Service.

Self-Study Programme 248

The W Engine Concept

Design and Function

Introduction

The constantly rising demands regarding performance, running comfort and fuel economy have led to the advancement of existing drive units and the development of new drive units.

The new W8 as well as the W12 engine by VOLKSWAGEN are representatives of a new engine generation - the W engines.

The W engines set exacting demands on design. Large numbers of cylinders were adapted to the extremely compact dimensions of the engine.
In the process, more attention was paid to lightweight design.
This Self-Study Programme will familiarise you with the engine mechanicals of the W engine family.

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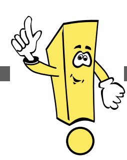
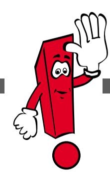
New





Important Note

This Self-Study Programme explains the design and function of new developments.
The contents will not be updated!

Please always refer to the relevant Service Literature for current inspection, adjustment and repair instructions.

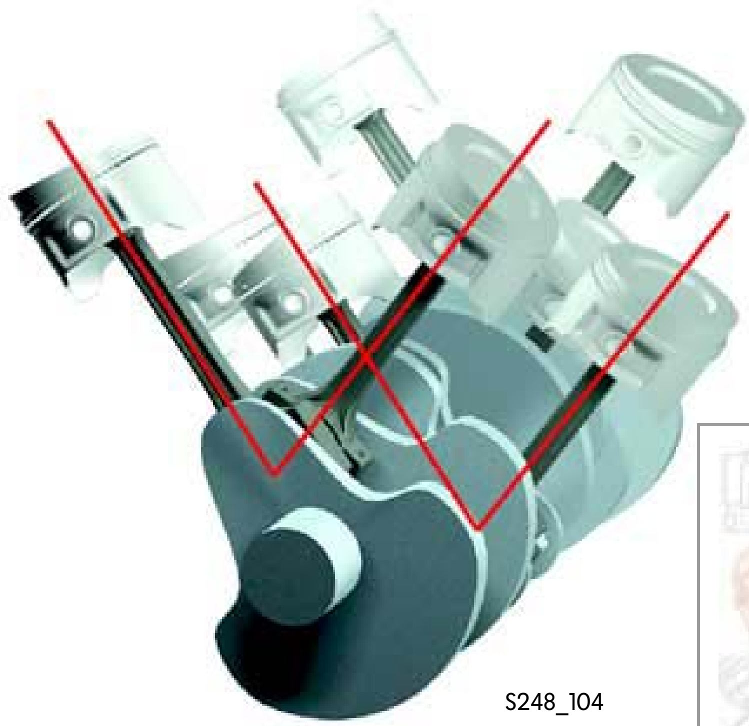
At a glance

W engines - what does the W stand for?

With the aim of building even more compact units with a large number of cylinders, the design features of the V and VR engines were combined to produce the W engines.

As with the V engines, the cylinders are distributed to two banks. In the W8 and W12 engines, these banks of cylinders are aligned at a V-angle of 72° in relation to one another. As in the VR engine, the cylinders within each bank maintain an angle of 15°.

When the W engine is viewed from the front, the cylinder arrangement looks like a double-V. Put the two Vs of the right and left cylinder banks together, and you get a W. This is how the name "W engine" came about.



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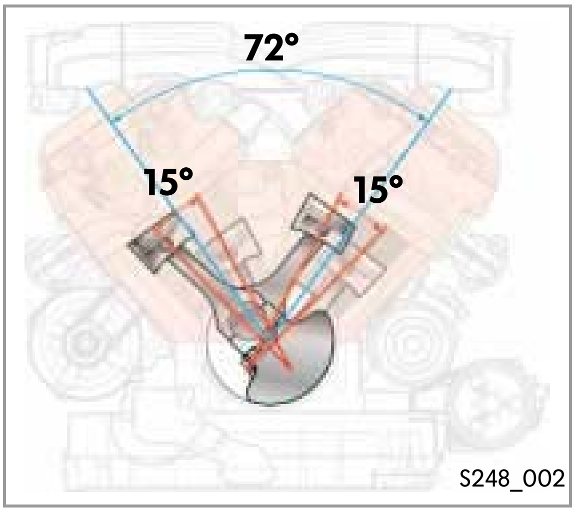

