16 Nm	

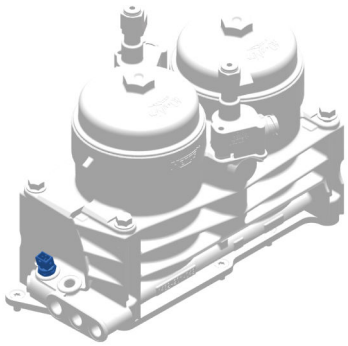
Tab. 111: Tightening instruction 13425170-000

Pressure sensor and temperature sensor on connection line

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	3.3 Nm	

Tab. 112: Tightening instruction 13410296-000

Temperature sensor on fuel fine filter console

Tightening instruction for temperature sensor		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	16 Nm	

Tab. 113: Tightening instruction 13425170-000

Pressure sensor on fuel fine filter console

Tightening instruction for pressure sensor		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	-	
Stage	**Tightening torque**	
1.	32.5 Nm	

Tab. 114: Tightening instruction 13410304-000

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3.12.7 Cable harness

Removing the cable harness

Make sure that the following prerequisite is met:
❑ Engine is disconnected from power supply, see documentation from the device manufacturer.

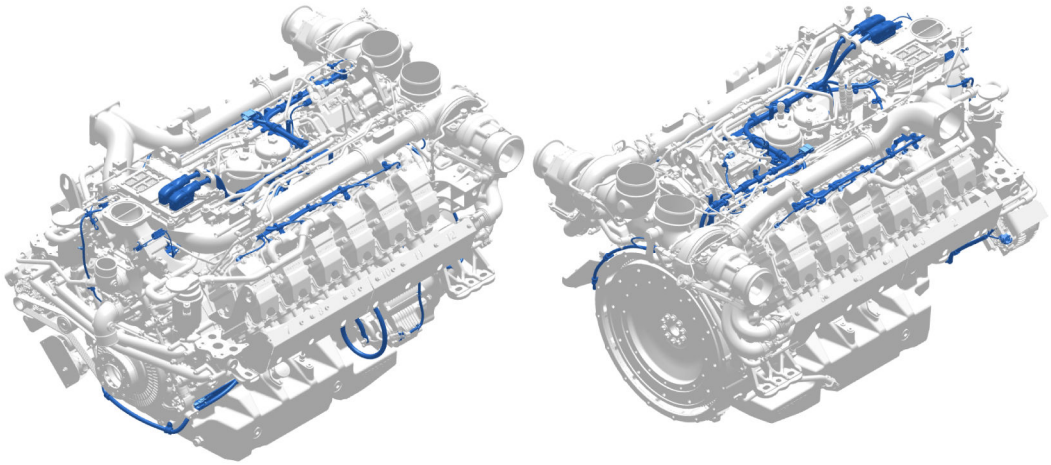

Fig. 580: Cable harness on engine

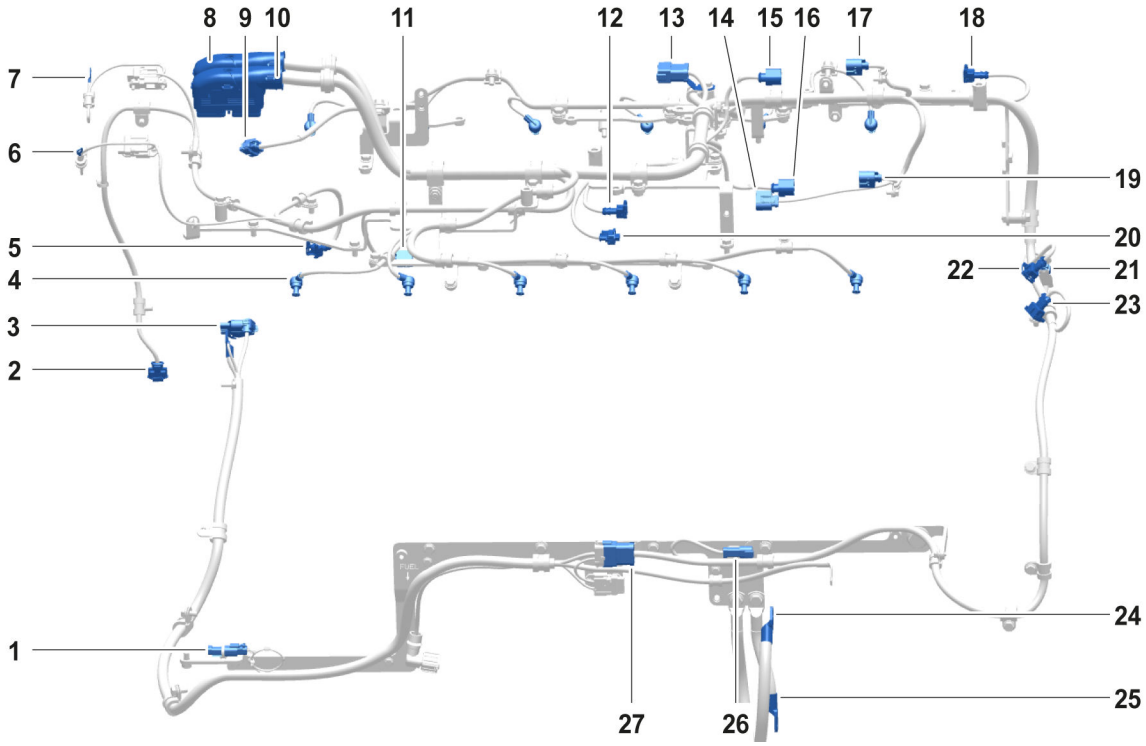

Fig. 581: Cable harness

1 Y760 Air conditioning compressor clutch control 1
2 B701 Oil pressure sensor 1
15 Y707 Fuel pressure control valve 1
16 Y708 Fuel pressure control valve 2

See next page for continuation of the image legend

3 G700 Alternator 1
4 Y731-Y742 Cylinder 1 to cylinder 12 injectors
5 B708 Coolant temperature sensor 1
6 E701 Heating flange 2 (left)
7 E700 Heating flange 1 (right)
8 A700 ECU2
9 B715 Charge air pressure & temperature sensor 1
10 A700 ECU2
11 B704 Rail pressure sensor 1
12 B709 Fuel temperature sensor 1
13 X710.S Interface
14 B705 Rail pressure sensor 2
17 Y703 Fuel volume control valve 1
18 Y705 Wastegate control valve 1
19 Y704 Fuel volume control valve 2
20 B702 Fuel pressure sensor 1
21 X720.S Splitter box temperature sensor
22 B713 Camshaft speed sensor
23 B711 Crankshaft speed sensor 1
24 M700 Starter motor 1
25 M701 Starter motor 2
26 X700.S Left starter motor interface
27 X706.S Left interface

▶ Document routing and fixing points of cable harness.

▶ Disconnect electrical plug connections.

▶ Remove holding clamps.

▶ Remove cable tie.

▶ Remove cable harness.

Installing the cable harness

Make sure that the following prerequisite is met:
❑ Engine is disconnected from power supply, see documentation from the device manufacturer.

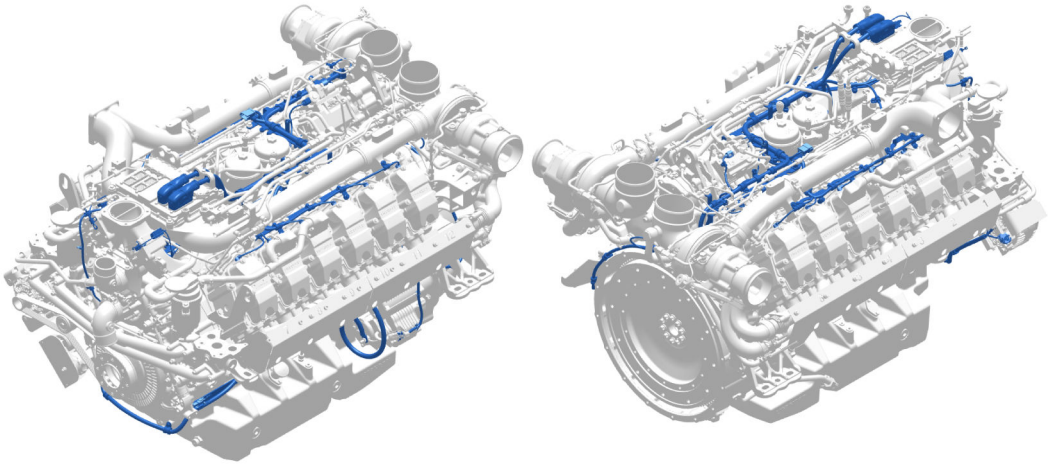

Fig. 582: Cable harness on engine

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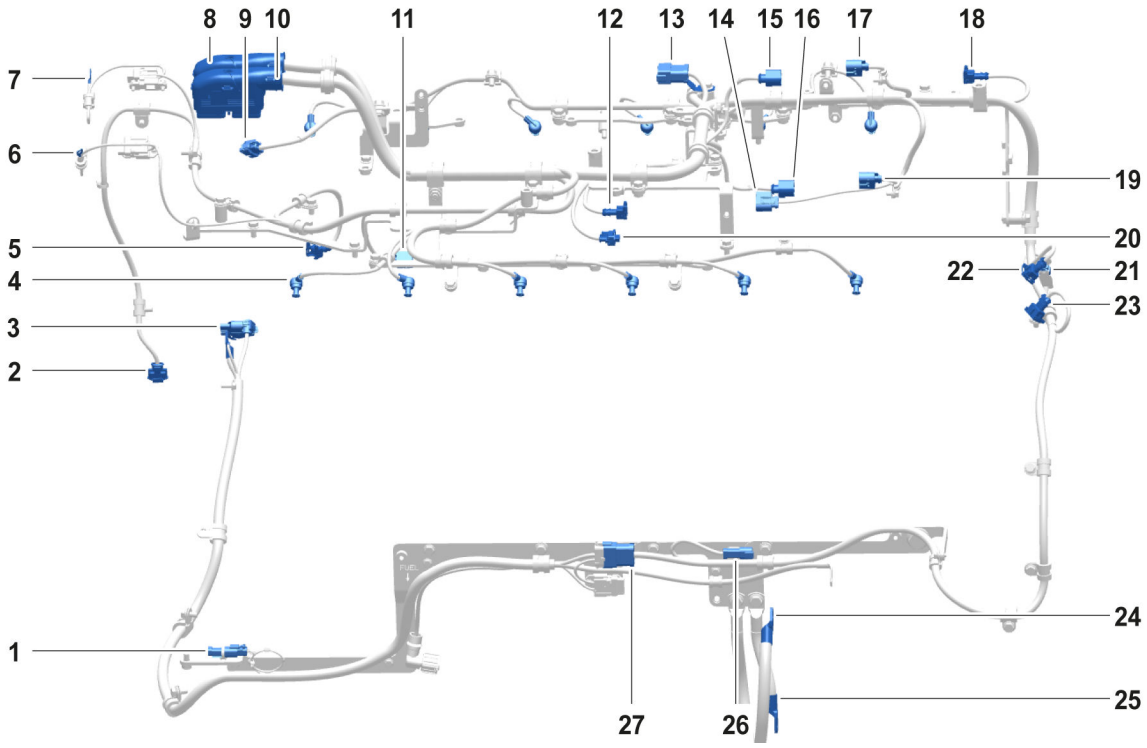

Fig. 583: Cable harness

1 Y760 Air conditioning compressor clutch control 1
2 B701 Oil pressure sensor 1
3 G700 Alternator 1
4 Y731-Y742 Cylinder 1 to cylinder 12 injectors
5 B708 Coolant temperature sensor 1
6 E701 Heating flange 2 (left)
7 E700 Heating flange 1 (right)
8 A700 ECU2
9 B715 Charge air pressure & temperature sensor 1
10 A700 ECU2
11 B704 Rail pressure sensor 1
12 B709 Fuel temperature sensor 1
13 X710.S Interface
14 B705 Rail pressure sensor 2
15 Y707 Fuel pressure control valve 1
16 Y708 Fuel pressure control valve 2
17 Y703 Fuel volume control valve 1
18 Y705 Wastegate control valve 1
19 Y704 Fuel volume control valve 2
20 B702 Fuel pressure sensor 1
21 X720.S Splitter box temperature sensor
22 B713 Camshaft speed sensor
23 B711 Crankshaft speed sensor 1
24 M700 Starter motor 1
25 M701 Starter motor 2
26 X700.S Left starter motor interface
27 X706.S Left interface

- ▶ Align cable harness.
- ▶ Install holding clamps loosely.
- ▶ Connect electrical plug connections.
- ▶ Make sure that the cable harness is installed free of stress.
- ▶ Tighten holding clamps.
- ▶ Install cable tie.

