Service.

3,3 l V8 TDI Engine - Mechanicals

Design and Function

Self-Study Programme 226

10 years of TDI – The history of the TDI

1989

Audi presented the first diesel-powered passenger car with direct injection in the Audi 100.
The 2.5-ltr. 5 cylinder TDI developed 88 kW (120 bhp) and 265 Nm of torque. A short while later, an 85 kW (115 bhp) version conforming to the US standard valid at that time was launched. This engine was installed in over 20% of the Audi 100/A6 models.

1991

saw the introduction of the four-cylinder 1.9-ltr. TDI developing 66 kW (90 bhp) and 202 Nm of torque in the Audi 80.

1995

The performance-enhanced version of the 1.9-ltr. TDI developing 81 kW (115 bhp) and 235 Nm of torque came on the market. It was the first direct injection diesel to be equipped with a mapped exhaust gas turbocharger with variable turbine geometry (VTG).

The 103 kW (140 bhp) version of the 2.5-ltr. engine developing 290 Nm of torque was presented together with the permanent four-wheel drive quattro. This combination of two typical Audi technologies was to become a meteoric success.

1997

Audi laid a yet another milestone with the V6 4-valve TDI.
It was world's first six-cylinder direct injection engine diesel to be used in a passenger car. It is also the most powerful of the production TDIs, developing 110 kW (150 bhp) and 310 Nm of torque.

Audi has revolutionised the popular conception of diesels with its TDI engines, proving that this engine concept can even compete with the petrol engine in terms of dynamics and driving enjoyment, with the added advantage of 30% lower fuel consumption and outstanding bottom-end torque.
This engine therefore strikes a perfect balance between apparent opposites such as sporty driving on the one hand as well as eco-friendly mobility and long range on the other.
Audi perfected these qualities, as exemplified by the five-cylinder TDI from 1989, with the

V8 TDI Common Rail

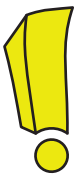
Contents

The Self-Study Programme informs you about designs and functions.

The Self-Study Programme is not a Workshop Manual!

Please refer to the relevant technical literature for all maintenance and repair instructions.

New!

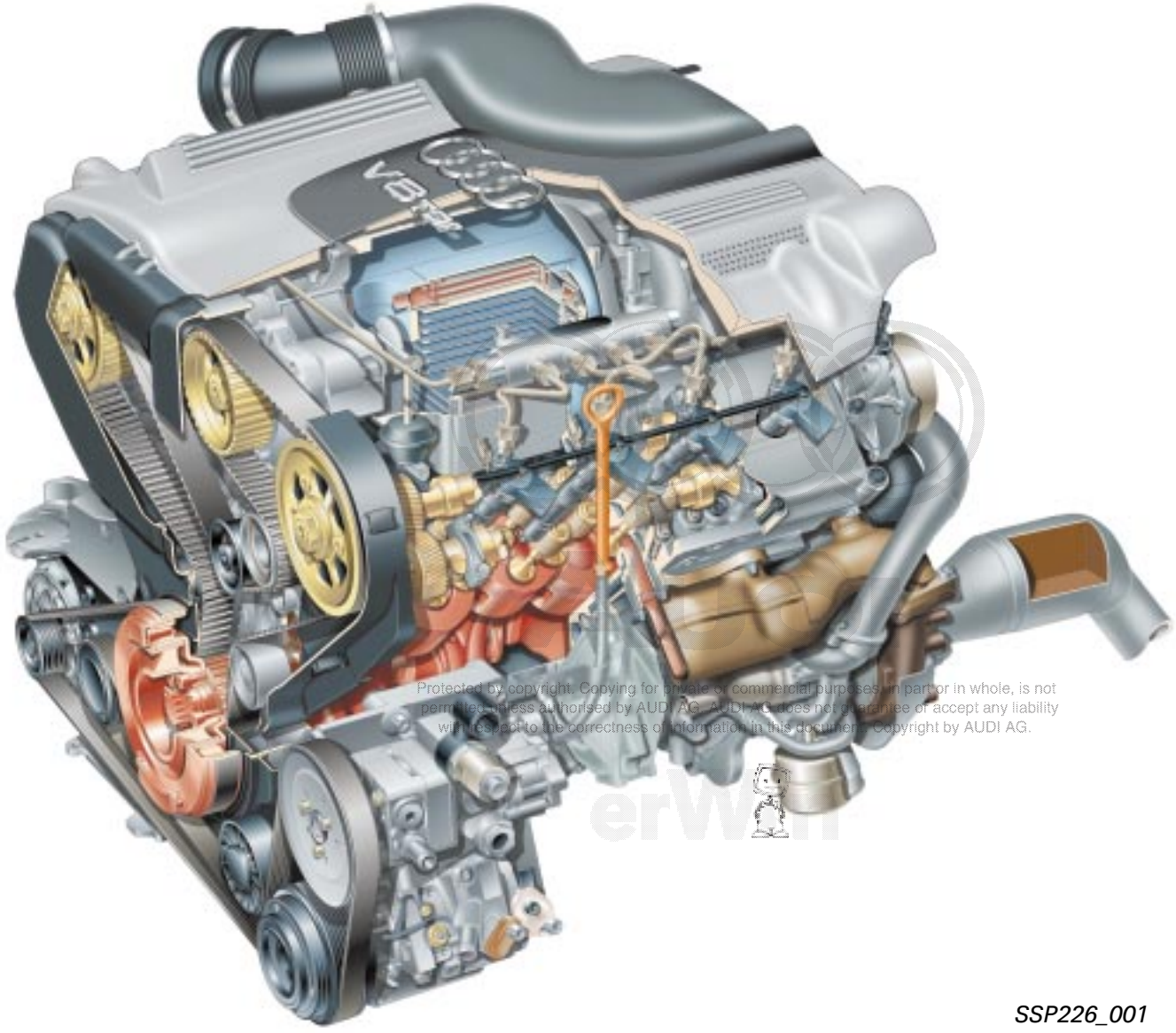


Important! Note!

Introduction

V8 TDI engine

The new V8 TDI engine combines exceptional performance with high fuel economy and low exhaust emissions, not to mention extraordinary smoothness and a high standard of comfort.

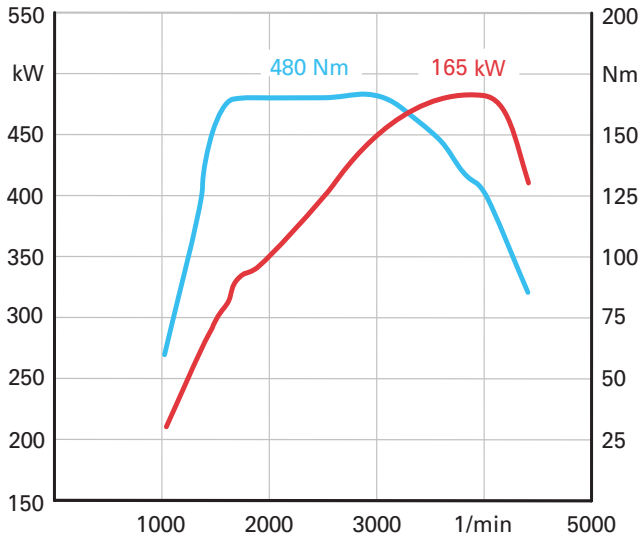


SSP226_001

Specifications

Code:	AKF
Type:	V8 engine with 90° V angle and biturbocharging
Displacement:	3328 cm^3
Power output:	165 kW (225 PS) at 4000 rpm
Torque:	480 Nm at 1800 rpm
Bore:	78.3 mm
Stroke:	86.4 mm
Compression ratio:	18.0 : 1
Weight:	265 kg
Firing order:	1-5-4-8-6-3-7-2
Mixture preparation:	Direct injection with Common Rail System
Exhaust gas turbocharger:	Biturbocharger with variable turbine geometry
Exhaust gas treatment:	Bank-specific exhaust gas recirculation with pre- and post-oxidation catalytic converters

Conforms to exhaust emission standard EU III



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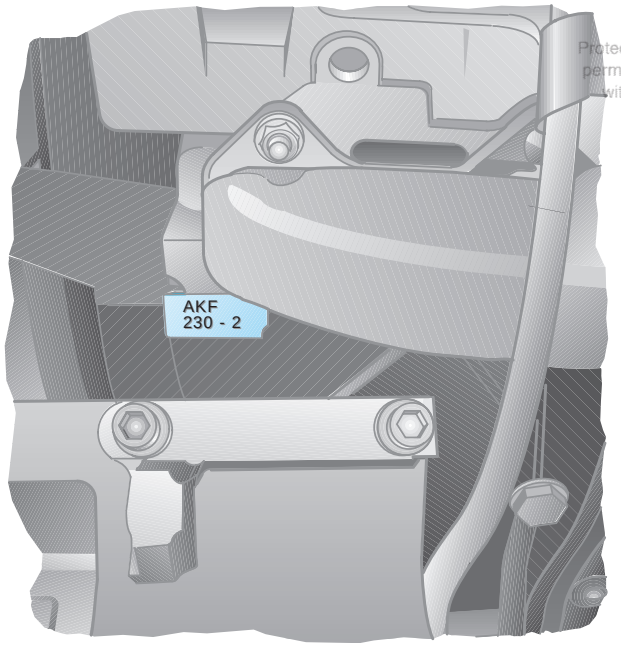
Torque (Nm)

Power output (kW)

The maximum torque of 480 Nm is achieved at only 1800 rpm and remains constant at this high level up to an engine speed of 3000 rpm. Max. output is 165 at 4000 rpm.



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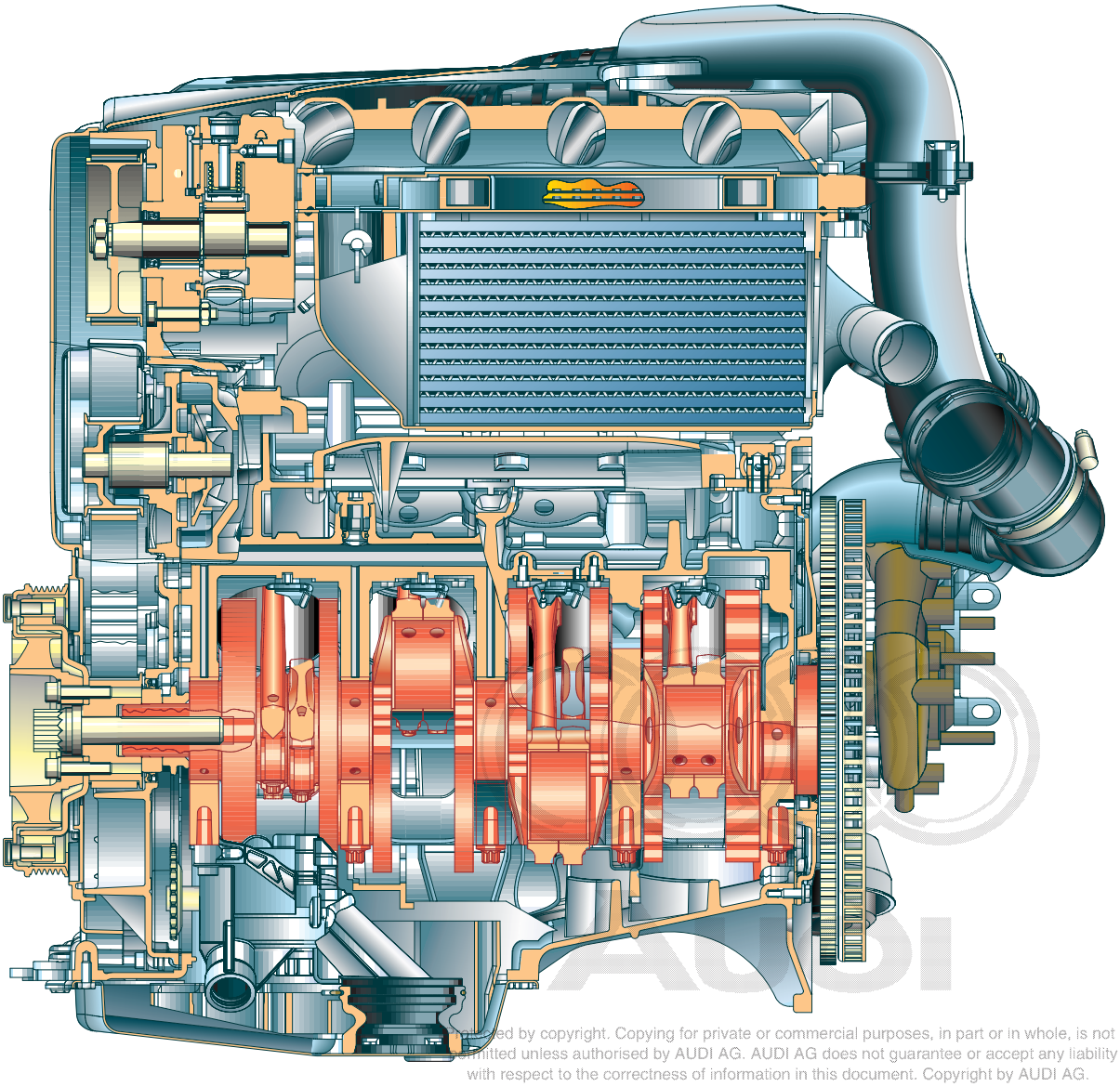
Engine code and engine number are located on cylinder 5 below the exhaust manifold mount.