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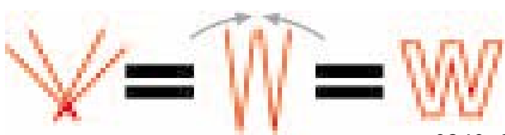

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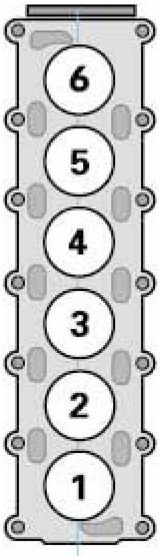
The W principle

To illustrate the principle of the W engine cylinder arrangement, we will first show you conventional engine types.



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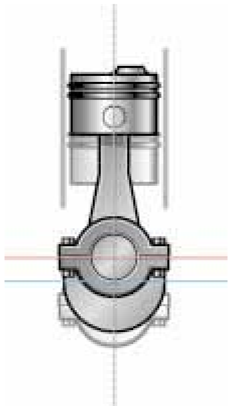

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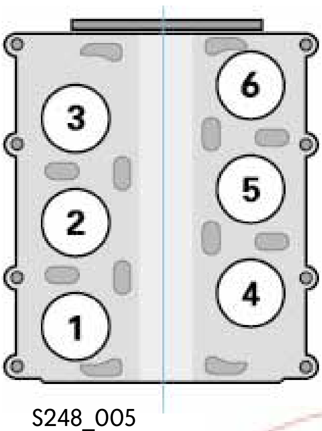
The inline engine

Represents the earliest development level in engine development. The cylinders are arranged in-line vertically above the crankshaft.

Advantage: Simple design

Drawback: Large numbers of cylinders result in very long units unsuitable for transverse mounting.



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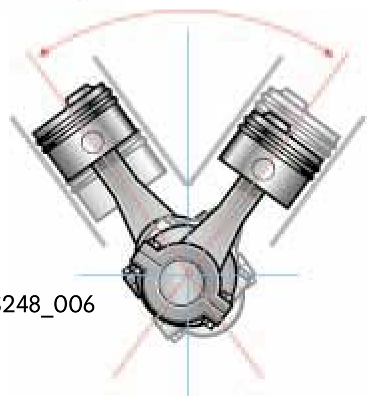
60 - 120°



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The V engine

To make engines shorter, the cylinders in the V engines are arranged at an angle of between 60° and 120°, with the centre lines of the cylinders intersecting with the centre line of the crankshaft.

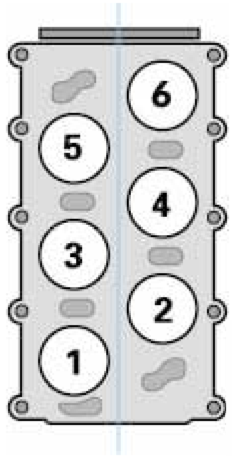
Advantage: Relatively short engines

Drawback: The units are relatively wide, have two separate cylinder heads, and therefore require a more complex design and a larger engine compartment volume.

Introduction

VR engines

The need for a powerful alternative suitable for transverse mounting for use in lower mid-range vehicles saw the development of the VR engine. Six cylinders, offset at a V-angle of 15°, are accommodated in a fairly slender and very short engine block. Unlike previous designs, the engine only has one cylinder head. This made it possible to supply the Golf with a compact VR6 cylinder engine, for example.