Cable designation itemization

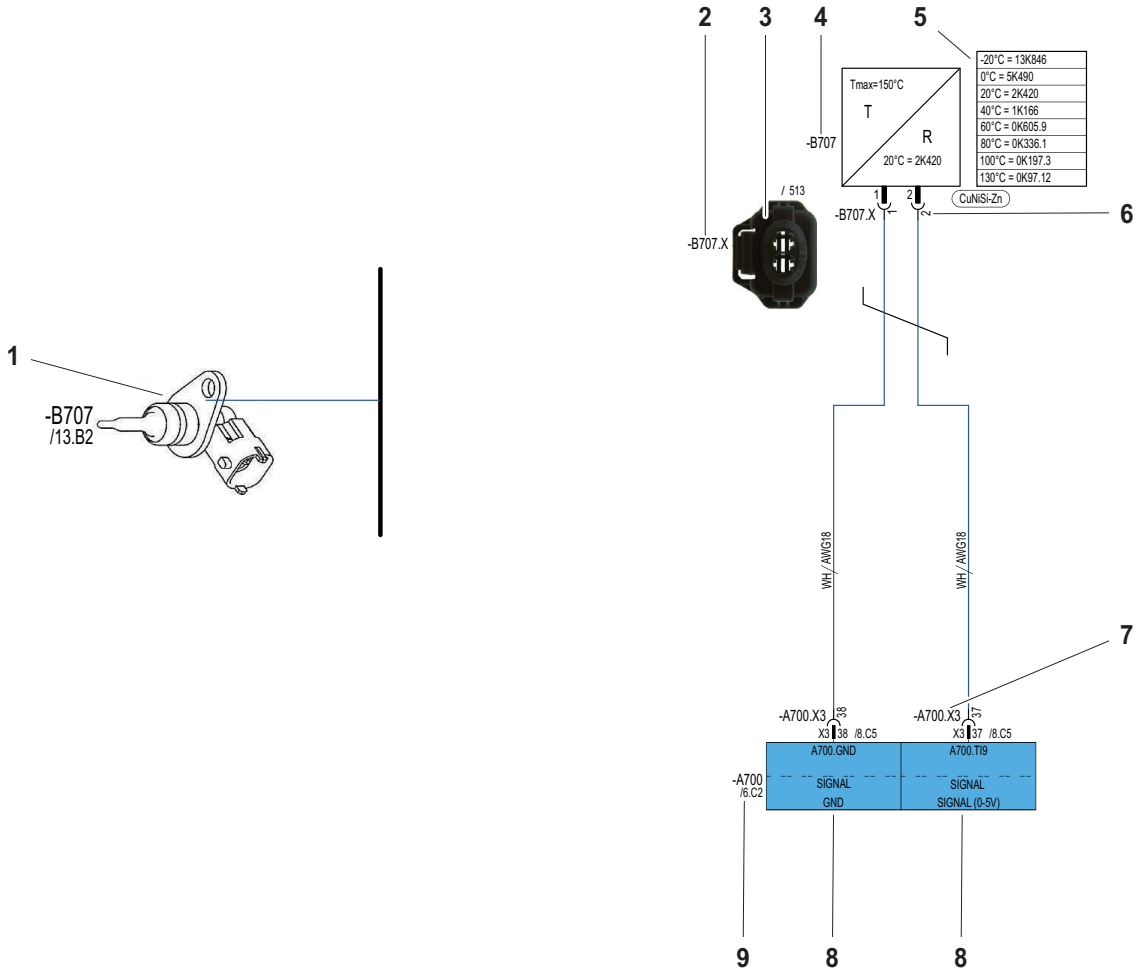

Fig. 584: Circuit diagram example

1 Figure in circuit diagram
2 BMK plug designation
3 Plug representation
4 Component designation, equipment designation
5 Technical information for component
6 Plug designation with pin connections
7 Plug connection to control
8 Engine control unit
9 Connection to control

Example: B707X	
B	Definition of which element type it is
707	Reference to component
X	Plug

Tab. 115

Reference identifier according to EN 81346-2	
A	Multiple functions
B	Sensor
C	Condenser

Reference identifier according to EN 81346-2	
E	Radiator
F	Fuse
G	Alternator
H	Lamp
K	Relay
M	Engine
R	Resistor
S	Electromechanical control element
X	Plug connection
Y	Valve

Tab. 116

Itemization of strand designation according to circuit diagram

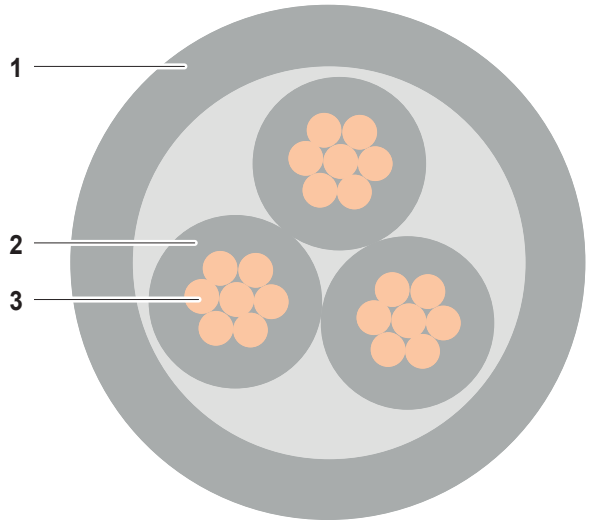

Fig. 585: Cable construction

1 Cable
2 Strands in cable
3 Conductors in strand

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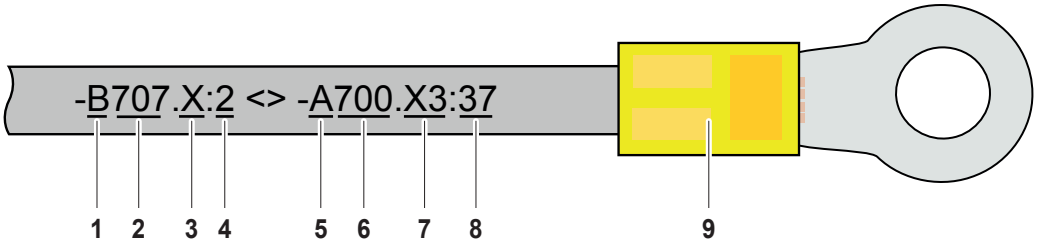

Fig. 586: Strand designation

1 Origin: Equipment designation
2 Origin: Component
3 Origin: Plug
4 Origin: Pin on plug
5 Destination: Equipment designation
6 Destination: according to circuit diagram
7 Destination: Plug
8 Destination: Pin on plug
9 Crimp contact

3.13 SCRonly exhaust aftertreatment system

3.13.1 SCRonly inlet module

Removing the SCRonly inlet module

Make sure that the following prerequisites are met:
- ❑ Outlet module and device side exhaust pipe are fastened.
- ❑ Mixing pipe is fastened.

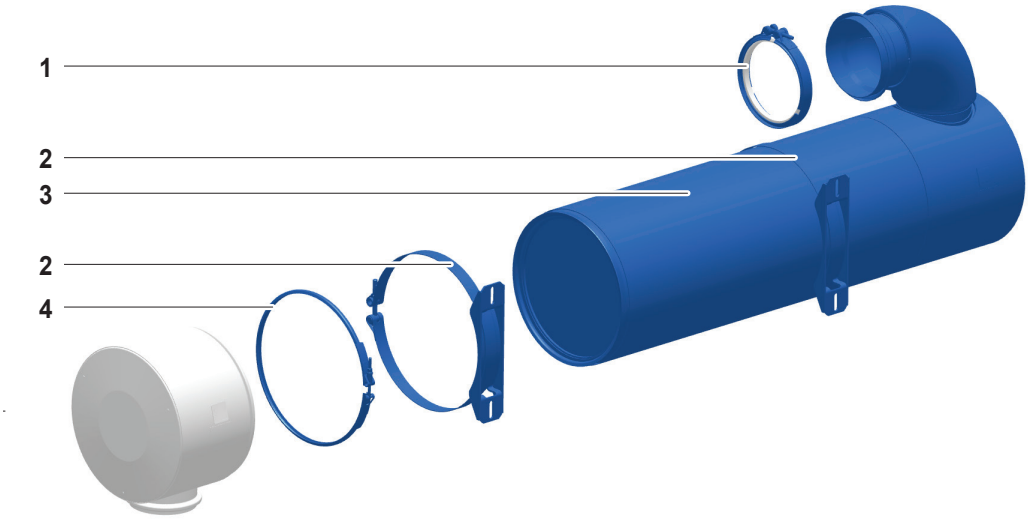

Fig. 587: SCRonly inlet module

1 V-band clamp
2 Hinged console clamp
3 SCRonly inlet module
4 V-band clamp

▶ Remove V-band clamp **4**.

▶ Remove V-band clamp **1**.

▶ Open hinged console clamp **2**.

▶ Remove SCRonly inlet module **3** from SCRonly outlet module and mixing pipe.

▶ Pull SCRonly inlet module **3** out of hinged console clamp **2**.

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Installing the SCRonly inlet module

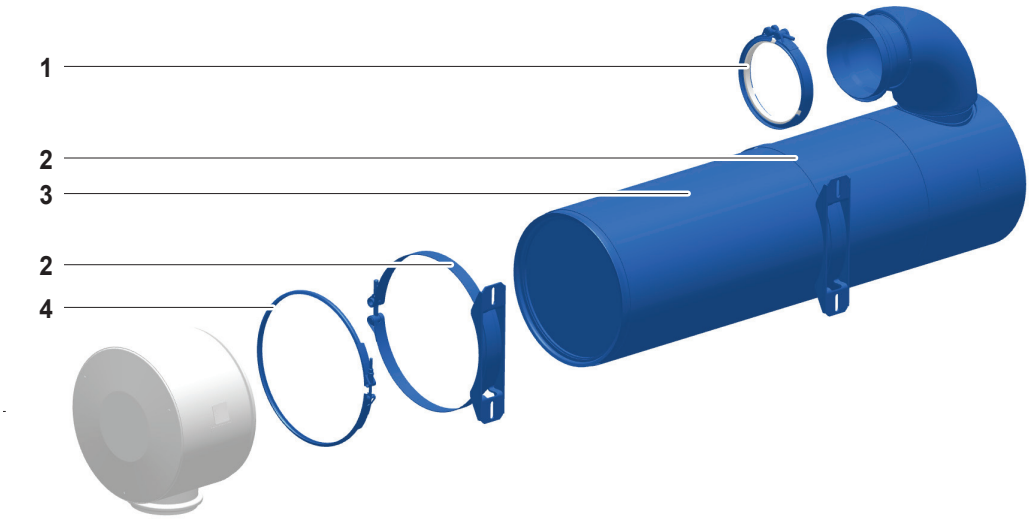

Fig. 588: SCRonly inlet module

1 V-band clamp
2 Hinged console clamp
3 SCRonly inlet module
4 V-band clamp

▶ Push SCRonly inlet module **3** into hinged console clamp **2**.

▶ Put SCRonly inlet module **3** onto SCRonly outlet module and mixing pipe.

▶ Tighten hinged console clamp **2**.

▶ Align V-band clamp **1**.

▶ Tighten V-band clamp **1** with 23 Nm.

▶ Align V-band clamp **4**.

▶ Tighten the V-band clamp **4** with $9^{+2/-1}$ Nm.

3.13.2 SCRonly outlet module

Removing the SCRonly outlet module

Make sure that the following prerequisite is met:
❑ Device side exhaust pipe is disconnected from SCRonly outlet module.

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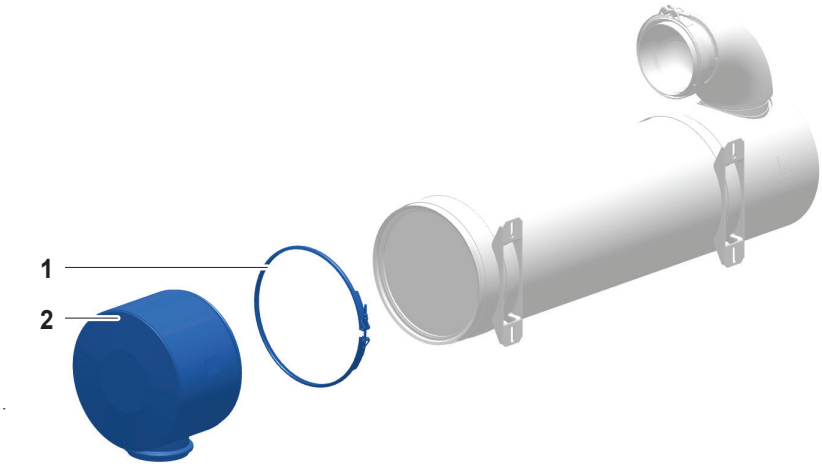

Fig. 589: SCRonly outlet module

1 V-band clamp **2** SCRonly outlet module

▶ Remove V-band clamp **1**.

▶ Remove SCRonly outlet module **2**.

Installing the SCRonly outlet module

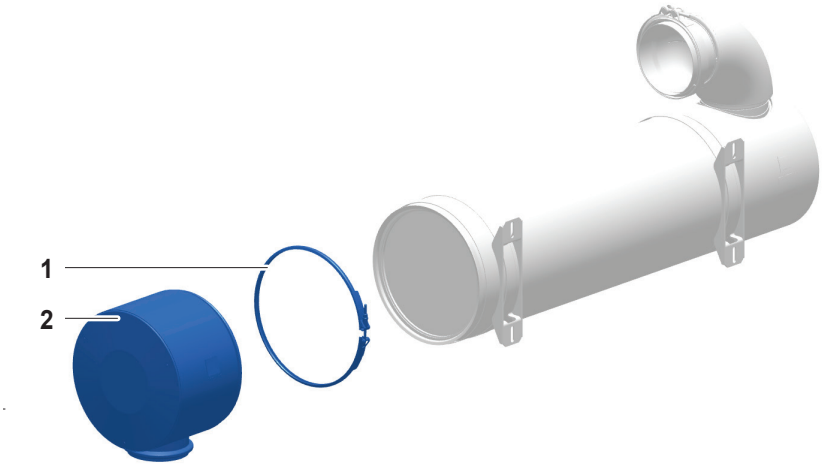

Fig. 590: SCRonly outlet module

1 V-band clamp **2** SCRonly outlet module

▶ Slide SCRonly outlet module **2** onto SCRonly inlet module.

▶ Align V-band clamp **1**.

▶ Tighten the V-band clamp **1** with 9 $^{+2/-1}$ Nm.