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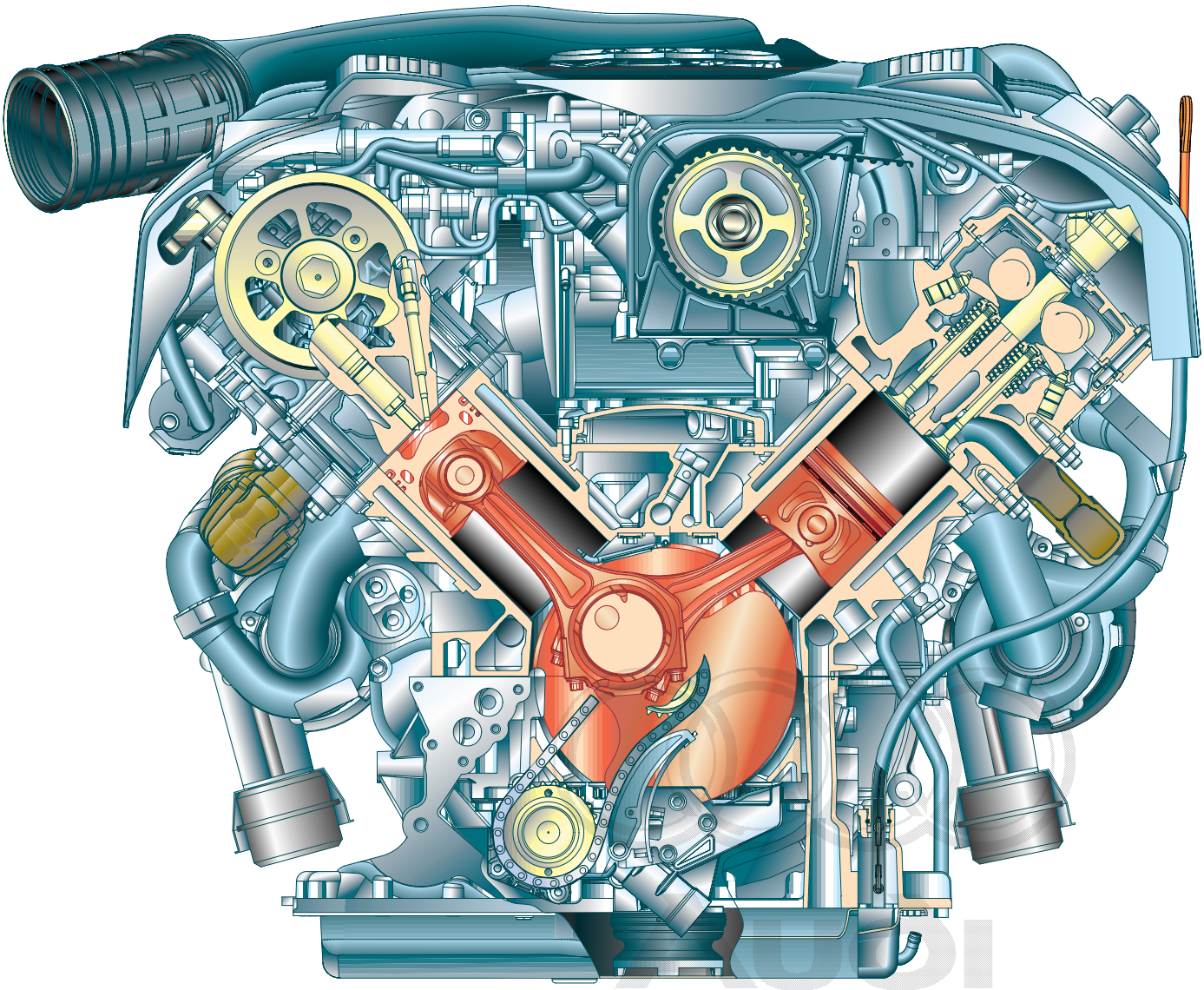

SSP226_004

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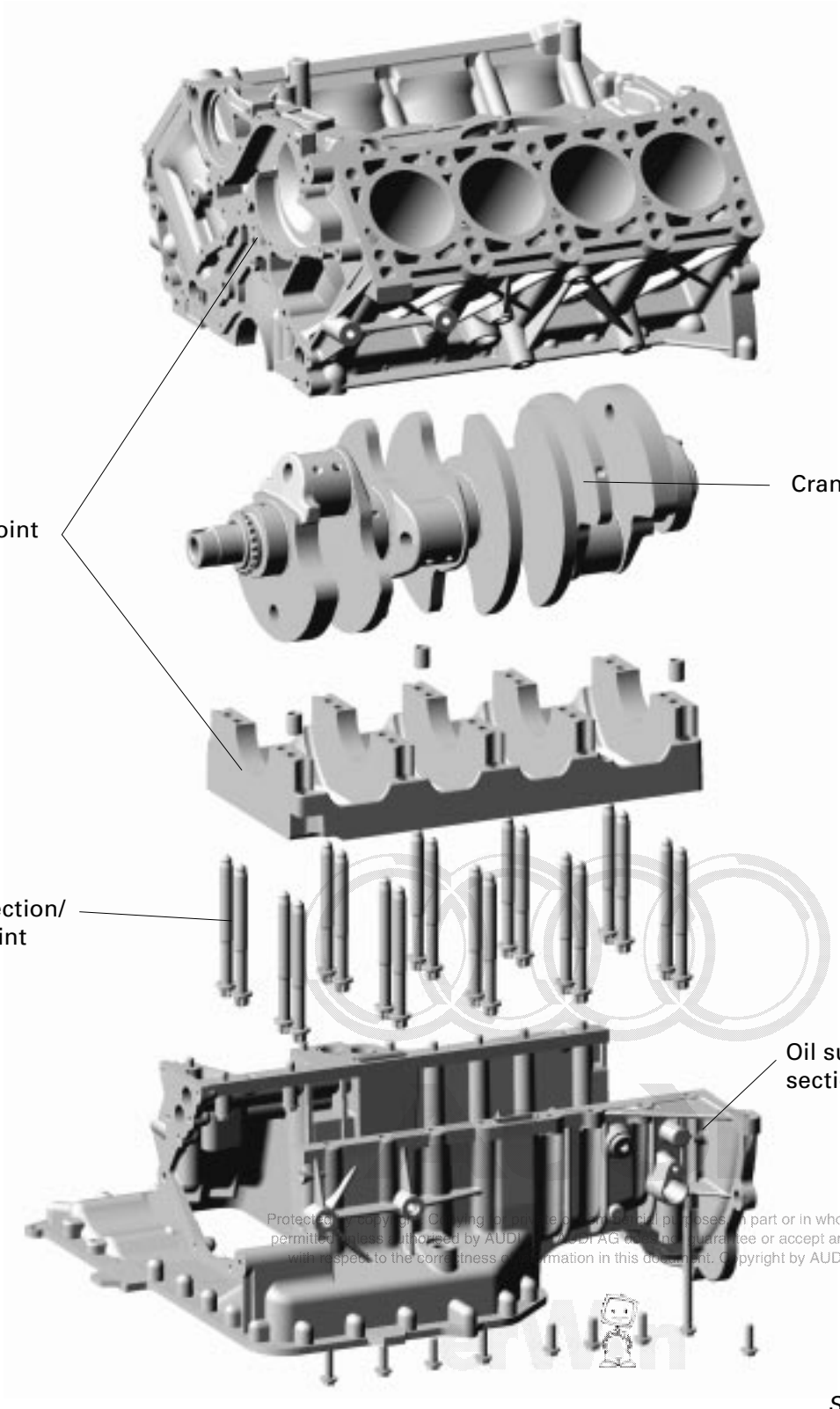


SSP226_005

High ignition pressures build up in the area of the main bearing and throughout the bearing block. In addition to the given strength criteria, the crankcase/main bearing joint also had to meet certain acoustic criteria.

To meet these requirements, the crankcase for V8 TDI was split in the middle of the crankshaft and a composite construction was chosen for the main bearing part.

The main bearing joint (four bolts per bearing) absorbs the high forces exerted on the bearings. The lateral connections of the individual bearing points produce a highly rigid frame which prevents longitudinal vibration of the bearing seats.

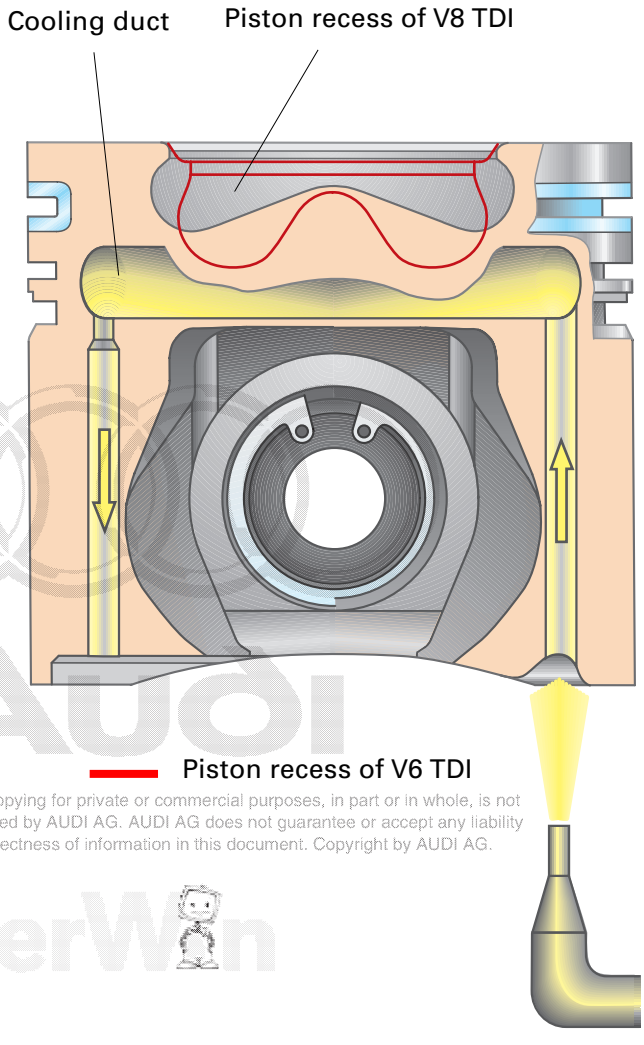
The oil sump has been raised up to the centre of the bearing. This separates the crankshaft bearing from the oil sump acoustically, minimising noise radiation.

The forged crankshaft is made of tempered steel.
Two conrods run on a single crank pin.
In a V8 engine, with its typical 90° V angle crankshaft and 90° offset, this makes for a uniform spark gap.

Piston

The piston has a cooling duct for reducing the temperature in the ring area and at the rim of the recess (refer to SSP 183).

A wide piston recess is used in combination with a 6-hole injector.

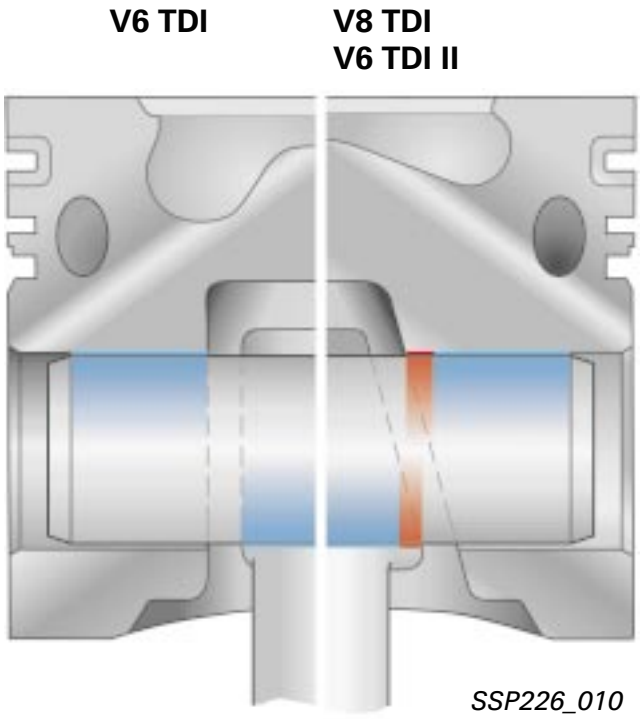


SSP226_007

Conrod

Through its trapezoidal shape, the contact surface of the conrod eye and piston hub at the piston pin is larger than the conventional joint between the piston and conrod.

Combustion forces are distributed over a larger surface area, reducing conrod and piston pin stress.

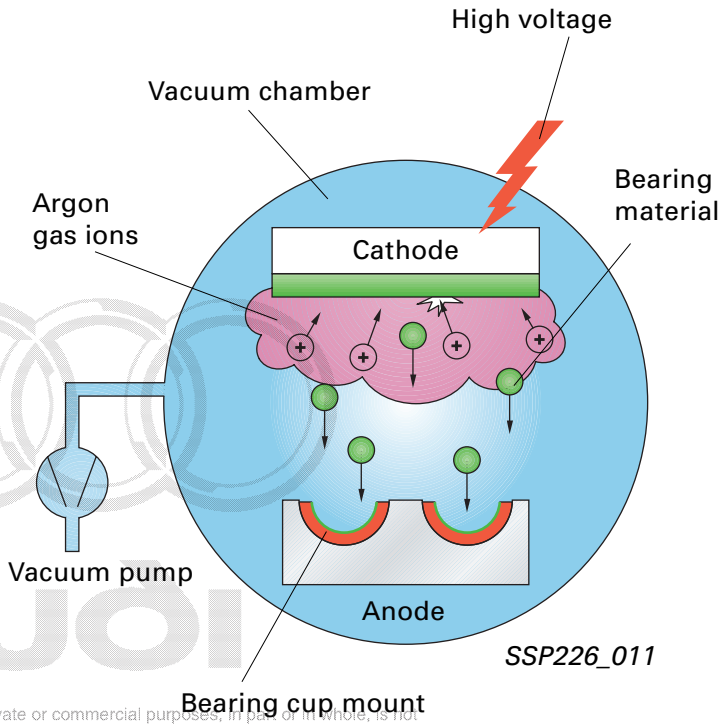


The high combustion pressures of approx. 160 bar are transmitted to the crankshaft via a "sputter bearing“ on the conrod side, as in the V6 TDI.

