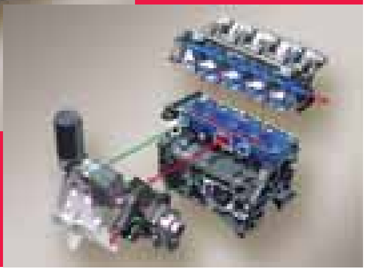
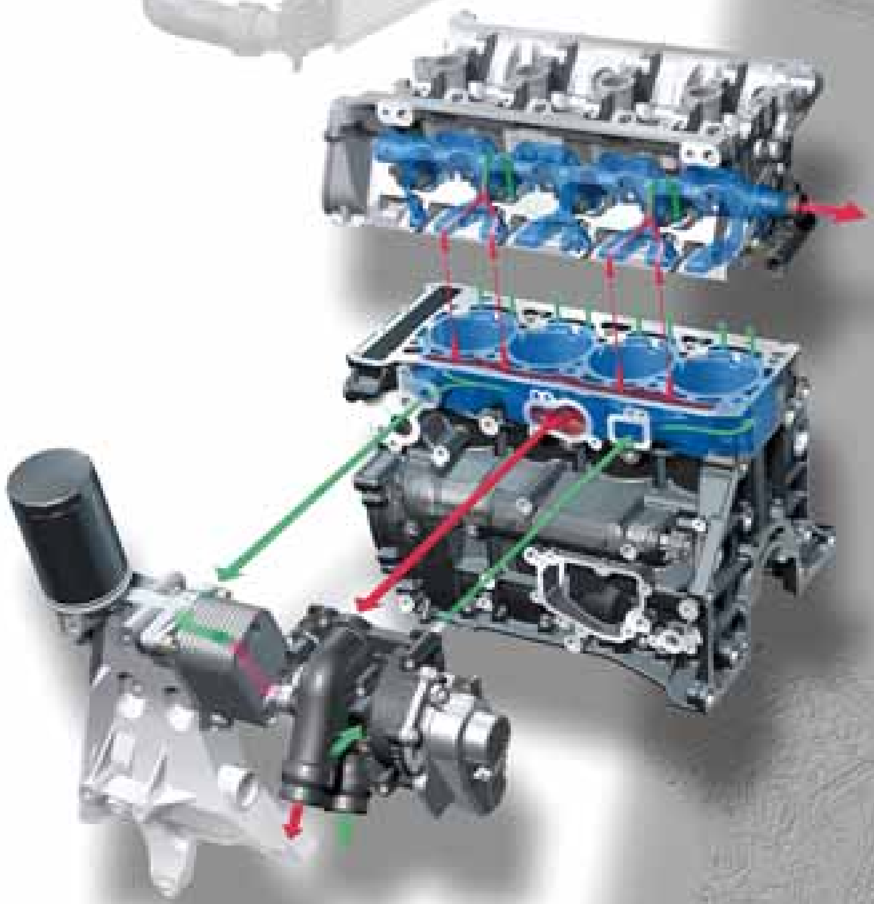
Service Training



Audi chain-driven 1.8 litre 4V TFSI engine

Self-Study Programme 384



The new 1.8-litre 4V TFSI engine belongs to the a new technology optimised R4 engine generation.
It will replace today's MPI engines and supersede the old engine family (EA 113).
The new engine generation (EA 888) will be used throughout the VW Group in many different products.
The first application is in the Audi A3.

This Self-Study Programme describes the new engine, which is installed transversely in the Audi A3.
In the case of longitudinally installed engines or when the engine is installed in other vehicles of the VW Group, it may be necessary to modify the technical specifications to suit each vehicle.

The focus of development work was on achieving the following project goals:

- ► Cutting unit costs by implementing:
  - new standards in technical concepts and production technologies
  - a common parts strategy
- ► Compliance with miscelleneous vehicle-specific requirements:
  - transverse and longitudinal installation
  - statutory requirements, such as pedestrian safety and *footwell intrusion**
- ► Technology:
  - compact design
  - acoustics
  - improved efficiency (mechanical and thermodynamic)
- ► Compliance with applicable exhaust emission, noise emission and environmental regulations
- ► Ease of servicing

Characteristic features:

- High/low-end torque
- High power potential
- High fuel efficiency
- Excellent spontaneity and elasticity
- High level of comfort

* *Footwell intrusion*
The intrusion of objects into the footwell during an accident.

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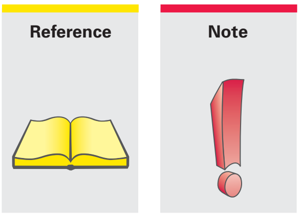
Service



Brief technical description

- Four-cylinder 4-valve four-stroke turbocharged petrol engine

- Engine block
  Cast iron cylinder crankcase
  Balancer shafts in the cylinder crankcase
  Steel crankshaft
  Sump-internal oil pump - chain driven by the crankshaft
  Timing gear chain; at the front end of the engine
  Mass balancer - chain driven at the front end of the engine

- Cylinder head
  4-valve cylinder head
  1 intake camshaft adjuster

- Intake manifold with flap (tumble flap)

- Fuel supply
  Demand controlled on low and high pressure ends
  Multi-port high-pressure injector

- Engine management
  MED 17 engine control unit
  Hot-film air mass meter (digital) with integral temperature sensor
  Throttle valve with contactless sensor
  Map-controlled ignition with cylinder-selective, digital knock control
  Single-spark ignition coils

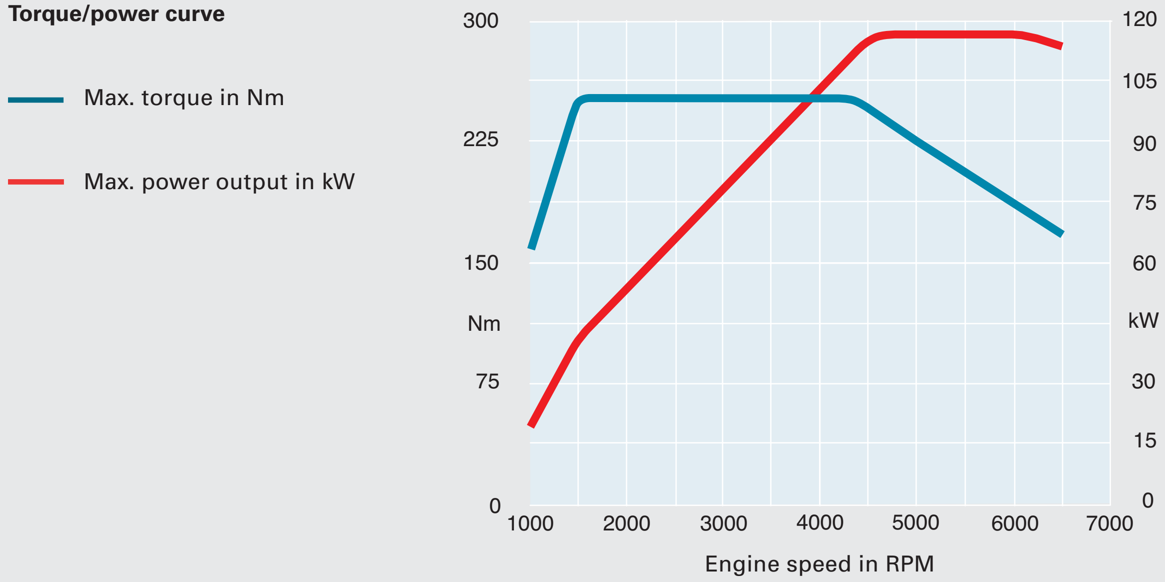
- Turbocharging
  Integral exhaust turbocharger
  Charge-air cooler
  Boost pressure control with overpressure
  Electrical wastegate valve

- Exhaust system
  Single-chamber exhaust system with close-coupled pre-catalyst
  No "continuous" pre-catalyst oxygen sensor in the EU IV

- Combustion process
  Direct injection, homogeneous

384_003

Torque/power curve



Specifications

Engine code	BYT
Type of engine	Inline petrol engine
Displacement in cm^3	1798
Max. power output in kW (bhp)	118 (160) at 5000 - 6200 rpm
Max. torque in Nm	250 at 1500 - 4200 rpm
Number of valves per cylinder	4
Bore in mm	82.5
Stroke in mm	84.2
Compression ratio	9.6 : 1
Firing order	1-3-4-2
Engine weight in kg	144
Engine management	Bosch MED 17.5
Fuel grade	95/91 RON
Exhaust emission standard	EU IV

Crankshaft drive

Cylinder block

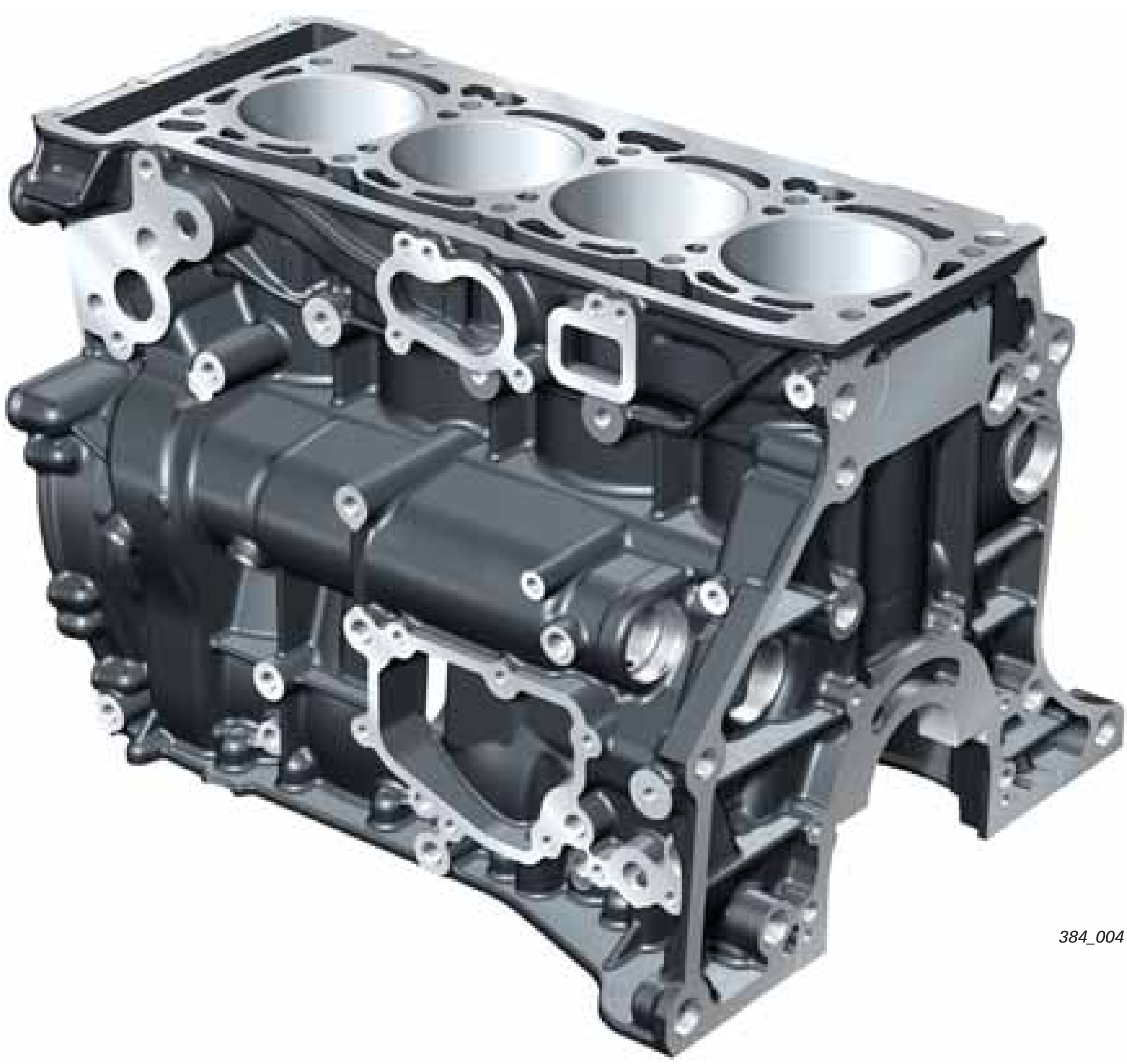
The cylinder crankcase has a closed-deck configuration and is made of cast iron (*GJL 250**). It houses the five-bearing crankshaft assembly and the two balancer shafts.

The chain housing for mounting the chain drives is also integrated in the cylinder crankcase.
The cylinder liners are finished in a three-stage fluid jet honing process.

The piston bases are cooled in the cylinder crankcase by mounted spray nozzles which spray the pistons with engine oil from below.

The cylinder crankcase is sealed on the gearbox side by means of a sealing flange with oil seal and at the front by the timing case cover, which likewise has an oil seal.

* *GJL 250 - designation according to current standard. The earlier designation was GG 25.*



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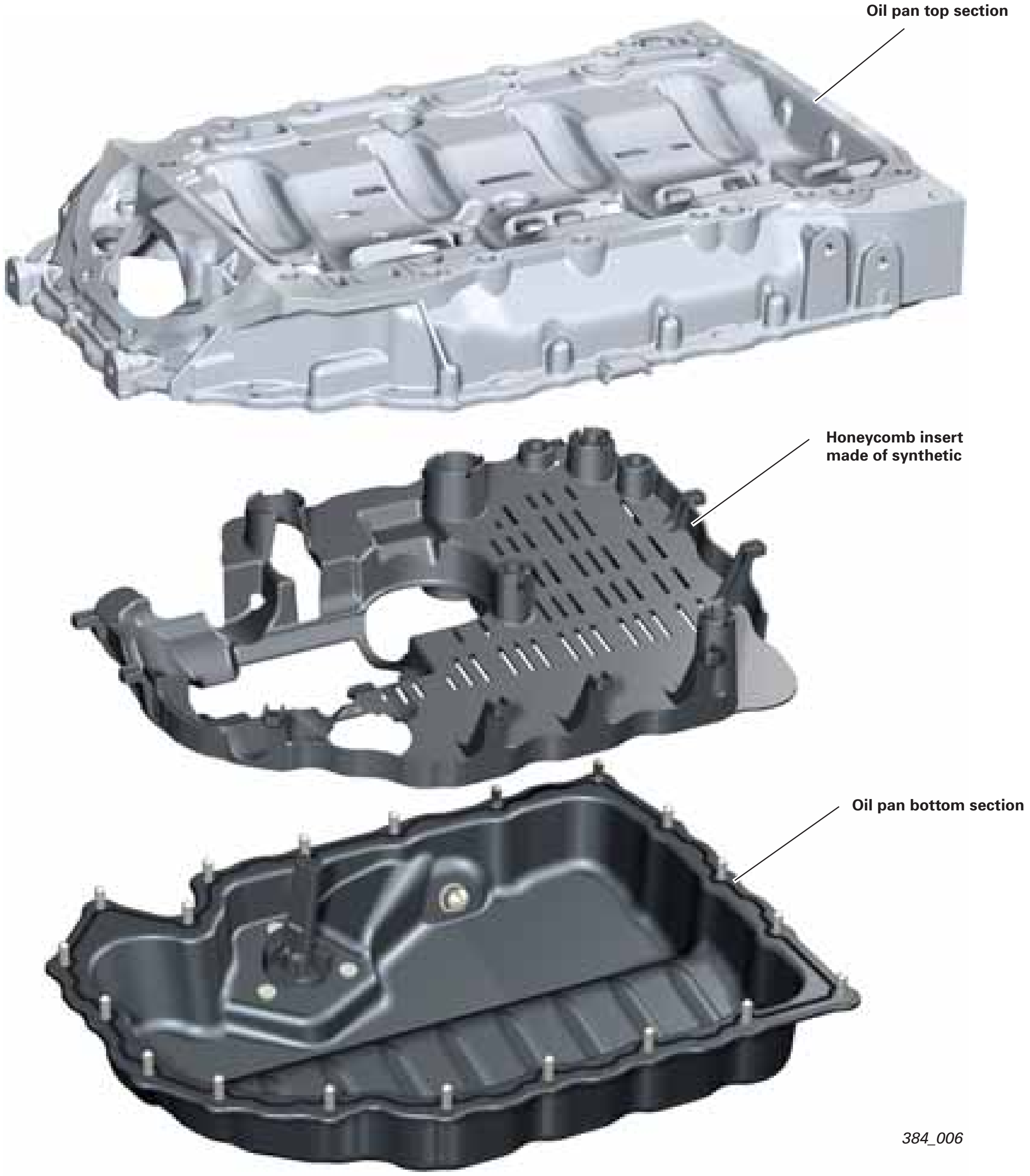
Oil pan

The oil pan top section is made of an aluminium alloy (AlSi12Cu).
It houses the oil pump and additionally reinforces the crankcase (bedplate effect). The oil pan top section is bolted to the crankcase and made airtight by a liquid sealant.

The oil pan bottom section is made of sheet steel (deep drawn, punched and catalytically coated).
It houses the oil level sender G12 and the oil drain screw.
The oil pan bottom section is also bolted to the oil pan top section and made airtight with liquid sealant.

The oil pan has an integral honeycomb insert made of polyamide to prevent oil churning when the vehicle is driven in a sporty manner.



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Crankshaft

The five-bearing crankshaft is manufactured from steel and induction hardened.
Optimal inner balancing is achieved by using eight counterweights.

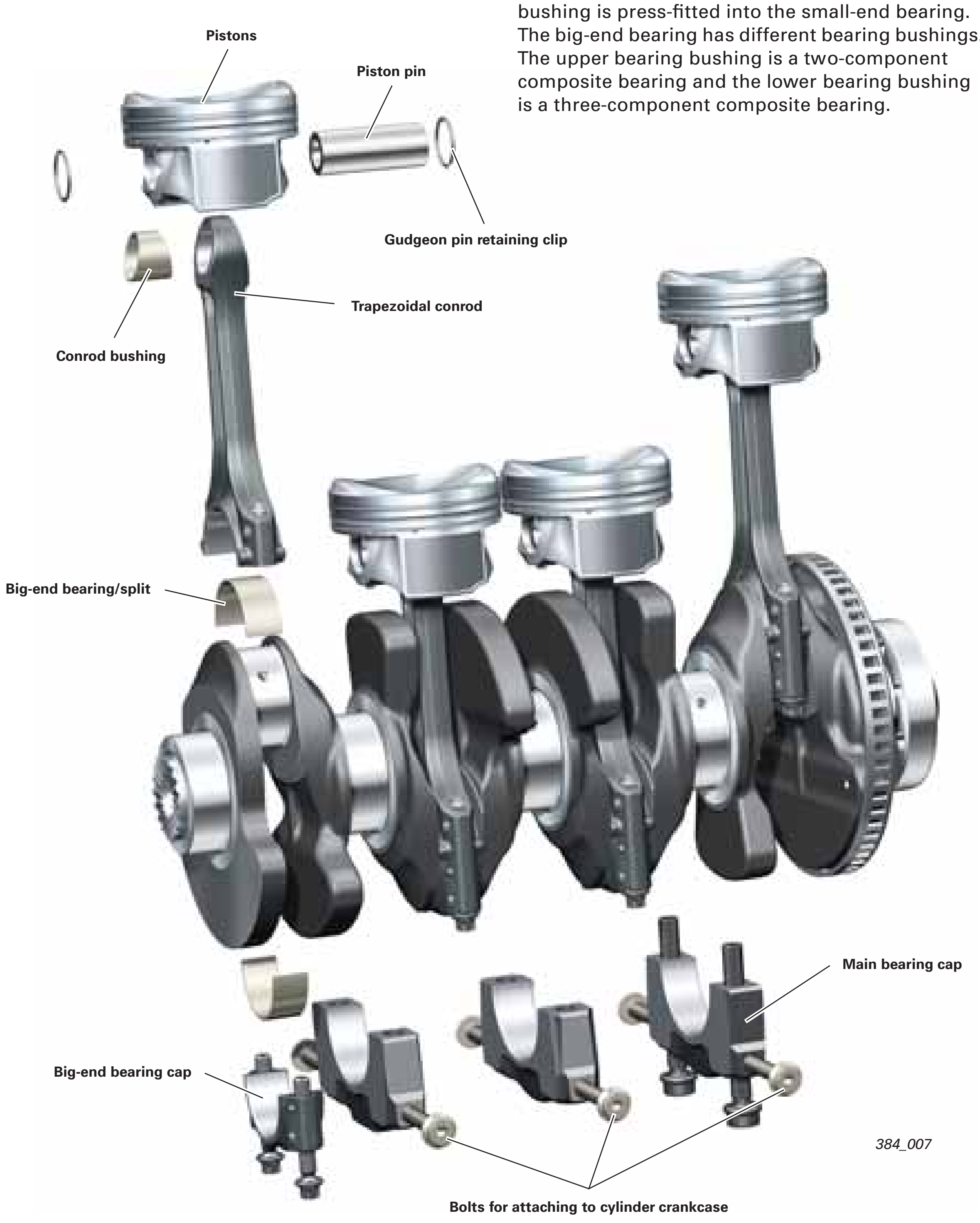
To additionally reinforce the crankshaft assembly, the three inner main bearing covers are bolted laterally to the crankcase.

Trapezoidal conrod

Material:	36MnVS4
Length:	148 mm
Big-end bearing:	47.8 mm
Small-end bearing:	21 mm

The main bearing bushes are composite two-component bearings. The crankshaft is located axially by thrust washers in the middle support bearing.