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3.13.3 Exhaust regulation sensors

Removing the temperature sensor

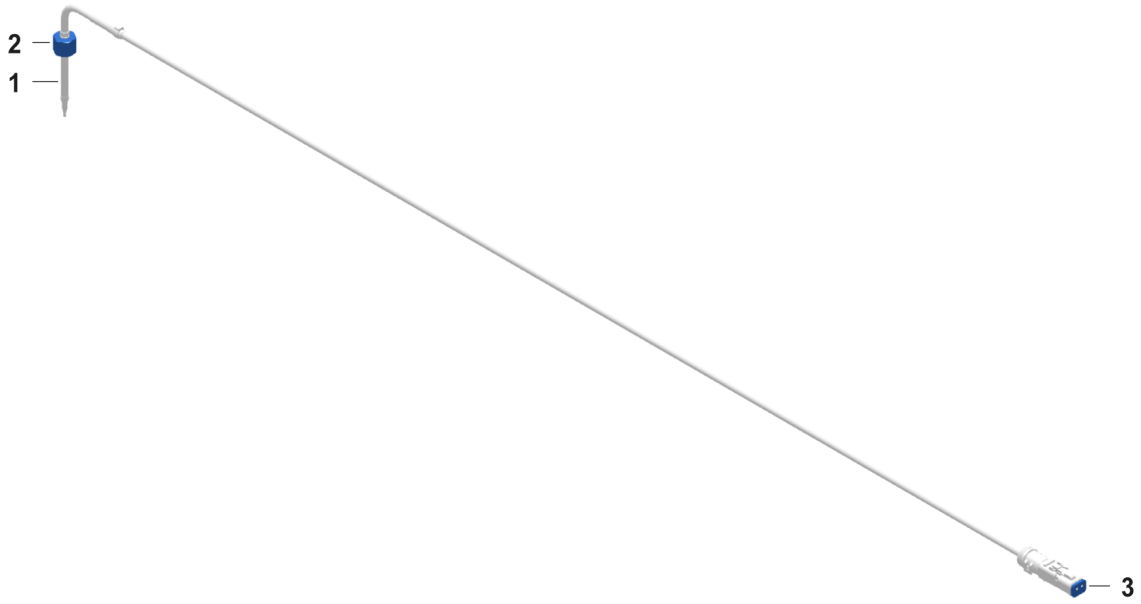

Fig. 591: Exhaust regulation sensors

1 Temperature sensor
2 Box nut
3 Electrical plug connection

▶ Disconnect electrical plug connection **3** from control unit.

▶ Unscrew box nut **2**.

▶ Remove temperature sensor **1** from sensor pipe.

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Removing the lambda NO_x sensor

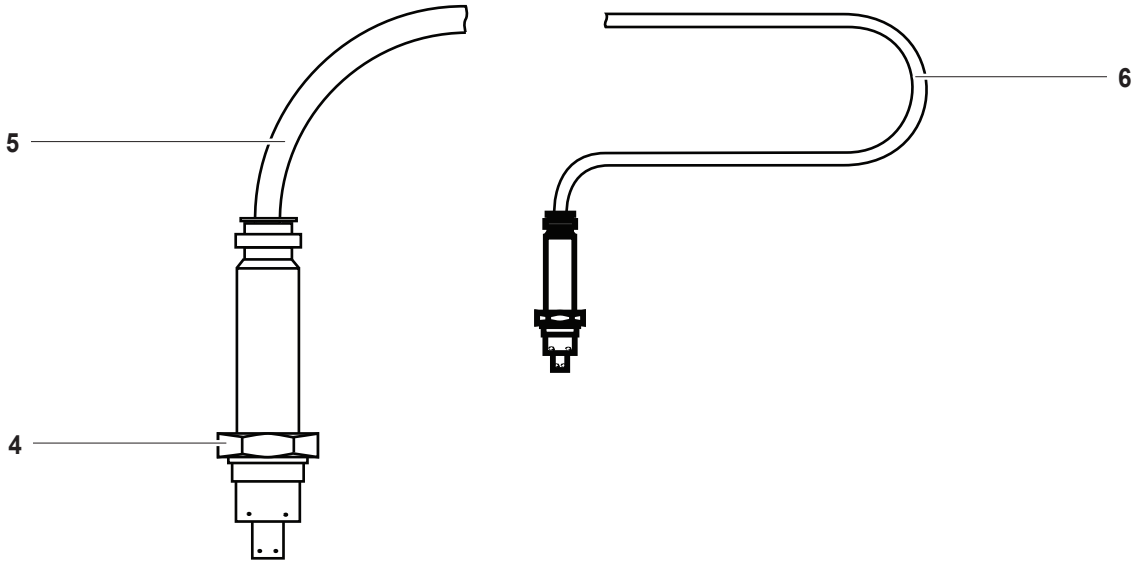

Fig. 592: Lambda NO_x sensor

4 Hexagon
5 Sensor cable
6 180° loop

▶ Disconnect plug connection of lambda NO_x sensor from control unit.

▶ Release hexagon **4** of lambda NO_x sensor.

▶ Remove lambda NO_x sensor.

Removing the humidity sensor

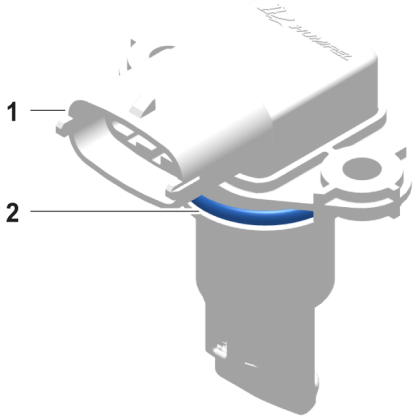

Fig. 593: Humidity sensor

1 Humidity sensor
2 O-ring

▶ Disconnect electrical plug connection from humidity sensor **1**.

▶ Unscrew screws of humidity sensor **1**.

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▶ Remove humidity sensor **1**.

▶ Remove o-ring **2**.

Removing the temperature sensor

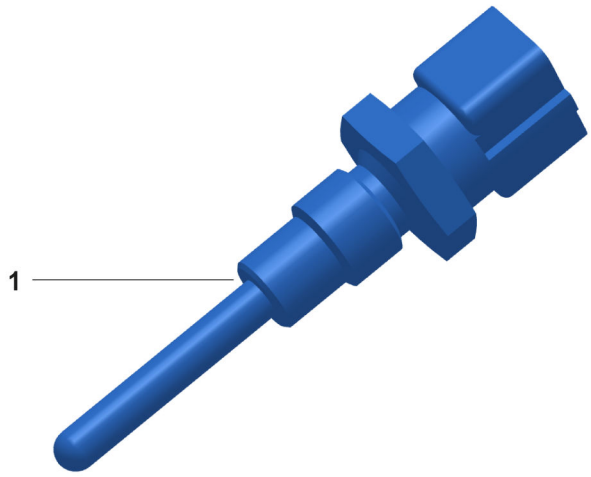

Fig. 594: Temperature sensor

1 Temperature sensor

▶ Disconnect electrical plug connection from temperature sensor **1**.

▶ Remove temperature sensor **1**.

Installing the temperature sensor

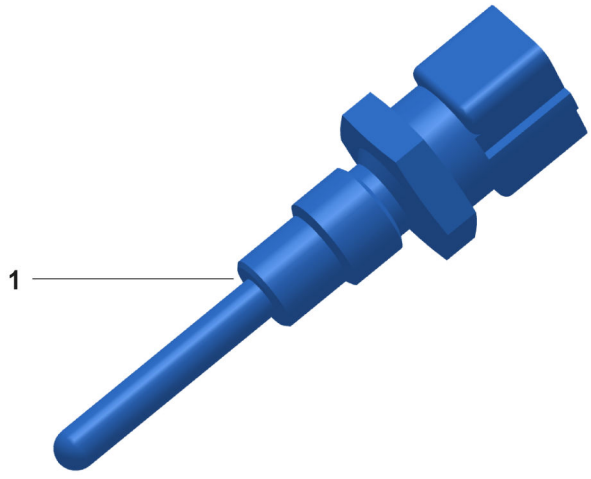

Fig. 595: Temperature sensor

1 Temperature sensor

▶ Screw in temperature sensor **1**.

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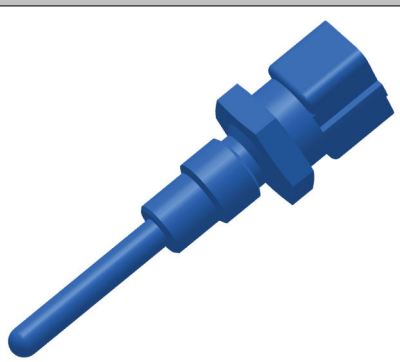
Tightening instruction for temperature sensor		
Lubricant (thread and head contact surface)	-	
Screw locking (thread)	-	
Sensor	Reusable	
Stage	**Tightening torque**	
1.	15 Nm	

Tab. 117: Tightening instruction 11691801-000

- ▶ Tighten temperature sensor **1** according to tightening instruction.
- ▶ Connect electrical plug connection to temperature sensor **1**.

Installing the humidity sensor

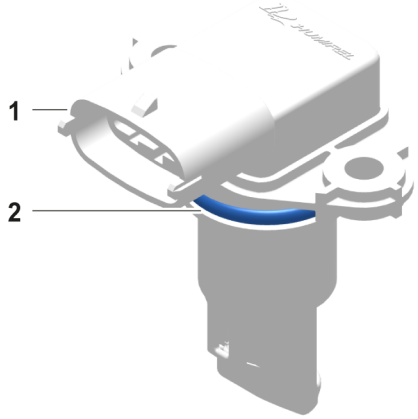


Fig. 597: Humidity sensor

1 Humidity sensor **2** O-ring

- ▶ Install new o-ring **2**.
- ▶ Install humidity sensor **1**.

Tightening instruction for humidity sensor screws		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	15 Nm	

Tab. 118: Tightening instruction 11691847-002

▶ Tighten screws of humidity sensor **1** according to tightening instruction.

▶ Connect electrical plug connection to humidity sensor **1**.

Installing the lambda NO_x sensor

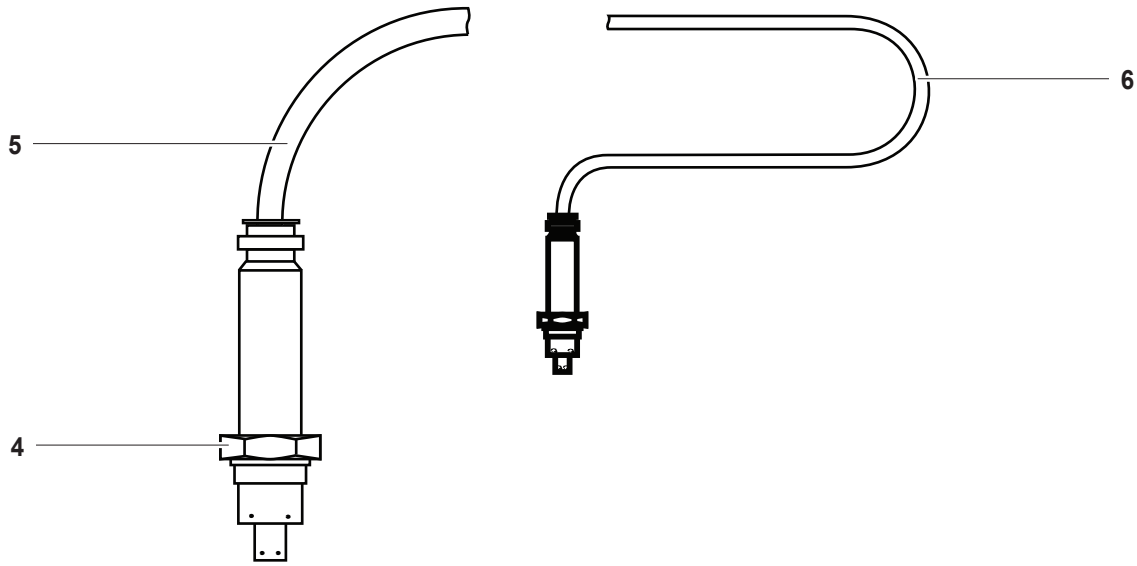
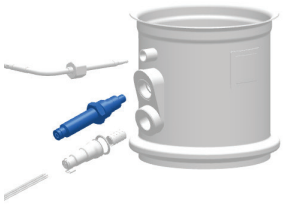


Fig. 598: Lambda NO_x sensor

4 Hexagon
5 Sensor cable
6 180° loop

▶ Make sure that the internal thread of the sensor pipe is clean.

▶ Screw new lambda NO_x sensor into hole of sensor pipe.

Tightening instruction for NO_x sensor		
Lubricant (thread and head contact surface)	Anti-Seize "High-Tech" Montagespray AS 400	
Screw locking (thread)	-	
Sensor	2x reusable	
Stage	**Tightening torque**	
1.	50 $^{\pm 10}$ Nm	

Tab. 119: Tightening instruction 11692122-007

▶ Lubricate hexagon **4** according to tightening instruction.

▶ Tighten hexagon **4** according to tightening instruction.

▶ Lay sensor cable **5** in 180° loop **6**.

▶ Make sure that the sensor cable **5** is not kinked.

▶ Connect the sensor cable **5** to the control unit.