Sputtering is the application of a bearing material using electrical energy.

By accelerating the particles of the bearing material from positive to negative, the material is transferred onto the substrate in a highly compressed form at supersonic speed.

This final wafer-thin, anti-friction layer has a high surface hardness and exhibits better wear resistance.



Cylinder head

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SSP226_013

Derived from the V6 TDI and provided with an additional cylinder, the cylinder head is of narrow construction due to the constraints on installation space.

The intake camshafts are driven by the toothed belt and, in turn, drive the exhaust camshaft by means of helical gears.

The valves are actuated via cam followers (refer to SSP 183).

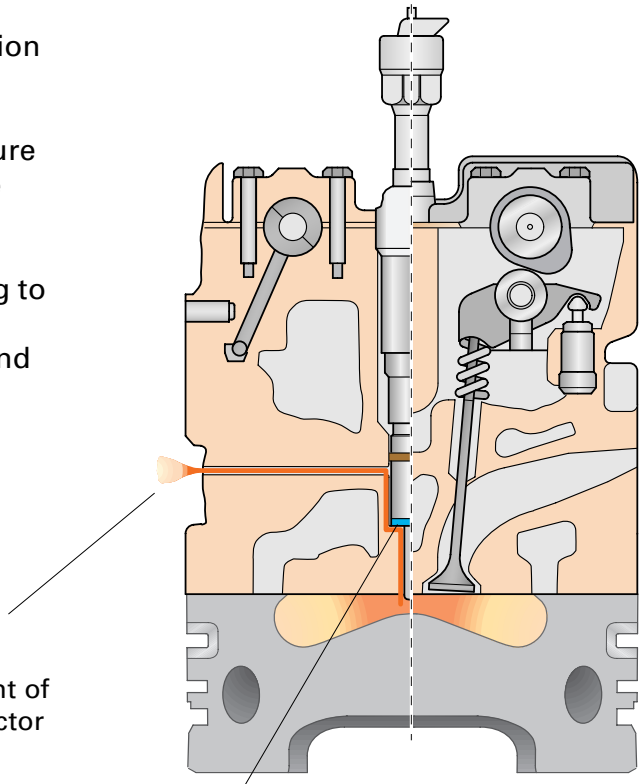
The injectors are secured by elastic spring clips. Thismakes a precisely defined and uniform load with low distortion possible whether the engine is cold or hot.

The common rail injectors are installed in the upright position midway between the exhaust and intake valves.

The injectors are sealed off from combustion chamber by means of a sealing disc.

If a leak occurs, excess combustion pressure can escape into the atmosphere along the duct.

This prevents large amounts of gas flowing to the compressor side of the exhaust gas turbocharger via the crankcase breather and causing it to malfunction.



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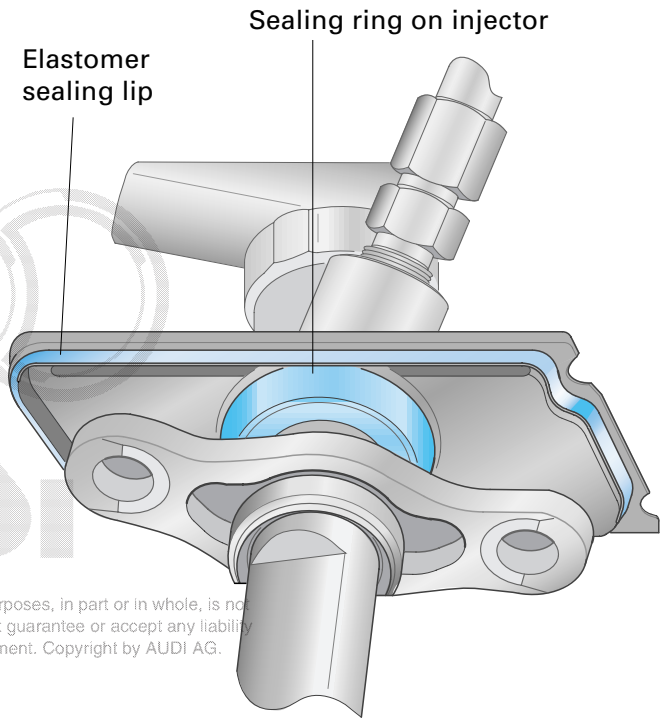
Cylinder head cover

The isolation of the cylinder head cover serves as soundproofing (refer to SSP 217).

The injectors are sealed by separate cover plates with an injection-moulded elastomer-sealing lip.



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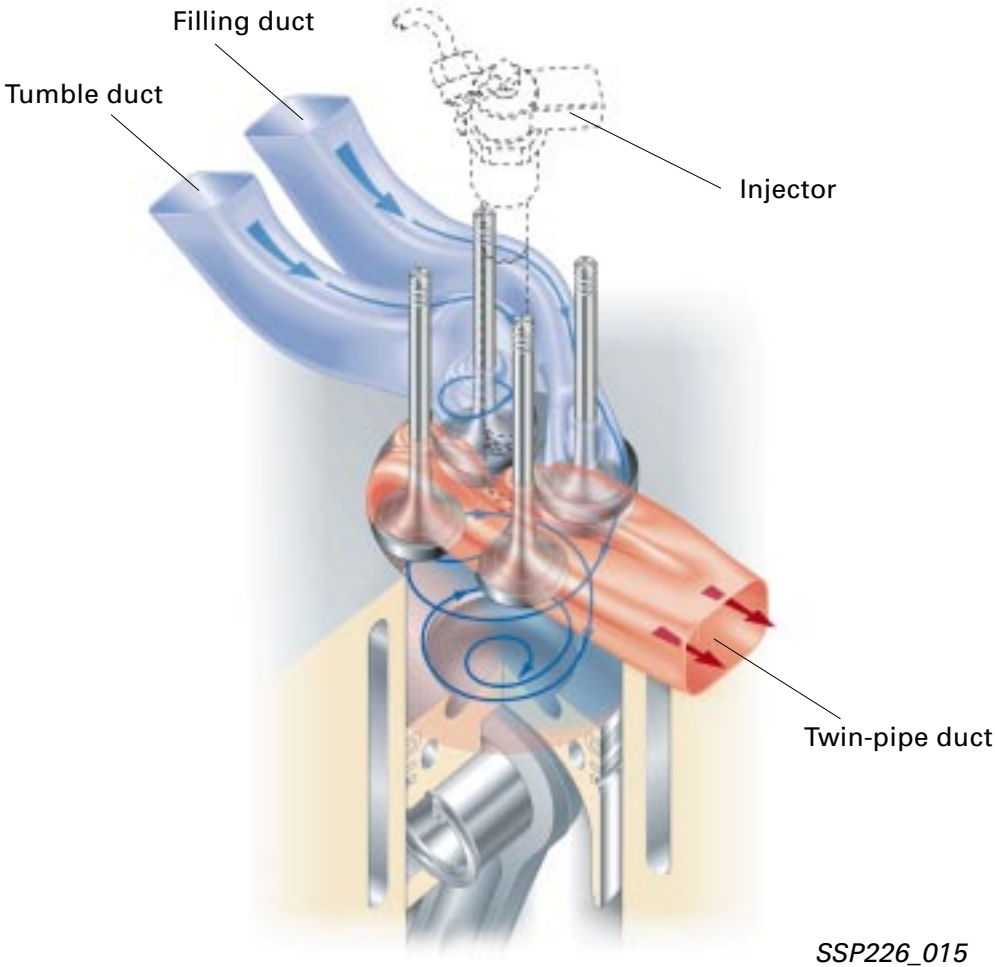
During installation, the transitions from straight surfaces to curved surfaces have to be sealed with a special sealing compound (refer to Workshop Manual).

Four-valve concept



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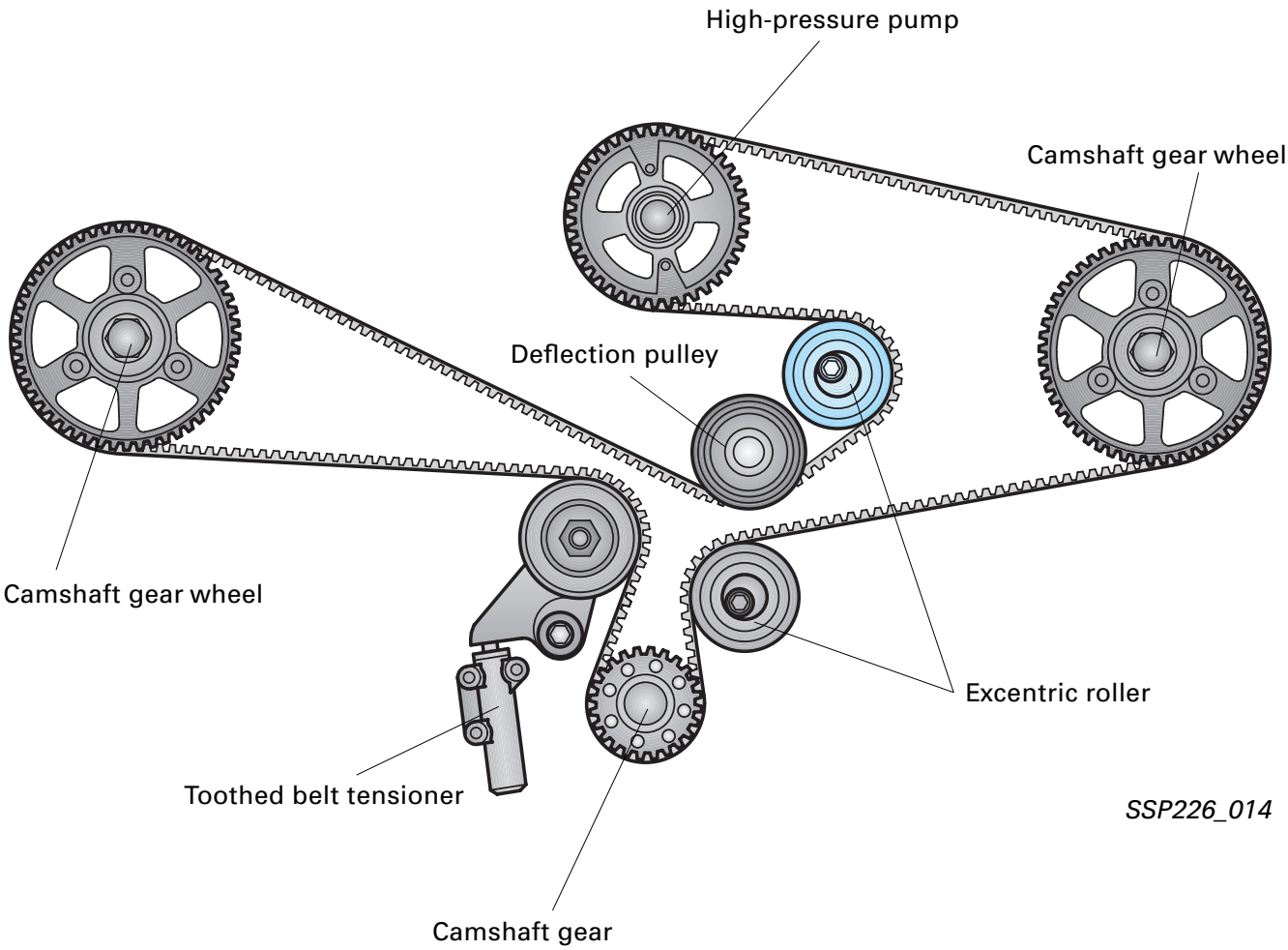
The 4-valve arrangement known from the V6 TDI engine with

- two intake ports per cylinder (tumble duct and filling duct)
- two exhaust ports per cylinder (twin-pipe duct)
- central, upright injector position
- central combustion chamber
- rotated valve position for better thermodynamics

was adopted unchanged.