The trapezoidal conrods are cracked. A bronze bushing is press-fitted into the small-end bearing. The big-end bearing has different bearing bushings. The upper bearing bushing is a two-component composite bearing and the lower bearing bushing is a three-component composite bearing.



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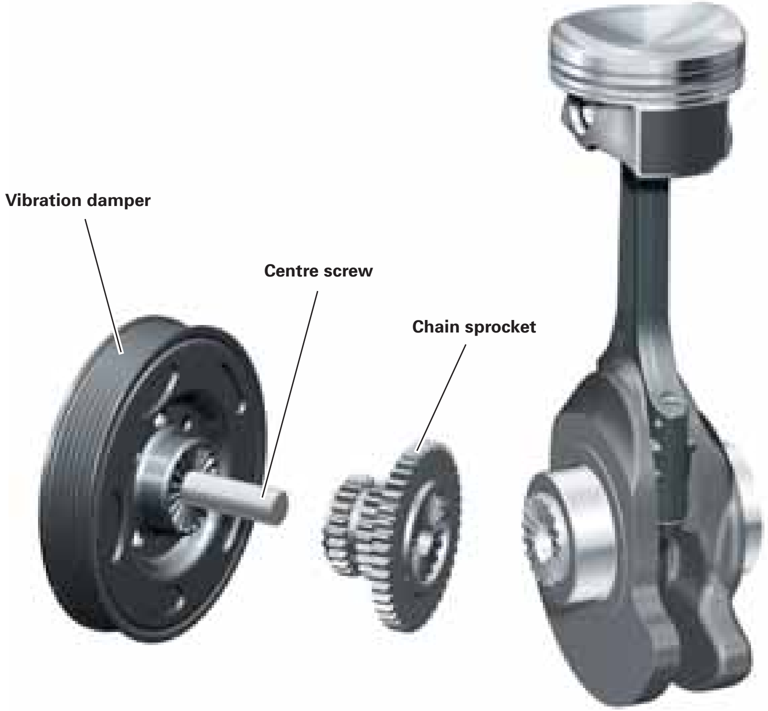
The drive gear for the chain drives and the dual-mass vibration damper is mounted to the crankshaft face.
A spur gear provides a positive connection to the crankshaft. The centre screw interconnects the parts non-positively.

This method of joining allows high torque to be transmitted to the torsion damper and the chain sprocket using a small diameter. This allows better sealing to be provided by the radial shaft sealing ring at the vibration damper hub.

On the transmission side of the engine, the dual-mass flywheel or the torque converter plate is connected to the crankshaft by eight bolts.



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Pistons

The pistons are specially shaped FSI casting pistons with a cast-in ring carrier for the upper piston ring. The ring carrier technology is typical of high-stress passenger-car diesel engines. This technology was used for the first time in a petrol engine in the 2.0 litre TFSI. Thanks to the lightweight design concept, the ring carrier and a coated skirt, the pistons are highly durable and operate very smoothly with minimal friction losses.

The upper piston ring is rectangular. The second piston ring is a taperface ring and the oil scraper ring is a bevelled ring with expander.
The 31CrMoV gudgeon pins are held in place by snap rings.

384_051

Crankcase breather

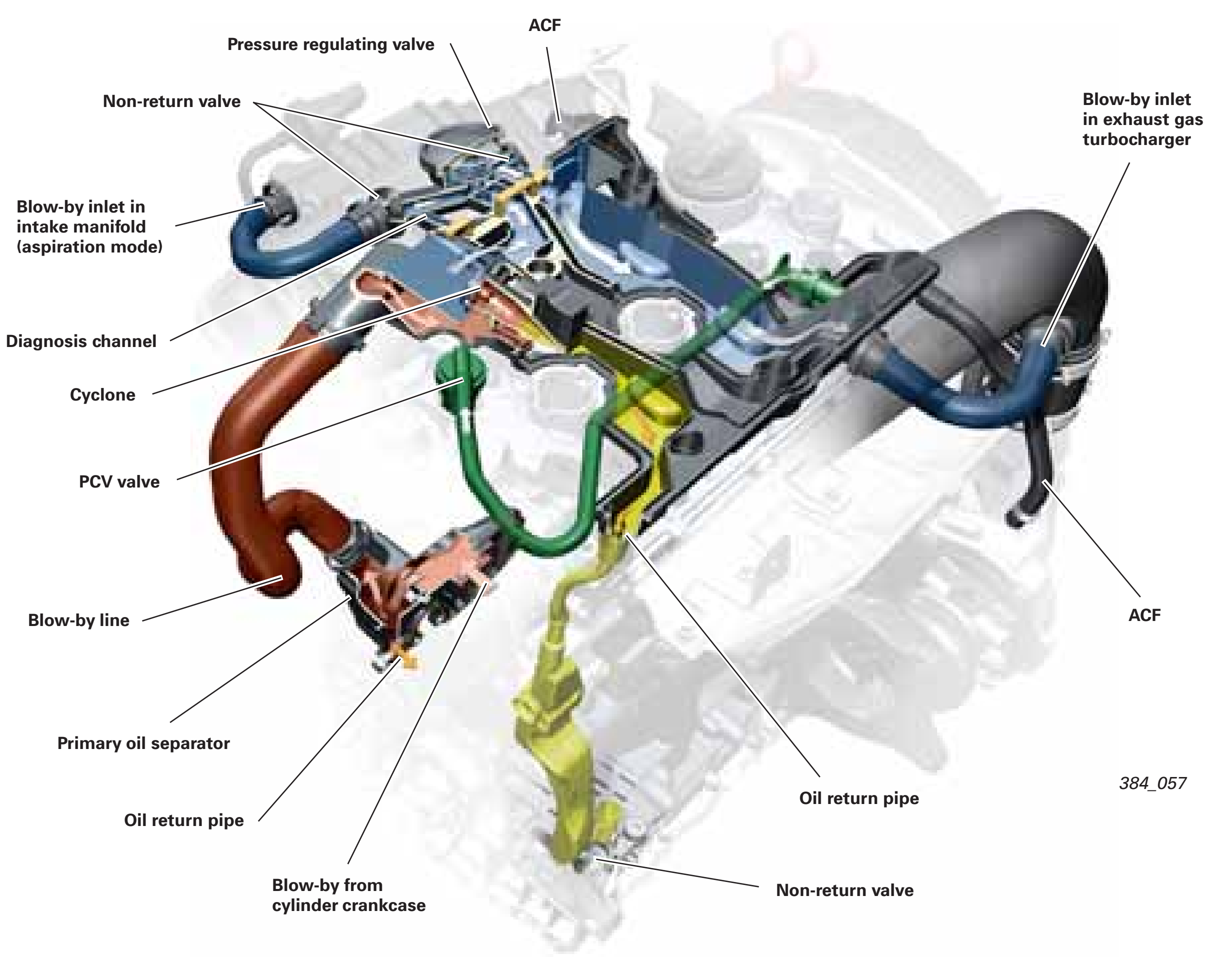
In the EA 888 the crankcase is ventilated through the engine block.
For this purpose, an oil separator is installed on the cylinder crankcase below the coolant pump.
A baffle plate in the oil pan top section prevents direct impingement of oil at the extraction point.

In the primary oil separator, the blow-by gases flow through a labyrinth to separate coarse particles from the oil. The primary oil separator has two separation stages which work on the baffle-plate principle.
The separated oil flow back along oil return lines into the oil pan to below the dynamic oil level. The pretreated gas flows from the primary oil separator along a pipe with a large cross-section to the design engine cover. The large line cross-section results a low crankcase breather gas flow rate and thus prevents oil droplets travelling along the side wall of the pipe.
The hose pipe is encased in insulating material. This prevents the system from freezing when there is a high water content in the blow-by gas. This occurs in cold conditions and when the vehicle used frequently for short-distance commuting.

A fine oil separator is integrated in the design engine cover. A single-stage cyclone separator with a parallel bypass valve, it filters out any residual ultra-fine oil particles.

The separated oil flows into the cylinder head through a port in the cylinder head cover. The draining engine oil flows along the engine oil return channel and into the oil pan below the oil level.
To prevent intake of the engine oil under excessively high vacuum, a non-return valve is installed at the end of the oil return duct. This non-return valve is installed in the honeycomb insert in the oil pan.
The treated blow-by-gas flows along a duct integrated the design cover into the two-stage pressure regulating valve. The pressure regulating valve prevents excessively high vacuum from developing within the crankcase.

The pressure regulating valve is installed in a housing together with two non-return valves.
The non-return valves regulate exhaustion of the treated blow-by gases, depending on the pressure conditions in the engine intake.
If a vacuum is present in the intake manifold, i.e. at low engine speed, when the exhaust gas turbocharger is still producing no charge pressure, the blow-by gases are drawn directly into the intake manifold. If charge pressure is present, the blow-by gas is introduced on the intake side of the exhaust gas turbocharger.



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Crankcase breather system (*PCV**)

This system supplies the engine with fresh air. This fresh air is admixed to the blow-by gas and engine oil mixture.
The fuel and water vapours in the blow-by gases are absorbed by the admixed fresh air and discharged through the crankcase breather.

For ventilation of the crankcase, fresh air is extracted from the engine intake behind the air filter and the air mass meter. The breather pipe is connected to the cylinder head cover via a non-return valve.

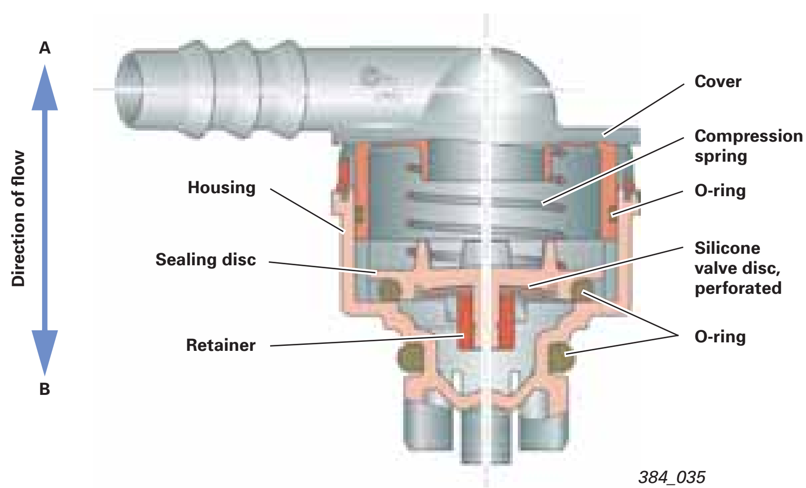
The non-return valve ensures a continuous air supply and that unfiltered blow-by gases cannot be aspirated directly.

The non-return valve is also designed to open under overpressure inside the crankcase. This precaution prevents damage to seals due to overpressure.

* *Positive Crankcase Ventilation*

384_056

Cutaway view of crankcase breather valve



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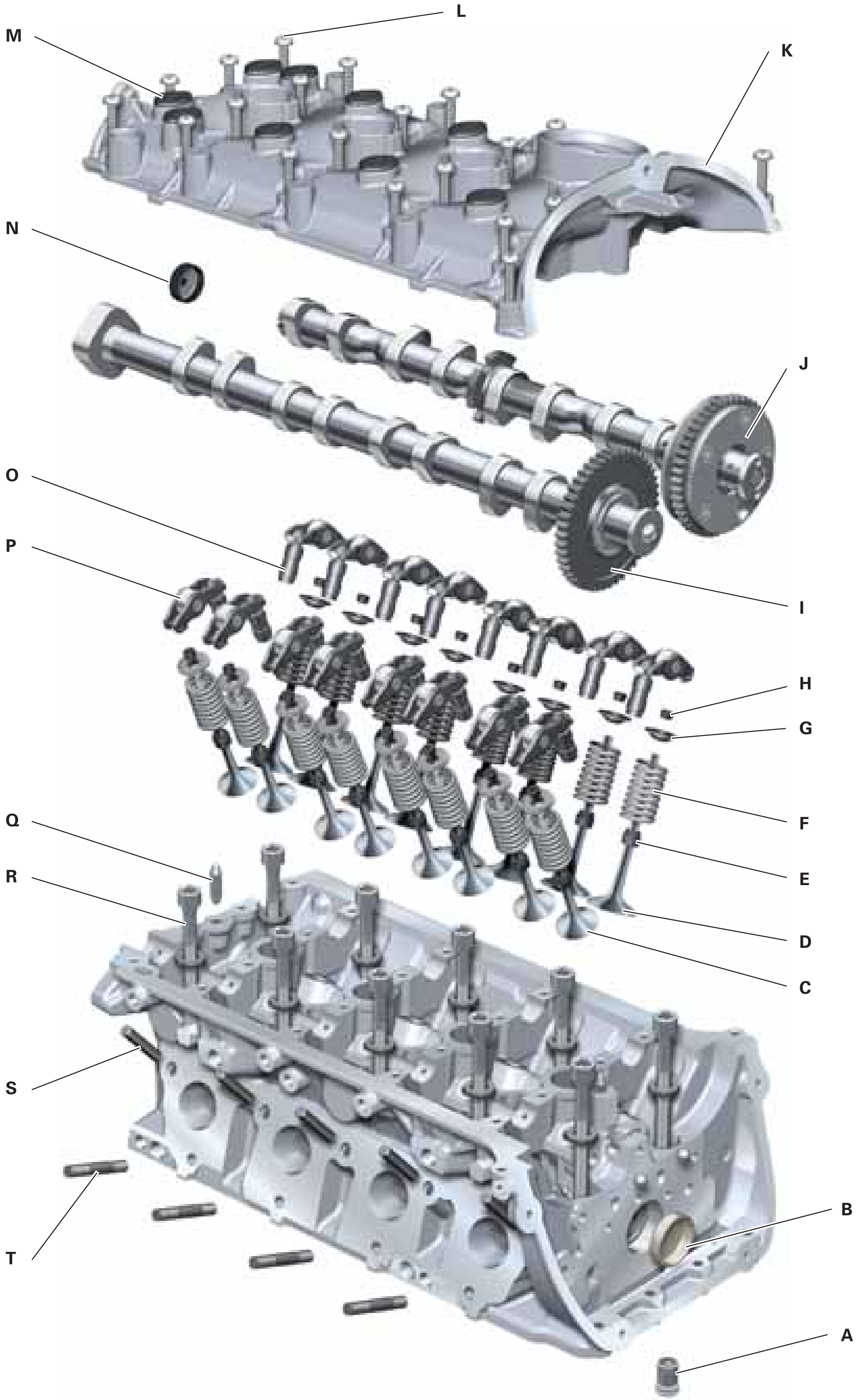
	Direction of flow A-B	Direction of flow B-A
Opening pressure	p</ = 7 hPa	100 ± 15 hPa

Cylinder head



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The 4-valve cylinder head is cast from aluminium alloy.
The intake and exhaust valves are actuated by roller cam followers.
They are supported by hydraulic valve lifters and are driven by camshafts. The camshafts are driven via a chain drive.

The intake camshaft is controlled via a camshaft adjustment system.
The cylinder head cover serves simultaneously as a ladder frame. It does not have to be dismantled to remove the cylinder head.
The cylinder head is sealed on the control side by the chain housing. The diagonal sealing face simplifies chain assembly.

Specifications

- Crossflow cylinder head made of ASi10Mg(Cu)wa
- Three-layer metal head gasket
- Intake ports are divided by a baffle plate
- Cylinder head cover made of AlSi9Cu3 with integrated ladder frame, bolted to the cylinder head and sealed with liquid sealant
- Intake valve: solid-stem valve, chrome-plated with reinforced seat
- Exhaust valve: sodium filled hollow-stem valve, chrome-plated and tempered with reinforced seat
- Single valve spring made of steel
- Roller cam followers running in needle bearings, hydraulic valve clearance adjustment
- Assembled intake camshaft with variable valve timing, dwell angle 190°, valve lift 10.7 mm
- Assembled exhaust camshaft with press-fitted drive gear, dwell angle 180°, valve lift 8 mm
- INA camshaft adjuster, timing range 60° crank angle, basic position is locked in "retard"

Legend

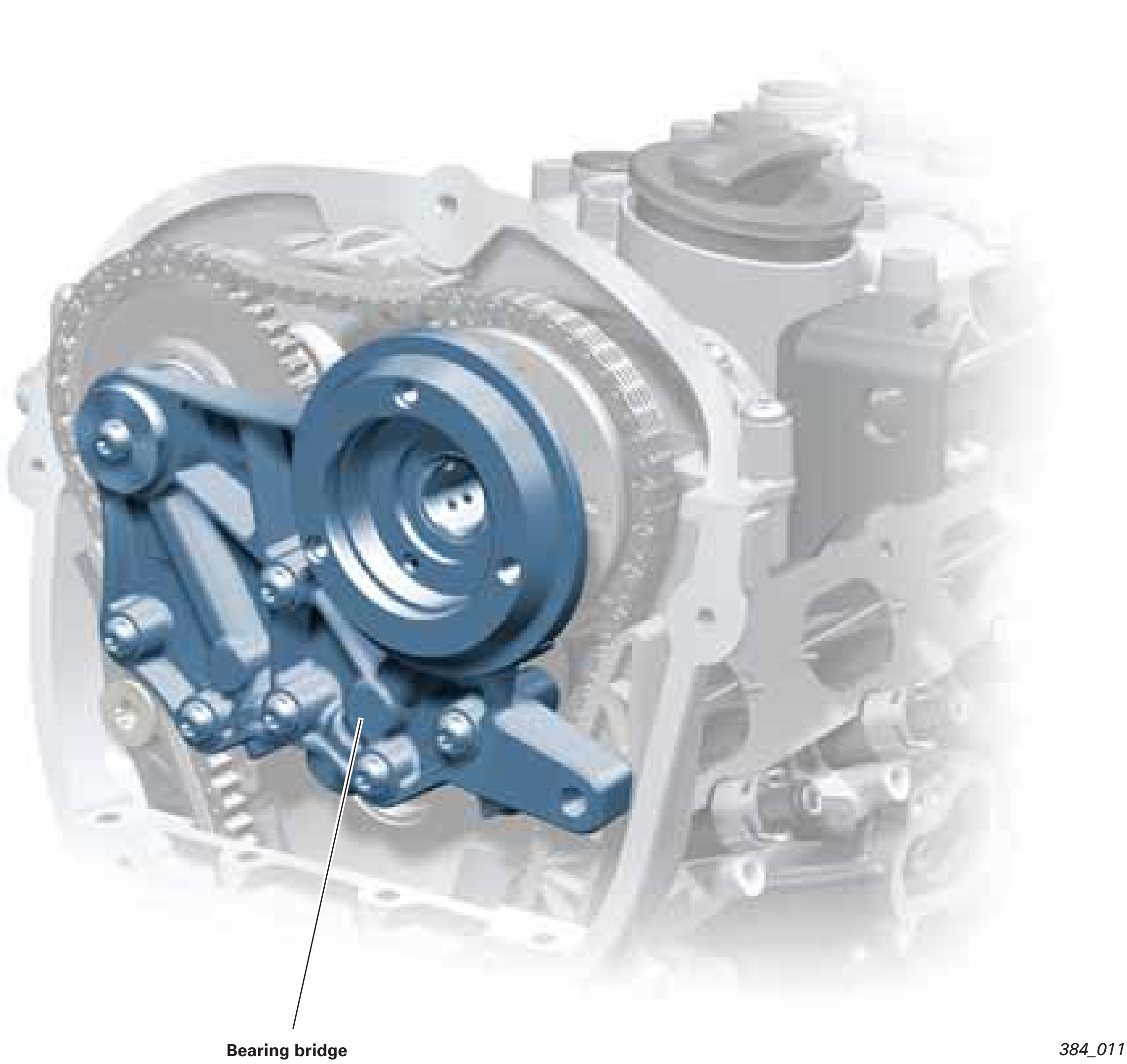
A	Check valve
B	End cap
C	Exhaust valve
D	Intake valve
E	Valve stem seal
F	Valve spring
G	Valve spring retainer
H	Valve cone
I	Camshaft exhaust
J	Camshaft intake with camshaft adjuster
K	Cylinder head cover
L	Pan head screw
M	Screw plug
N	End cap
O	Hydraulic valve clearance adjuster
P	Roller cam follower
Q	Dowel pin
R	Cylinder head bolt with washer
S	Headless bolt
T	Fitted stud bolt

Bearing bridge

The die-cast aluminium bearing bridge has the following tasks:

- Supporting the camshafts
- Supplying pressurised oil to the two camshaft bearings
- Supplying pressurised oil to the camshaft adjuster
- Mounting the intake camshaft timing adjustment valve -1- N205

The camshafts are retained axially in the bearing bridge.
For operation of the camshaft adjuster, a non-return valve and a screen are integrated in bearing bridge in the pressurised oil duct to the camshaft adjuster, see page 24/25.
The pressurised oil duct continues to connect the main oil duct to the two oil galleries in the cylinder head.



384_011

INA camshaft adjustment system

The EA 888 uses an intake camshaft adjuster. This adjuster operates on the principle of a hydraulic vane cell adjuster. The adjuster uses the oil pressure provided by the engine oil pump.

The variable camshaft adjuster operates in an adjustment range of 60° crank angle. The camshaft is locked in the retard position at engine shut-off. This function is performed by a spring-loaded locking pin. The camshaft is released when the engine oil pressure exceeds 0.5 bar.

The rotor of the vane cell adjuster is welded to the intake camshaft. The 4/3-way central valve required for adjuster control is integrated in the camshaft.