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Installing the temperature sensor

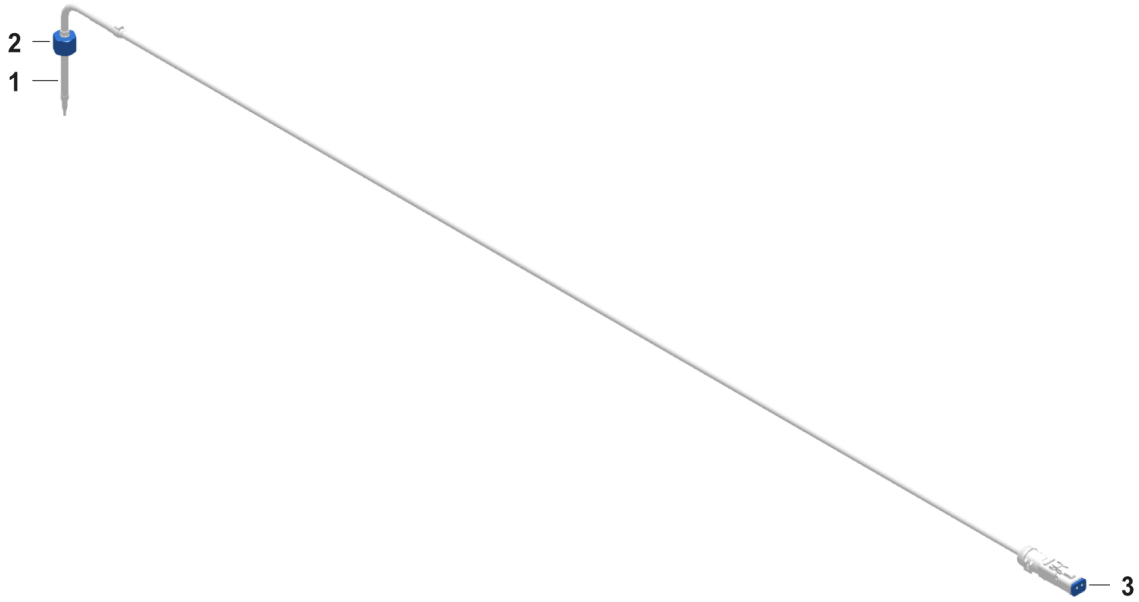
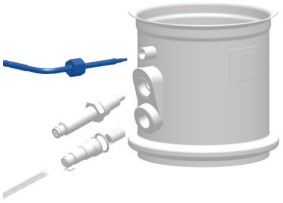


Fig. 600: Exhaust regulation sensors

1 Temperature sensor
2 Box nut
3 Electrical plug connection

▶ Make sure that the thread of the sensor pipe is clean.

▶ Install new temperature sensor **1** in hole of sensor pipe.

Tightening instruction for temperature sensor		
Lubricant (thread and head contact surface)	Anti-Seize "High-Tech" Montage-spray AS 400	
Screw locking (thread)	-	
Sensor	Not reusable	
Stage	**Tightening torque**	
1.	35^{+5} Nm	

Tab. 120: Tightening instruction 11692124-005

▶ Lubricate box nut **2** according to tightening instruction.

▶ Tighten box nut **2** according to tightening instruction.

▶ Make sure that the sensor cable is not kinked.

▶ Connect electrical plug connection **3** to control unit.

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3.13.4 Removing and installing the reduction agent pump

Removing the reduction agent pump

Representation	Description	Required number	Part number
	Tool for removing the air connection hoses of the reduction agent pump	1	11621284

Tab. 121: Special tool

CAUTION
Hot reduction agent and hot coolant!
Burns.

- ▶ Let the system including all liquids cool down to below 40 °C.
- ▶ Put on gloves.
- ▶ Put on safety glasses.

NOTICE
Improper maintenance!
Damage to pump system.

- ▶ Prevent electrostatic discharges.
- ▶ Do not touch electrical contacts.
- ▶ Observe ESD guidelines.

NOTICE
Improper maintenance!
Damage to pump system.

- ▶ During welding work in the surrounding area, make sure that the pump is separated from the surrounding area and that no electrical welding current flows through the pump system.

NOTICE
Improper wiring!
Damage to the electrical wiring.

- ▶ Lay cables and connection pieces for sensors at a sufficient distance from hot surfaces.
- ▶ Make sure that the cables and connection pieces do not chafe.

NOTICE
Improper handling!
Damage to pump system.

- ▶ To prevent errors, do not touch electrical contacts.

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NOTICE
Improper maintenance!
Damage.

▶ Do not dismantle reduction agent pump.

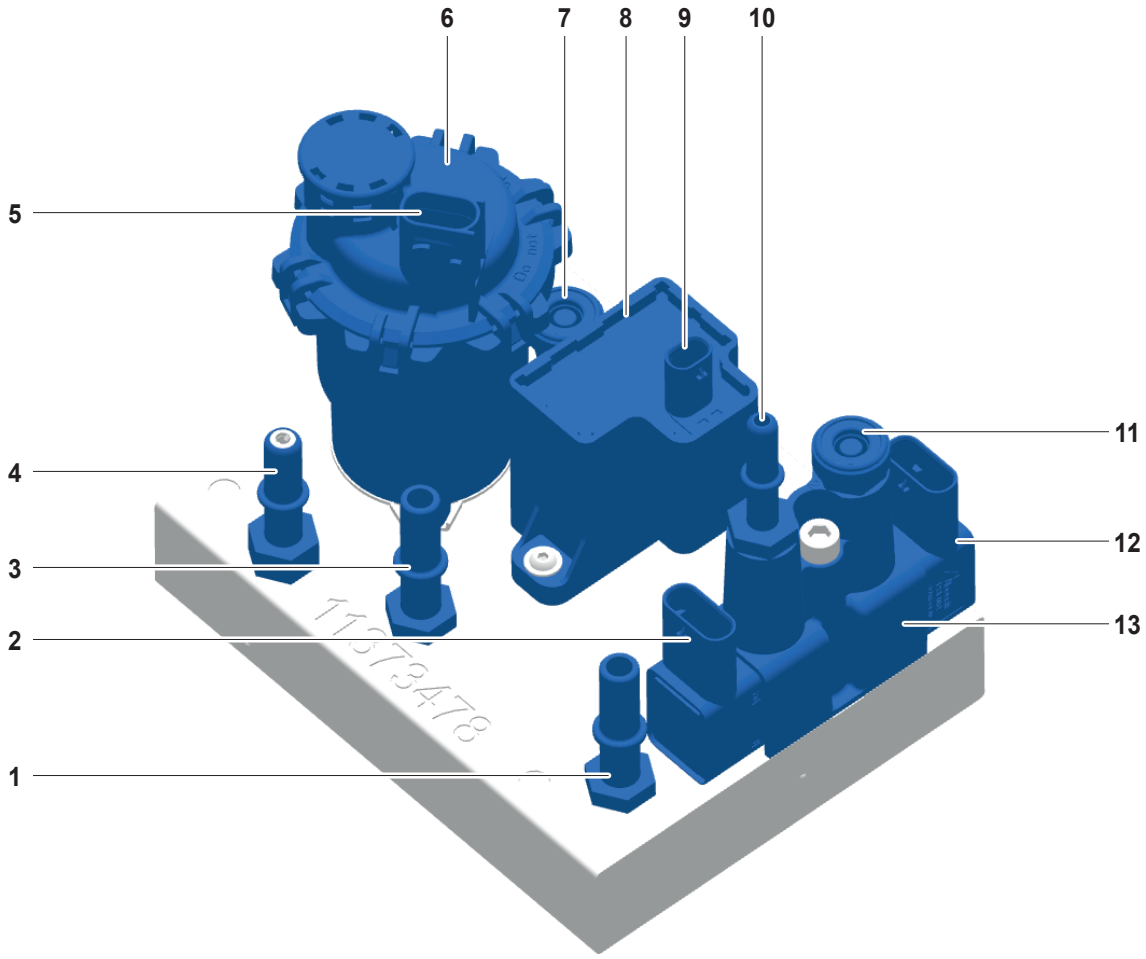

Fig. 603: Removing the reduction agent pump

1 Coolant connection
2 Reduction agent pressure sensor and temperature sensor
3 Coolant connection
4 Reduction agent connection from reduction agent tank
5 Reduction agent pump electrical connection
6 Reduction agent pump
7 Inlet air connection
8 Switchover valve
9 Switchover valve electrical connection
10 Reduction agent connection to mixing section
11 Air connection to mixing section
12 Compressed air sensor
13 Sensor block

▶ Mark coolant lines with marker due to risk of confusion.

▶ Seal coolant lines with clamping tongs.

▶ Remove quick release coolant connection **1**.

▶ Seal openings.

▶ Remove quick release coolant connection **3**.

- ▶ Seal openings.
- ▶ Remove air connection to mixing section **11** with special tool.
- ▶ Seal openings.
- ▶ Remove inlet air connection **7** with special tool.
- ▶ Seal openings.
- ▶ Mark reduction agent connection from reduction agent tank **4** and reduction agent connection to mixing section **10** with marker due to risk of confusion.
- ▶ Remove quick release reduction agent connection from reduction agent tank **4**.
- ▶ Seal openings.
- ▶ Remove quick release reduction agent connection to mixing section **10**.
- ▶ Seal openings.
- ▶ Remove switchover valve electrical connection **9**.
- ▶ Remove air pressure sensor **12**.
- ▶ Remove reduction agent pressure sensor and temperature sensor **2**.
- ▶ Remove reduction agent pump electrical connection **5**.

Installing the reduction agent pump

NOTICE
Improper assembly of urea lines or coolant lines!
Damage of engine or SCR exhaust system.

- ▶ Install marked coolant lines on correct connections.
- ▶ Install marked urea lines on correct connections.

NOTICE
Improper assembly!
Connect quick couplings with low pressure. Pay attention to “clicking sound” of quick coupling.

- ▶ Connect with low pressure.

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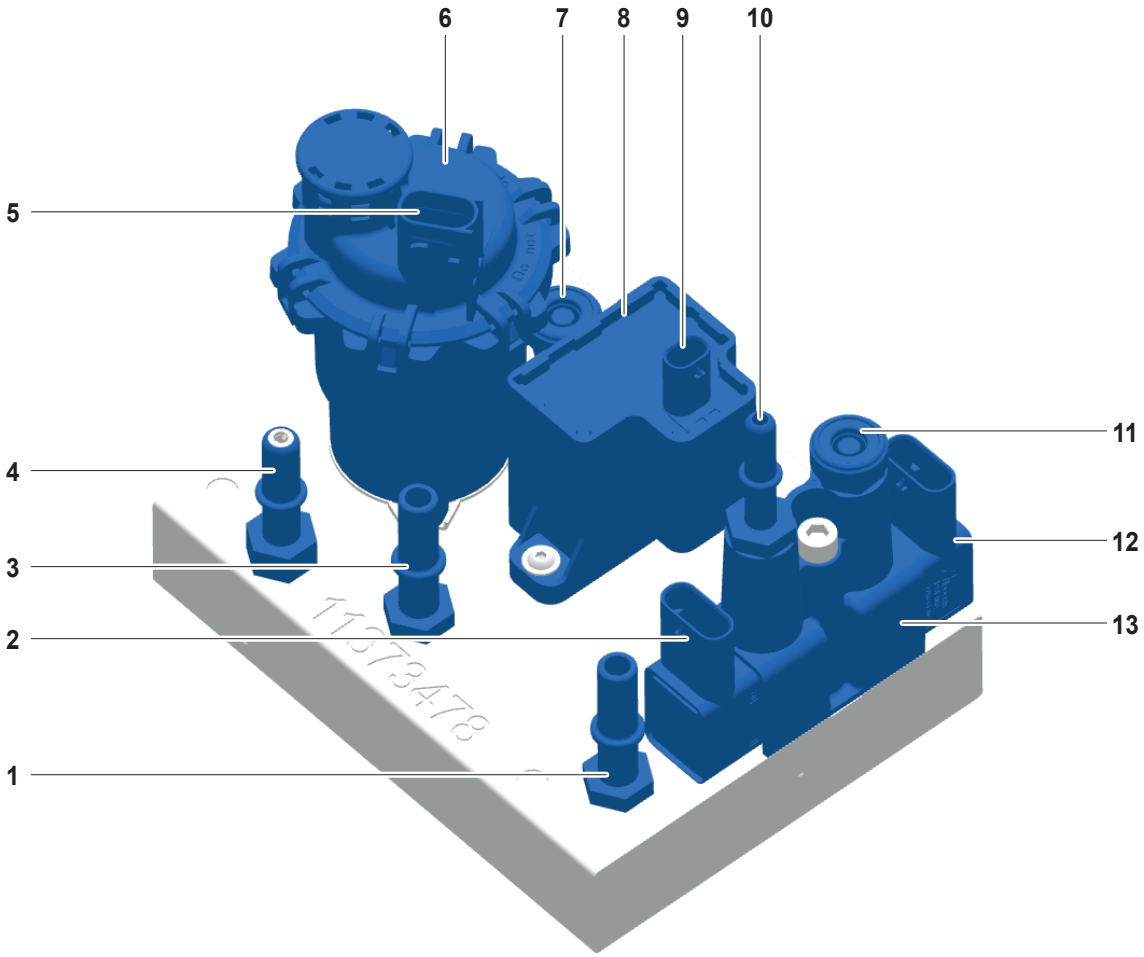

Fig. 604: Installing the reduction agent pump

1 Coolant connection
2 Reduction agent pressure sensor and temperature sensor
3 Coolant connection
4 Reduction agent connection from reduction agent tank
5 Reduction agent pump electrical connection
6 Reduction agent pump
7 Inlet air connection
8 Switchover valve
9 Switchover valve electrical connection
10 Reduction agent connection to mixing section
11 Air connection to mixing section
12 Compressed air sensor
13 Sensor block

- ▶ Align reduction agent pump.
- ▶ Tighten reduction agent pump with fastening screws with tightening torque of 7 Nm.
- ▶ Install reduction agent connection from reduction agent tank **4**.
- ▶ Install reduction agent connection to mixing section **10**.
- ▶ Install inlet air connection **7**.
- ▶ Install air connection to mixing section **11**.
- ▶ Install coolant connection **3**.
- ▶ Install coolant connection **1**.
- ▶ Install switchover valve electrical connection **9**.

- ▶ Install air pressure sensor **12**.
- ▶ Install reduction agent pressure sensor and temperature sensor **2**.
- ▶ Install reduction agent pump electrical connection **5**.