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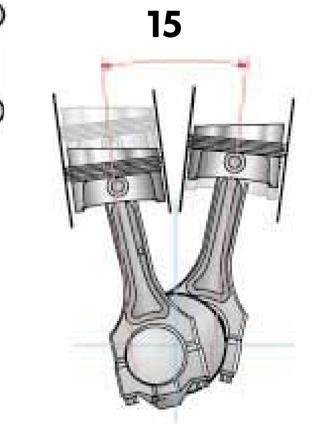

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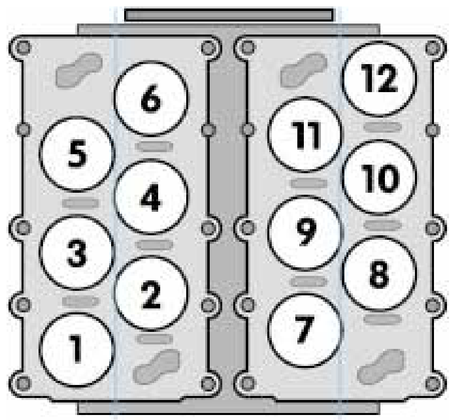
W engines

The engines of the W family are a combination of two "VR banks" based on a modular design principle.

The cylinders of one bank have an angle of 15° relative to each other while the two VR banks are arranged at a V-angle of 72°.



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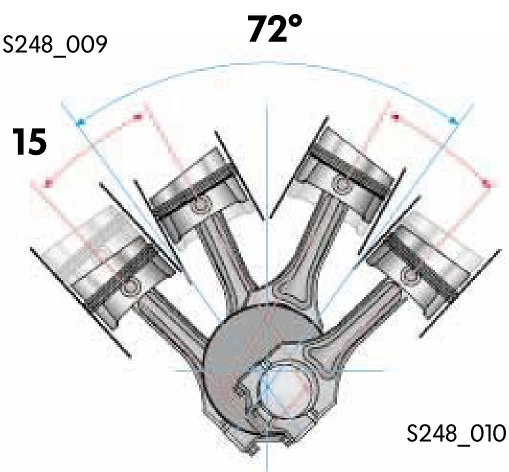

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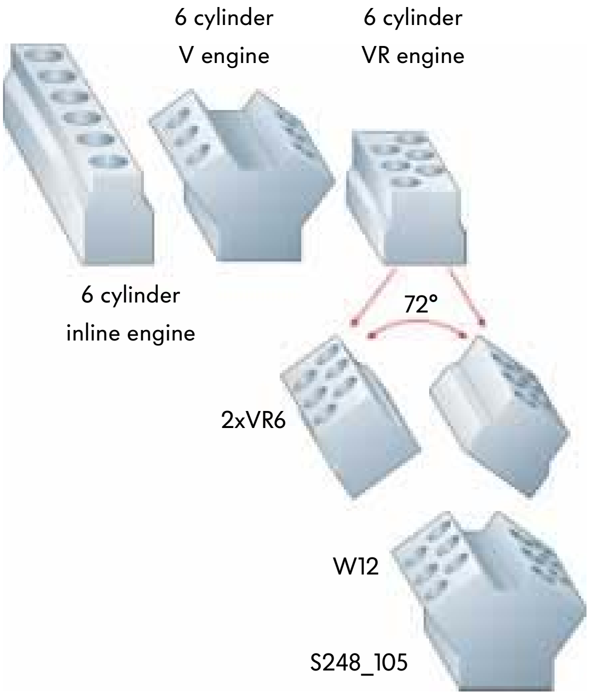
The modular design principle of the W engines

Proven, serial-produced components from the modules of the VR engine family were integrated into the new W engine concept. The principle is very simple.
Two compact VR engines from the VR series are combined to produce a W engine. The result is a series of compact petrol engines ranging from the W8 to the W16.