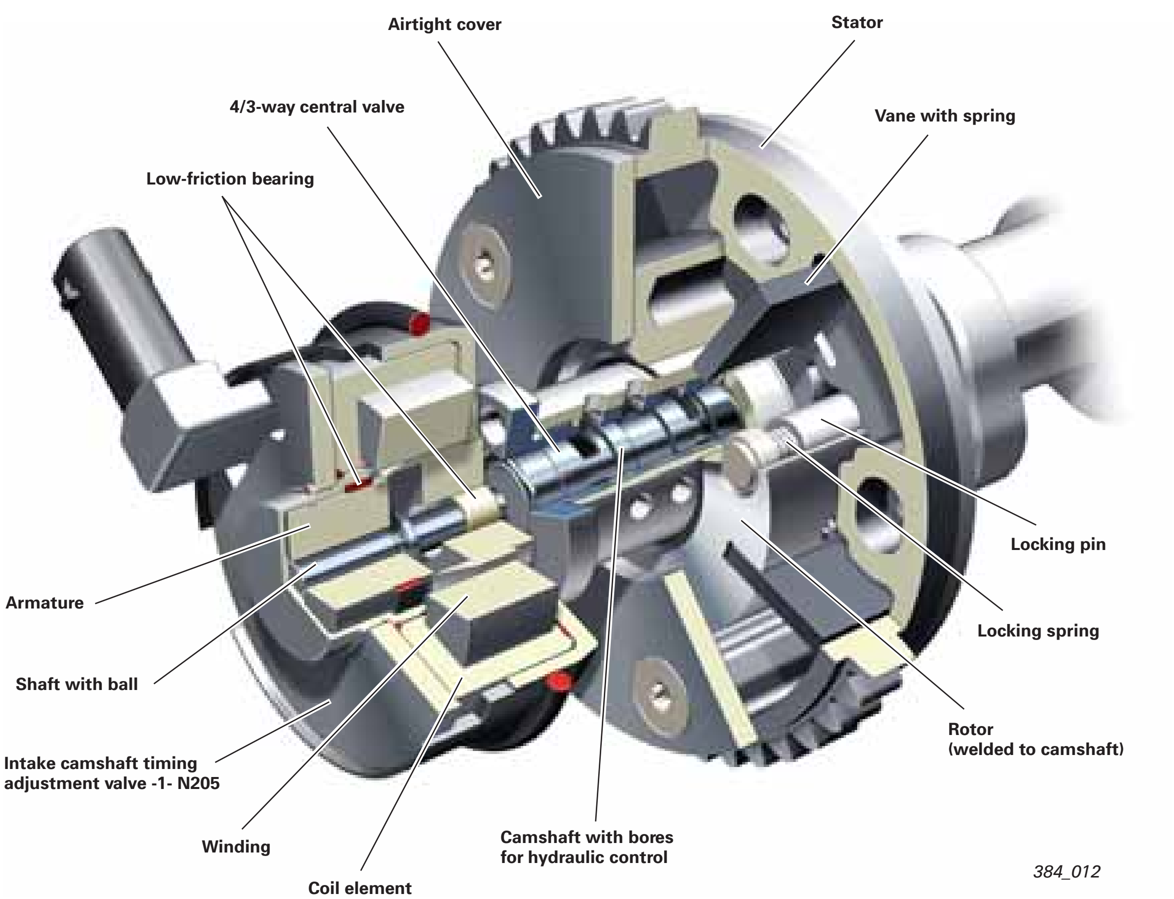
The phasing of the camshafts is engine map controlled. The aims are to improve engine power, torque, running smoothness and emission quality (internal exhaust gas recirculation).

Function

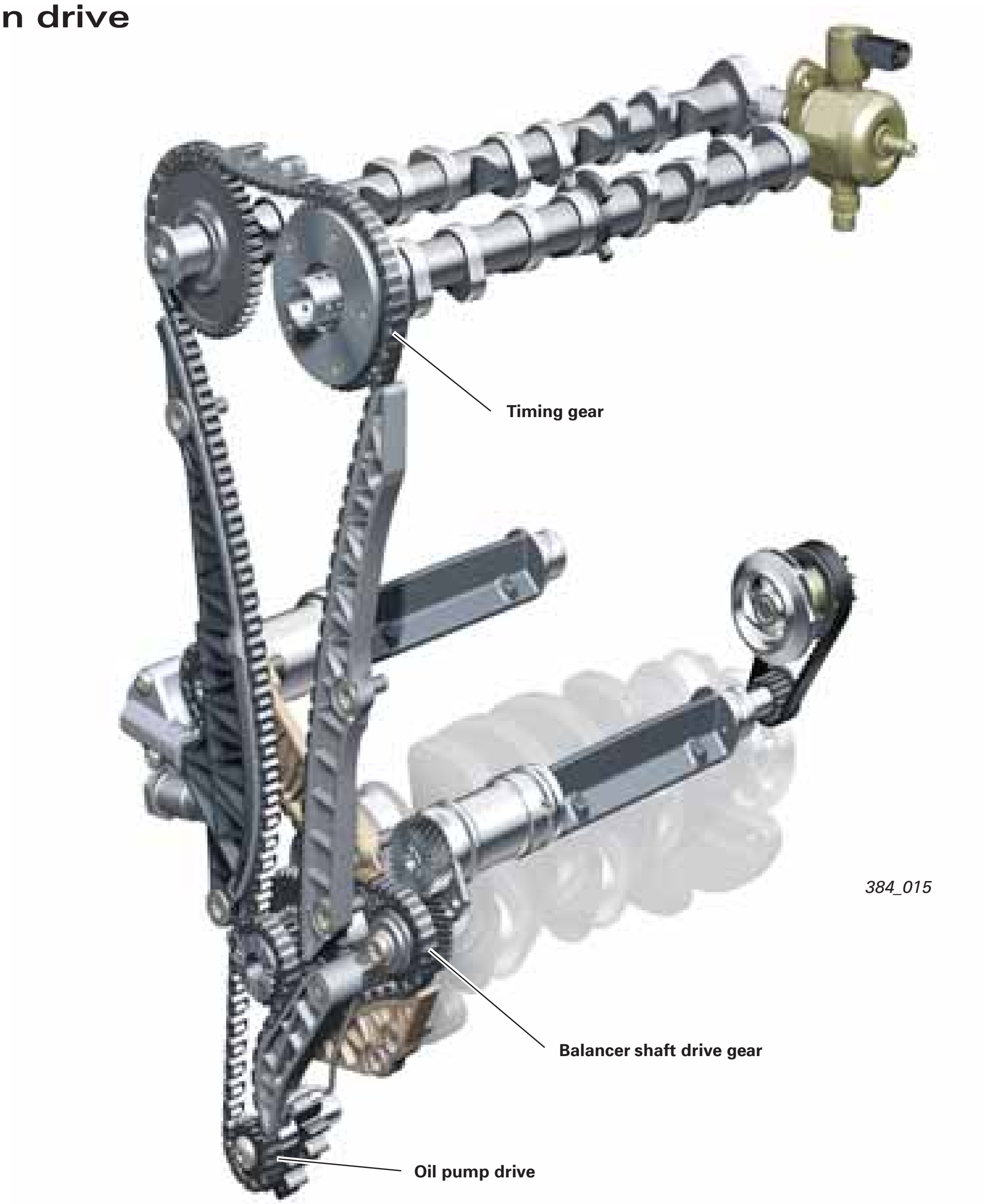
The pressurised oil flows to the central valve via the camshaft bearing through bores in the camshaft. From here, depending on adjustment requirements, the oil flows through further bores in the camshaft into one of the chambers in the adjuster.

The valve is activated electrically via a separate fixed central solenoid (intake camshaft timing adjustment valve -1- N205).
When activated by a PWM signal, the solenoid produces a variable magnetic field. Depending on the strength of the magnetic field, the shaft with ball is shifted towards the camshaft's axis of rotation. This, in turn, displaces the 4/3-way central valve and allows the oil to flow to the corresponding chamber.

The advantage of this new design is that it allows very high adjustment rates, even in unfavourable conditions, such as during cold starting or at high oil temperatures during idling.



Chain drive



The chain drive of the EA 888 is arranged in three planes. All three chain drives are driven directly by the crankshaft.

- 1st plane - balancer shaft drive
- 2nd plane - timing gear drive
- 3rd plane - oil pump drive

Gear chains are used in all three planes. The chains are configured as 1/4" gear chains with four tension plates and five guide plates.

Advantage of gear chains:

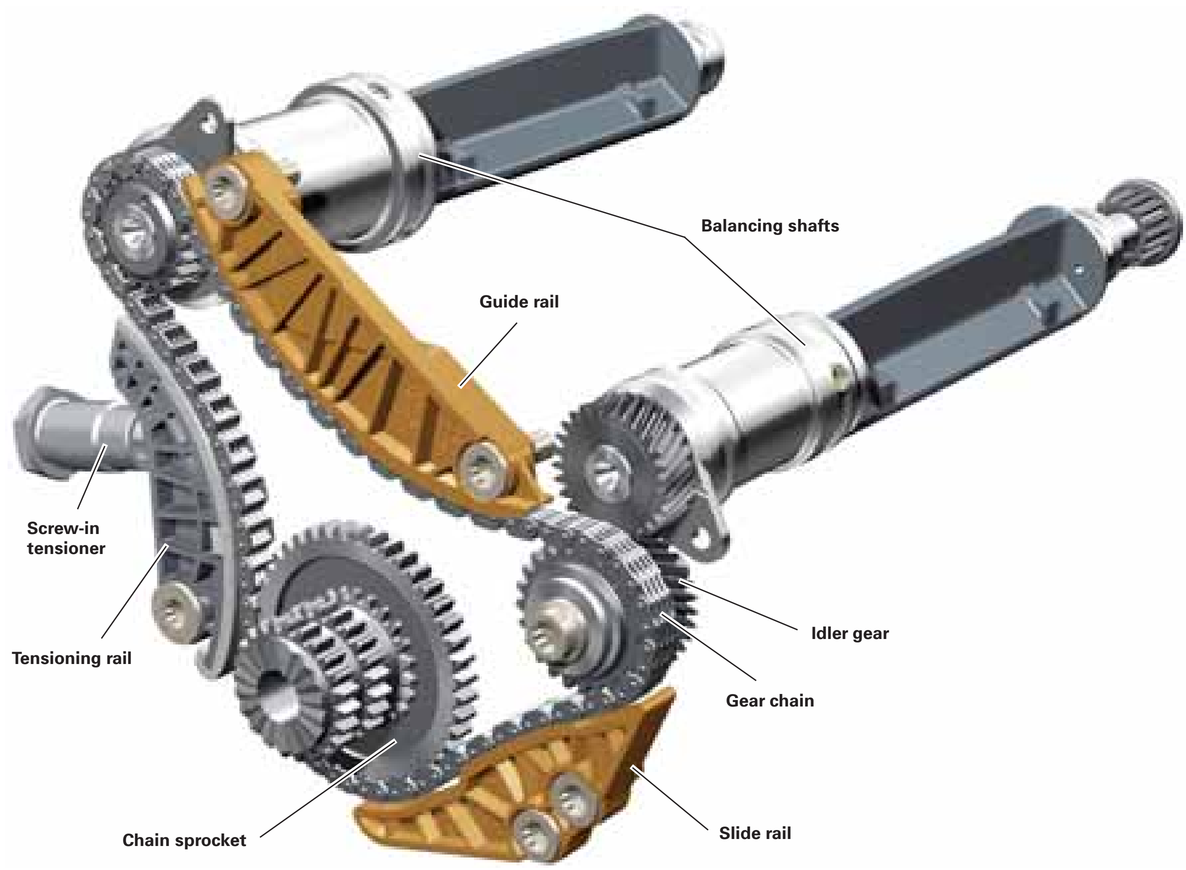
The gear chains are silent running and hard wearing. The amount of space required for a given power transmission capacity is less than that of a timing belt or roller chain.

Gear chains are highly flexible in application because their width can be adapted for any power requirement by selecting the number of plates accordingly. They have an efficiency of approx. 99 %.

Note

Blue outer plates are attached to each chain at defined intervals. They serve as an aid for setting the valve timing.
For details of the exact procedure, please refer to the Workshop Manual.

1st plane - balancer shaft drive



384_016

Mass and torque balancing

In the case of a four-cylinder engine, vibrations occur at engine speeds of 4000 rpm and higher and are transmitted through the car body.
They produce an unpleasant buzzing sound which can impair comfort. These vibrations are caused by second-order inertial forces.

These vibrations are counteracted by means of two in the shafts with counterweights running at twice engine speed in the opposite direction.
The direction of rotation of the second shaft is reversed via a gear step on the intake side.
The vertically staggered arrangement of the balancer shafts also reduces unwanted second-order moments. They take the form of alternating moments about the engine's longitudinal axis.

The balancer shafts are made from spheroidal-graphite cast iron and run in three bearings.
The balancer shafts are mounted in bearings level with crankshaft bearing seats 1 and 2 in a cast aluminium bearing housing.

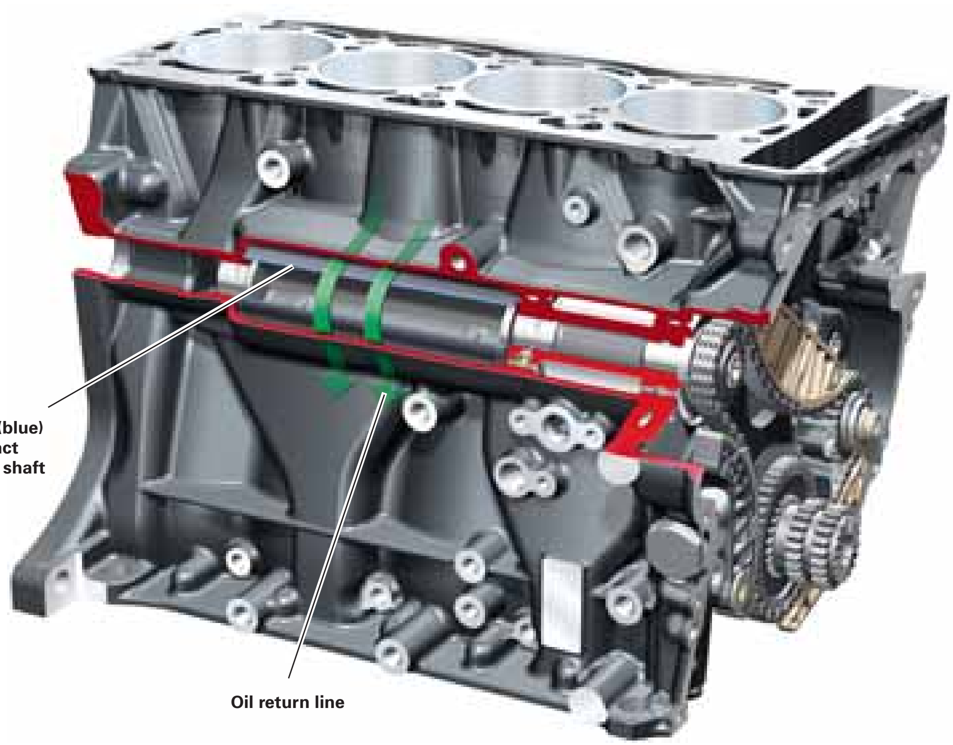
The balancer shafts are bolted in the crankcase.
The balancer shafts in the cylinder crank gear are mounted in a composite bearing bush at the same height as crankshaft bearing seat 4.
All bearing points are lubricated with engine oil from the engine lube oil system (refer to hydraulic diagram on page 24/25).

For lubricating the chain, oil returning from the cylinder head is collected and fed to the balancer shaft chain via a lubrication channel.

The advantages of integrating the balancer shaft in the cylinder crankcase are as follows:

– Higher cylinder crankcase rigidity
– Oil foaming by rotating parts has been reduced by moving the balancer shaft away from the oil pan.

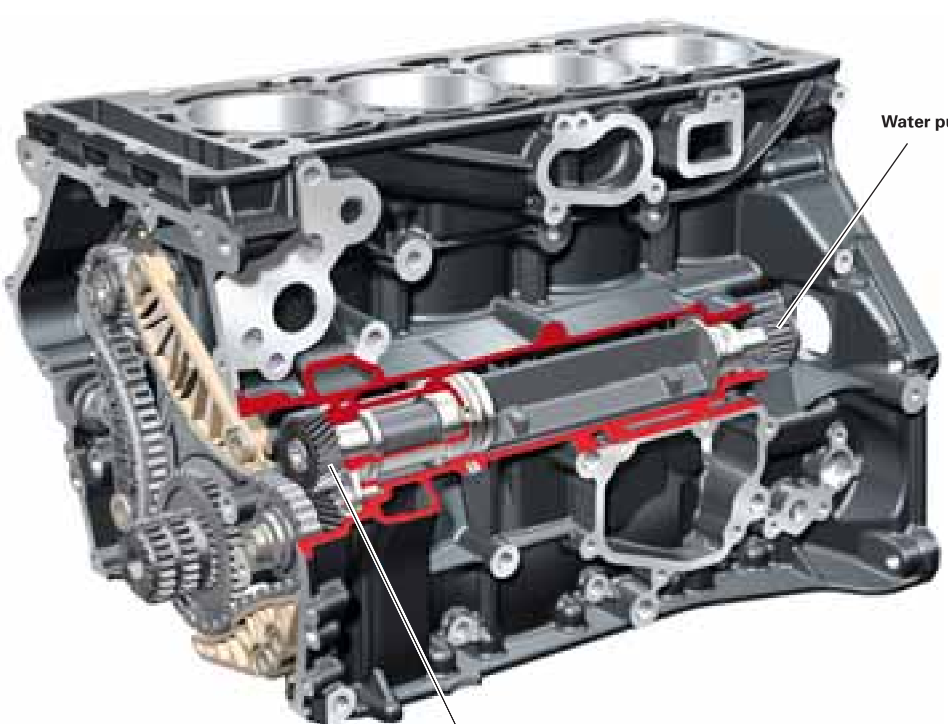
Layout of the balancer shafts in the cylinder crankcase



384_017

The cylinder head oil return line is located on the engine exhaust side. The returning oil flows through the chamber housing the balancer shaft.

To prevent oil churning on contact with the rotating balancer shaft, the balancer shaft is sheathed in a plastic pipe.
The oil flows around the pipe and then drains off into the oil pan.



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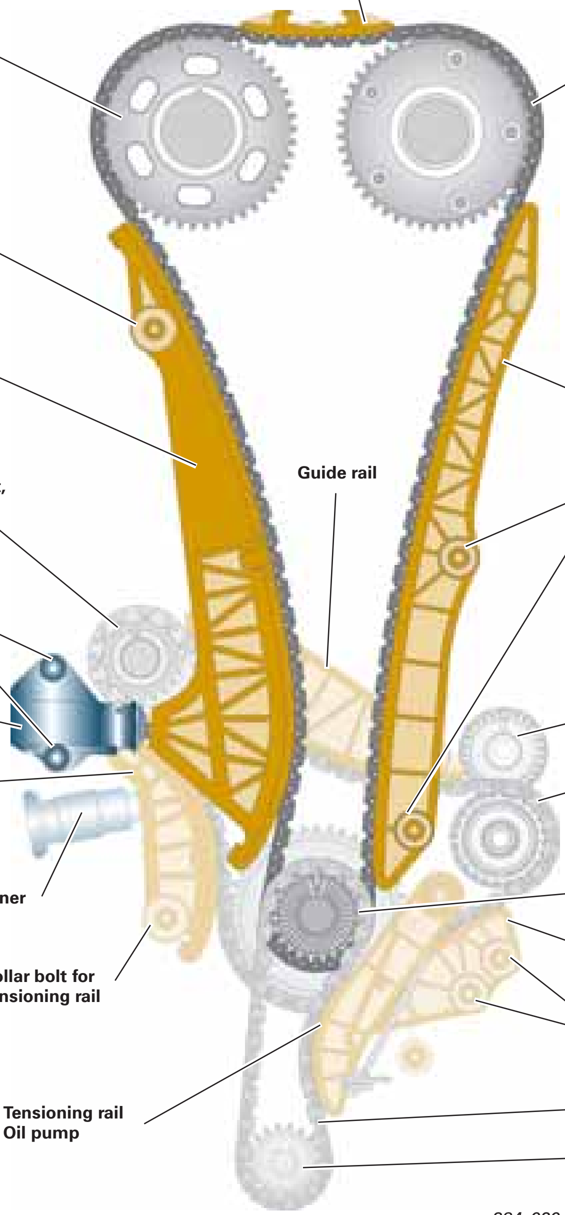
2nd plane - timing gear



384_020

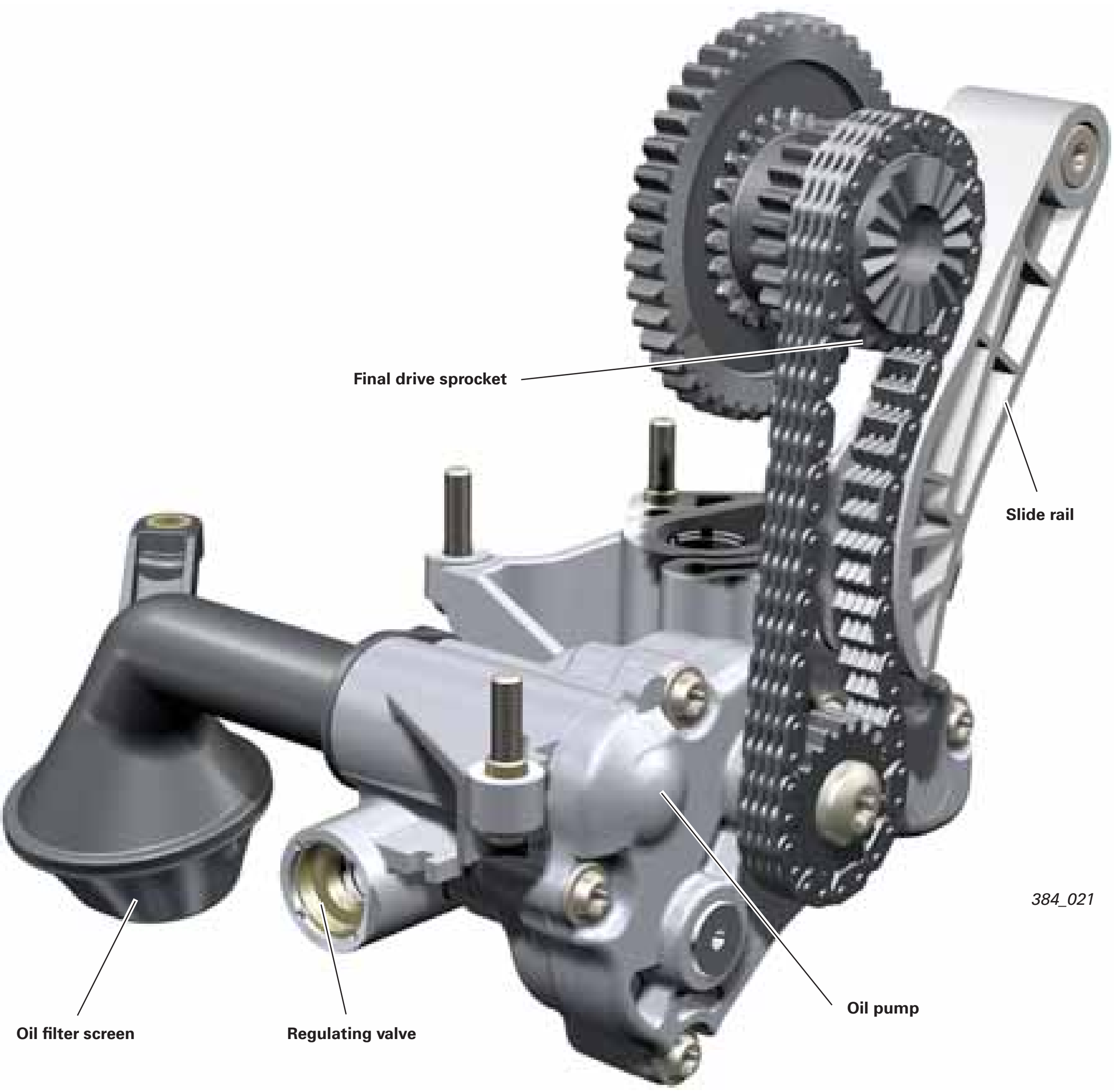
The two camshafts in the cylinder head are driven via the second plane.
Chain tensioning is provided by a hydraulic chain tensioner. It can be accessed from the exterior through a service port.
This allows the timing chain to be detached after removing the cylinder head without having to take off the engine timing case cover.