3.13.5 Exhaust gas mixing tube

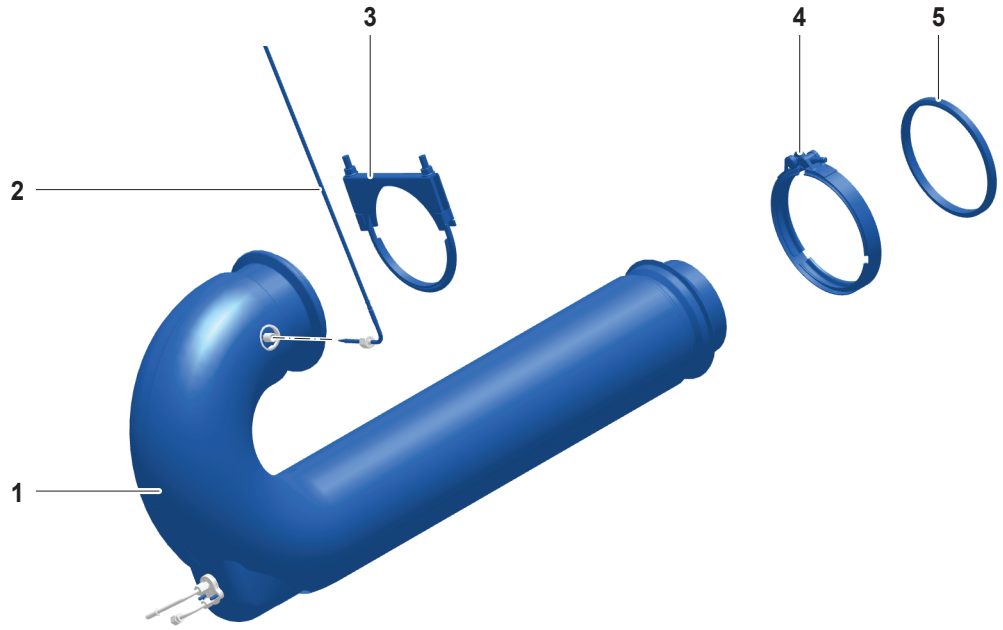

Fig. 605: Exhaust gas mixing tube

1 Exhaust gas mixing tube
2 Temperature sensor
3 Bracket clip
4 Profile clamp
5 Seal

Removing the exhaust gas mixing tube

Make sure that the following prerequisites are met:
- ❑ Reduction agent injector is removed.
- ❑ Seal **5** is removed.
- ❑ Device side exhaust pipe is fastened.
- ❑ SCRonly inlet module is fastened.

- ▶ Open and remove the profile clamp **4**.
- ▶ Remove the bracket clip **3**.
- ▶ Remove mixing pipe **1**.

Installing the exhaust gas mixing tube

- ▶ Slide mixing pipe **1** on nozzle on inlet module.
- ▶ Install the bracket clip **3**.
- ▶ Put on the profile clamp **4**.
- ▶ Tighten the profile clamp **4** with 23 $^{\pm 2}$ Nm .

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3.13.6 Removing and installing the reduction agent injector

Removing the reduction agent injector

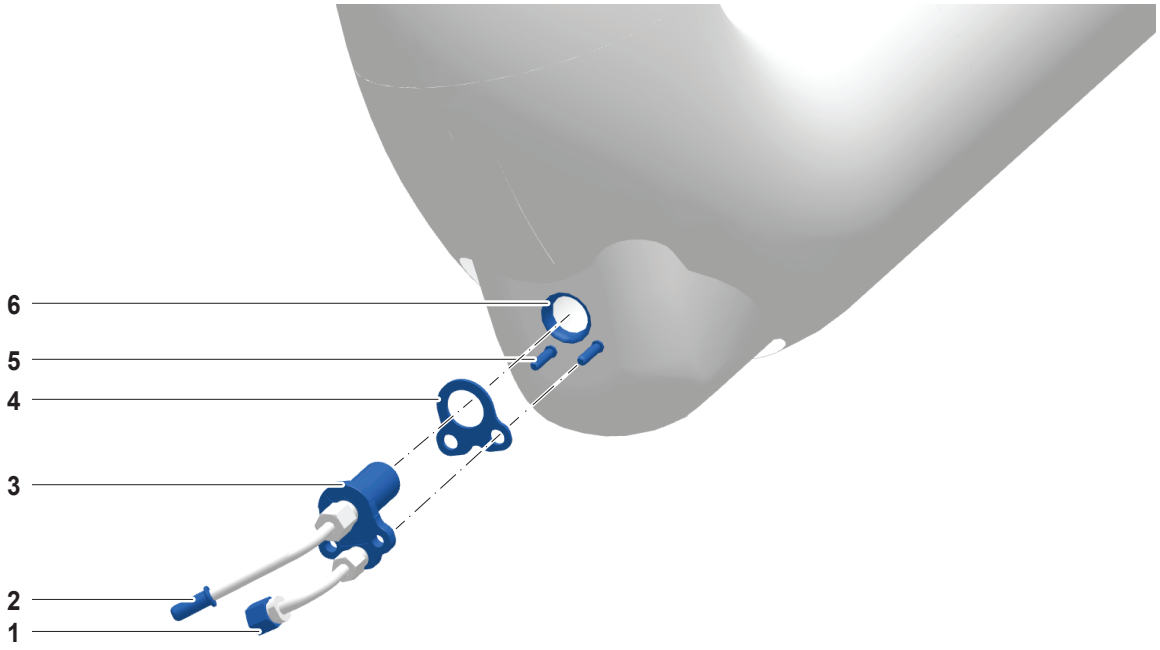

Fig. 606: Removing the reduction agent injector

1 Compressed air connection
2 Reduction agent line connection
3 Reduction agent injector
4 Seal
5 Grub screw (2x)
6 Hole

▶ Unscrew lock nuts.

▶ Remove washers.

▶ Remove reduction agent injector **3**.

▶ Remove seal **4**.

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Installing the reduction agent injector

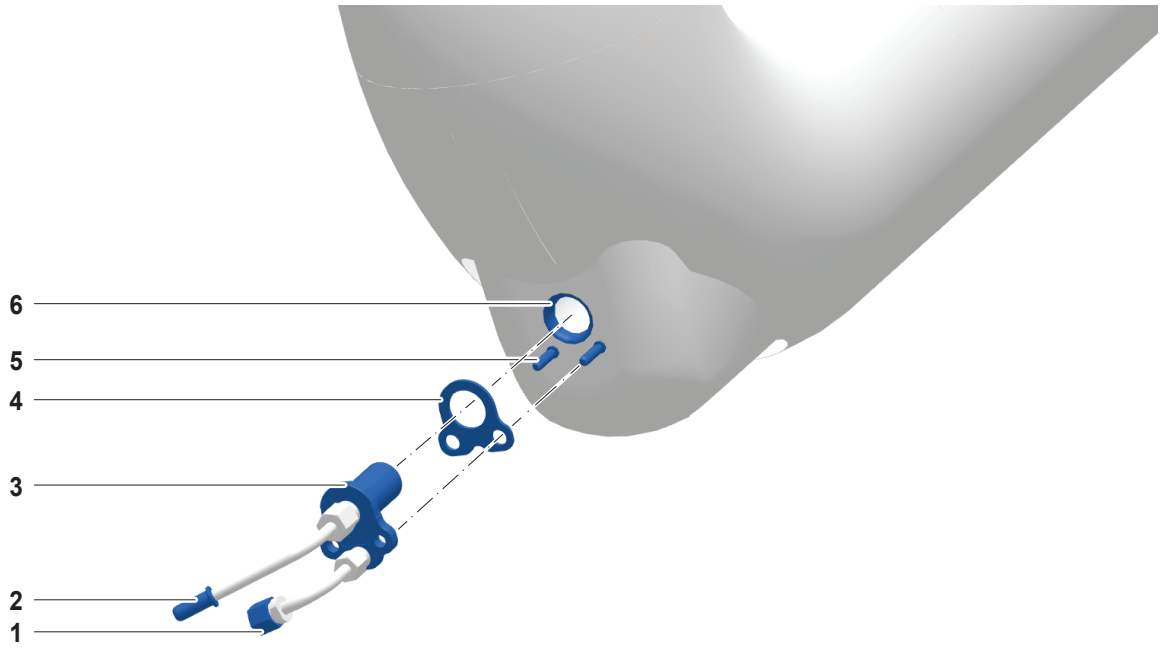

Fig. 607: Installing the reduction agent injector

1	Compressed air connection	**4**	Seal
2	Reduction agent line connection	**5**	Grub screw (2x)
3	Reduction agent injector	**6**	Hole

- ▶ Make sure that the reduction agent line connection **2** and compressed air connection **1** are tightened.
- ▶ Install new seal **4** on grub screws **5**.
- ▶ Make sure that there is no dirt on and under the reduction agent injector **3**.
- ▶ Spray grub screw **5** with Anti-Seize “High-Tech” assembly spray AS 400.
- ▶ Install reduction agent injector **3** on grub screws **5** and simultaneously install in hole.
- ▶ Install washers on grub screws **5**.

Tightening instruction for lock nut		
Lubricant (thread and head contact surface)	-	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	5 Nm	

Tab. 122: Tightening instruction 12474378-002

- ▶ Tighten lock nuts according to tightening instruction.

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3.13.7 Removing and installing the sensor pipe

Removing the sensor pipe

Make sure that the following prerequisites are met:

- ❑ Temperature sensor is removed. (For more information see: Removing the temperature sensor, page 484.)
- ❑ Lambda NO_x sensor is removed. (For more information see: Removing the lambda NO_x sensor, page 485.)

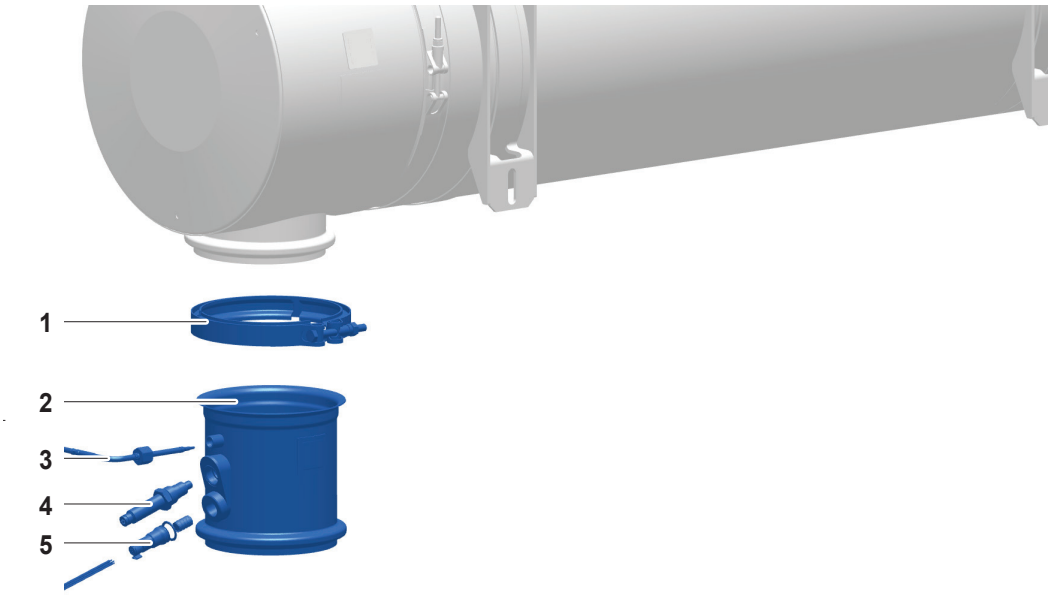

Fig. 608: Removing the sensor pipe

1 V-band clamp
2 Sensor pipe
3 Temperature sensor
4 Lambda NO_x sensor
5 NH_3 sensor

▶ Remove V-band clamp **1**.

▶ Remove sensor pipe **2**.

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Installing the sensor pipe

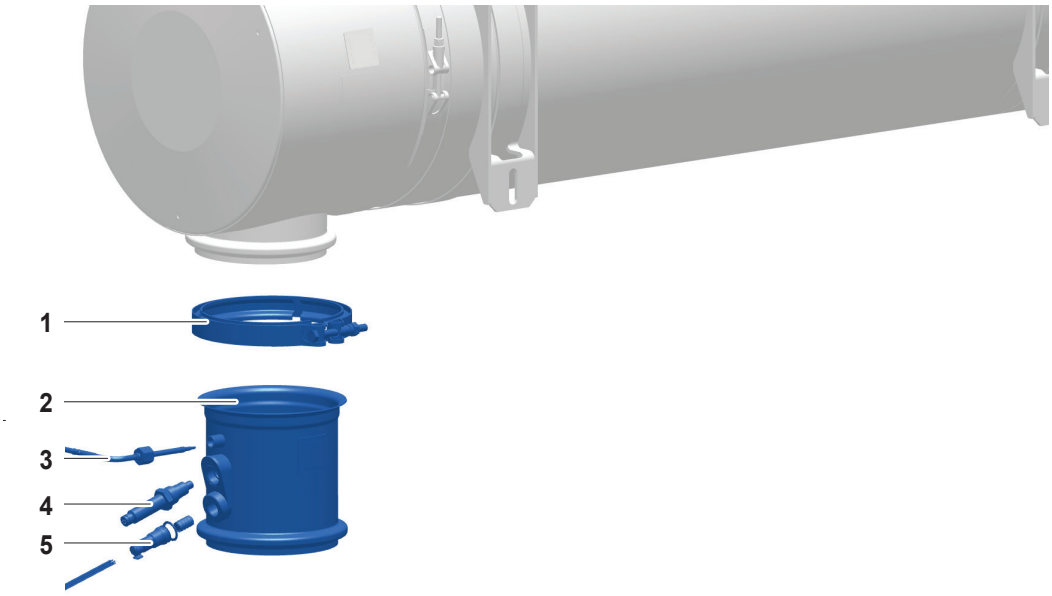

Fig. 609: Installing the sensor pipe

1 V-band clamp
2 Sensor pipe
3 Temperature sensor
4 Lambda NO_x sensor
5 NH_3 sensor

▶ Install sensor pipe **2**.