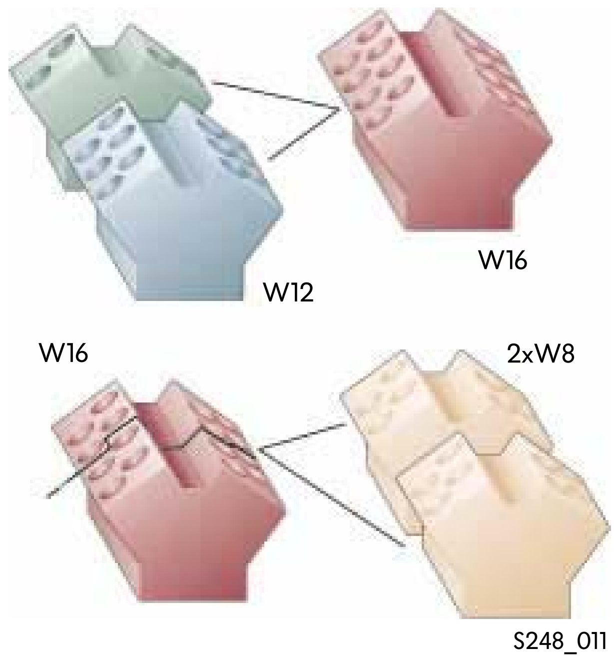
Numerous components of the VR and W series are identical, e.g.:

- valves, valve springs and valve seat inserts
- roller rocker fingers
- valve clearance compensating elements

This allows us to manufacture many parts in series and achieve high volumes.



With regard to the evolution of the 6-cylinder engine, the VR6 engine stands out due to its compactness. It is much shorter than the comparable inline engine, and narrower than the V engine. Combining two VR6 engines with a cylinder angle of 72° produces a W12 engine.



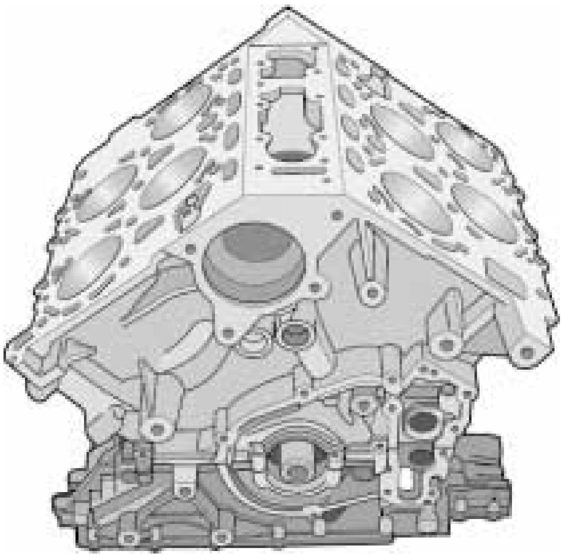
A W16 engine is obtained by joining two cylinders to each cylinder bank of a W12 engine. Splitting the W16 in the middle leaves two W8 engines. A W10 engine consisting of two VR5 engines is also a possibility. This covers the complete range of W engines.

A comparison

When a conventional 8-cylinder V engine (comparable displacement) is compared to an 8-cylinder W engine, the latter particularly stands out due to its compact design and very small external dimensions.

This is also reflected in a comparison of the crankshafts. The compact design of the 12-cylinder
W engine is highlighted by the fact that it has even smaller external dimensions than a conventional V8 engine.

The W8 engine



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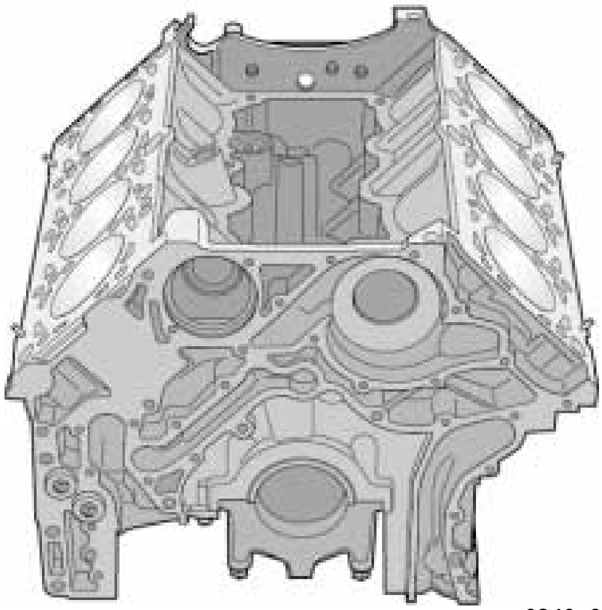
The V8 engine