The chain is lubricated with oil flowing from the clean oil duct through a port in the bottom layer of the cylinder head gasket facing the engine block (refer to hydraulic diagram, page 24/25, item 15).

Chain tensioner with rig pin

384_043

3rd plane - oil pump drive



384_021

The chain drive for the oil pump is located in the third plane.
A polyamide slide rail is used in this drive to locate and tension the chain. The tension is produced by a mechanical spring.

A hydraulically damped system is not needed due to the low dynamic load. The chain is lubricated by the oil pan or by the returning oil.

384_022

Drive - ancillary units/ components

The subframe supports the alternator and the air conditioner compressor.

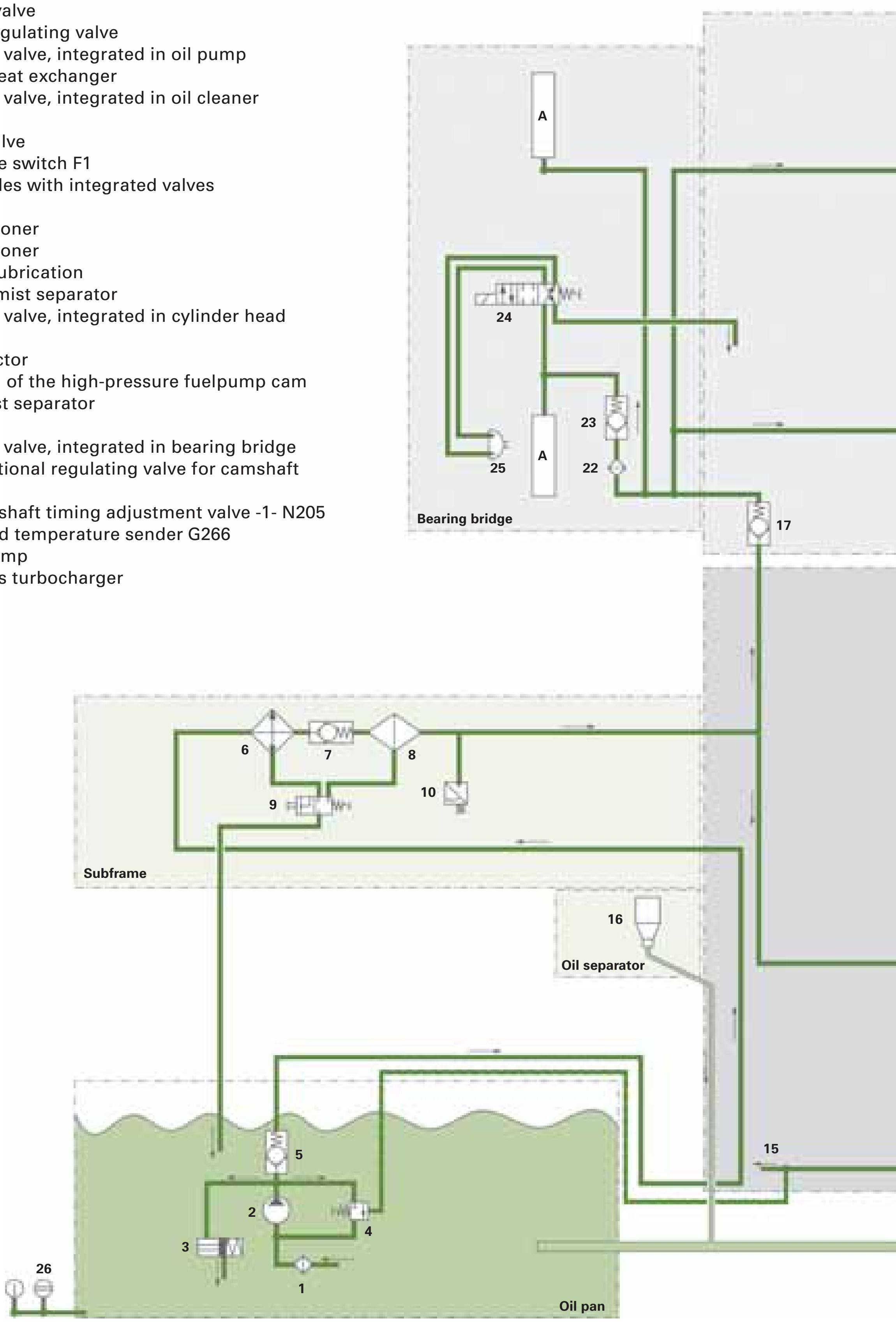
An automatic belt tensioner is also bolted to the subframe and ensures that the crankshaft is tensioned correctly via the ribbed vee belt driven by the vibration damper.

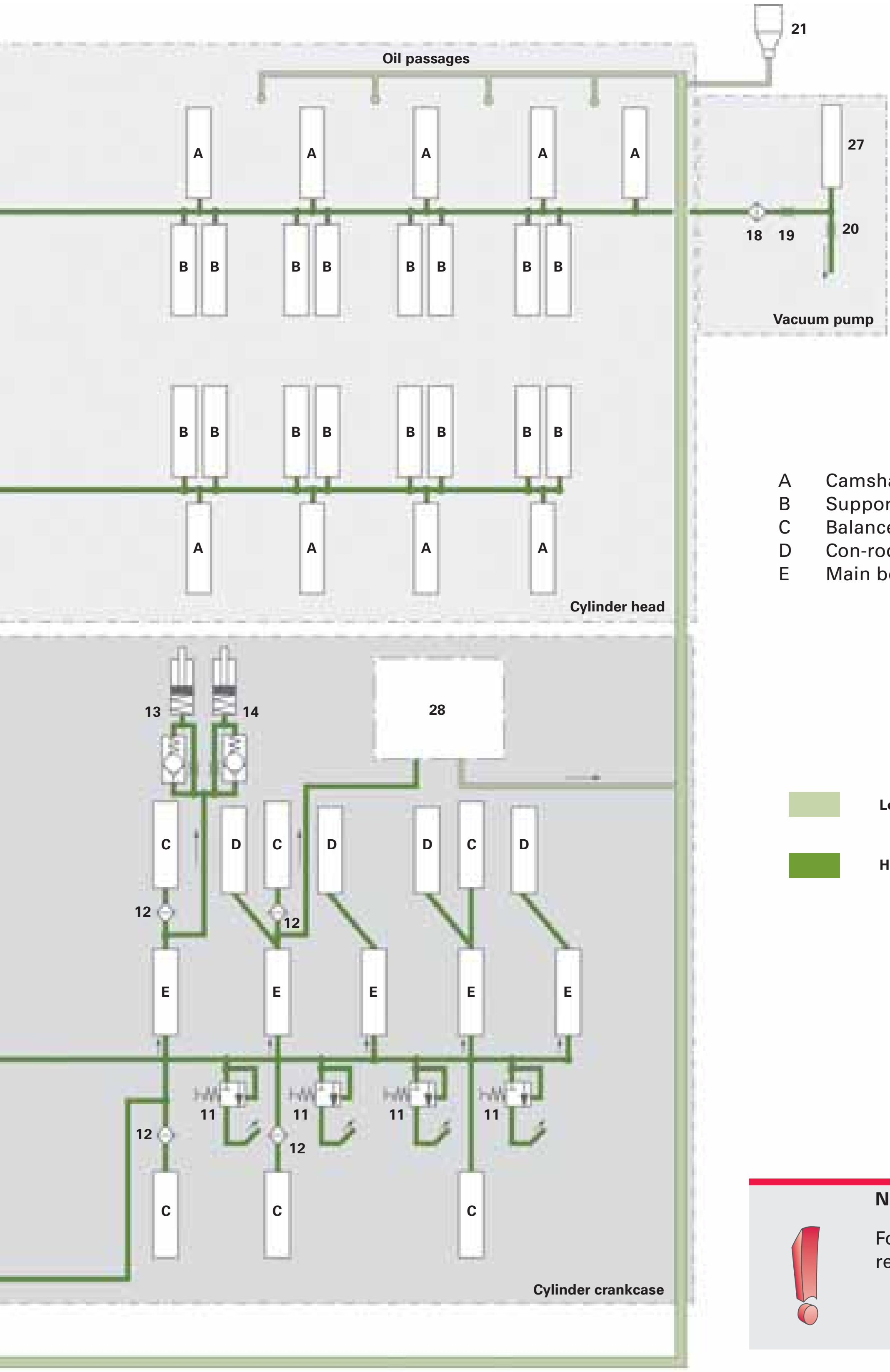
384_023

Lubrication system

Legend

1 Screen
2 Oil pump, chain-driven
3 Cold start valve
4 Pressure regulating valve
5 Non-return valve, integrated in oil pump
6 Water-oil heat exchanger
7 Non-return valve, integrated in oil cleaner
8 Oil cleaner
9 Oil drain valve
10 Oil pressure switch F1
11 Spray nozzles with integrated valves
12 Oil screen
13 Chain tensioner
14 Chain tensioner
15 Gear step lubrication
16 Coarse oil mist separator
17 Non-return valve, integrated in cylinder head
18 Oil screen
19 Flow restrictor
20 Lubrication of the high-pressure fuelpump cam
21 Fine oil mist separator
22 Oil screen
23 Non-return valve, integrated in bearing bridge
24 Multi-directional regulating valve for camshaft adjuster
25 Intake camshaft timing adjustment valve -1- N205
26 Oil level and temperature sender G266
27 Vacuum pump
28 Exhaust gas turbocharger





A Camshaft bearing
B Support element
C Balancer shaft bearing
D Con-rod
E Main bearing

Low-pressure circuit

High-pressure circuit

384_024

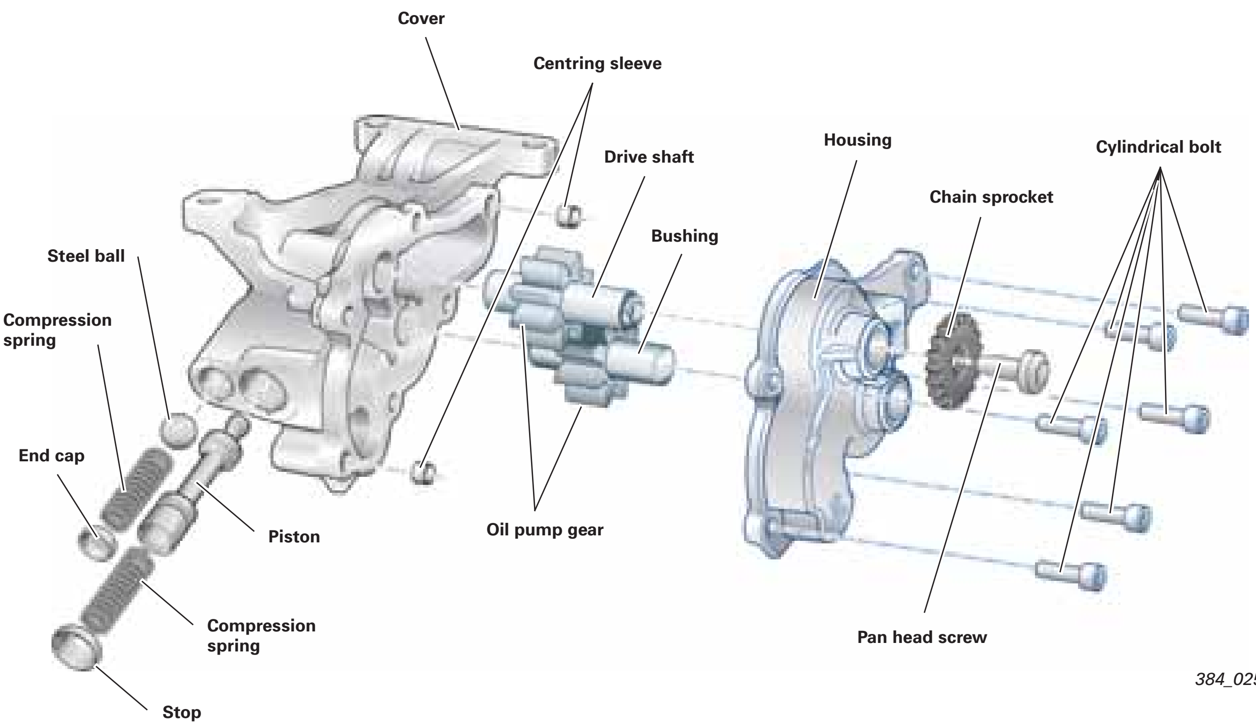
Note

For oil pressure values, please refer to the Workshop Manual.

Oil pump

The external gear pump is integrated in the oil pan top section and is driven by the crankshaft via a chain drive.

The oil pressure is controlled on the clean oil side inside the pump via the control spring and control piston. The system is also protected against over-pressure via a spring loaded valve ball (cold start valve).
Excessively high oil pressures can occur at high oil viscosity levels during cold starting.



384_025

Oil cleaner and oil cooler

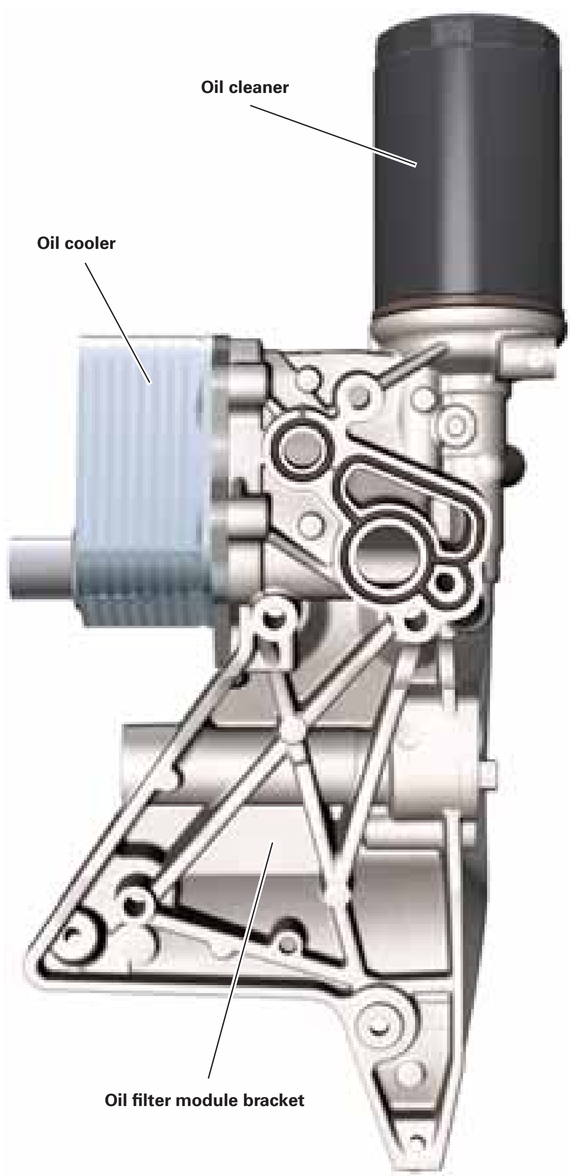
The oil cleaner and oil cooler bracket are integrated in the engine subframe. It also houses the oil pressure switch and the sheave for the belt drive.

The oil filter cartridge is accessible from above for easy servicing. To prevent oil spillage when changing the filter, a breech pin opens as the filter is removed. This allows the oil to flow back into the oil pan.

384_060

View of engine flange

View of engine flange



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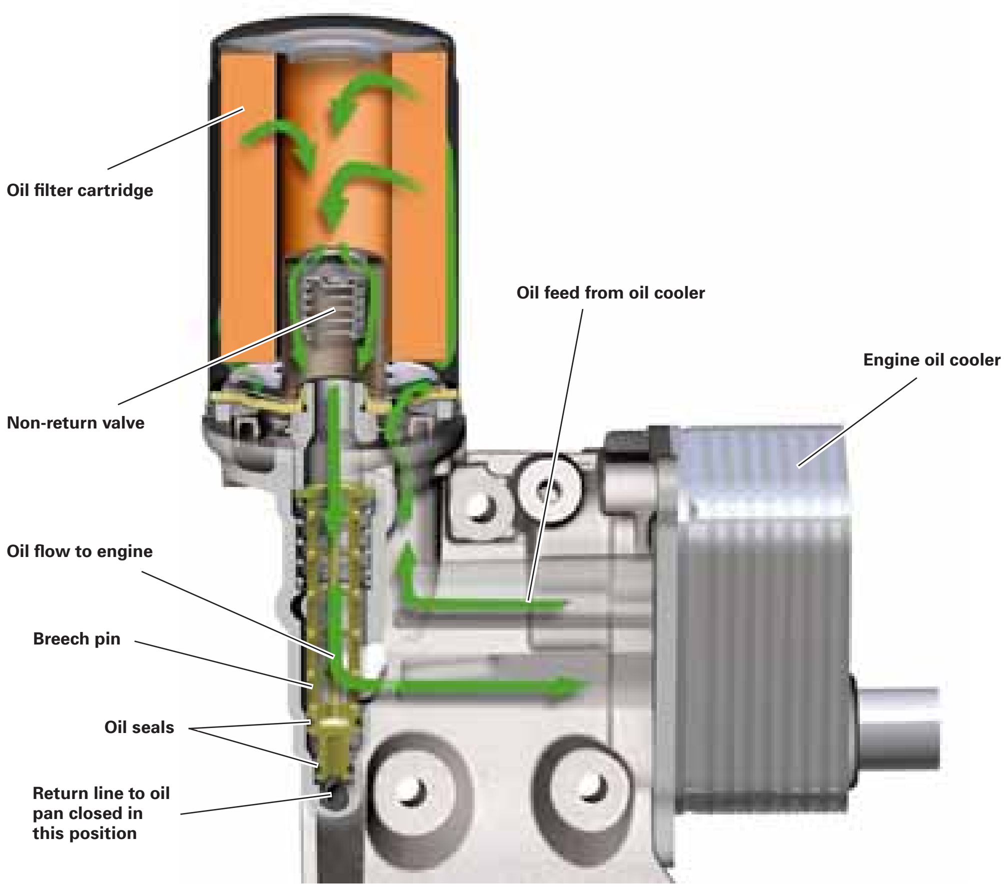
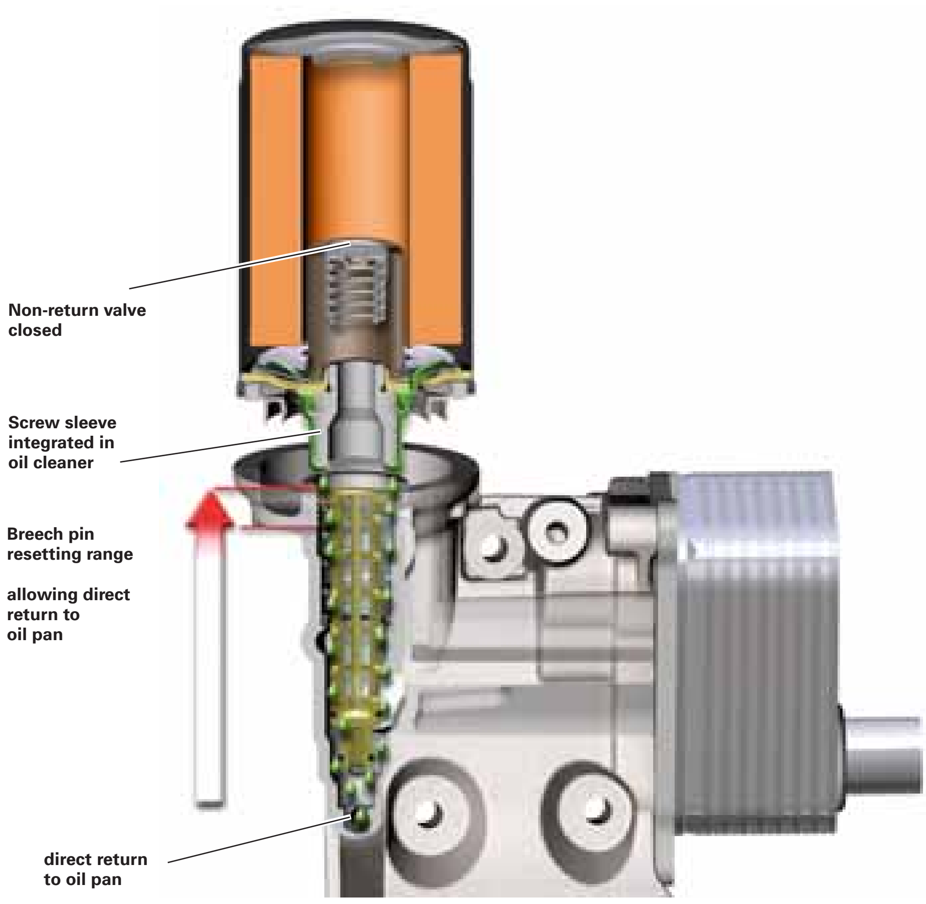