▶ Install V-band clamp **1**.

▶ Tighten V-band clamp **1** with $23^{\pm 2}$ Nm .

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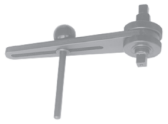
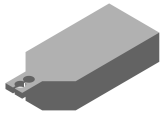
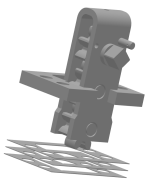
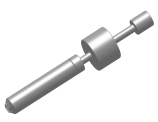
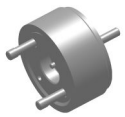
4 Tools and devices

4.1 Tools

4.1.1 Special tools

Representation	Description	Required number	Part number
	Angle of rotation device for 1/2” drive	1	0524062
	Angle of rotation device for 3/4” drive	1	10023839
	Dial gauge (universal)	1	11127327
	Dial gauge holder (universal)	1	10023385
	Turning device	1	10123791
	Turning device	1	9078688
	Valve jack	1	10354008
	Assembly device	1	10023928

Representation	Description	Required number	Part number
	Mounting sleeve	1	10023909
	Assembly tool	1	11211940
	Holding device	2	10118850
	Piston strap	1	8000592
	Piston ring pliers	1	7009319
	Extraction device	1	0528462
	Extractor for radial shaft sealing ring	1	7019858
	Press-in tool	1	10118887
	Lifting device	1	11067454
	Press-in tool	1	10118886
	Jacking screw (M18)	4	10129075

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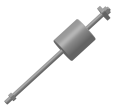
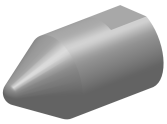
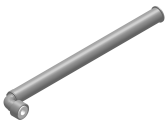
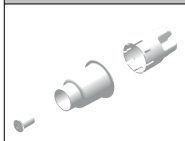
Representation	Description	Required number	Part number
	Special wrench width across flats 17 for injection pipes	1	10020852
	Special wrench width across flats 19 for injection pipes	1	10289118
	Extraction device	1	0524072
	Adapter for extraction device 0524072	1	12440945
	Extraction device for injector	1	11355589
	Assembly tool for injector (centering aid)	1	10153847
	Replacement tip for assembly tool for injector [10153847]	As needed	10148425
	Drain hose	1	12690422
	Drain hose 90°	1	12690423
	Assembly device	1	12973095
	M8 assembly pin	2	0524059
	Assembly pin (M10)	2	12214084

Representation	Description	Required number	Part number
	Assembly pin (M12)	2	0528471
	Assembly pin (M16)	2	0528470
	Assembly pin (M18)	2	10118882
	Lifting traverse	1	10815480

Tab. 123: Special tool

4.1.2 Locking pieces

Representation	Description	Required number	Part number
	Fuel lines/high pressure pump protecting cap	1	12489819
	Covering caps	1	10129392
	Universal protector	1	10145185
	Suction throttle valve sealing cap	1	11835061

Representation	Description	Required number	Part number
	Covering caps kit for injector LI2.7-22	1	12503031

Tab. 124: Locking pieces

4.1.3 Diagnostic tools

▶ For information on diagnostic tools, see diagnostics software operating instructions.

4.2 Devices

4.2.1 Lifting traverse with three-point-raising

DANGER
Pulling out of the lifting devices on the engine and falling of the engine!
Leads to death or serious crushing.

- ▶ Make sure that no one is standing or walking under suspended loads.
- ▶ Maintain safety distance.
- ▶ Observe maximum weight for lifting points.
- ▶ Maintain a maximum of a 10° deviation from the vertical to the engine axis.
- ▶ Use a Liebherr lifting traverse.
- ▶ Take safety instructions / warning signs from the operator's manual of the lifting traverse into account.
- ▶ Observe national and international guidelines for lifting heavy loads.
- ▶ Make sure that no persons reside in the danger zone (see safety chapter).
- ▶ Remove the transmission or other attachments before lifting the diesel engine.

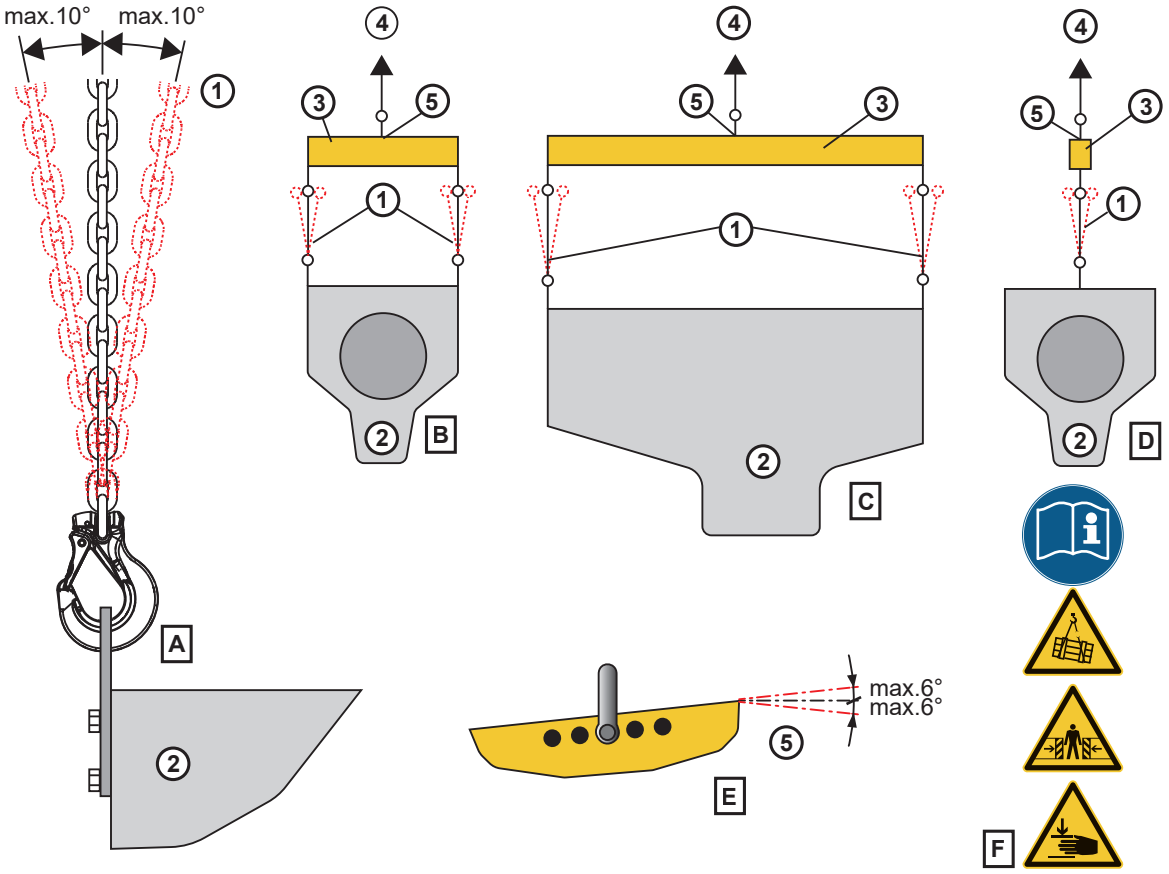


Fig. 650: Lifting the engine

A Transport device detail view

1 Tolerance for maximum deviation of motor axis

See next page for continuation of the image legend

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B Front / rear view of two lateral transport devices
C Side engine view
D Front / rear view of lateral transport device
E Lifting traverse lifting point detail view
F Take lifting traverse warning signs, lifting traverse operator's manual into account.
2 Crankcase
3 Lifting traverse
4 Engine lifting traverse lifting point (observe maximum total load)
5 Tolerance for maximum horizontal deviation

Note

▶ Before commissioning the lifting traverse, carefully read and follow the description included in the scope of delivery and the safety instructions included therein.

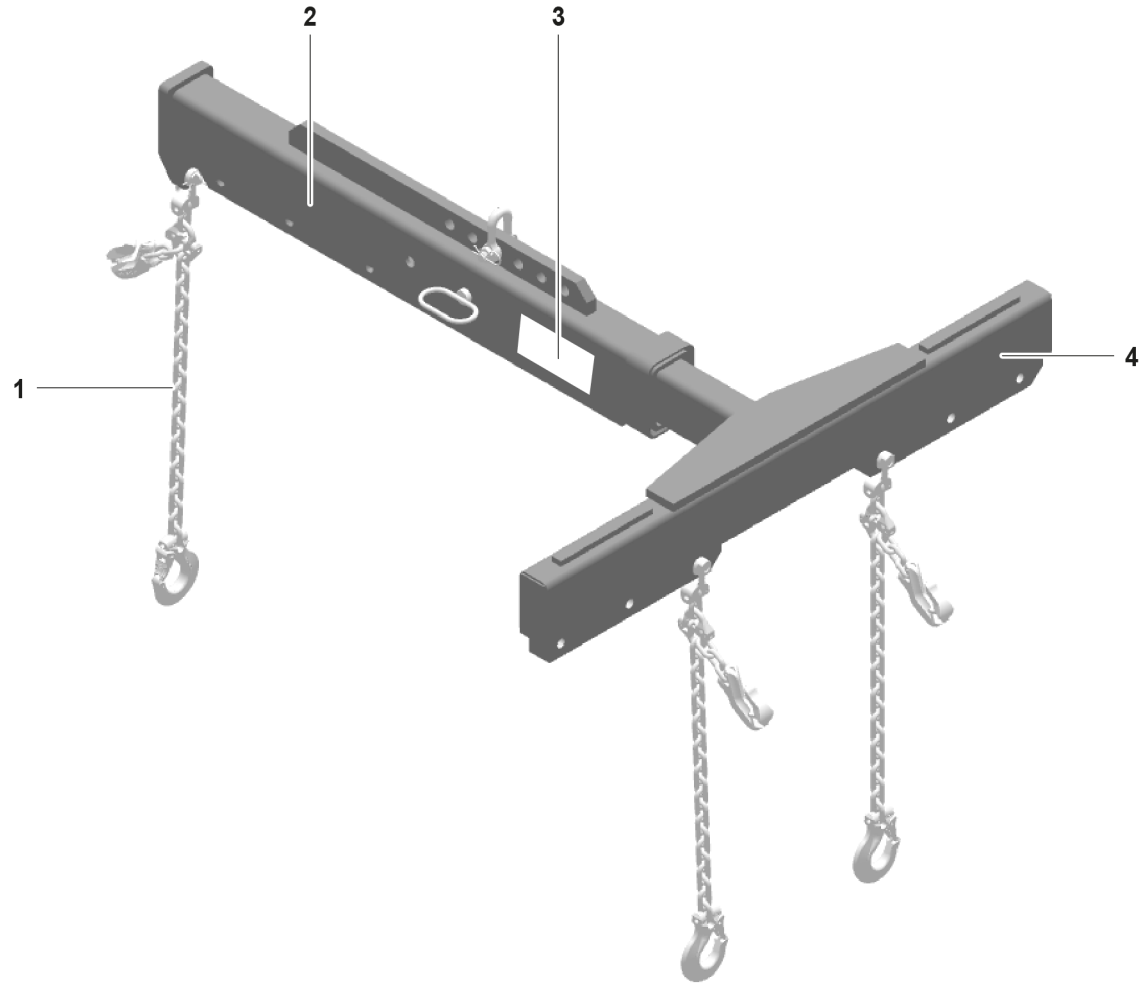
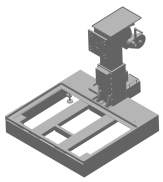
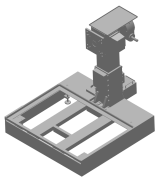
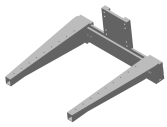
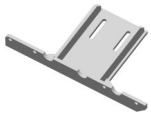


Fig. 651: Lifting traverse basic version

1 Chain suspension (3x)
2 Reception tube
3 Attachment point sign
4 T-slide piece

4.2.2 Engine assembly stand and adapter

Representation	Description	Required number	Part number
	Assembly stand (mechanical)	1	10471324
	Assembly stand (electric)	1	12696052
	Universal mount	1	10467810
	Right front adapter	1	10467813
	Left front adapter	1	10467817
	Right rear adapter	1	10472284
	Left rear adapter	1	10472383