Toothed belt drive

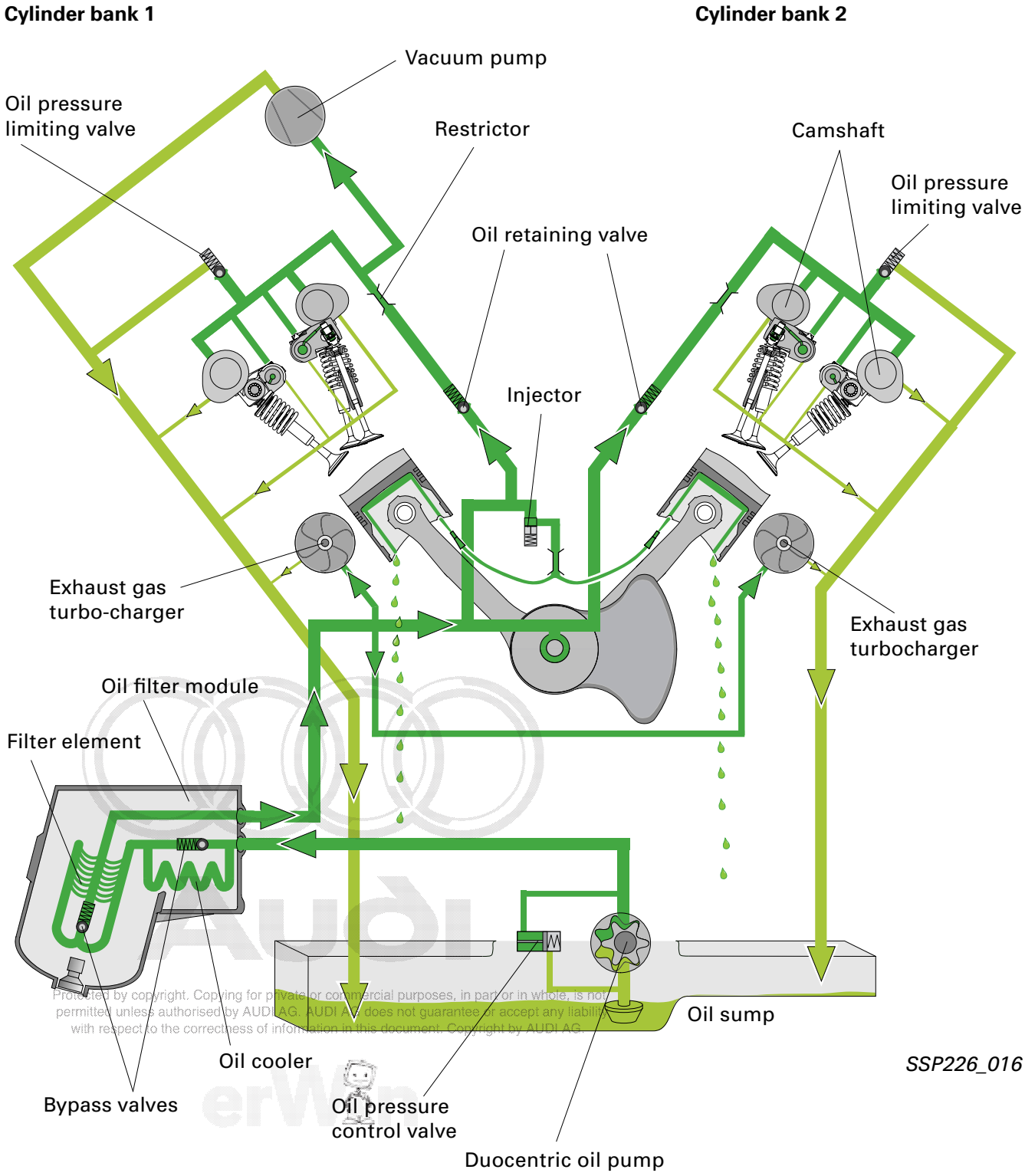


The high-pressure pump drive is integrated in the toothed belt drive.
The toothed belt guide was modified compared to the V8 5V engine for this reason. It requires an additional deflection pulley but does without a stabilising pulley.

Use special tool 3458 of the V6 TDI to fix the camshaft (refer to Workshop Manual).

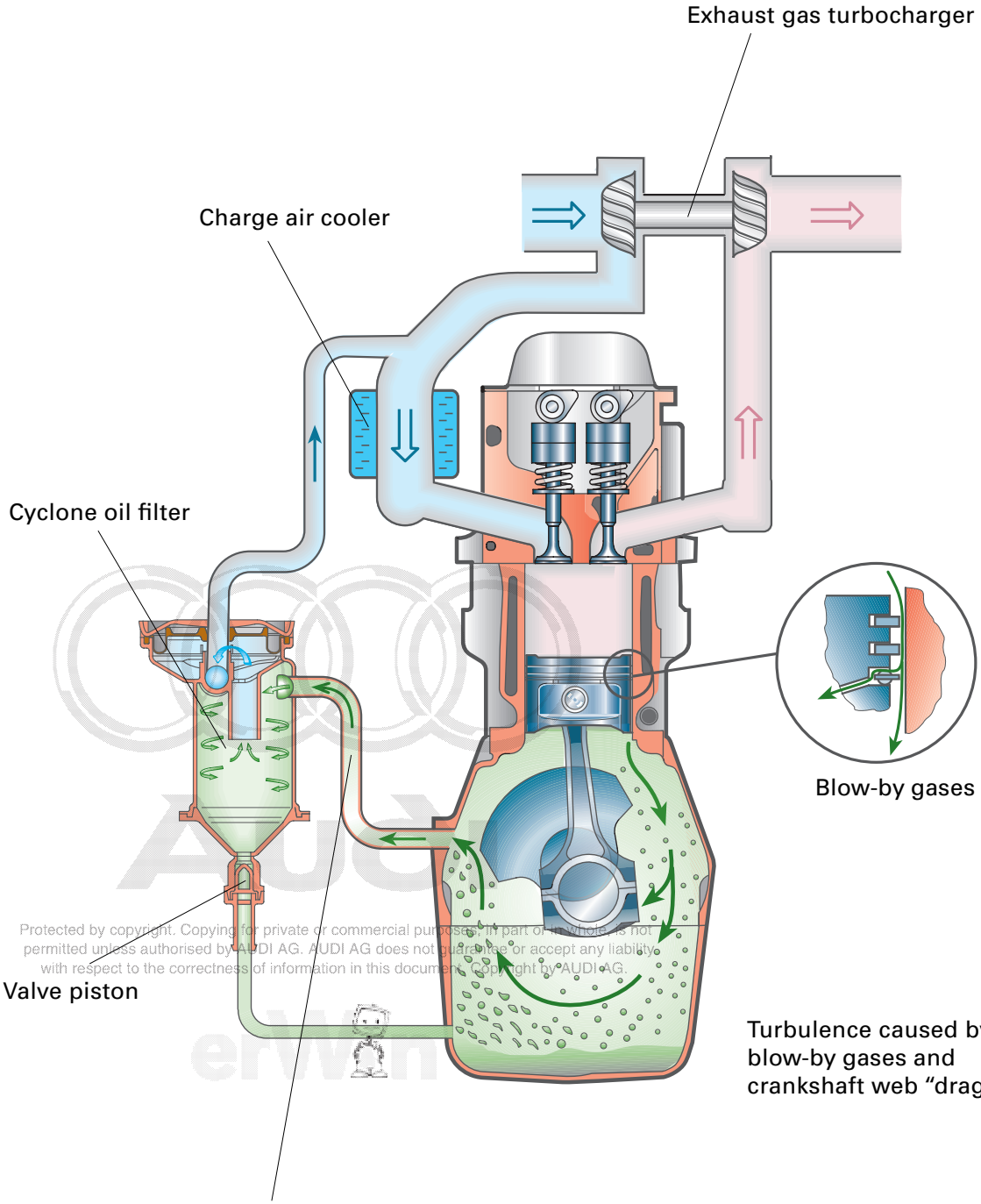
Installation positions need not be observed when installing the high-pressure pump.

Oil circuit



Crankcase breather

In charged diesel engines, so-called blow-by gases occur as a result of leakage flows at the piston rings. These gases are discharged from the combustion chamber and flow into the crankcase. They have to be burned for ecological reasons.



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Cyclone oil separator

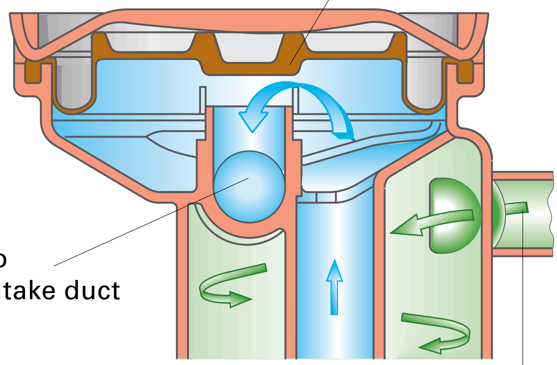
The blow-by gases are fed along a line into the oil separator from the inner V of the engine.

The swirling movement of the gases inside the oil separator separates the oil from the gases because the oil exhibits inertia.

The oil-free blow-by gases now enter in the intake duct upstream of the left turbocharger and are then burned.

The membrane integrated in the cyclone filter cover is used to control the vacuum in the crankcase.

If the suction capacity in the intake duct exceeds the pressure in the crankcase, the membrane closes the turbocharger suction port.
This prevents oil from entering the intake duct.



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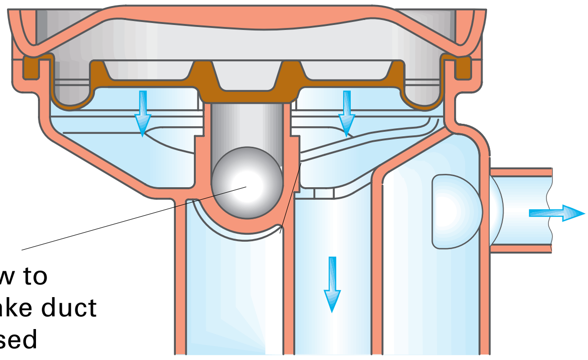

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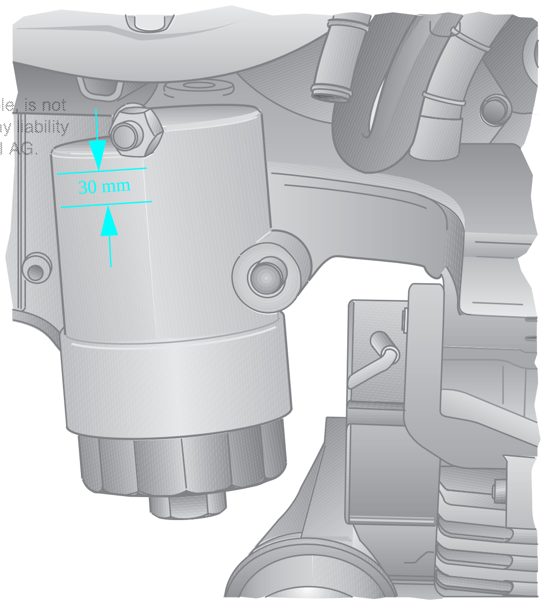
Oil filter module

The oil filter module is largely identical to that used in the 4.2-litre petrol engine.

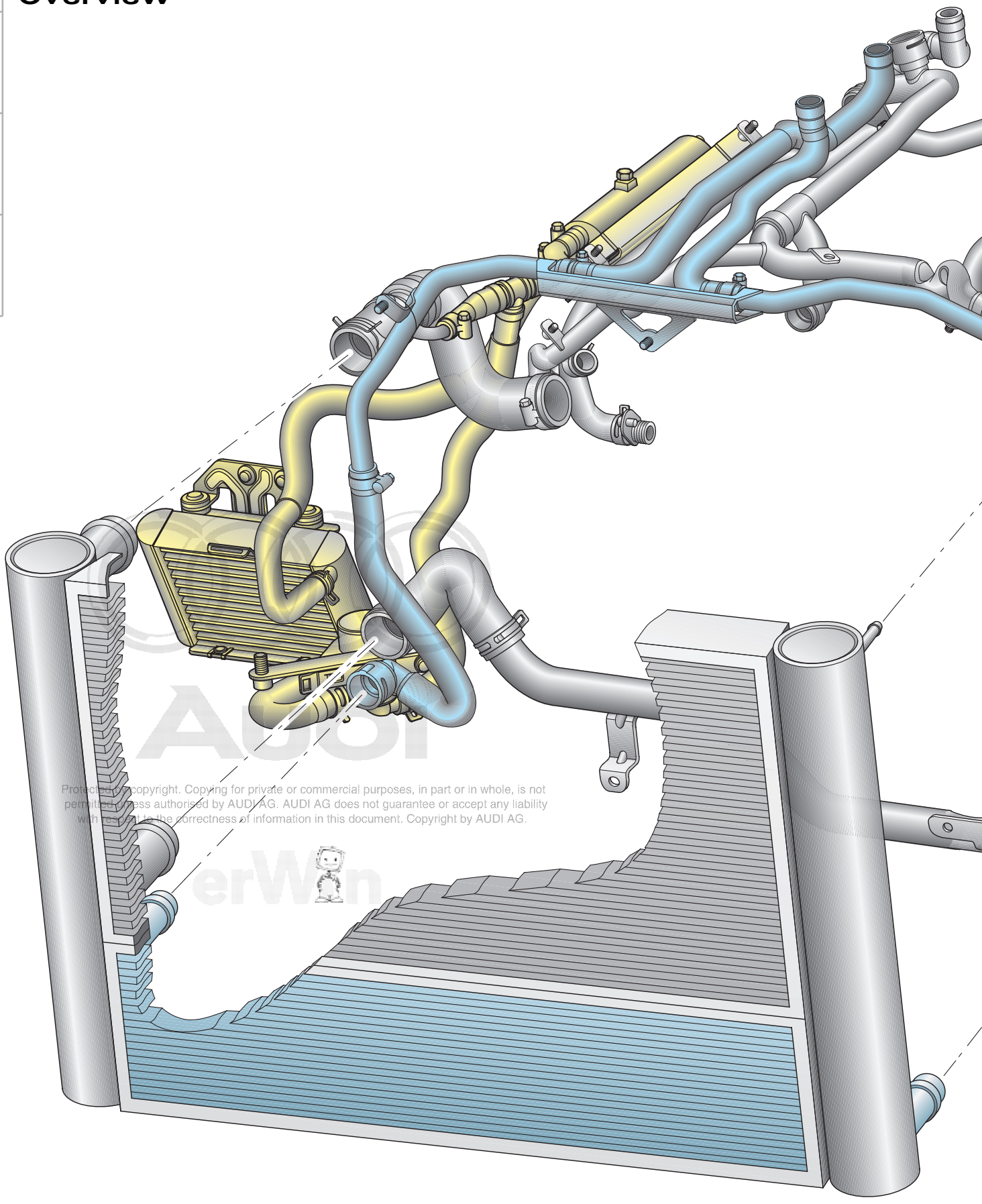
The oil filter housing has been extended upwards by approx. 30 mm in order to absorb a larger quantity of oil and to mount a larger oil filter cartridge for long life service.