Oil filter cartridge
Oil feed from oil cooler
Engine oil cooler
Non-return valve
Oil flow to engine
Breech pin
Oil seals
Return line to oil pan closed in this position



Non-return valve closed
Screw sleeve integrated in oil cleaner
Breech pin resetting range
allowing direct return to oil pan
direct return to oil pan

384_027

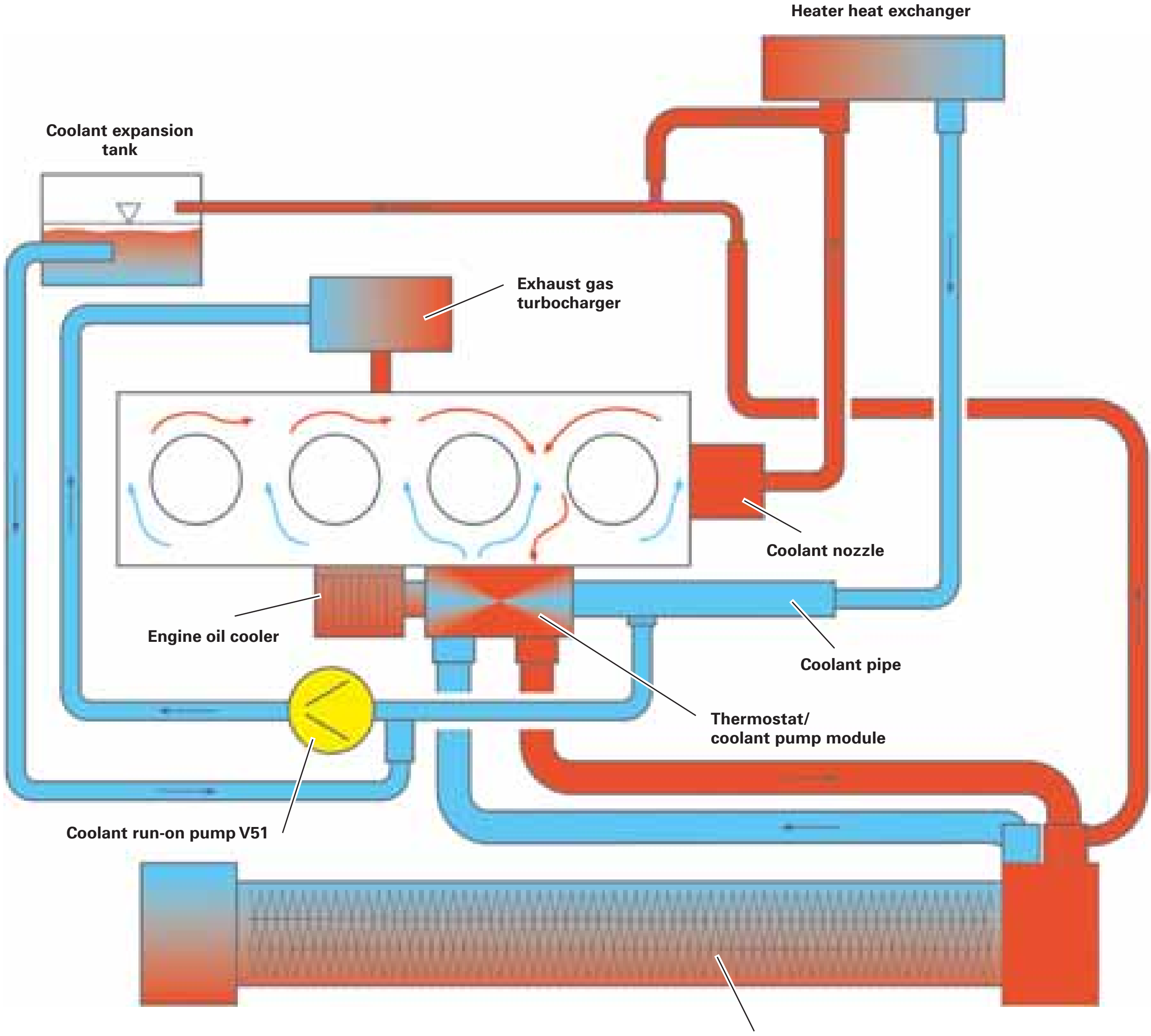
Engine cooling

The engine has a crossflow cooling system. The cold coolant flows to the front of the engine through the coolant pump into the engine block and flows circulates around the engine block via the end faces.

On the hot end of the engine (exhaust end), the coolant is distributed along the ducts to the individual cylinders and circulates around the cylinders to the intake end (cold end). Here the heated coolant is collected in a reservoir and fed to the radiator via the thermostat or, in the case of a closed thermostat, directly back to the water pump.

The heating heat exchanger and the exhaust gas turbocharger are integrated in the engine internal coolant circuit via additional connections.
The oil heat exchanger is connected directly to the engine block by the subframe.

The coolant run-on pump V51 protects the exhaust gas turbocharger against overheating after engine shut-off.
Activation of pump V51 is controlled by the engine control unit according to a characteristic map.



384_028

Note

Coolant hoses may have different connecting diagrams.
For information on variants, please refer to the relevant Workshop Manual.

Coolant pump

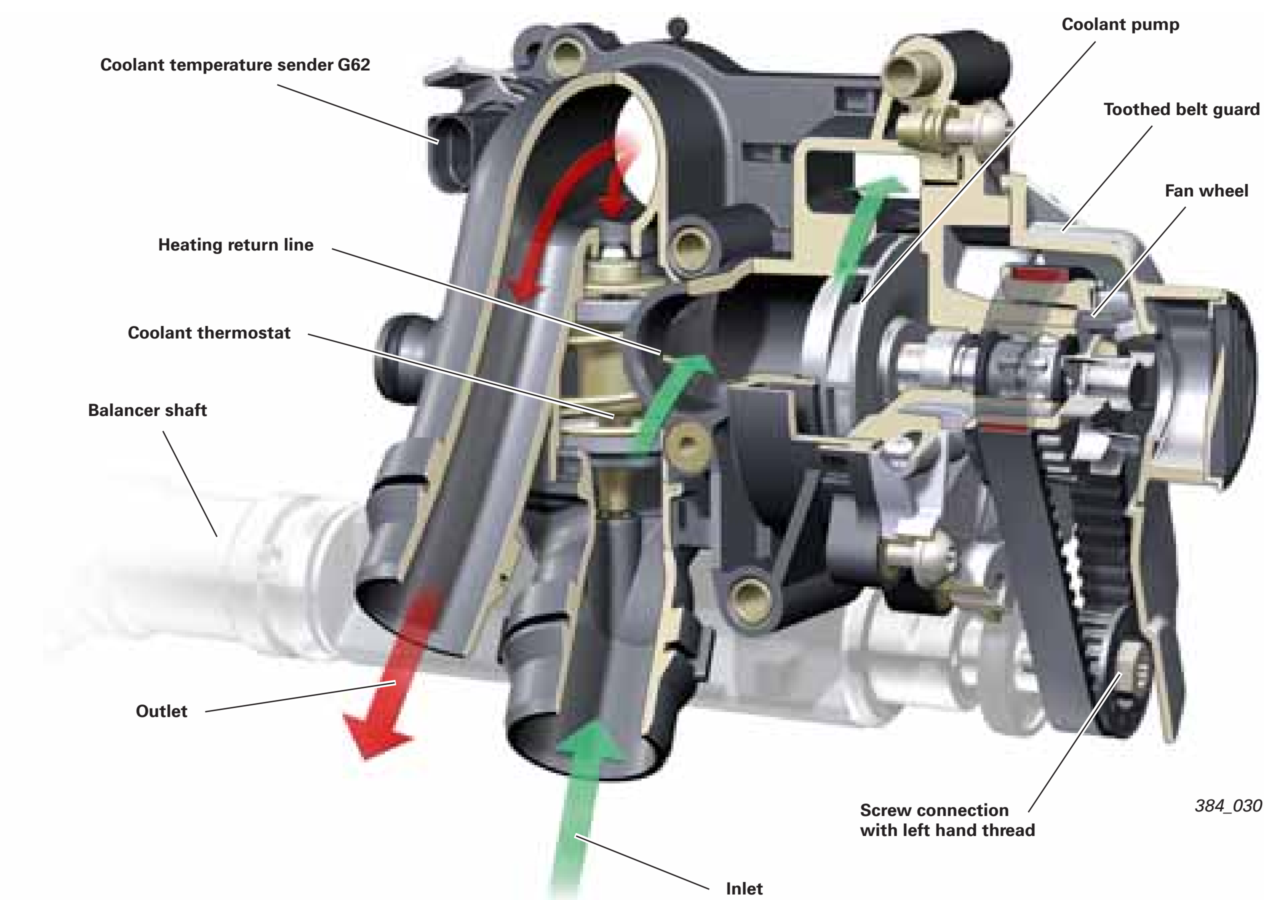
The coolant pump, the temperature sender and the coolant thermostat are integrated in a common housing made of duroplastic.
This housing is attached to the engine housing on the intake end below the intake manifold.

The coolant pump is driven by the balancer shaft, where the engine speed is reduced (i = 0.59).
A drive gear at the end of the balancer shaft drives the coolant pump via a toothed belt. The larger drive gear on the pump acts as a speed reducer.
A rotor is attached to the coolant pump drive gear. It serves to cool the belt drive.

The coolant thermostat opens at 95 °C. The maximum stroke of 8 mm is reached at 105 °C.
The coolant pump impeller is made of plastic (PPS GF40) and has a special vane contour which permits high engine speeds with a low risk of cavitation.

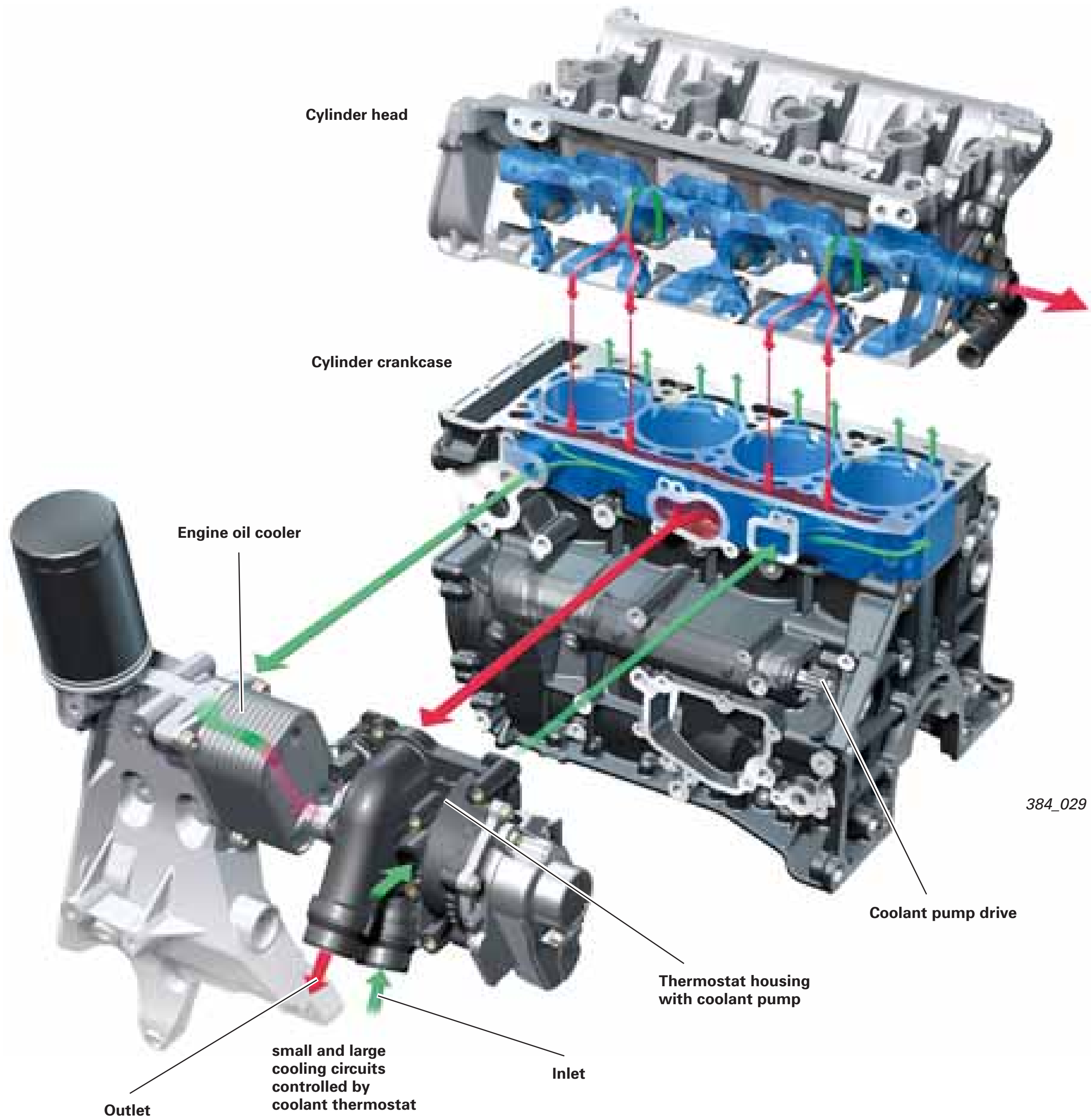
Note

The tension of the belt drive is defined by the installation position of the water pump in the housing and cannot be adjusted using workshop equipment. In the event of a fault in the coolant pump, therefore, housing must also be replaced.
The installation position of the thermostat must also be observed.
The toothed belt drive gear also has a left hand thread!



384_030

Crossflow cooling system of 1.8 litre 4V TFSI



384_029

Intake manifold module

The exhaust gas turbocharger and concept of the intake manifold have been adopted from the 2.0 litre TFSI engine.

Legend

1 Throttle valve control unit

2 Intake air temperature sensor G42

3 Activated charcoal filter system solenoid valve 1 N80

4 Vacuum box for intake manifold flap changeover

5 Fuel port, high-pressure pump

6 Fuel port, high pressure fuel rail

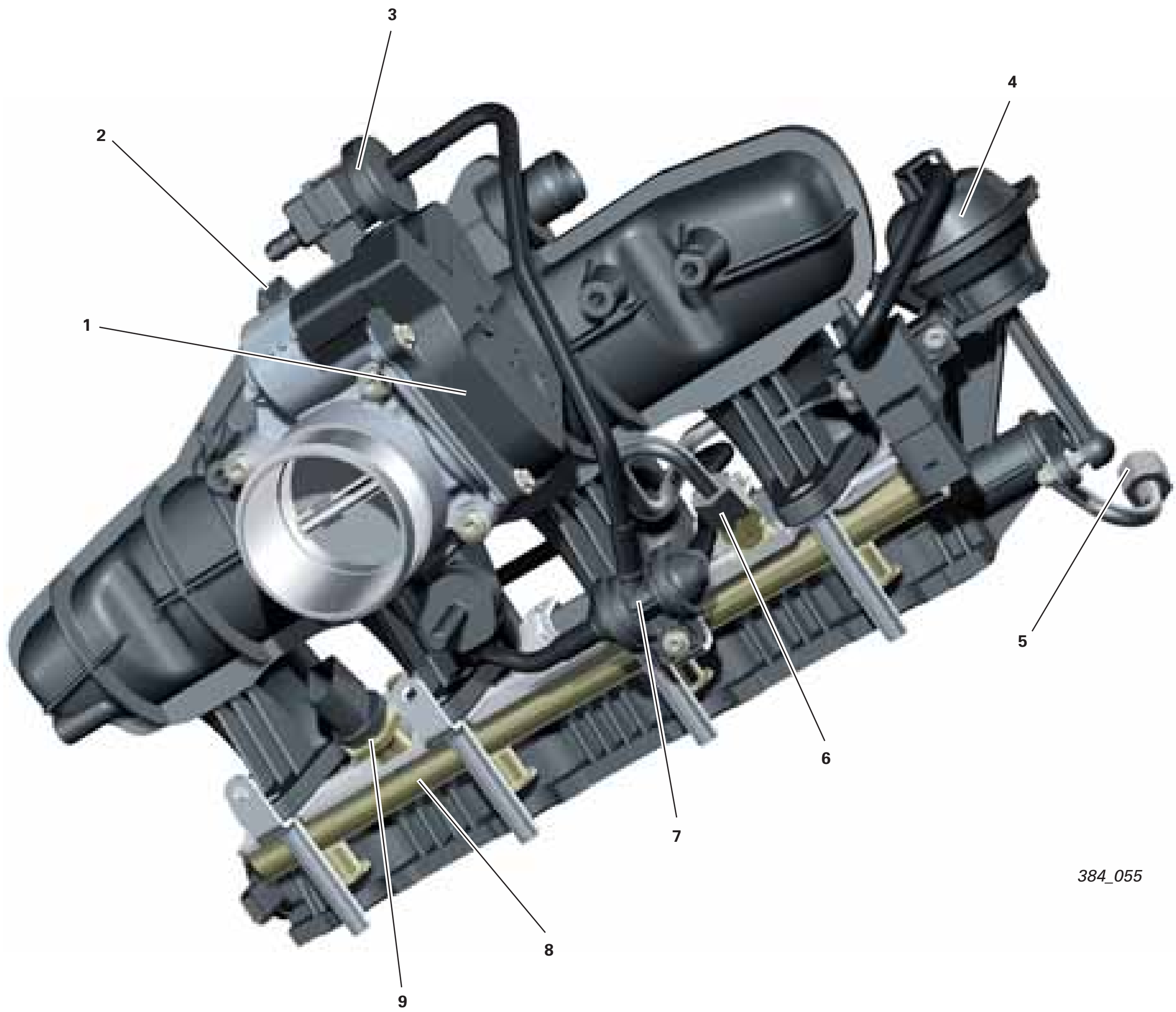
7 ACF system with double check valve

8 High pressure rail

9 Fuel pressure sender G247

10 Intake manifold flaps

11 Intake manifold flap potentiometer G336



384_055

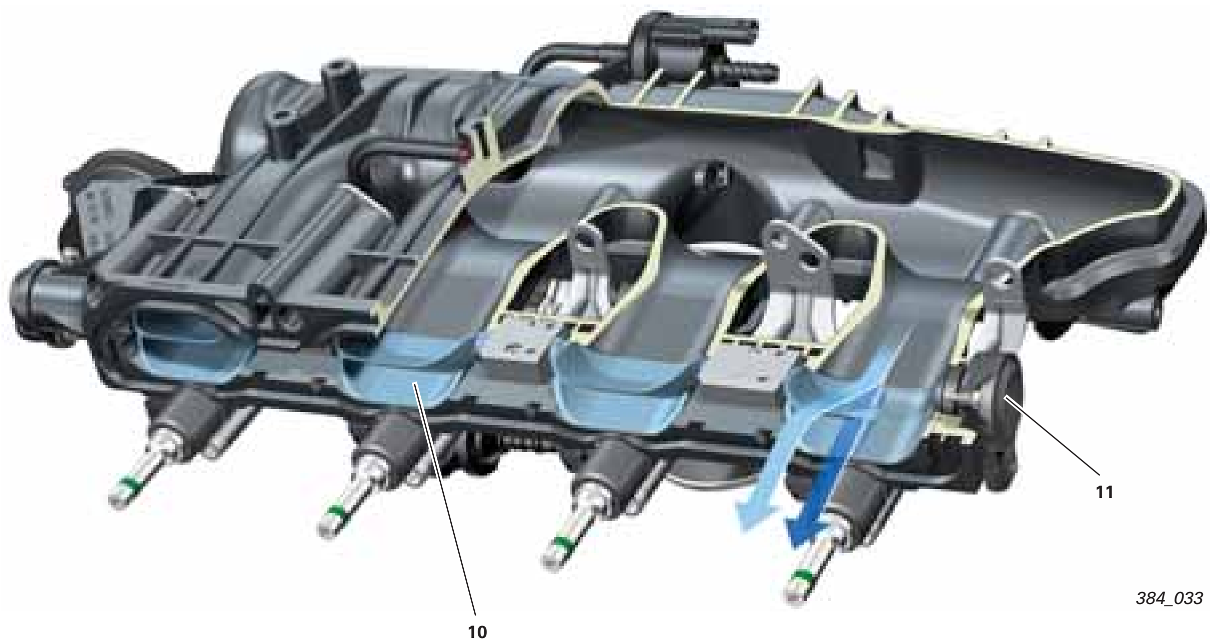
The body of the intake manifold module is made of polyamide and consists of two shells which are welded together.
The intake manifold flaps are trough shaped. Together with the input shaft, they are unitary components made of plastic (*PPS**).