Tab. 125: Engine assembly stand and adapter

4.2.3 Removing and installing the lifting hook

Removing the lifting hook

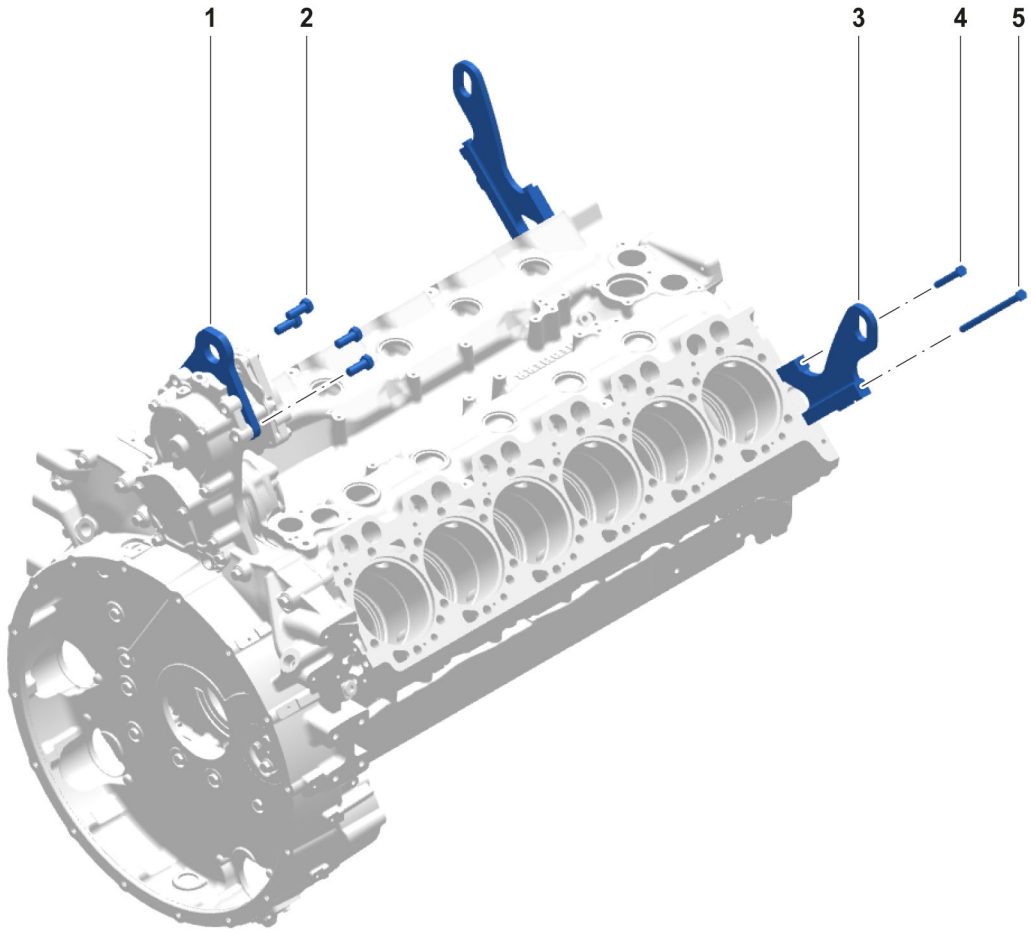


Fig. 659: Lifting hook

1 Lifting hook
2 Hex head screw (4x)
3 Lifting hook (2x)
4 Hex head screw (2x)
5 Hex head screw (2x)

- ▶ Unscrew hex head screws **2**.
- ▶ Remove lifting hook **1**.
- ▶ Unscrew hex head screws **4**.
- ▶ Unscrew hex head screws **5**.
- ▶ Remove lifting hook **3**.

Cleaning the lifting hook

- ▶ Clean contact surface of lifting hook **1**.
- ▶ Clean contact surface of flywheel housing.
- ▶ Clean contact surfaces of lifting hook **3**.
- ▶ Clean contact surfaces of crankcase.

Installing the lifting hook

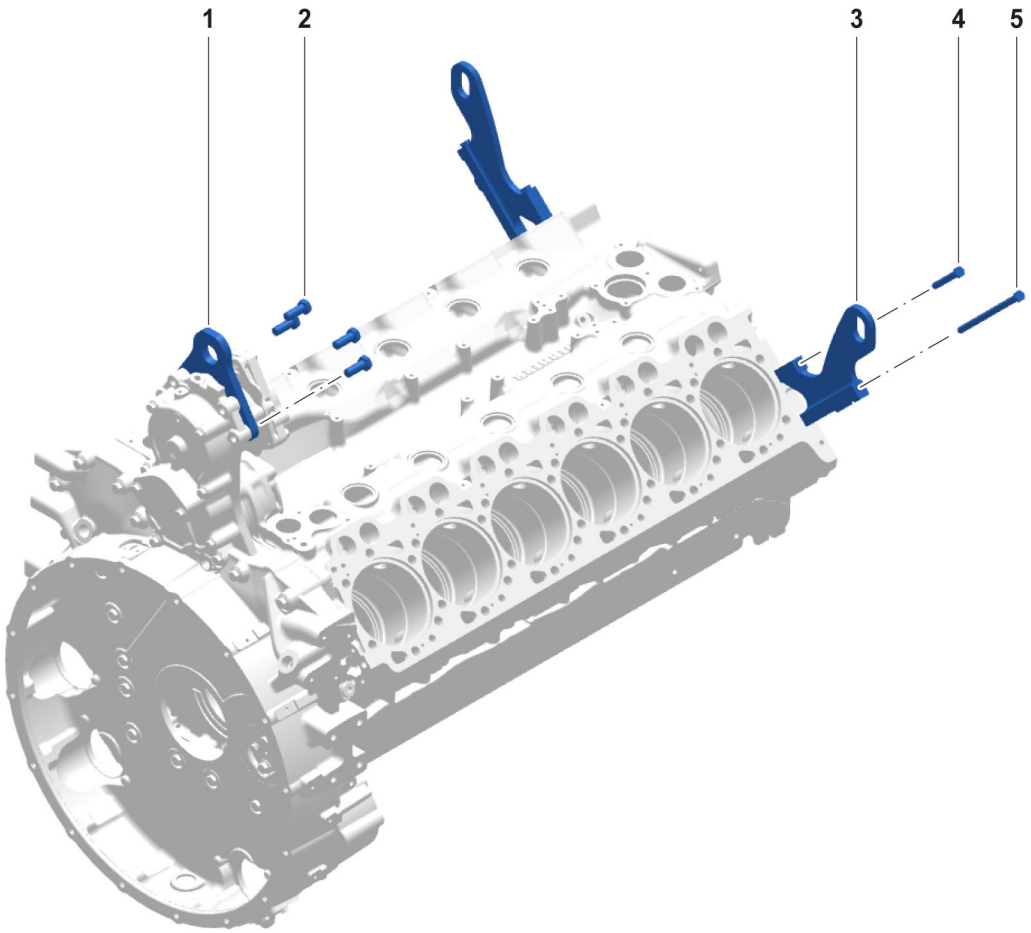
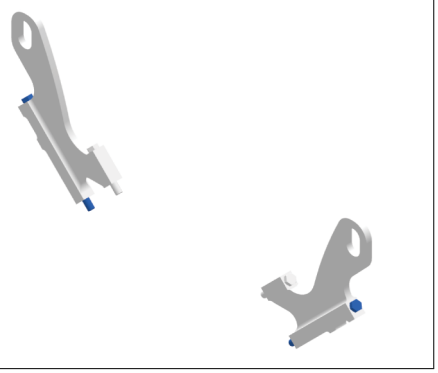


Fig. 660: Lifting hook

1 Lifting hook
2 Hex head screw (4x)
3 Lifting hook (2x)
4 Hex head screw (2x)
5 Hex head screw (2x)

▶ Install lifting hook **3**.

▶ Tighten hex head screws **4**.

Tightening instruction for hex head screw		
Lubricant (thread and head contact surface)	Engine oil	
Locking agent (thread)	-	
Screws	Reusable	
Stage	**Tightening torque**	
1.	104 Nm	

Tab. 126: Tightening instruction 10126728-000

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- ▶ Tighten hex head screws **5** according to tightening instruction.
- ▶ Install lifting hook **1**.
- ▶ Tighten hex head screws **2**.

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5 Assembly agents

Use the following locking agent, sealant and greases for repair and maintenance work. Refer to the respective work description for the application.

Note

Safety data sheets for assembly agents, see manufacturer's website.

Locking agent			
Designation	**Part number**	**Quantity**	**Manufacturer information**
Loctite® 243	811205708	50 ml	https://www.henkel-adhesives.com
Loctite® 278	811200908	50 ml	https://www.henkel-adhesives.com
Loctite® 572	870001914	50 ml	https://www.henkel-adhesives.com
Loctite® 2701	811208001	50 ml	https://www.henkel-adhesives.com

Tab. 127: Locking agent

Sealant			
Designation	**Part number**	**Quantity**	**Manufacturer information**
Loctite® 577	811201314	50 ml	https://www.henkel-adhesives.com
Loctite® 5910	10354595	300 ml	https://www.henkel-adhesives.com
Weicon® Black seal	12697087	85 ml	https://www.weicon.de

Tab. 128: Sealant

Lubricants			
Designation	**Part number**	**Quantity**	**Manufacturer information**
NBU 30 grease	10285708	1 kg	https://www.klueber.com
Motorex 14	10002552	850 g	https://www.motorex.com
Altemp QNB 50	10490569	80 g	https://www.klueber.com
Klüberplus S 06-100	12694669	1 kg	https://www.klueber.com
Ceramic grease	11830242	200 ml	https://www.techno-ag.ch/de/home.cfm
Anti-Seize "High-Tech" assembly spray AS 400	861203005	400 ml	htpp//:www.debus-spray.de

Tab. 129: Lubricants

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6 Appendix

6.1 Tightening torques

6.1.1 For hex bolts / cylinder screws / external hex bolts

For hex bolts according to:

– ISO 4014
– ISO 4017
– ISO 8765
– ISO 8676

For cylinder screws according to: DIN EN ISO 4762 (formerly DIN 912)

For external hex bolts according to: DIN 34800.

Values for an average coefficient of friction of μ = 0.12

Tightening torques valid for the following screw coatings:
– A2K (coating material= zinc; thickness= 5 µm; chromate coating= silver, bluish)
– bare (black)
– A3C/A2C (coating material= zinc; thickness= 8 µm; chromate coating= yellowish)

Standard thread	Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
Strength class	8.8		10.9		12.9	
M4	3	2	4	3	5	4
M5	6	4	8	6	10	7
M6	10	7	14	10	17	13
M7	16	12	23	17	27	20
M8	23	17	34	25	40	30
M10	46	34	68	50	79	58
M12	79	58	117	86	135	100
M14	125	92	185	136	215	159
M16	195	144	280	207	330	243
M18	280	207	390	288	460	339
M20	390	288	560	413	650	479
M22	530	391	750	553	880	649
M24	670	494	960	708	1120	826
M27	1000	738	1400	1033	1650	1217
M30	1350	996	1900	1401	2250	1660

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Standard thread	Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
M33	1850	1364	2600	1918	3000	2213
M36	2350	1733	3300	2434	3900	2876
M39	3000	2213	4300	3172	5100	3762

Tab. 130: Tightening torques for metric standard thread

Standard thread	Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
Strength class	8.8		10.9		12.9	
M 8 x 1	25	18	36	27	43	32
M 9 x 1	36	27	53	39	62	46
M 10 x 1	52	38	76	56	89	66
M 10 x 1.25	49	36	72	53	84	62
M 12 x 1.25	87	64	125	92	150	111
M 12 x 1.5	83	61	122	90	145	107
M 14 x 1.5	135	100	200	148	235	173
M 16 x 1.5	205	151	300	221	360	266
M 18 x 1.5	310	229	440	325	520	384
M 18 x 2	290	214	420	310	490	361
M 20 x 1.5	430	317	620	457	720	531
M 22 x 1.5	580	428	820	605	960	708
M 24 x 1.5	760	561	1090	804	1270	937
M 24 x 2	730	538	1040	767	1220	900
M 27 x 1.5	1110	819	1580	1165	1850	1364
M 27 x 2	1070	789	1500	1106	1800	1328
M 30 x 1.5	1540	1136	2190	1615	2560	1888
M 30 x 2	1490	1099	2120	1564	2480	1829
M 33 x 1.5	2050	1512	2920	2154	3420	2522
M 33 x 2	2000	1475	2800	2065	3300	2434
M 36 x 1.5	2680	1977	3820	2817	4470	3297
M 36 x 3	2500	1844	3500	2581	4100	3024
M 39 x 1.5	3430	2530	4890	3607	5720	4219
M 39 x 3	3200	2360	4600	3393	5300	3909

Tab. 131: Tightening torques for metric fine thread

For hex bolts according to:

– DIN 6921
– DIN EN 1665

For cylinder screws according to: DIN EN ISO 4762 (formerly DIN 912)

Values for an average coefficient of friction of μ = 0.12

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Tightening torques valid for the following screw coatings:
– PHR (phosphated/black)
– flZn (zinc flake coating/gray)
– 480H (galvanized according to DIN 50979/zinc flake coating according to ISO10683/silver)

Standard thread	Nm	Nm
Strength class	8.8	10.9
M4	2.2	3.3
M5	4.5	7
M6	8	12
M7	13	19
M8	19	28
M10	38	55
M12	65	95
M14	104	150
M16	158	234
M18	230	326
M20	320	450

Tab. 132: Tightening torques for metric standard thread

Standard thread	Nm	Nm
Strength class	8.8	10.9
M 8 x 1	20	29
M 9 x 1	29	42
M 10 x 1	40	59
M 10 x 1.25	39	57
M 12 x 1.25	69	102
M 12 x 1.5	67	99
M 14 x 1.5	109	160
M 16 x 1.5	165	240
M 18 x 1.5	245	350
M 18 x 2	238	335
M 20 x 1.5	340	480

Tab. 133: Tightening torques for metric fine thread

6.1.2 For locking screws and banjo bolts

Banjo bolts according to DIN 7643.

Locking screws according to DIN 910.

Locking screws according to DIN 908.