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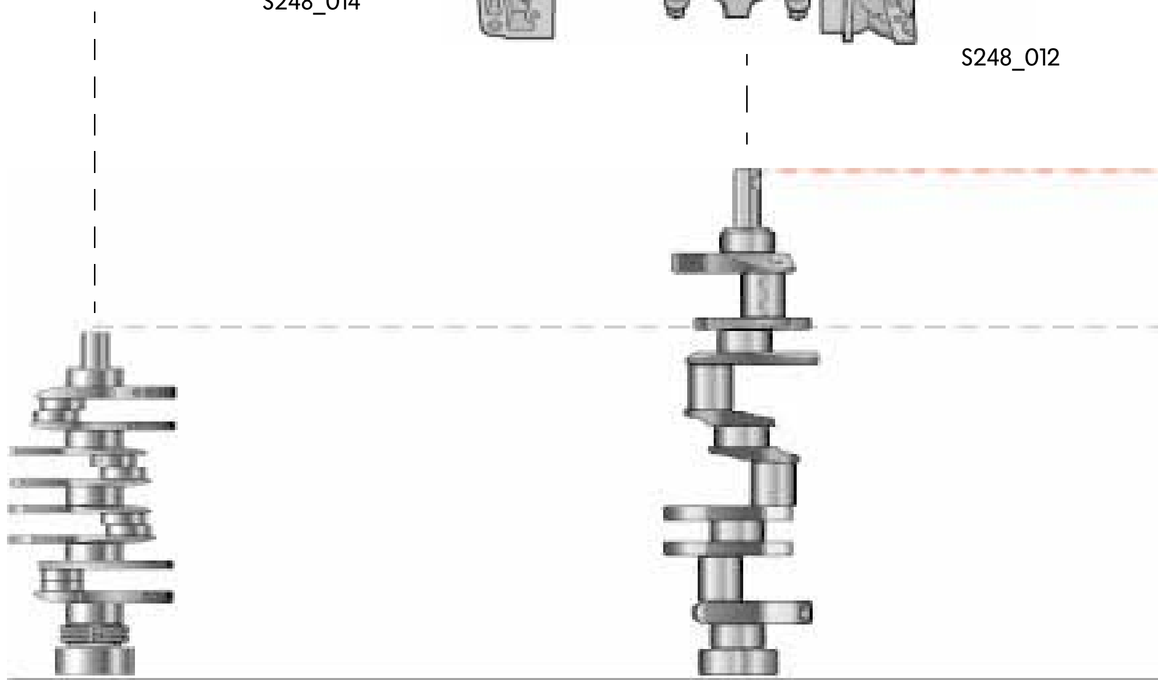


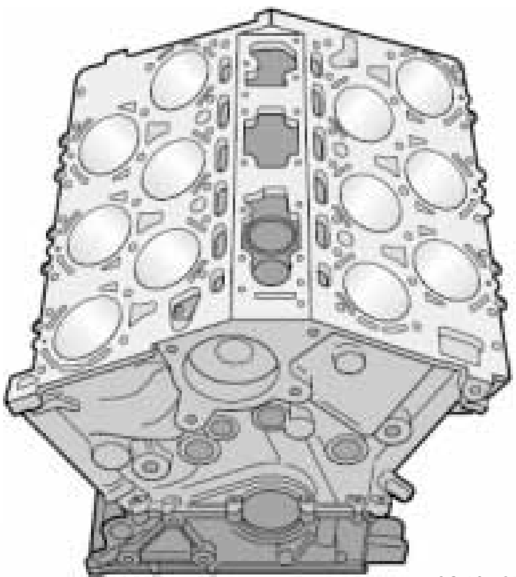
W8 crankshaft

V8 crankshaft

Comparing the 12-cylinder crankshaft of a conventional V12 engine with that of a 12-cylinder W engine emphasises the constructional advantage.