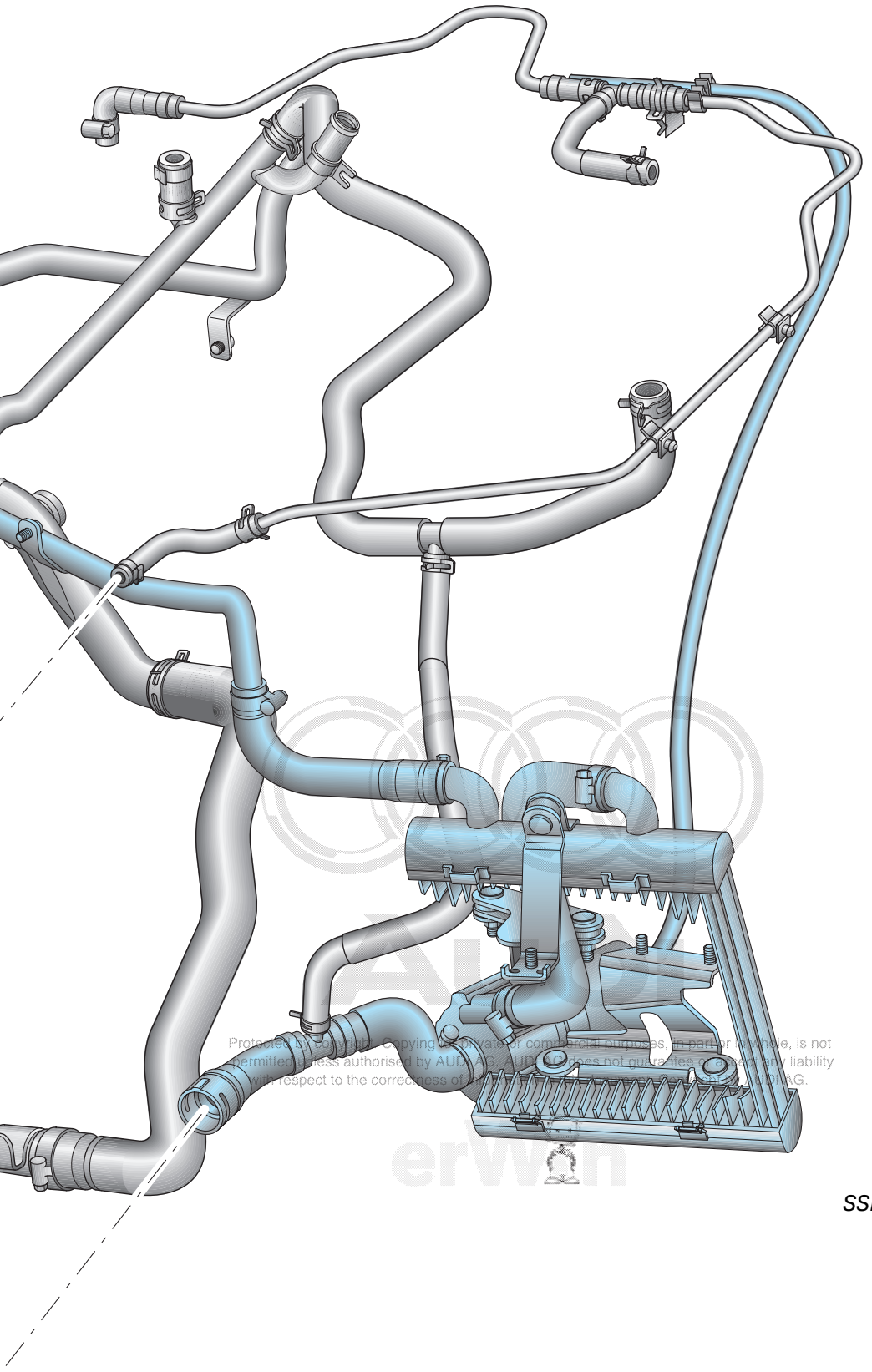


SSP226_017

Cooling circuit

Overview





SSP226_019

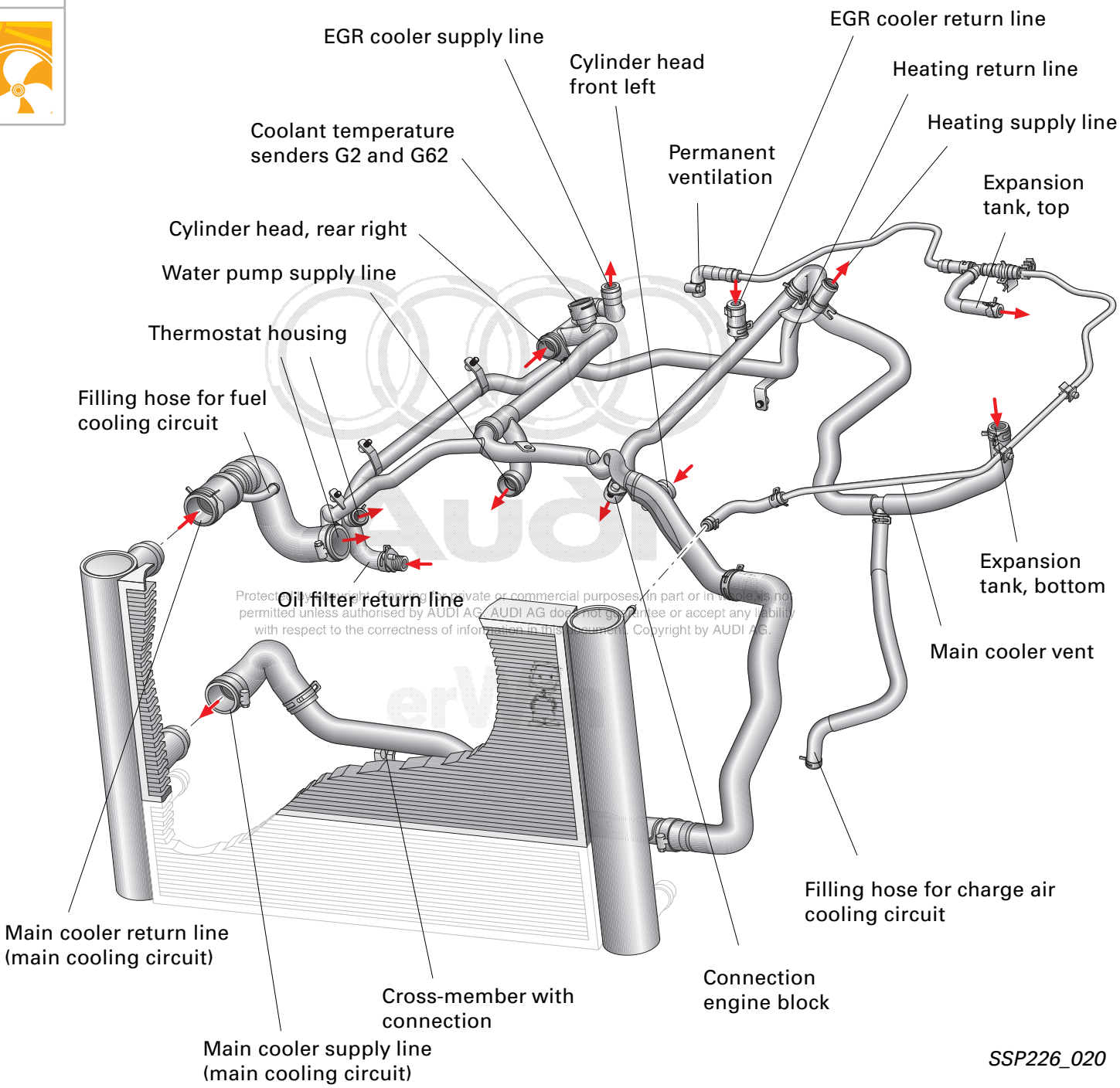
The cooling circuit is subdivided into three areas:

high-temperature	- main cooling circuit
low-temperature	- charge air cooling circuit
low-temperature	- fuel cooling circuit

Cooling circuit

Main cooling circuit

The engine cooling and EGR cooling systems are integrated in the high-temperature circuit.

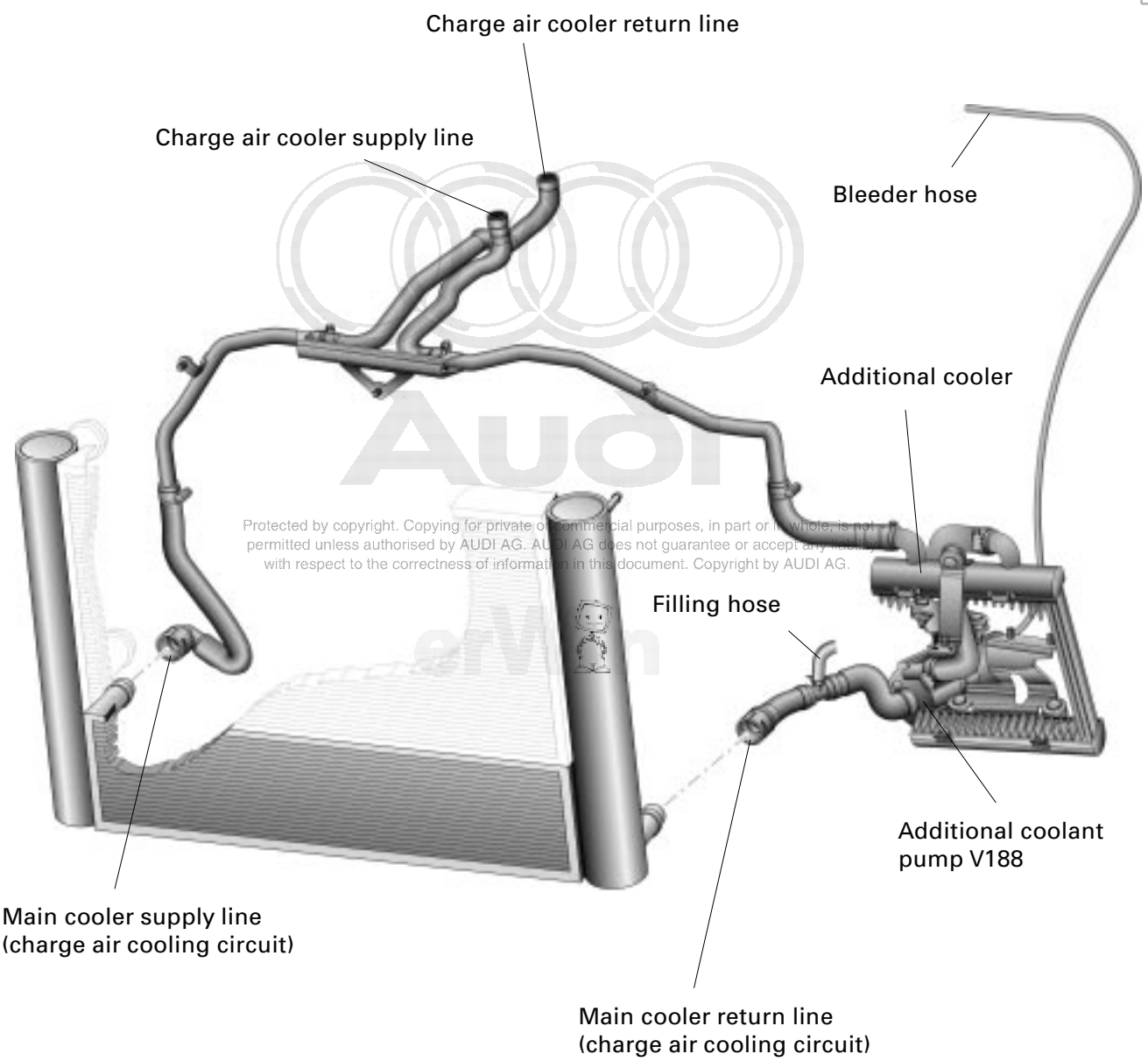


SSP226_020

Charge air cooling circuit

The charge air cooling circuit is connected to the main cooling circuit by a filling hose and has its own additional electrical coolant pump and an additional cooler (air - water).

The charge air cooling circuit also has a low-temperature area in the main cooler.