The intake manifold flaps are arranged excentrically in the intake port. Through this arrangement and the shape of the flaps, the full intake port is fully opened when the intake manifold flaps are opened. The result is an improvement in intake air flow. An improvement in tumble capacity was also achieved when closing the flaps.
To achieve this, it was also necessary to optimise the vanes in the intake port.

The intake manifold flaps are adjusted by a vacuum adjuster.
The adjustment is a two-stage process.
It was possible to eliminate intermediate flap positions. Feedback on the positions of the flaps is provided by the intake manifold flap potentiometer G336.
This sensor is positioned on the other end of the shaft. In the rest state, the intake manifold flaps are closed.

The crankcase and ACF vent directly into the air flow downstream of the throttle valve.

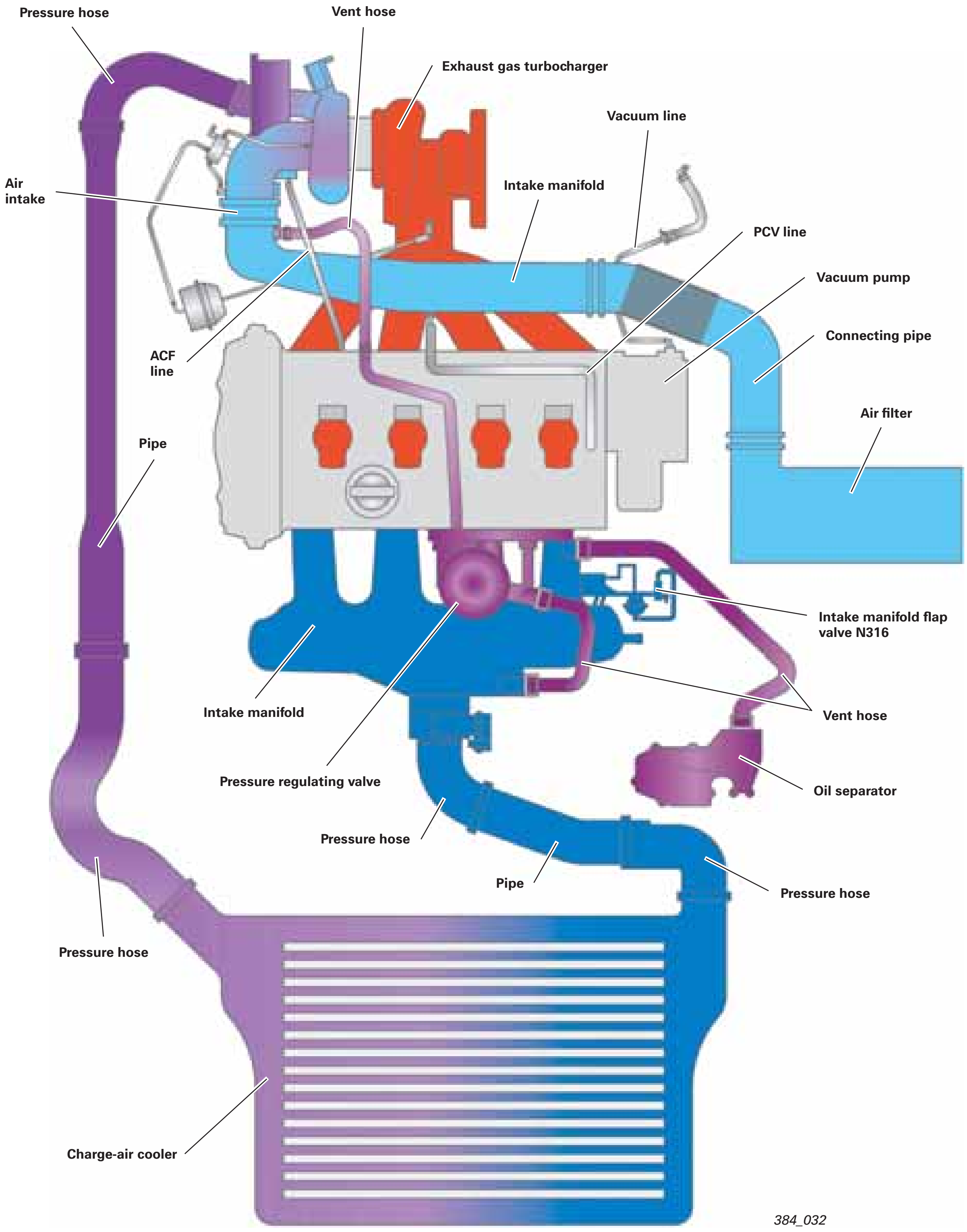
* *polyprophenyl sulphide*



384_033

Air supply

The intake system of the EA 888 functions similarly to the system in the 2.0 litre TFSI engine.

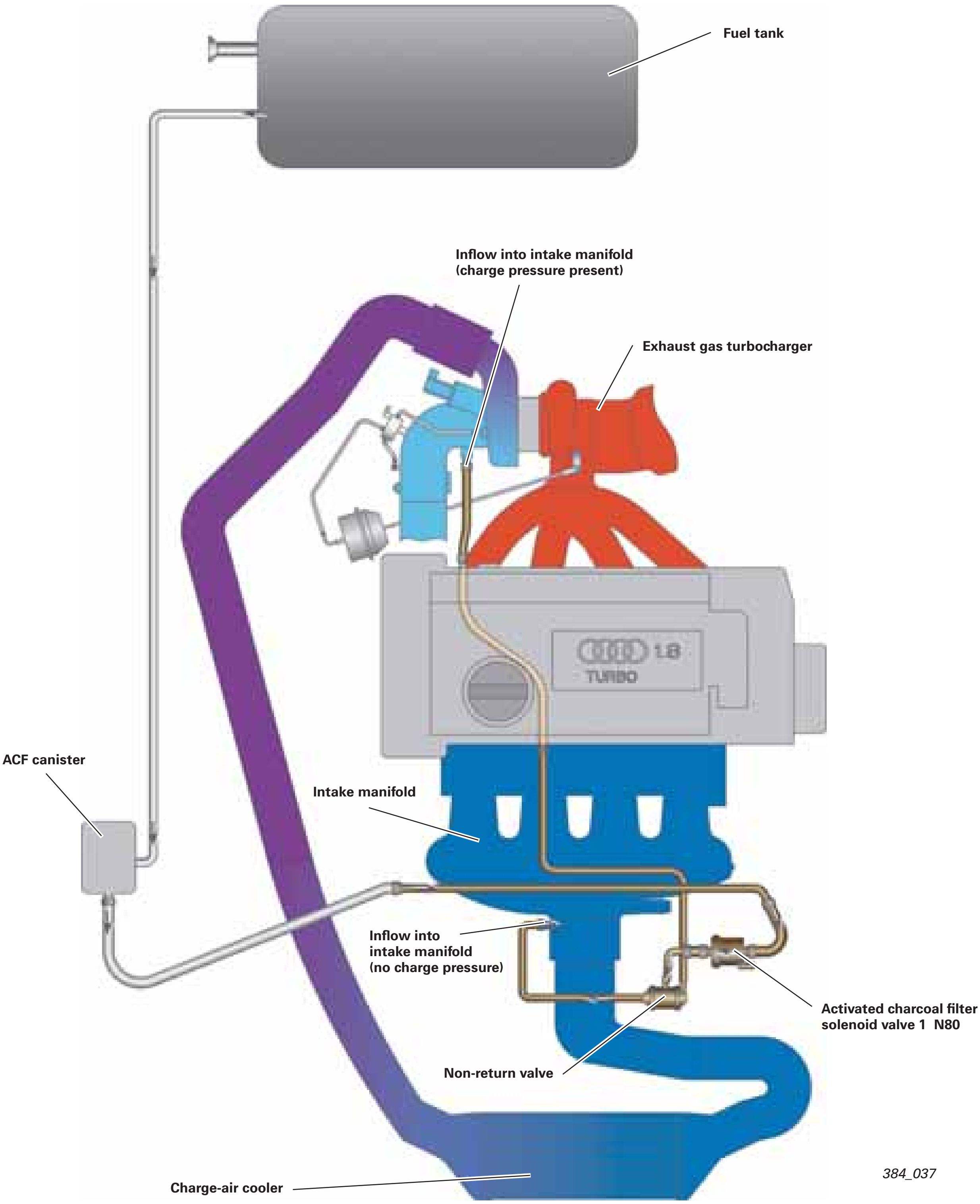


384_032

Evaporation system

The extraction by suction of fuel vapours from the activated charcoal canister while the engine is running involves the same problems as with the crankcase breather. When charge pressure is present, the fuel vapours cannot flow directly into the intake manifold.

With the double check valve, depending on the pressure conditions in the intake manifold,the fuel vapours flow either directly into the intake manifold (no charge pressure) or to the exhaust gas turbocharger (charge pressure present).

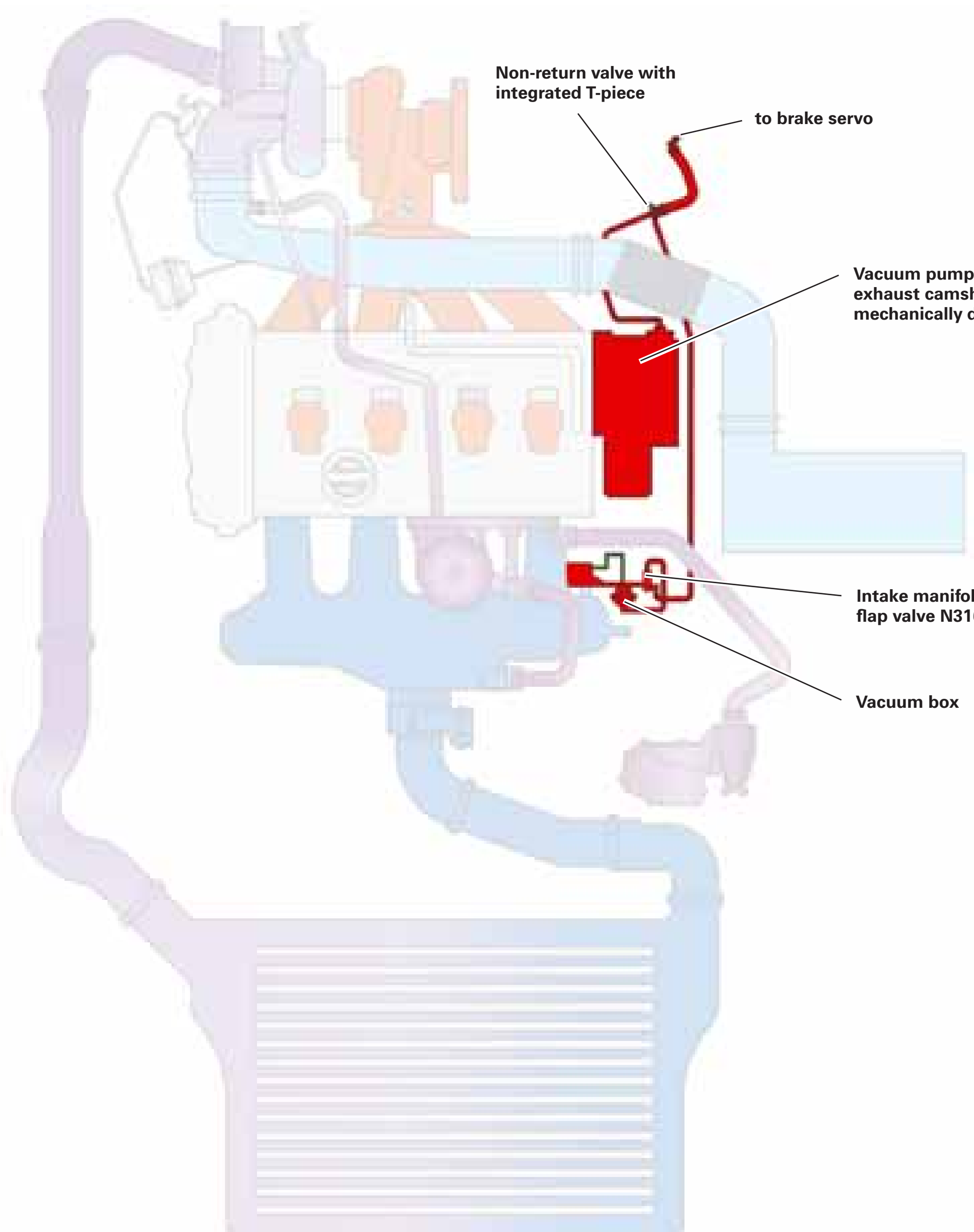


384_037

Vacuum supply

The vacuum for the brake servo and for the electrical consumers on the engine is produced by a mechanically driven vacuum pump.
The vacuum pump is a swivelling vane pump which is driven by the exhaust camshaft and installed behind the high-pressure fuel pump.
The vacuum pump is capable of providing a sufficient vacuum for all electrical consumers under any operating conditions.
For this reason, it is not necessary to use an additional vacuum reservoir. The pump is rated to deliver a continuous absolute pressure of 50 mbar.

The oil for lubricating the rotor and for sealing the vane in the pump housing is pumped from the camshaft to the vacuum pump via a port in the cylinder head.
The square cam for the high-pressure fuel pump is also supplied with lube oil at the same lubrication point (refer to hydraulic diagram, page 24/25).



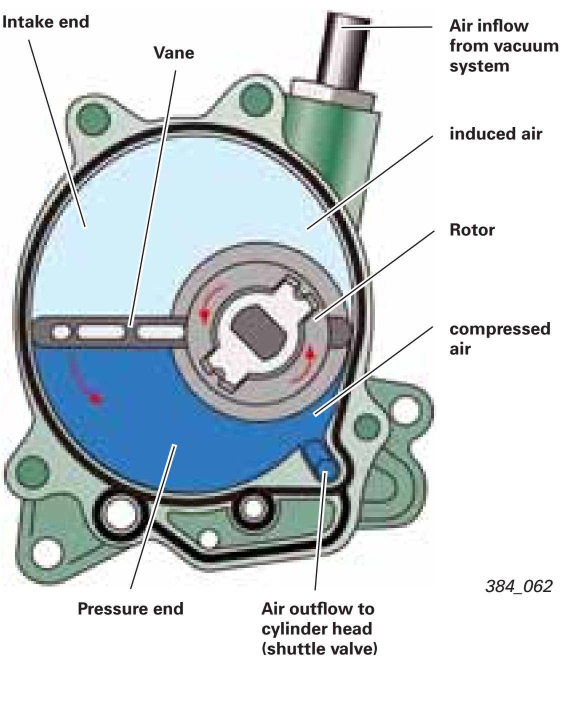
384_059

Vacuum pump

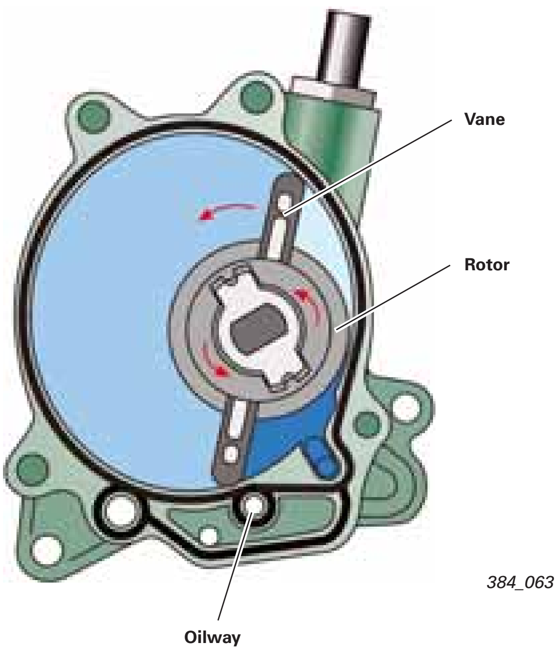
384_064

The vacuum pump consists of a rotor running in excentric bearings and a moving vane made of plastic which divides the vacuum pump into two sections. The position of the van is constantly changing due to the rotational movement of the rotor. As a result, the volume of one section increases and the volume of the other section decreases.

On the intake end, the air pumped into the cylinder head through a shuttle valve on the pressure end is induced from the vacuum system.



384_062



384_063

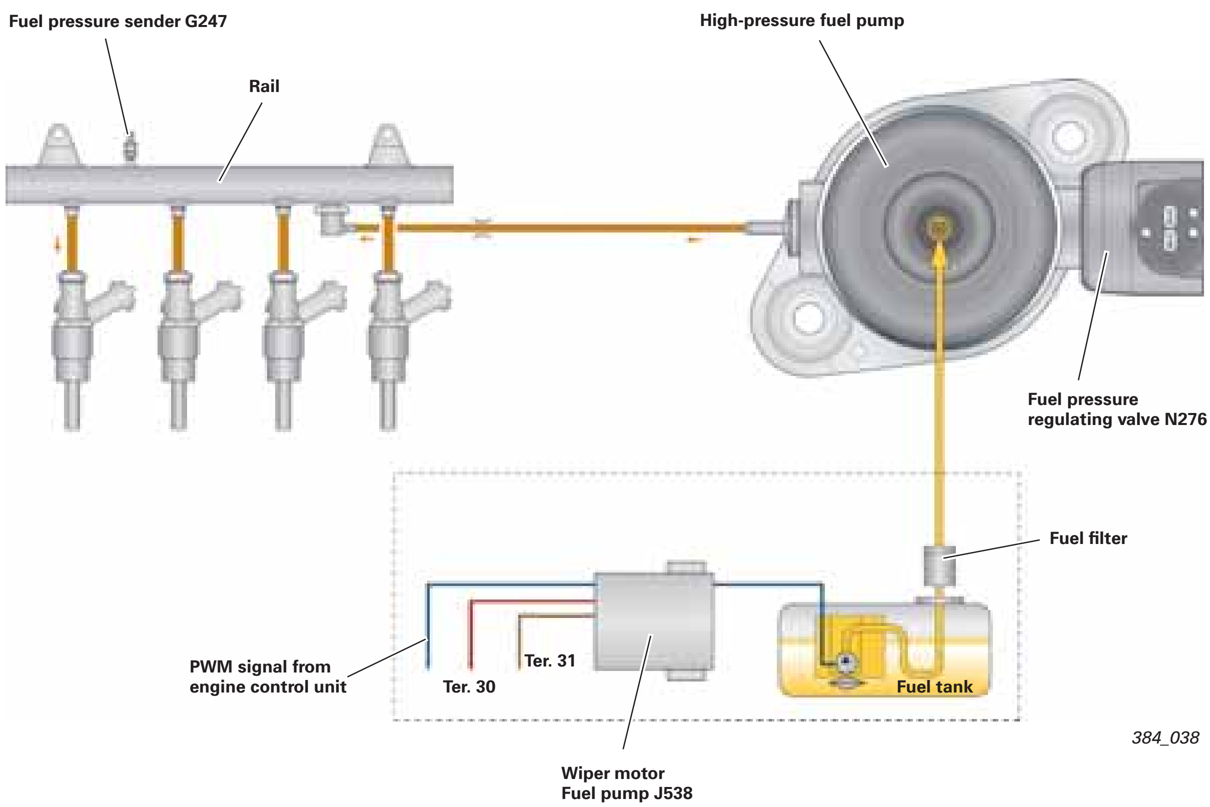
Fuel system

The fuel system is an advanced version of the system in the 2.0 litre TFSI engine.

All parts which are in direct contact with fuel are designed in such a way that the engine can run on any available fuel grade.
Special materials are used to ensure that the fuel system meets all requirements relating to corrosion protection.

The high pressure system is supplied with fuel by a returnless, demand controlled pre-supply system. Fuel is delivered at a variable pressure between 3.5 and 6 bar.

For the first time, no low-pressure sensor is used. The correct fuel pressure is mapped by the engine control unit and subsequently set by the fuel pressure regulating valve N276.



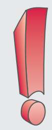
384_038

Fuel rail

The delivery rate per stroke has been reduced by using a square cam.
A quicker pressure build-up is thus possible. This benefits engine starting and engine restarting after overrun.