With copper seal according to DIN 7603:

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Standard thread	Nm	ft/lb	Standard thread	Nm	ft/lb
M 6 x 1	7	5	**M 20 x 1.5**	47	35
M 8 x 1	7.5	6	**M 22 x 1.5**	57	42
M 8 x 1.5	7.5	6	**M 24 x 1.5**	68	50
M 10 x 1	15	11	**M 26 x 1.5**	75	55
M 10 x 1.25	15	11	**M 27 x 2**	87	64
M 12 x 1.5	20	15	**M 30 x 1.5**	115	85
M 14 x 1.5	27	20	**M 30 x 2**	115	85
M 16 x 1.5	37	27	**M 33 x 2**	120	89
M 18 x 1.5	40	30	**M 36 x 1.5**	155	114
M 36 x 2	155	114	**M 52 x 1.5**	380	280
M 38 x 1.5	171	126	**M 52 x 2**	380	280
M 39 x 2	215	159	**M 56 x 2**	430	317
M 42 x 1.5	240	177	**M 60 x 2**	510	376
M 42 x 2	240	177	**M 64 x 2**	570	420
M 45 x 1.5	270	199	**M 65 x 2**	620	457
M 45 x 2	270	199			
M 48 x 1.5	300	221			
M 48 x 2	300	221			

Tab. 134: Tightening torques for locking screws and banjo bolts

6.1.3 Standard torques for metric flange connections

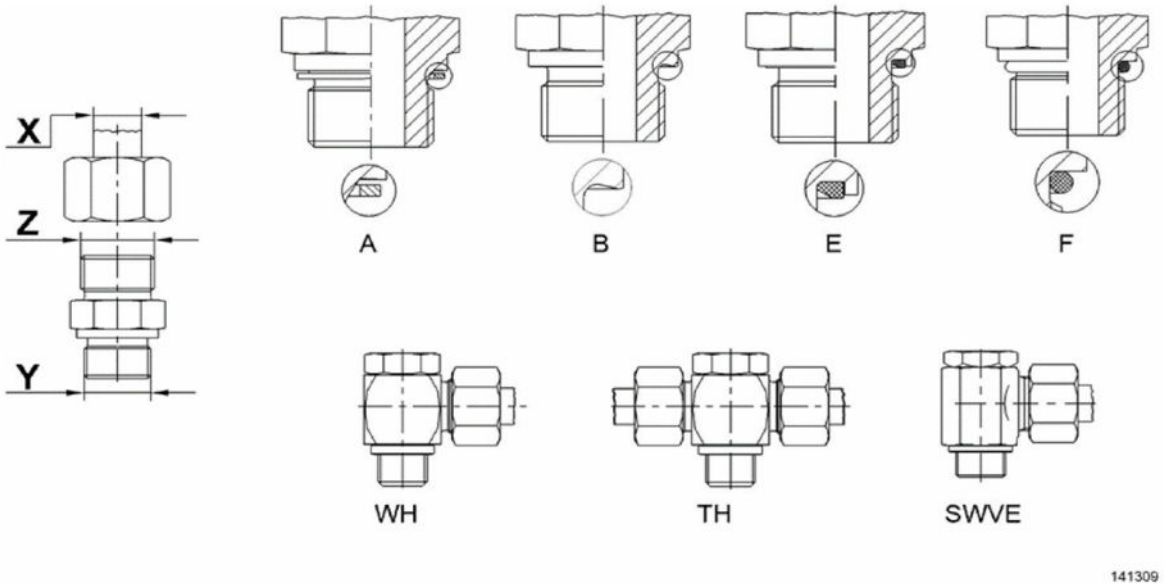

Fig. 662: Overview of flange connections

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Note

- ▶ Tightening torques apply for mating material: Steel.
- ▶ Tolerance for the tightening torques stated in the table: + 10 %.
- ▶ Lubricate the screw-in thread with engine oil before screwing it in.

6.1.4 Metric screw connection series L (light) (up to 500 bar/7252 Psi)

Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal		Form F with o-ring	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**M 10 x 1.0**	9	7	18	13	18	13	15	11
8	**M 12 x 1.5**	20	15	30	22	25	18	25	18
10	**M 14 x 1.5**	35	26	45	33	45	33	35	26
12	**M 16 x 1.5**	45	33	65	48	55	41	40	30
15	**M 18 x 1.5**	55	41	80	59	70	52	45	33
18	**M 22 x 1.5**	65	48	140	103	125	92	60	44
22	**M 26 x 1.5**	90	66	190	140	180	133	100	74
28	**M 33 x 2.0**	150	111	340	251	310	229	160	118
35	**M 42 x 2.0**	240	177	500	369	450	332	210	155
42	**M 48 x 2.0**	290	214	630	465	540	398	260	192

Tab. 135: Metric screw connection series L (light), part 1

Pipe diameter X	Thread Y	WH		TH		SWVE	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**M 10 x 1.0**	18	13	18	13	18	13
8	**M 12 x 1.5**	45	33	45	33	35	26
10	**M 14 x 1.5**	55	41	55	41	50	37
12	**M 16 x 1.5**	80	59	80	59	60	44
15	**M 18 x 1.5**	100	74	100	74	80	59
18	**M 22 x 1.5**	140	103	140	103	120	89
22	**M 26 x 1.5**	320	236	320	236	130	96
28	**M 33 x 2.0**	360	266	360	266		
35	**M 42 x 2.0**	540	398	540	398		
42	**M 48 x 2.0**	700	516	700	516		

Tab. 136: Metric screw connection series L (light), part 2

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6.1.5 Metric screw connection series S (heavy) (up to 800 bar/11603 Psi)

Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**M 12 x 1.5**	20	15	35	26	40	30
8	**M 14 x 1.5**	35	26	55	41	40	30
10	**M 16 x 1.5**	45	33	70	52	70	52
12	**M 18 x 1.5**	55	41	110	81	90	66
14	**M 20 x 1.5**	55	41	150	111	125	92
16	**M 22 x 1.5**	65	48	170	125	135	100
20	**M 27 x 2.0**	90	66	270	199	180	133
25	**M 33 x 2.0**	150	111	410	302	310	229
30	**M 42 x 2.0**	240	177	540	398	450	332
38	**M 48 x 2.0**	290	214	700	516	540	398

Tab. 137: Metric screw connection series S (heavy), part 1

Pipe diameter X	Thread Y	WH		TH		SWVE	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**M 12 x 1.5**	45	33	45	33	35	26
8	**M 14 x 1.5**	55	41	55	41	50	37
10	**M 16 x 1.5**	80	59	80	59	60	44
12	**M 18 x 1.5**	100	74	100	74	80	59
14	**M 20 x 1.5**	125	92	125	92	110	81
16	**M 22 x 1.5**	135	100	135	100	120	89
20	**M 27 x 2.0**	320	236	320	236	135	100
25	**M 33 x 2.0**	360	266	360	266		
30	**M 42 x 2.0**	540	398	540	398		
38	**M 48 x 2.0**	700	516	700	516		

Tab. 138: Metric screw connection series S (heavy), part 2

6.1.6 Inch screw connection series L (light) (up to 500 bar/7252 Psi)

Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**G 1/8A**	9	7	18	13	18	13
8	**G 1/4A**	35	26	35	26	35	26
10	**G 1/4A**	35	26	35	26	35	26

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Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
12	**G 3/8A**	45	33	70	52	70	52
15	**G 1/2A**	65	48	140	103	90	66
18	**G 1/2A**	65	48	100	74	90	66
22	**G 3/4A**	90	66	180	133	180	133
28	**G 1A**	150	111	330	243	310	229
35	**G 1 1/4A**	240	177	540	398	450	332
42	**G 1 1/2A**	290	214	630	465	540	398

Tab. 139: Inch screw connection series S (light) - part 1

Pipe diameter X	Thread Y	WH		TH		SWVE	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**G 1/8A**	18	13	18	13	18	13
8	**G 1/4A**	45	33	45	33	40	30
10	**G 1/4A**	45	33	45	33	40	30
12	**G 3/8A**	70	52	70	52	65	48
15	**G 1/2A**	120	89	120	89	90	66
18	**G 1/2A**	120	89	120	89	90	66
22	**G 3/4A**	230	170	230	170	125	92
28	**G 1A**	320	236	320	236		
35	**G 1 1/4A**	540	398	540	398		
42	**G 1 1/2A**	700	516	700	516		

Tab. 140: Inch screw connection series S (light) - part 2

6.1.7 Inch screw connection series S (heavy) (up to 800 bar/11603 Psi)

Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**G 1/4A**	35	26	55	41	40	30
8	**G 1/4A**	35	26	55	41	40	30
10	**G 3/8A**	45	33	90	66	80	59
12	**G 3/8A**	45	33	90	66	80	59
14	**G 1/2A**	65	48	150	111	115	85
16	**G 1/2A**	65	48	130	96	115	85
20	**G 3/4A**	90	66	270	199	180	133
25	**G 1A**	150	111	340	251	310	229
30	**G 1 1/4**A	240	177	540	398	450	332

Pipe diam-eter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
38	**G 1 1/2A**	290	214	700	516	540	398

Tab. 141: Inch screw connection series S (heavy) - part 1

Pipe diameter X	Thread Y	WH		TH		SWVE	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**G 1/4A**	45	33	45	33	40	30
8	**G 1/4A**	45	33	45	33	40	30
10	**G 3/8A**	70	52	70	52	65	48
12	**G 3/8A**	70	52	70	52	65	48
14	**G 1/2A**	120	89	120	89	90	66
16	**G 1/2A**	120	89	120	89	90	66
20	**G 3/4A**	230	170	230	170	125	92
25	**G 1A**	320	236	320	236		
30	**G 1 1/4**A	540	398	540	398		
38	**G 1 1/2A**	700	516	700	516		

Tab. 142: Inch screw connection series S (heavy) - part 2

6.1.8 Metric thread unit series L (light) (up to 500 bar/7252 Psi) for aluminum

Pipe diameter X	Thread Y	Form A with sealing ring		Form B with sealing edge		Form E with flat (ED) seal	
		Nm	ft/lb	Nm	ft/lb	Nm	ft/lb
6	**M 10 x 1.0**	15	11			12	9
8	**M 12 x 1.5**						
10	**M 14 x 1.5**	30	22			30	22
12	**M 16 x 1.5**	40	30	40	30	40	30
15	**M 18 x 1.5**						
18	**M 22 x 1.5**	80	59			80	59
22	**M 26 x 1.5**	80	59			150	111
28	**M 33 x 2.0**						
35	**M 42 x 2.0**						
42	**M 48 x 2.0**						

Tab. 143: Metric thread unit series L (up to 500 bar/7252 Psi) for aluminum

Standard torques for cutting ring screw connections

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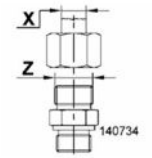

Fig. 663: Cutting ring flange connections

Series	Pipe diameter X	Standard thread Z	Nm	ft/lb
LL	**6**	**M 10 × 1**	14	10
L	**6**	**M 12 × 1.5**	14	10
	8	**M 14 × 1.5**	20	15
	10	**M 16 × 1.5**	27–30	20 - 22
	12	**M 18 × 1.5**	60	44
	15	**M 22 × 1.5**	105	77
	18	**M 26 × 1.5**	150	111
	22	**M 30 × 2**	200	148
	28	**M 36 × 2**	250	184
	35	**M 45 × 2**	450	332
	42	**M 52 × 2**	600	443
S	**16**	**M 24 × 1.5**	150	111
	20	**M 30 × 2**	250	184
	25	**M 36 × 2**	450	332
	30	**M 45 × 2**	600	443
	38	**M 52 × 2**	750	553

Tab. 144: Standard torques for cutting ring screw connections

Note

- ▶ Tighten screw connections with the prescribed tightening torque.
- ▶ Hold the screw connection in place.
- ▶ Screw on the box nut up until a clearly noticeable increase in force (without spanner extension).
- ▶ Tighten the box nut with the above-mentioned tightening torque.

Standard torques for Triple Lok® screw connections

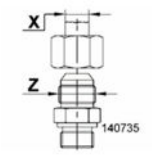

Fig. 664: Triple lock flange connections

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Series	Pipe diameter X		Standard thread Z	Nm	ft/lb	Nm	ft/lb
	mm	inch	UN/UNF	Steel		Stainless steel	
4	**6**	**1/4**	**7/17-20**	15	11	30	22
5	**8**	**5/16**	**1/2-20**	20	15	40	30
6	**10**	**3/8**	**9/16-18**	30	22	60	44
8	**12**	**1/2**	**3/4-16**	60	44	115	85
10	**14, 15, 16**	**5/8**	**7/8-14**	75	55	145	107
12	**18, 20**	**3/4**	**1 1/16-12**	110	81	180	133
16	**22**	**7/8**	**1 5/16-12**	135	100	225	166
	25	**1**	**1 5/16-12**	175	129	255	188
	28		**1 5/8-12**	260	192	295	218
20	**30, 32**	**1 1/4**	**1 5/8-12**	260	192	295	218
	35		**1 7/8-12**	340	251	345	254
24	**38**	**1 1/2**	**1 7/8-12**	340	251	345	254
28	**42**		**2 1/4-12**	380	280	400	295
32	**50**	**2**	**2 1/2-12**	450	332	470	347

Tab. 145: Standard torques for Triple Lok® screw connections

Note

- ▶ Screw tight the screw connections with the prescribed tightening torque.
- ▶ Hold the screw connection in place.
- ▶ Screw on the box nut up until a clearly noticeable increase in force (without spanner extension).
- ▶ Tighten the box nut with the above-mentioned tightening torque.

Standard torques for VSTI screw plugs

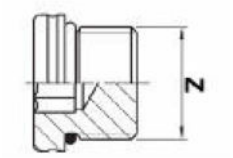

Fig. 665: VSTI screw plugs

Standard thread	Nm	ft/lb	Standard thread	Nm	ft/lb
M 10 x 1	10	7	**M 26 x 1.5**	100	74
M 12 x 1.5	20	15	**M 27 x 2**	120	89
M 14 x 1.5	30	22	**R 3/4”**	120	89
M 16 x 1.5	40	30	**M 30 x 1.5**	120	89
M 18 x 1.5	50	37	**M 33 x 2**	200	148

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Standard thread	Nm	ft/lb	Standard thread	Nm	ft/lb
M 20 x 1.5	60	44	**M 38 x 1.5**	280	207
M 22 x 1.5	80	59	**M 42 x 2**	350	258
M 24 x 1.5	90	66	**M 48 x 2**	400	295

Tab. 146: Standard torques for VSTI screw plugs

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Tightening torques