SSP226_021

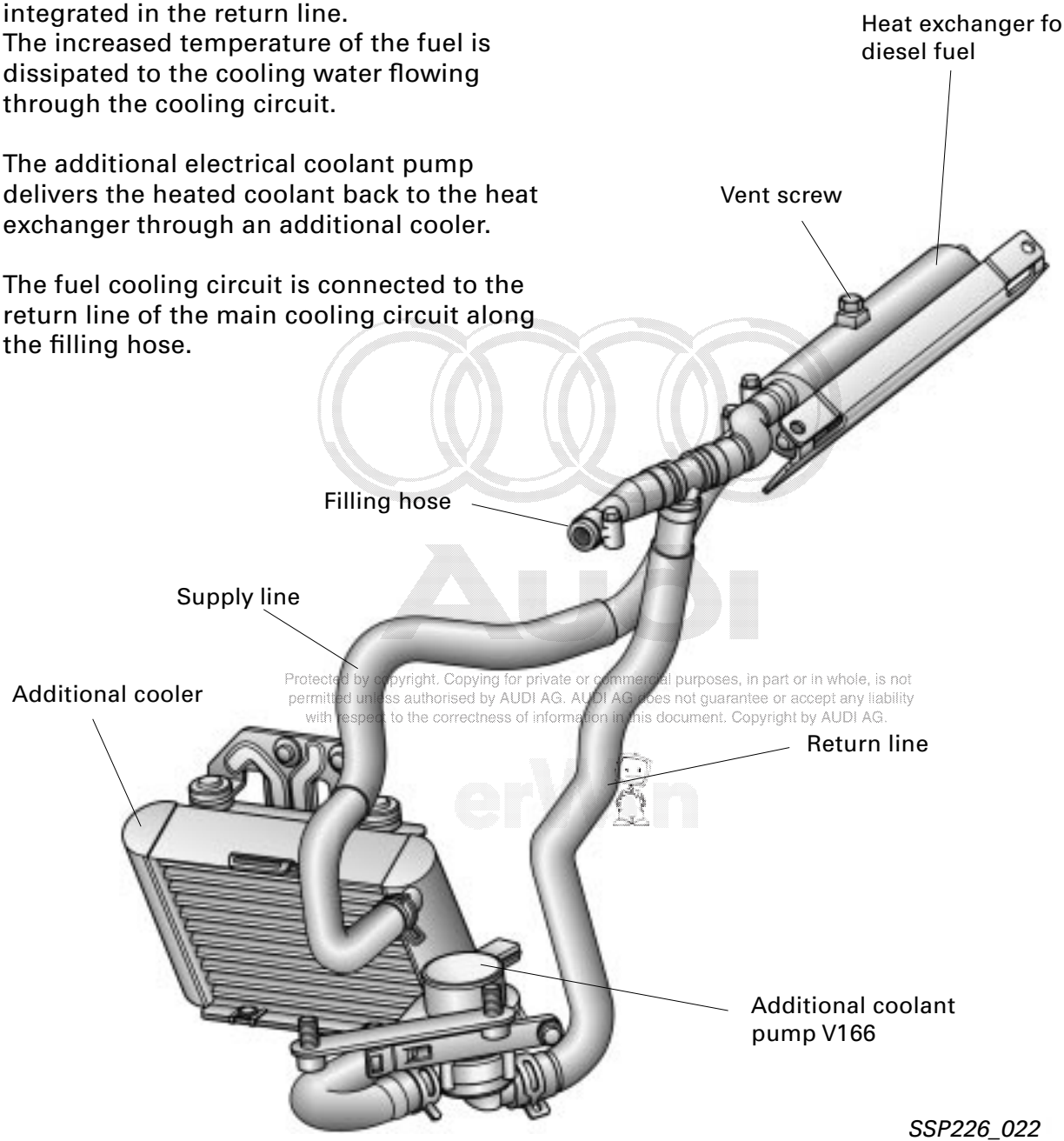
Fuel cooling circuit

It is important that the fuel enters the return line cooled, because of the high temperature which builds up when the diesel fuel is compressed (the temperature rises to approx. 1350 bar).

The heat exchanger for diesel fuel is integrated in the return line.
The increased temperature of the fuel is dissipated to the cooling water flowing through the cooling circuit.

The additional electrical coolant pump delivers the heated coolant back to the heat exchanger through an additional cooler.

The fuel cooling circuit is connected to the return line of the main cooling circuit along the filling hose.



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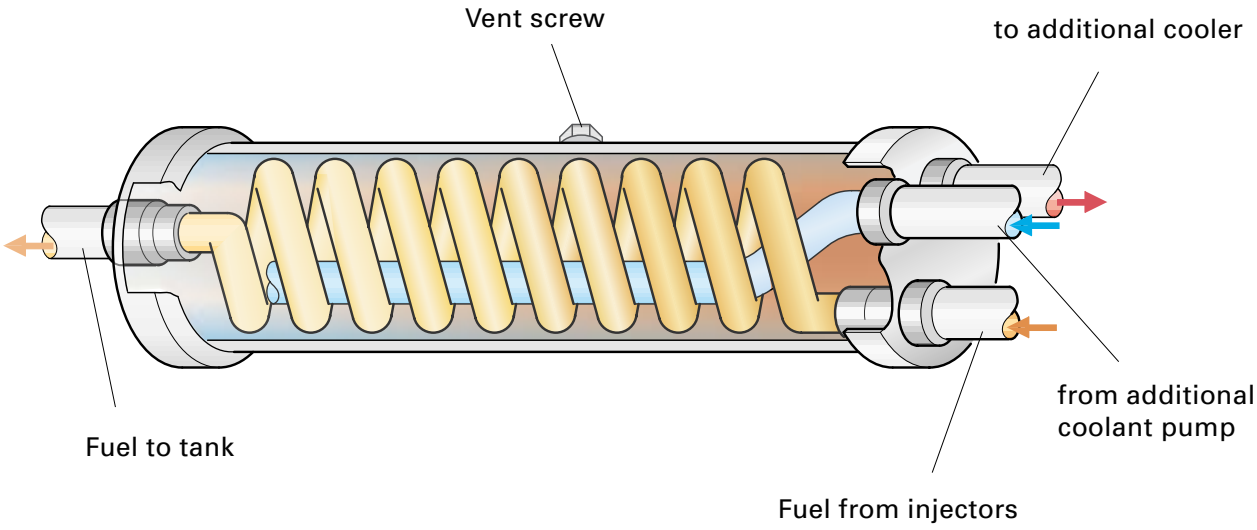
The additional electrical coolant pump runs continuously after the engine is started.



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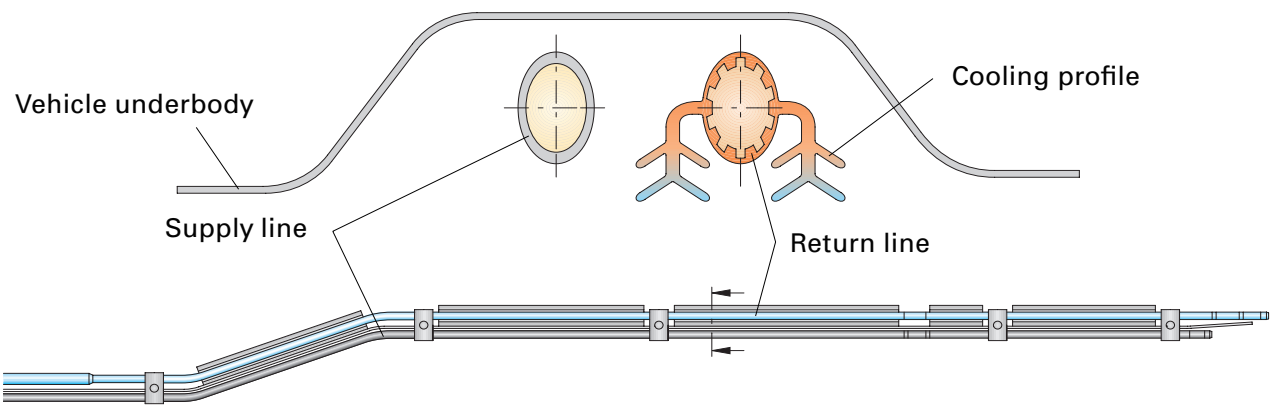
Fuel cooling (air)

The fuel is cooled additionally by a specially shaped return line located on the underside of the vehicle.

The aluminium profile provides a large cooling surface because of its shape.

The radial longitudinal grooves in the interior of the return line are conducive to heat transfer from the fuel to the cooling profile.



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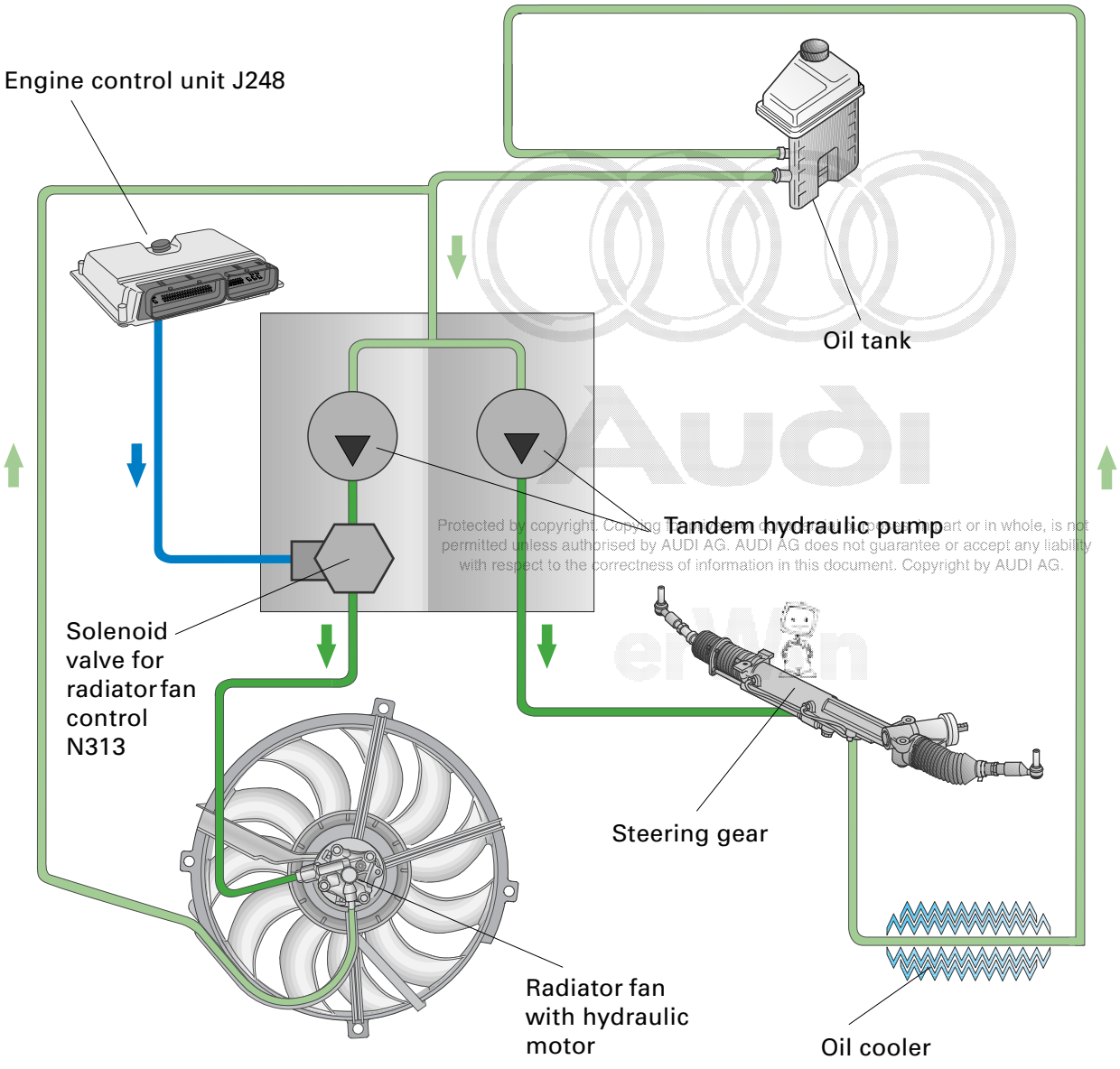
Cooling circuit

Hydraulic radiator fan

A hydraulic radiator fan system is used in order to utilise of the heat balance fully.

The system components include:

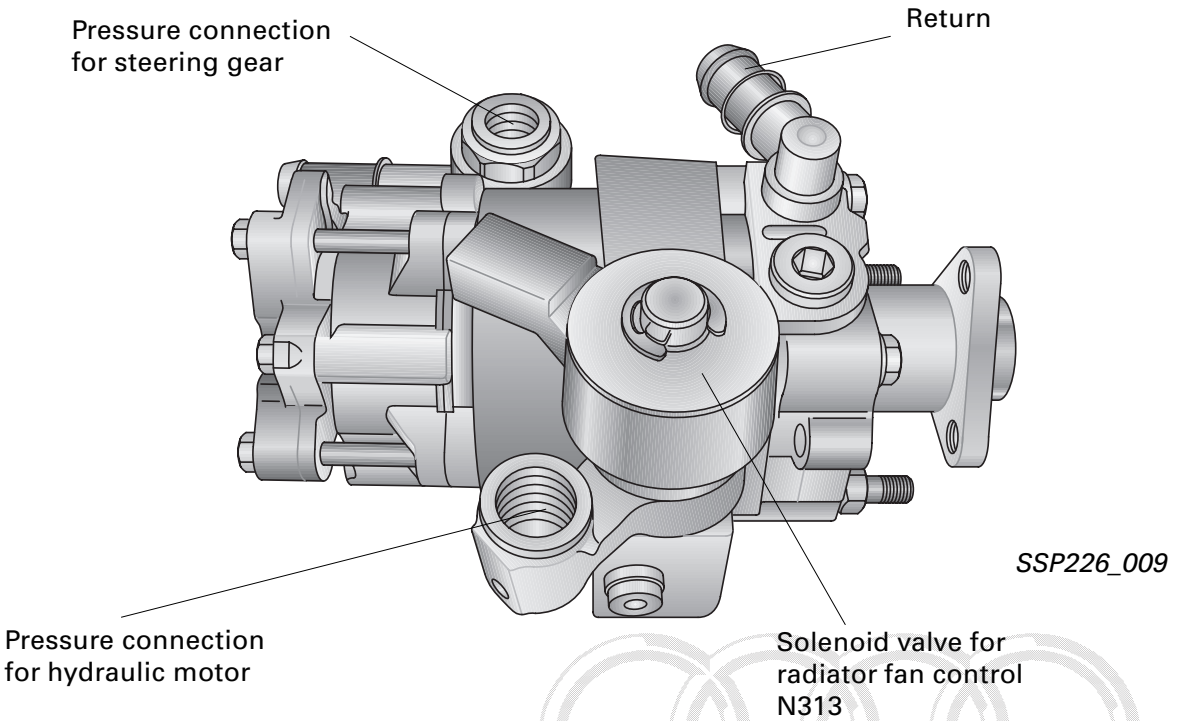
- Tandem hydraulic pump
- Solenoid valve for radiator fan control N313
- Radiator fan with hydraulic motor
- Oil tank
- Oil cooler



SSP226_008

Driven by the ribbed V-belt, the tandem hydraulic pump supplies the power steering and the hydraulic fan with oil pressure simultaneously.