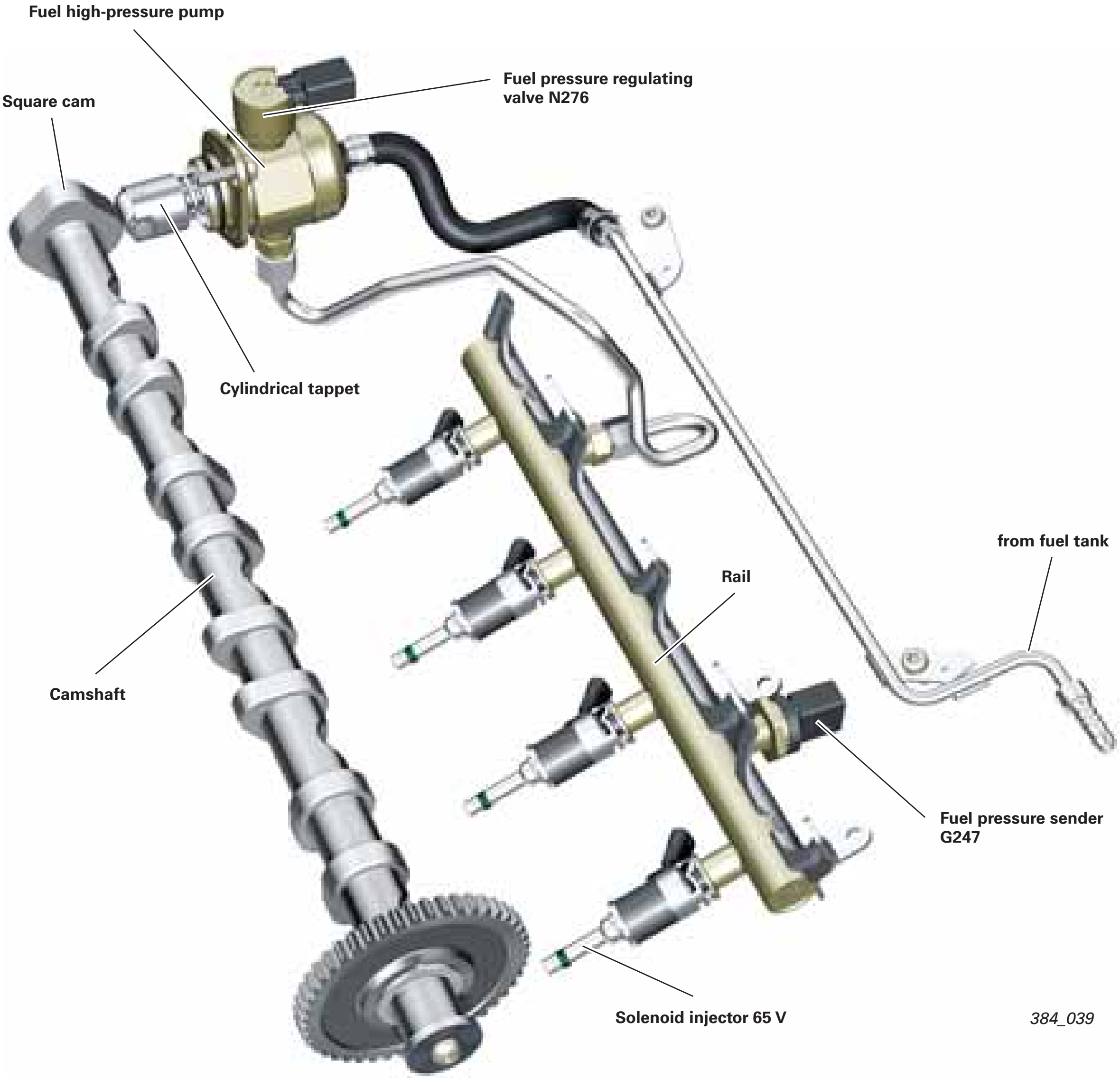
Fuel pressure sender G247

The fuel pressure sender is mounted in the fuel rail and is designed for measuring pressures up to 200 bar.



Note

The high-pressure pump must be installed in accordance with the instructions in the Workshop Manual.
Failure to follow these instructions can lead to the destruction of the pump because the tappet can become stuck.



High-pressure pump

A demand controlled high-pressure pump by Bosch is driven via a square cam on the end of the intake camshaft.

The pump piston is driven by the camshaft via a cylindrical tappet. This reduces friction and hence also the chain forces. The results are smoother engine operation and higher fuel economy.

In addition, the cam stroke was reduced by using the square cam.
It is now 3.5 mm, as compared to 5 mm in the 2.0 litre TFSI. Due to the shorter stroke, the individual delivery rates are lower. This, in turn, results in reduced pressure fluctuations. The metering precision of the injectors is also improved, as there is now one feed stroke per injection.
The advantage of this is improved lambda control and fuel efficiency.

The high-pressure pump produces a maximum pressure of 150 bar. The fuel pressure required by the engine control unit is adjusted by the fuel pressure regulating valve N276 installed in the pump. The pressure is regulated to between 50 - 150 bar according to a characteristic map.

A further new feature is the use of a pressure limiting valve in the high-pressure pump.
This valve opens at approx. 200 bar and admits pressure into the pump chamber. Previously, pressure was discharged into the low-pressure circuit. Excessively high pressures can build up in overrun or during the after-heating phase after shut-off of the hot engine.
The pressure pulsations in the low-pressure circuit are reduced by a damping element integrated in the pump.

Note

To open the high pressure system, please follow the instructions in the Workshop Manual. Failure to follow these instructions can result in injury.

384_040

High pressure regulation

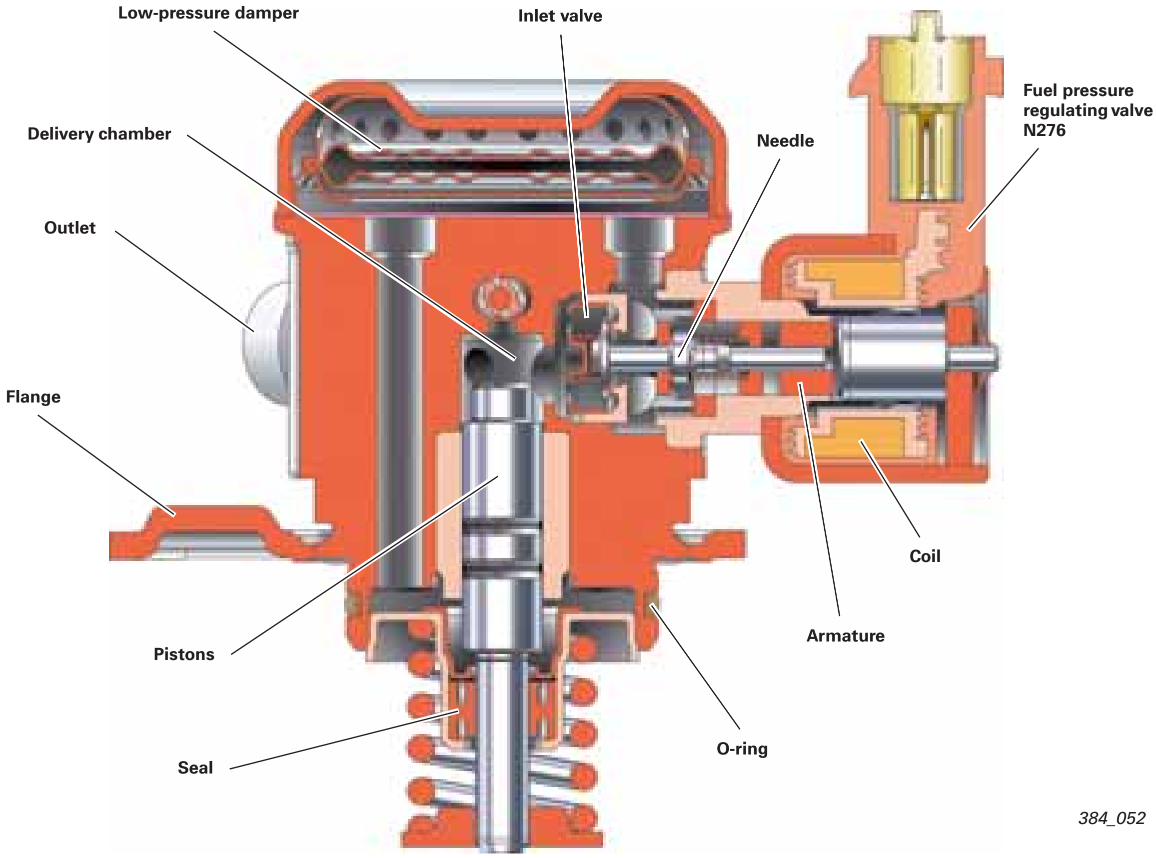
Fuel pressure, and hence fuel quantity, are regulated by the fuel pressure regulating valve N276.
The signal from the fuel pressure sender G247 is used by the engine control unit as a parameter.
The associated sensor is installed in the fuel rail.

Power demand has been reduced significantly through a newly designed fuel pressure regulating valve and associated control concept.
At the start of delivery, the fuel pressure regulating valve N276 is activated only very briefly. The intake valve closes, and pressure build-up, and hence fuel delivery, commence immediately.

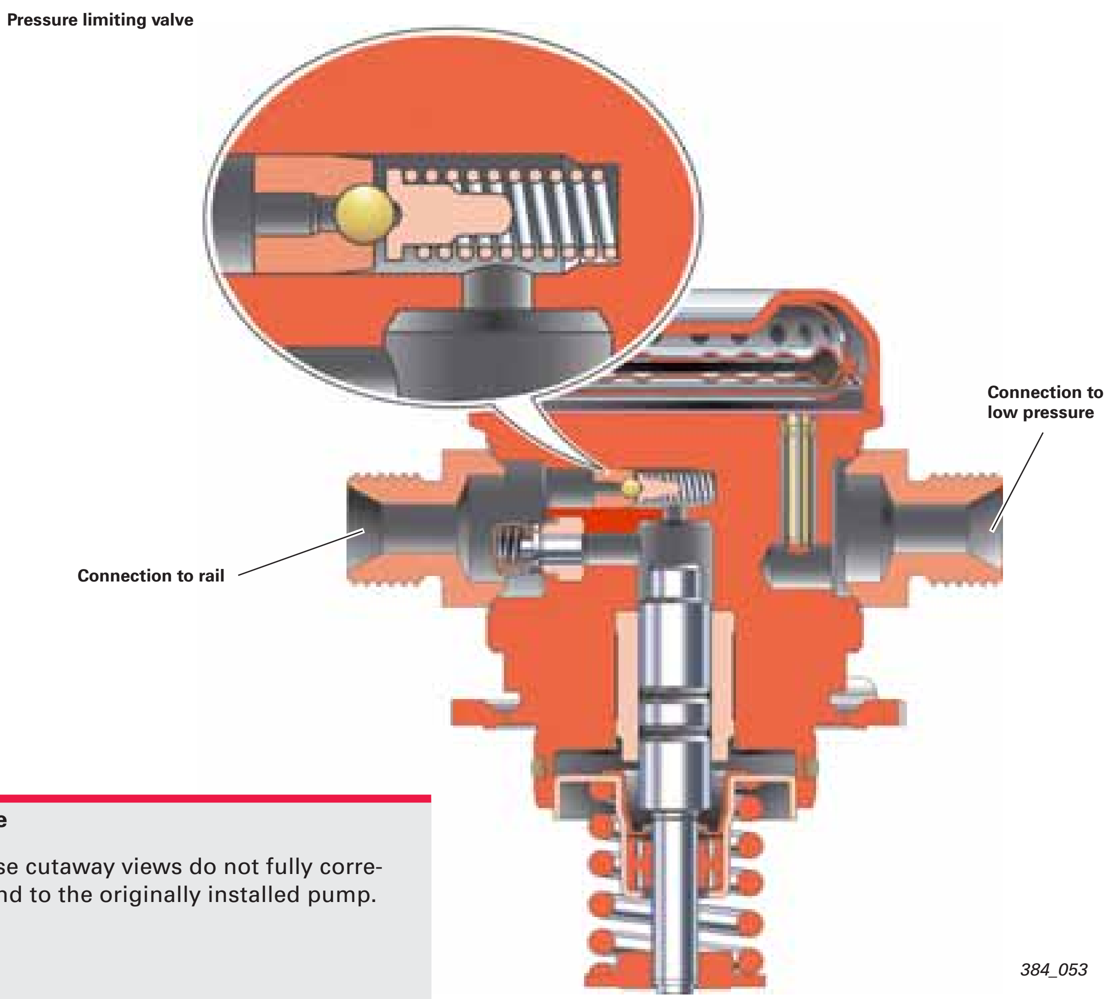
After the intake valve closes, electrical power to the solenoid valve is shut off.
The intake valve kept closed by the pressure in the pump until the pump piston feed stroke is complete and the intake stroke begins.

Note

Continuous energisation of the fuel pressure regulating valve N276 for longer than one second will lead to its destruction.



384_052



384_053

Note

These cutaway views do not fully correspond to the originally installed pump.

Control concept

The diagram shows the high pressure regulation function of the high-pressure pump. The complete delivery cycle for a cam is shown here. This cycle takes place four times during a single revolution of the camshaft. The bottom diagram shows the movement of the pump piston and the activation of the fuel pressure regulating valve N276.

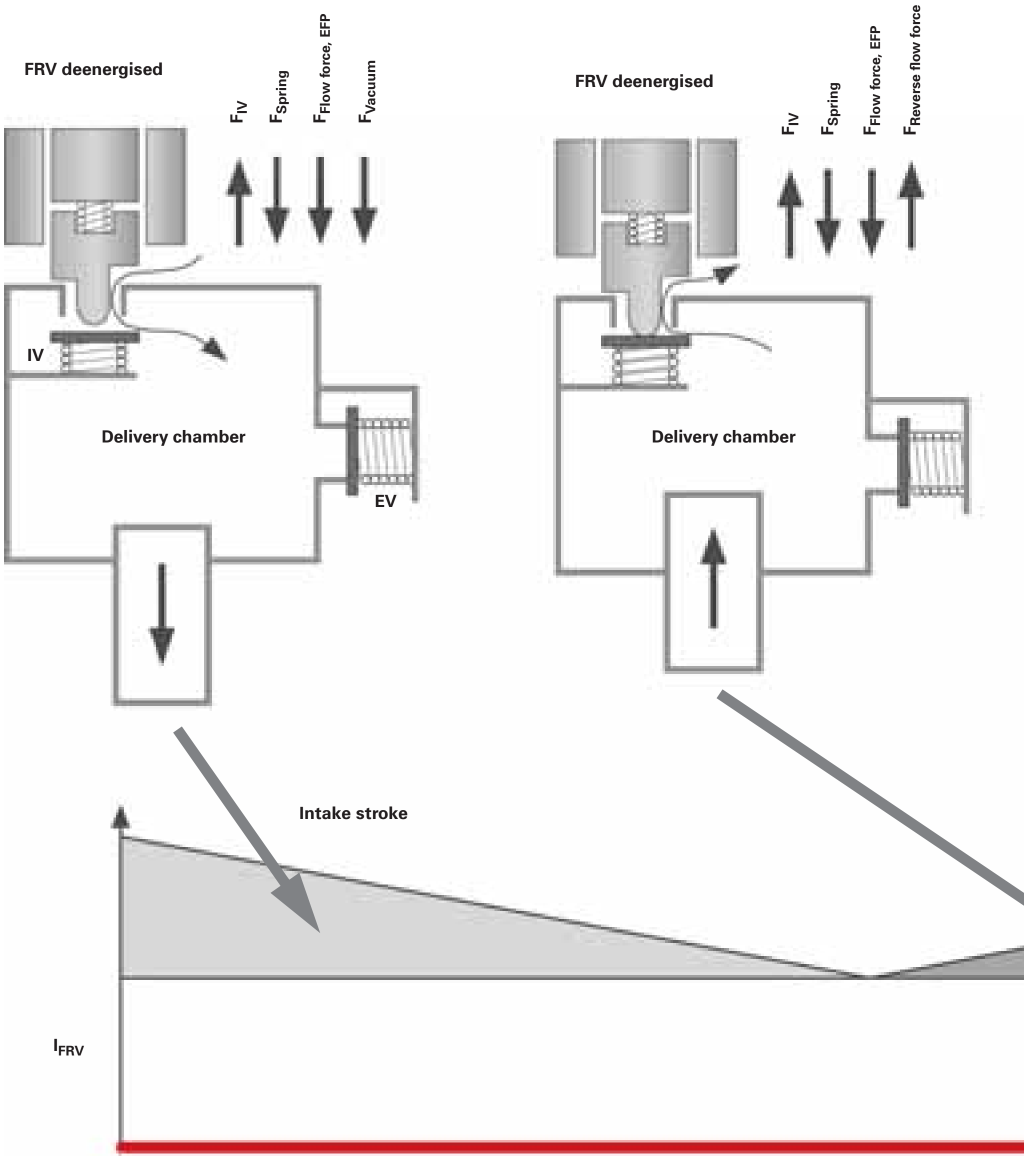


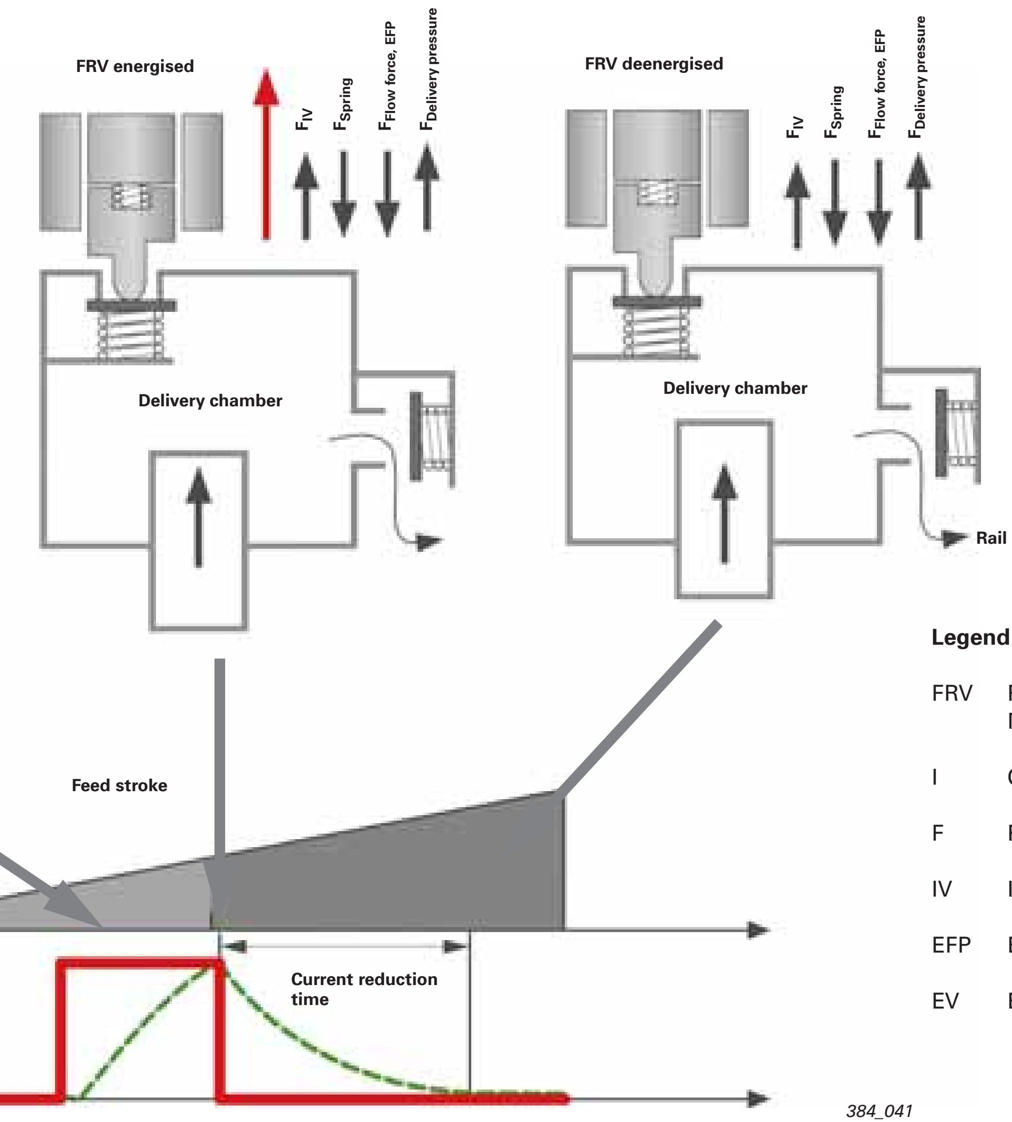
Fig. 1

- Pump piston in intake stroke, fuel flows into the pump chamber
- N276 deenergised
- Intake valve (IV) is open because the spring force is less than the flow force of the fuel pump G6 - a vacuum is present inside the pump
- Exhaust valve (EV) is closed

Fig. 2

- Pump piston in feed stroke, fuel flows back to the inlet
- N276 deenergised
- IV is open. Due to the upward motion of the pump piston, fuel is displaced from the pump chamber into the inlet
- EV is closed

The operating point of the N276 changes depending on when it is activated by the engine control unit. The “on” time remains the same. The earlier N276 is activated, the more actively the delivery stroke can be used and hence the more fuel can be delivered.



Legend

FRV	Fuel pressure regulating valve N276
I	Current
F	Force
IV	Intake valve
EFP	Electric fuel pump
EV	Exhaust valve

384_041

Fig. 3

- Pump piston in feed stroke, fuel flows to the rail
- N276 receives a short pulse of electrical current from the engine control unit
- IV closes. Due to the upward motion of the pump piston, pressure builds up immediately inside the pump
- EV opens

Fig. 4

- Pump piston in feed stroke, fuel flow to the rail until the intake stroke begins
- N276 deenergised
- IV closed
- EV open

Injector

A multi-port injector with six individual jets is used.