A regulating valve cycled by the engine control unit conveys a specific quantity of oil to the hydraulic motor in dependence upon engine temperature and speed.



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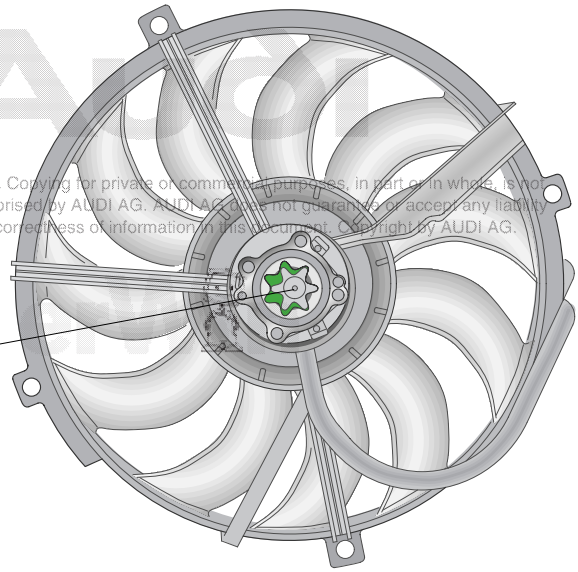
The internal geared wheel connected directly to the fan is driven by this quantity of oil.
The oil flows along the return line and into the intake line of the hydraulic tandem pump.



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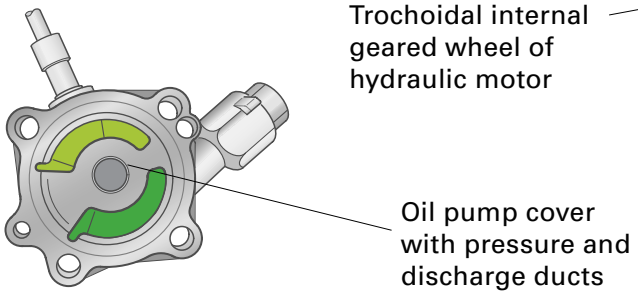

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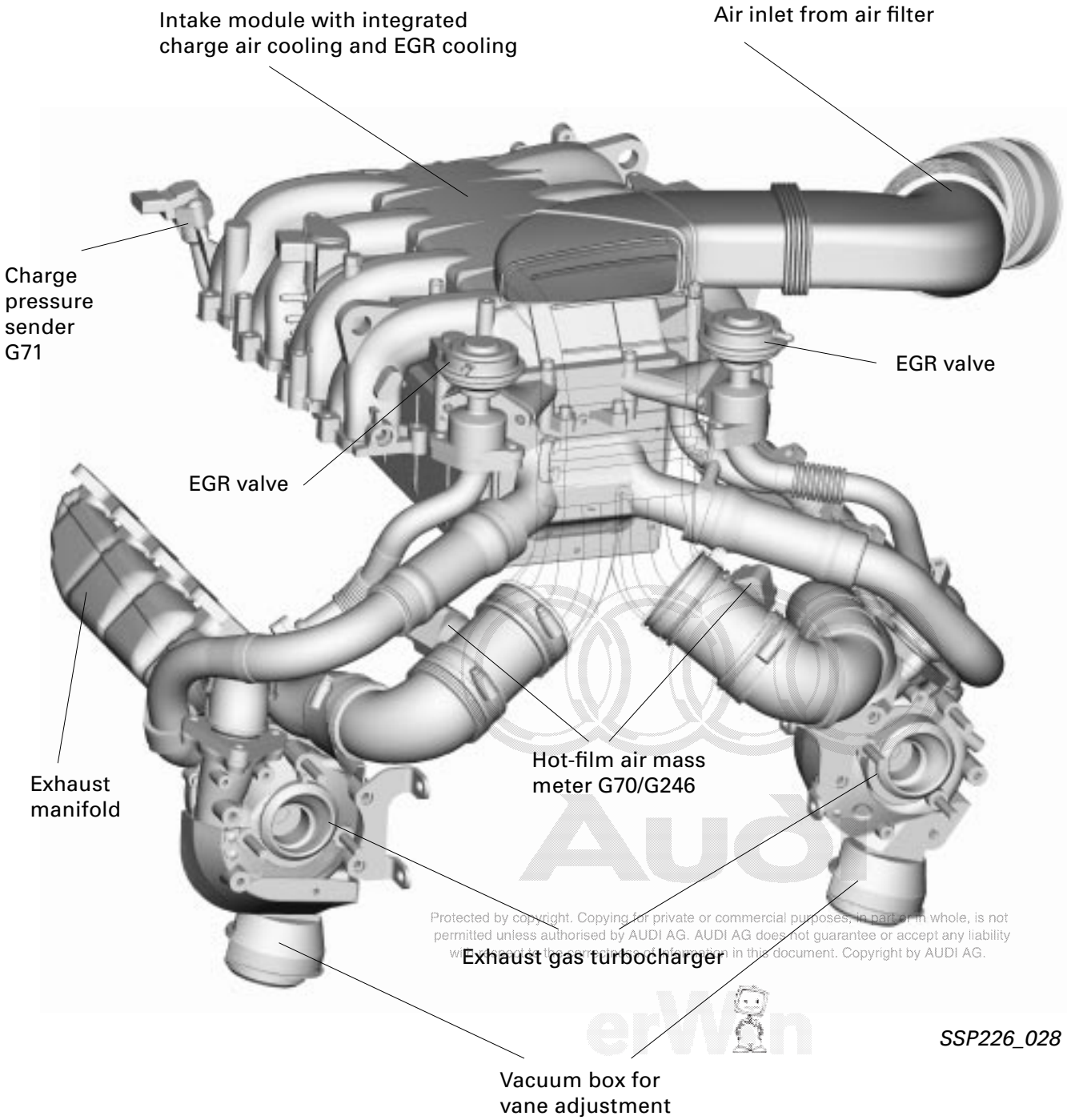
Air ducting

Overview



Charging

Two small exhaust gas turbochargers with a variable turbine geometry are used in the V8 TDI engine for charging purposes.

Advantage:

Using a small turbocharger improves the bottom-end torque curve.

The turbocharger controls the charge pressure through bank-specific air flow metering by means of two hot-film air mass meters.

The variable guide vanes of the turbocharger are actuated by means of vacuum boxes activated by electro-pneumatic valves.

To optimally utilise exhaust gas energy specifically in the warm-up period while ensuring that exhaust emissions conform to the EU III limit values, the manifolds for each cylinder bank are joined in a cloverleaf pattern and are insulated from the outer skin of the body-shell by an air gap.

The two independent air intake ducts are cooled by the turbocharger in a common intake module after the air is compressed. Each of these ducts supplies air to a single cylinder bank.

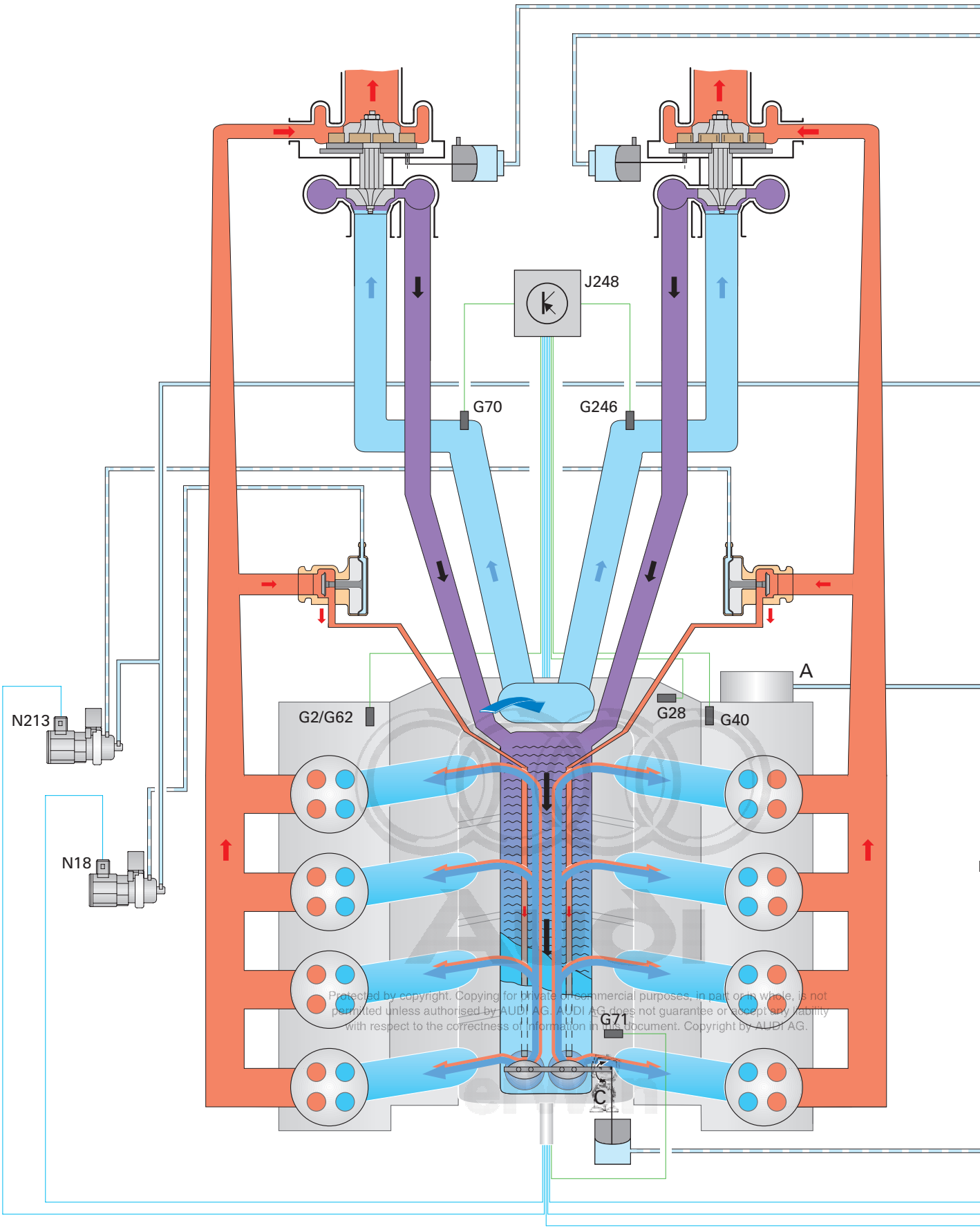
To be able to realise a highly compact engine design, the intake module was positioned in the inner V of the engine.

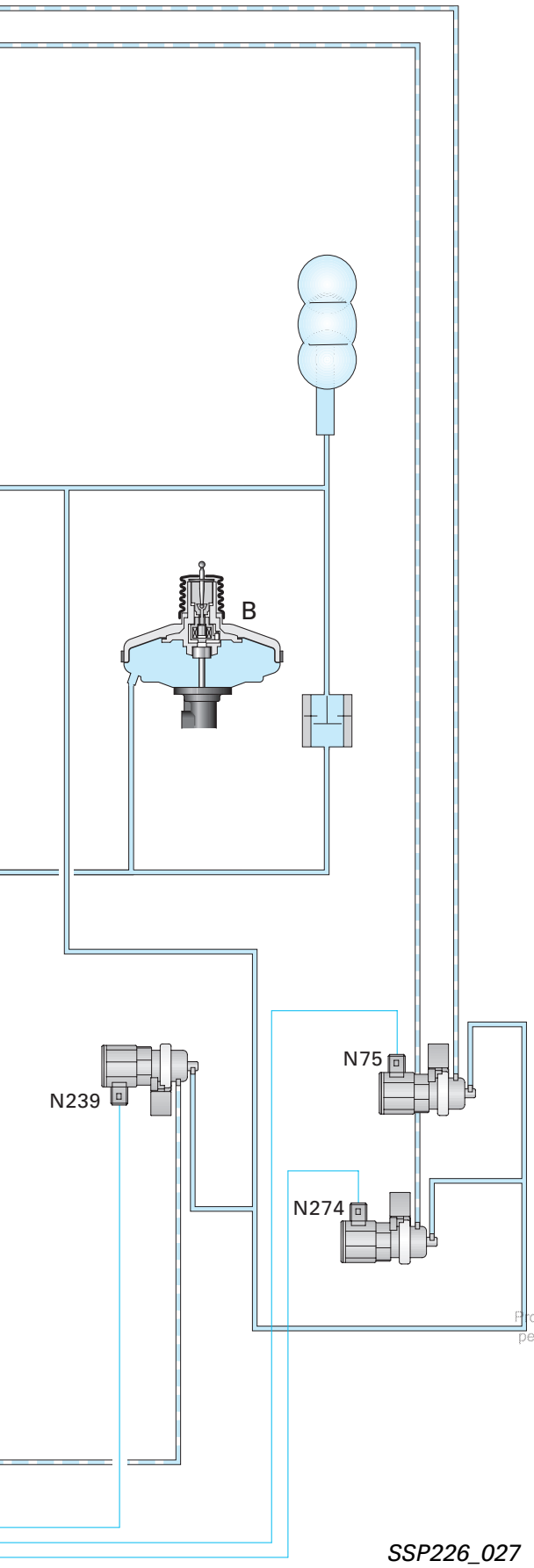
In addition to ducting the intake air, the intake module contains a combined charge-air and EGR cooler module..

The turbochargers may be replaced individually.