It provides better mixture preparation than the tumble valves because the fuel injection jet is freely formable.
Adaption to the combustion process is therefore possible.

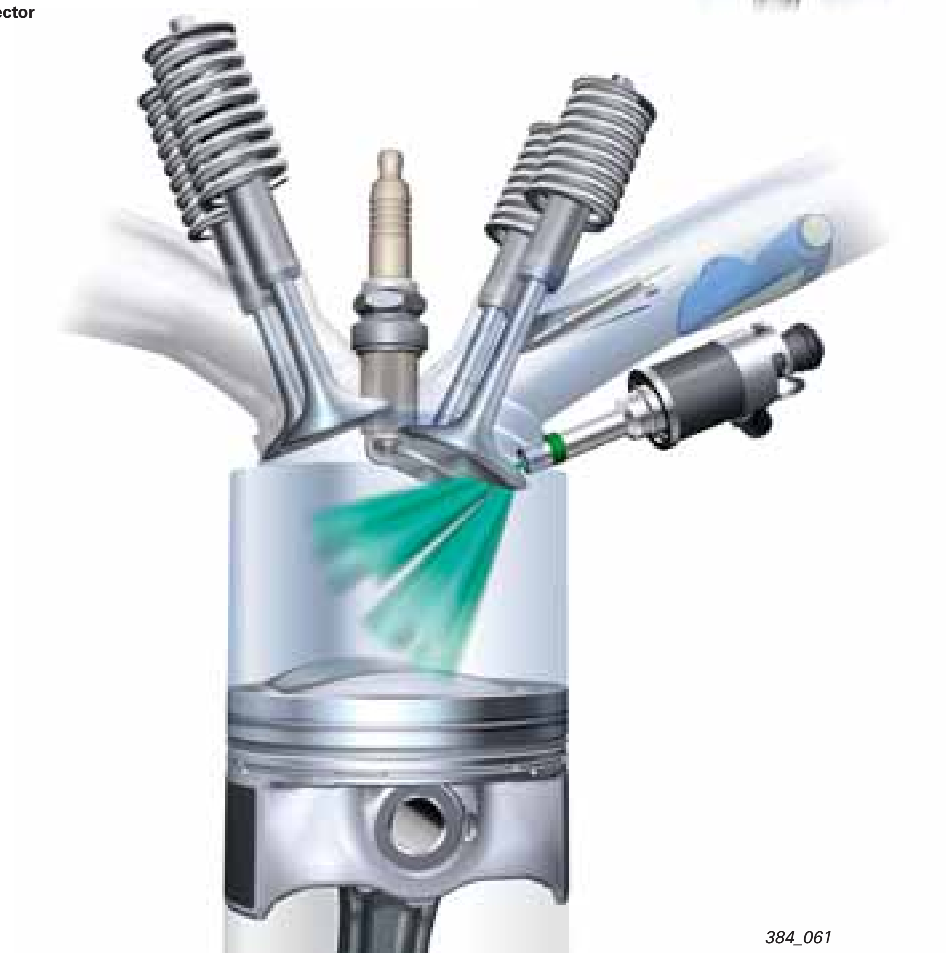
It was possible to avoid wetting of the intake valves during injection cycles synchronous with the intake cycle, as well as wetting of the combustion chamber surfaces.

The angle of cone of the jet is 50°.
These modifications have resulted in reduced HC emissions, particulate matter formation and oil thinning.

Single port injector

384_042

Multi port injector



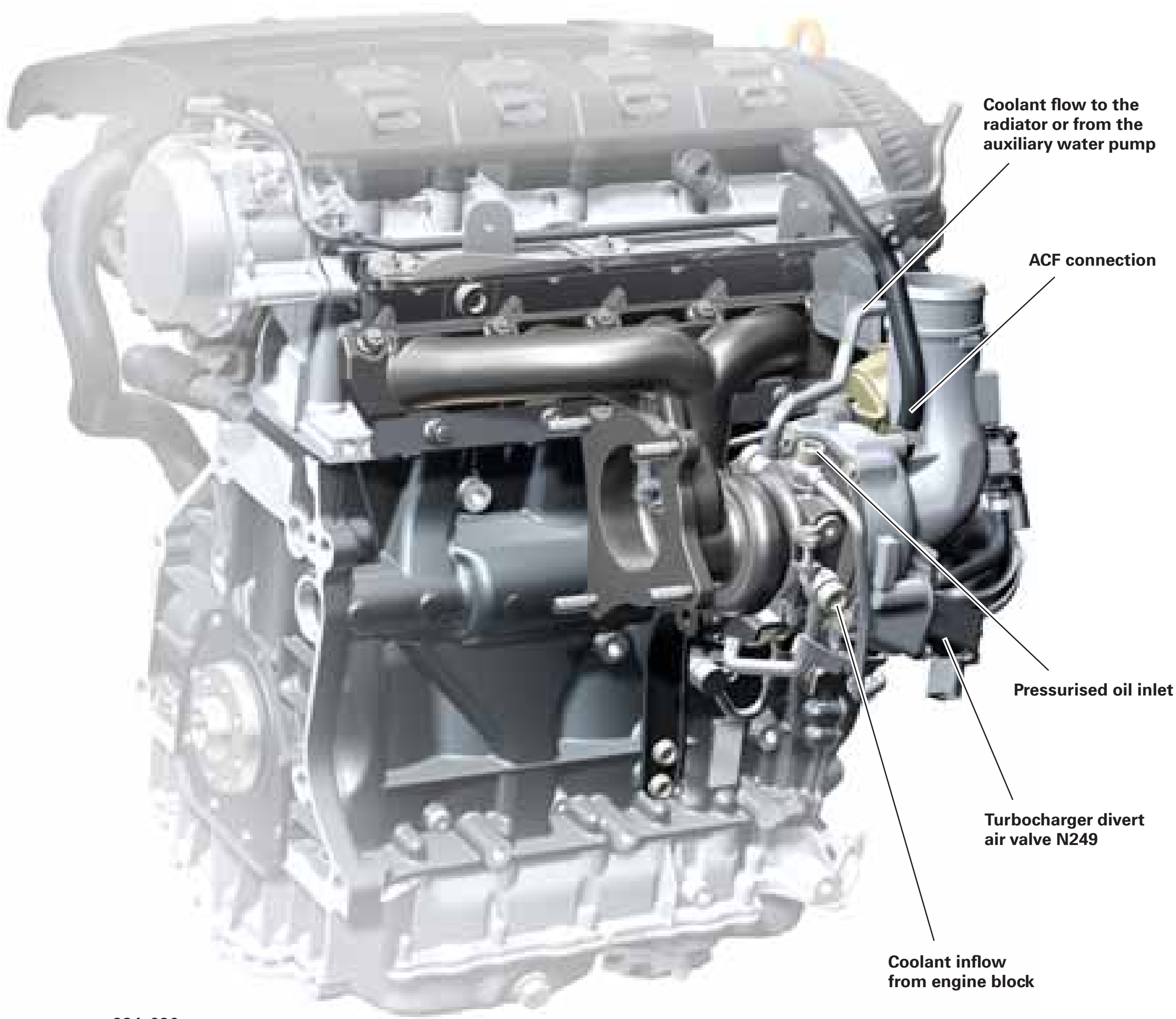
384_061

Exhaust gas turbocharger and manifold module

An exhaust gas turbocharger and manifold module is used. It is attached to the cylinder head by clamping flanges.

Reference

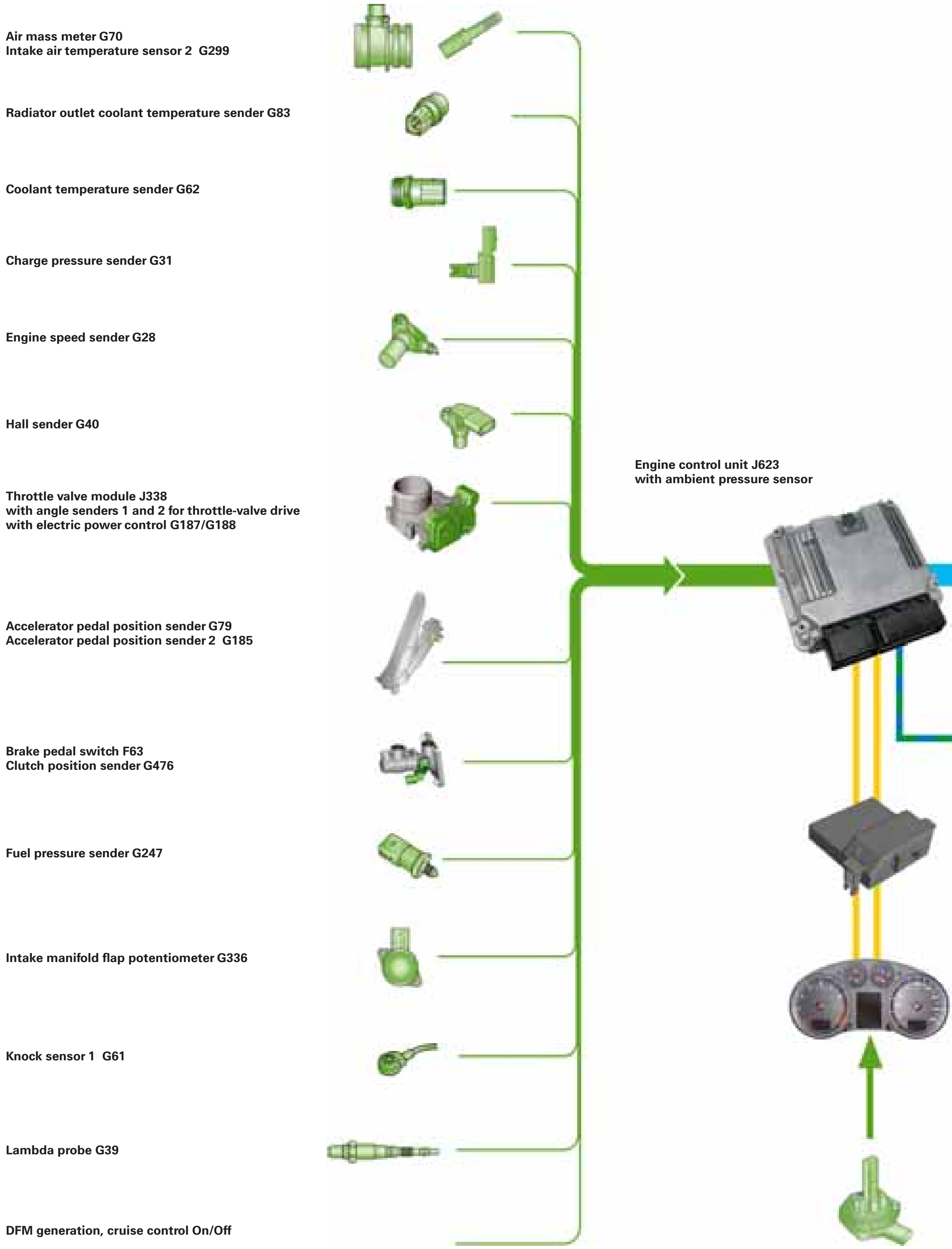
The exhaust gas turbocharger and manifold module, as well as the charge pressure control and the wastegate control system are described in SSPs 332 and 337.



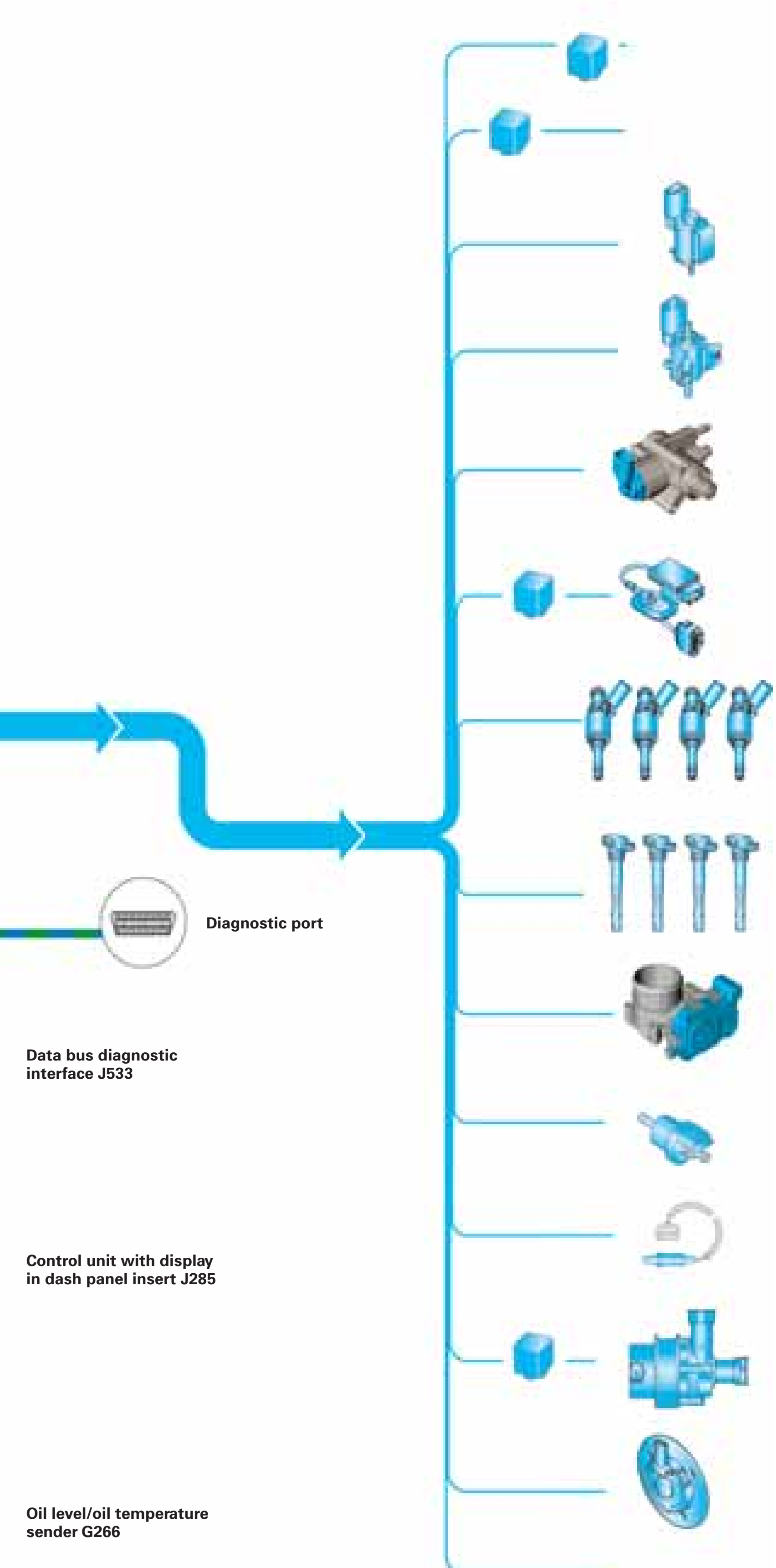
384_036

Overview of the Bosch MED 17.5 system

Sensors



Actuators



384_054

Motronic current supply relay J271

Engine component current supply relay J757

Intake manifold flap valve N316

Charge pressure control solenoid valve N75

Fuel pressure regulating valve N276

Fuel pump control unit J538
Fuel pump (pre-supply pump) G6

Injector, cylinders 1-4
N30-N33

Ignition coil 1-4 with output stage
N70, N127, N291, N292

Throttle valve module J338
with throttle-valve drive for electric power control G186

Activated charcoal filter solenoid valve 1 N80

Lambda probe heater Z19

Continued coolant circulation relay J151
Coolant run-on pump V51

Inlet camshaft timing adjustment valve -1- N205

Radiator fan setting 1, PWM signal

Engine control unit

The new MED 17 engine control unit generation by Bosch is used on the 1.8 litre TFSI engine.
The hardware and software components have been developed in such a way that they can be used for future projects both in petrol engines and in diesel engines.
This allows maximum use to be made of synergy effects with regard to functions and vehicle interfaces independent of the engine combustion process.
Examples of applications include driver input via the accelerator pedal and radiator fan activation.

The new IFX Tricore processor family has sufficient capacity in reserve to accommodate future advancements in order to meet market requirements.

Hardware in the engine control unit:

- Infineon IFX Tricore 1766 (Leda Light)
- 80 MHz system frequency
- 1.5 MByte internal flash
- Single Chip System

384_072

Lambda control

A new feature of the MED 17.5 is the deletion the continuous-duty oxygen sensor. Now, only a nonlinear lambda sensor is installed. The sensor is located between the close-coupled pre-catalyst and the underbody catalytic converter.

The function of the continuous-duty pre-cat sensor has been mapped by the new functions of the engine control unit. These maps are generated by conducting the appropriate tests during engine development.

Advantages:

- fewer potential sources of fault,
- more cost-effective,
- the requirements of EU IV are also met without the continuous-duty oxygen sensor,
- no adjustments are needed in customer service or for exhaust emission inspections

Operating modes

In all operating ranges of the engine, except directly after starting (in this case, the fuel-air mixture is slightly richer), the mixture composition is set to lambda 1.

The following operating modes are implemented:

- in the start phase: high pressure - start of fuel-air stratification.
- for several seconds after starting: HOSP.
- an engine map controlled dual injection cycle follows in the warm-up phase.
- at coolant temperatures of 80 °C or higher, fuel injection is synchronous with the intake cycle only.

The intake manifold flaps open at an engine speed of 3000 rpm.

Substitute functions in case of failure of sensors/actuators

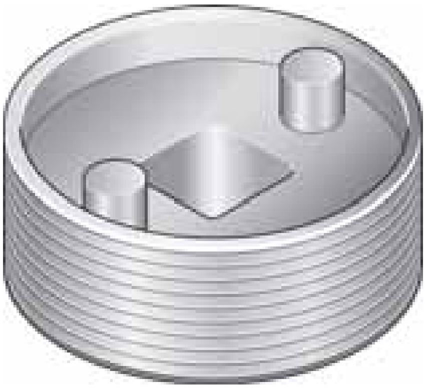
	Symptom in case of failure	Fault memory entry	MIL	EPC	Substitute signal	Power limitation	Emergency operation
F63	no cruise control	X	–	–	–	–	–
G39	no control	X	X	–	Model	–	–
G61	–	X	–	–	X	X	–
G62	–	X	X	–	Model	–	–
G83	Radiator fan runs permanently in setting 1	–	–	–	–	–	–
G79/G185	no throttle response	X	X	X	–	X	X
G187/G188	no throttle response	X	X	X	–	X	X
G247	no high pressure	X	X	–	–	X	X
G336	–	X	X	–	–	–	–
G476	no cruise control	X	–	–	–	–	–
J271	no power supply to ECU engine not running	–	–	–	–	–	–
J538	–	X	X	–	–	–	–
J757	no high pressure	X	X	X	–	X	X
Ignition coils	engine not running smoothly	X	X	X	–	X	X
N30–N33	engine not running smoothly	X	X	X	–	X	X
N75	–	X	X	X	–	X	X
N205	–	X	X	–	–	–	–
N276	no high pressure	X	X	X	–	X	X
N316	–	X	X	–	–	–	–

Note

This table refers to generally occurring faults. It is no substitute for fault finding with the Workshop Manual and the "Guided Fault Finding" function.
The parameters specified in the table are subject to deviation depending on fault type. Specifications are subject to change due to updating of the engine control unit software.

Special tools

Shown here are the special tools for the chain-driven 1.8 litre 4V TFSI engine.



384_066

T10352
For removing the 4/3-way central valve of the camshaft adjuster

384_067

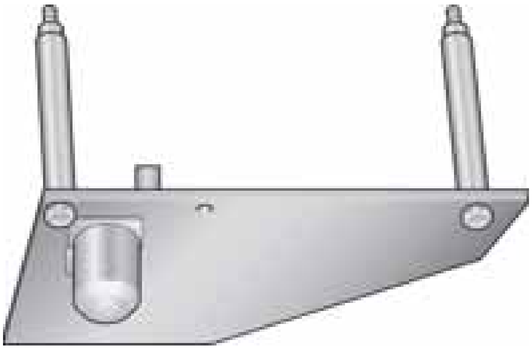
T10353
Thrust piece for installing the shaft oil seal Intermediate shaft output of water pump

384_068

T10354
Thrust piece for installing the shaft oil seal on the front crankshaft (vibration damper)

384_069

T10355
Retainer for undoing the crankshaft centre bolt



384_065

T10359
Engine holder for removing the engine with gearbox for engine/gearbox holder V.A.G 1383A

384_070

T10360
Insert for torque wrench V.A.G 1331
For undoing and fastening the belt pulley intermediate shaft drive bolt
Coolant pump

384_071

V.A.G 1331
for mounting insert T10361

Maintenance work

Engine lube oil replacement interval with LongLife/24 months: with engine lube oil specifications: (e. g. according to VW standard 503 00)	up to 30 000 km acc. to SID 24 months VW 504 00/503 00/503 01
Engine lube oil replacement interval without LongLife/12 months: with engine lube oil specifications: (e. g. according to VW standard 500 00/501 01/502 00)	up to 15 000 km or 12 months additionally to VW 502 00/501 01
Engine oil filter replacement interval	during every oil change
Engine lube oil change quantity (incl. filter)	4.6 litres
Extraction/drainage of engine lube oil	both are possible
Air cleaner replacement interval	90 000 km or 6 years
Fuel filter replacement interval	Lifetime
Spark plug replacement interval	90 000 km or 6 years

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