Air ducting

Vacuum chart





SSP226_027

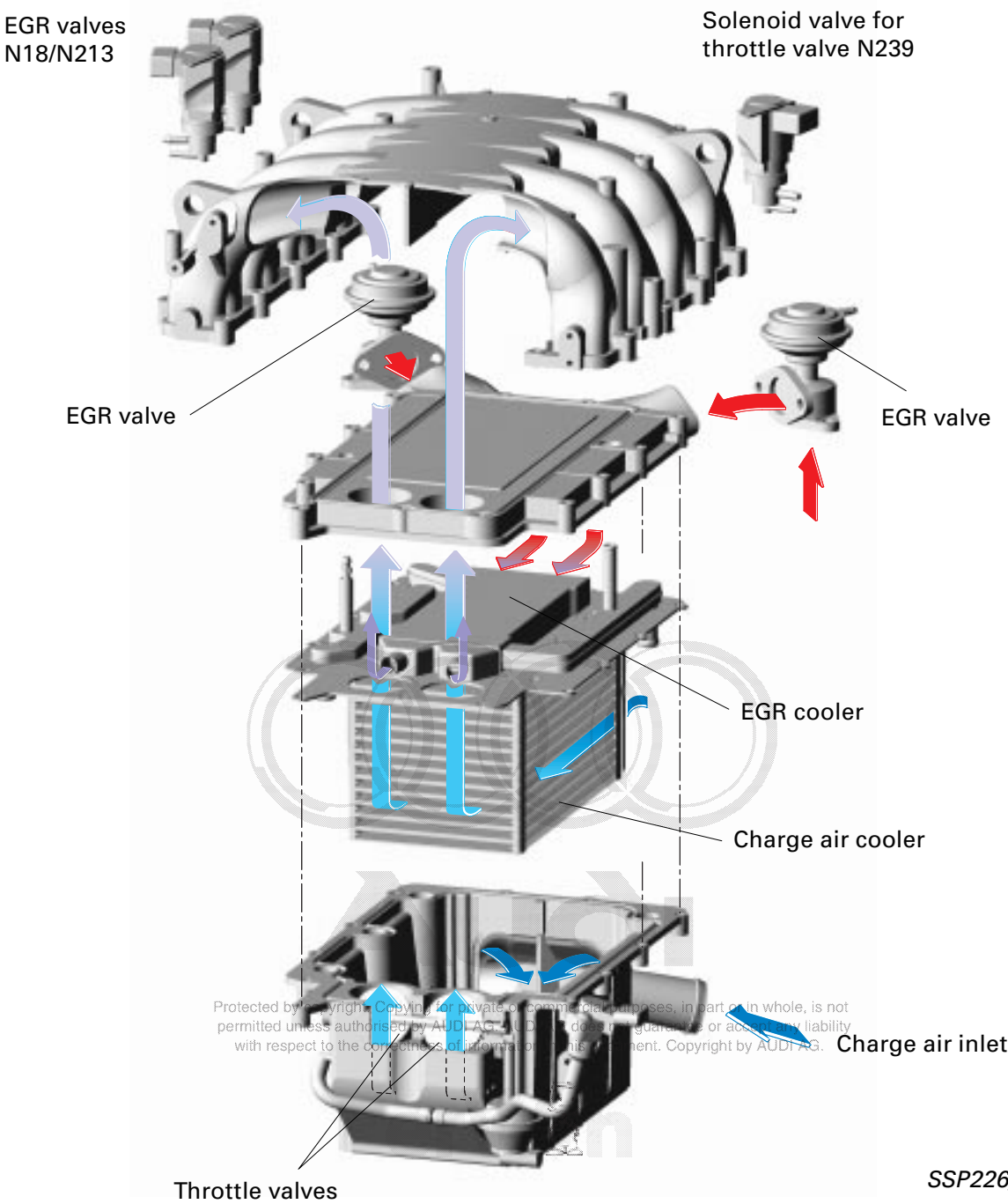
A	Vacuum pump
B	Brake servo
C	Throttle valves
G2/G60	Coolant temperature sender
G28	Engine speed sender
G40	Hall sender
G70	Air-mass flow meter
G71	Charge pressure sender
G246	Air-mass flow meter2
J248	Diesel direct injection system control unit
N18	EGR valve, cylinder bank1
N75	Solenoid valve for charge pressure control
N213	EGR valve, cylinder bank 2
N274	Solenoid valve 2 for charge pressure control
N239	Intake manifold changeover valves

Charge air and exhaust gas cooling

The charge air and EGR cooling systems are combined in a single module comprising two separate cooling circuits; the cooled air downstream of the two throttle valves is fed into the engine bank by bank.

Advantage:

The water-air cooling system achieves the same charge-air cooling effect with considerably less loss of charge pressure. Also, better efficiency is achieved in the reheating phase and when driving uphill.



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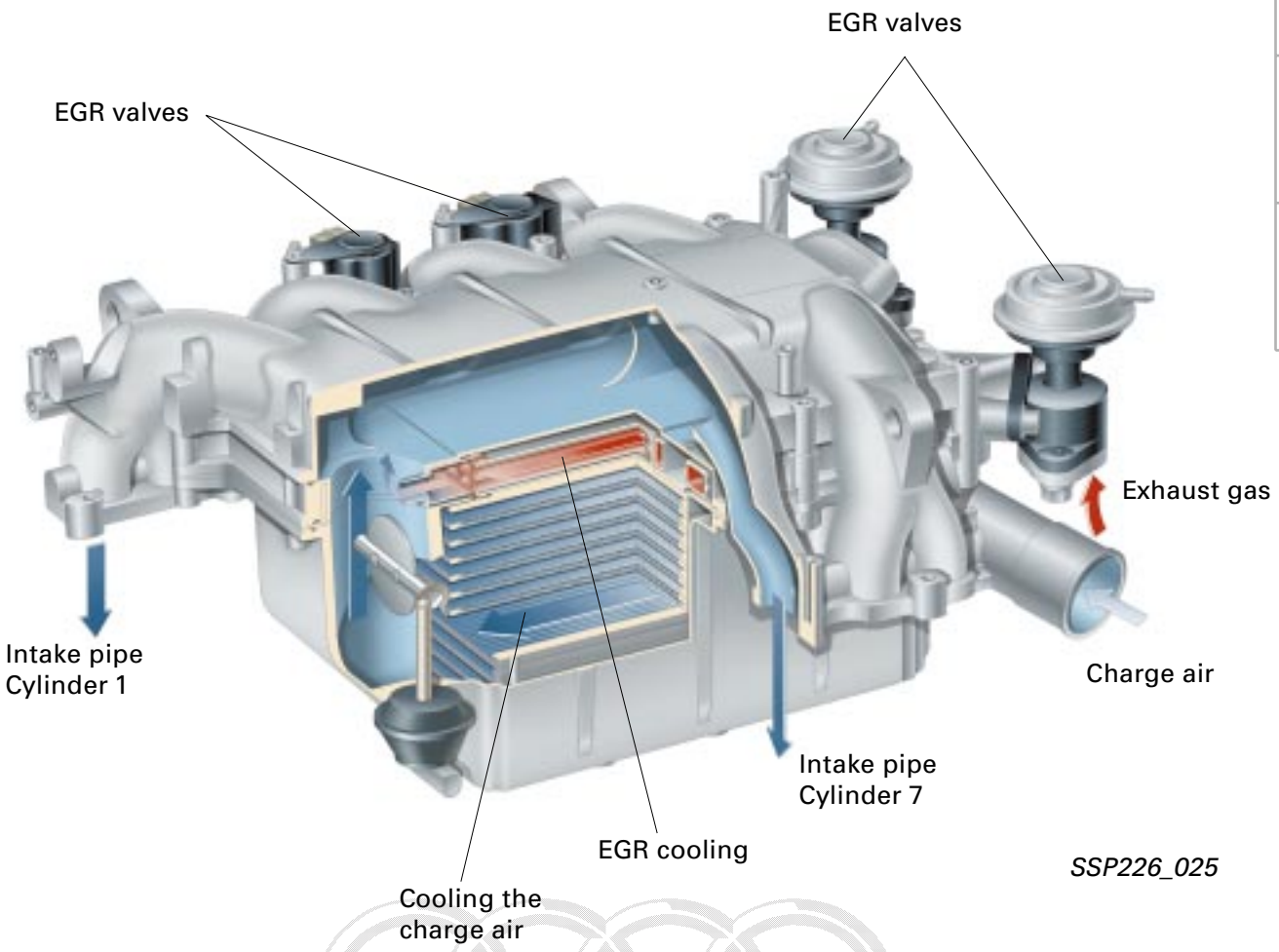
To reduce NO_x and particle emissions still further, the exhaust gas recirculated in the V8 TDI is additionally cooled by an air-water cooler.



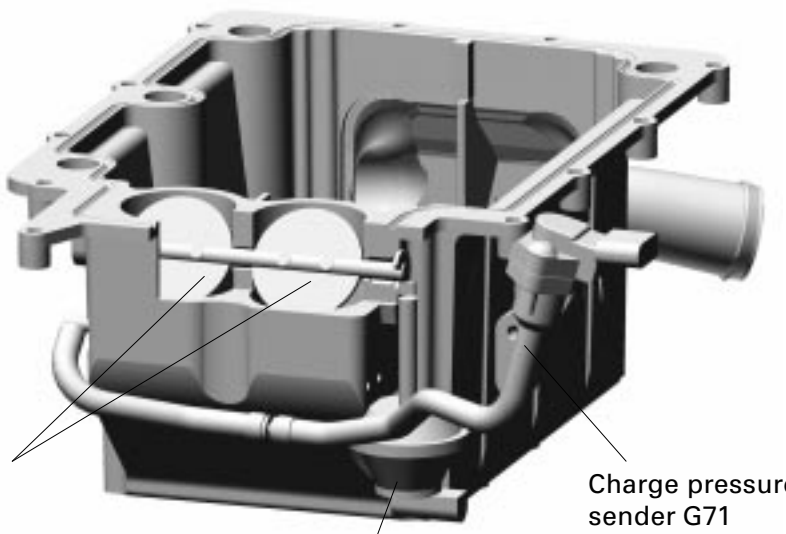
SSP226_025

Double-flow throttle valve

The double-flow throttle valve is closed when the engine is shut down for a short period of time.

Advantages:

The engine does not run on after it has been shut down and no unburned fuel enters the cylinders (when the engine is restarted, fewer unburned particles are emitted).



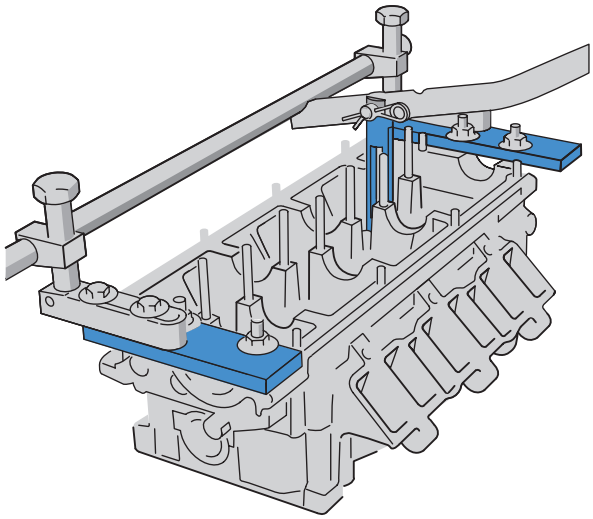
SSP226_026

In normal position and at full throttle, the two throttle valves are fully open.

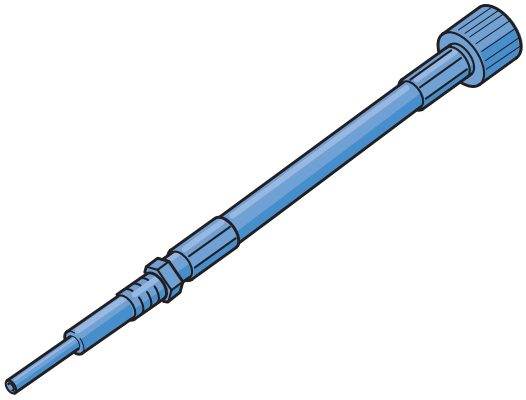
If the EGR system is active, the valve moves into intermediate positions so the fuel mixes better with the induced air.

Special tools

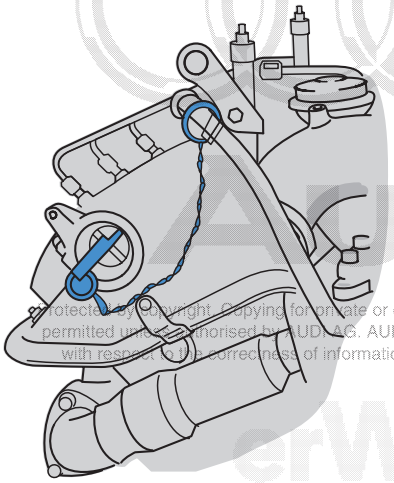
Shown below are the new specialtools and workshop equipment for the 3.3-ltr. V8 TDI engine.



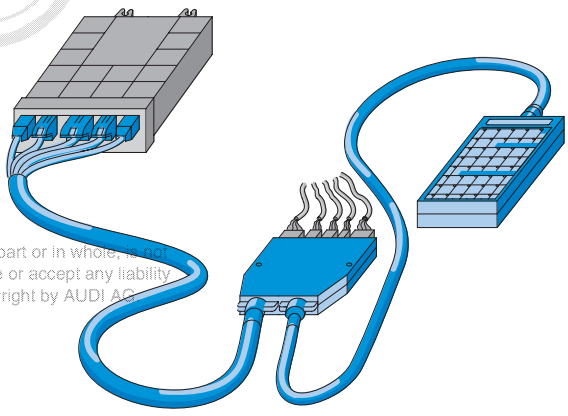
Special tool for valve removal
Pressure piece VW 541/6
Adapter for assembly fixture 2036/1



Compression test adapter
V.A.G. 1763/5



Setting gauge for camshaft retainer 3458



Test box for V6-TDI
V.A.G 1598/30

Notes

Notes

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