Depending on the number of cylinders, the W principle therefore saves material, and hence also weight.

The W12 engine



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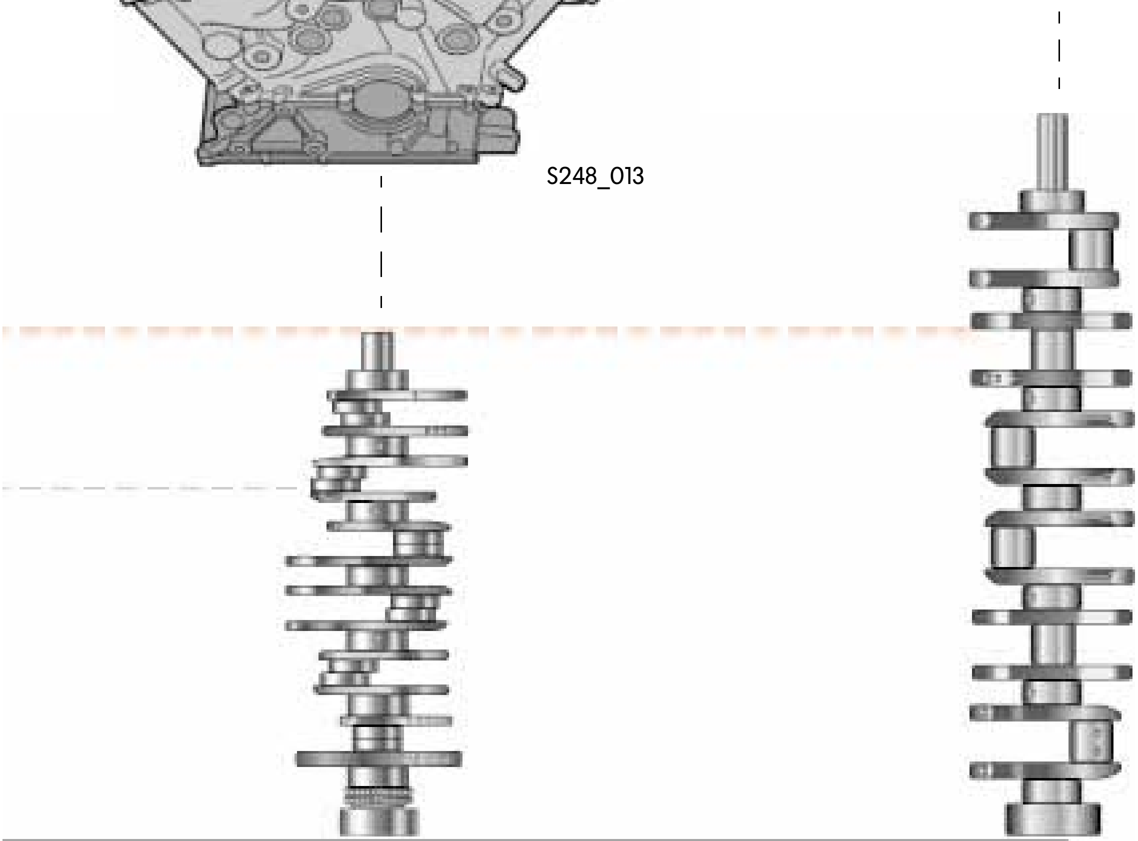
The crankshaft of a V12 engine with the most available space is shown by way of comparison



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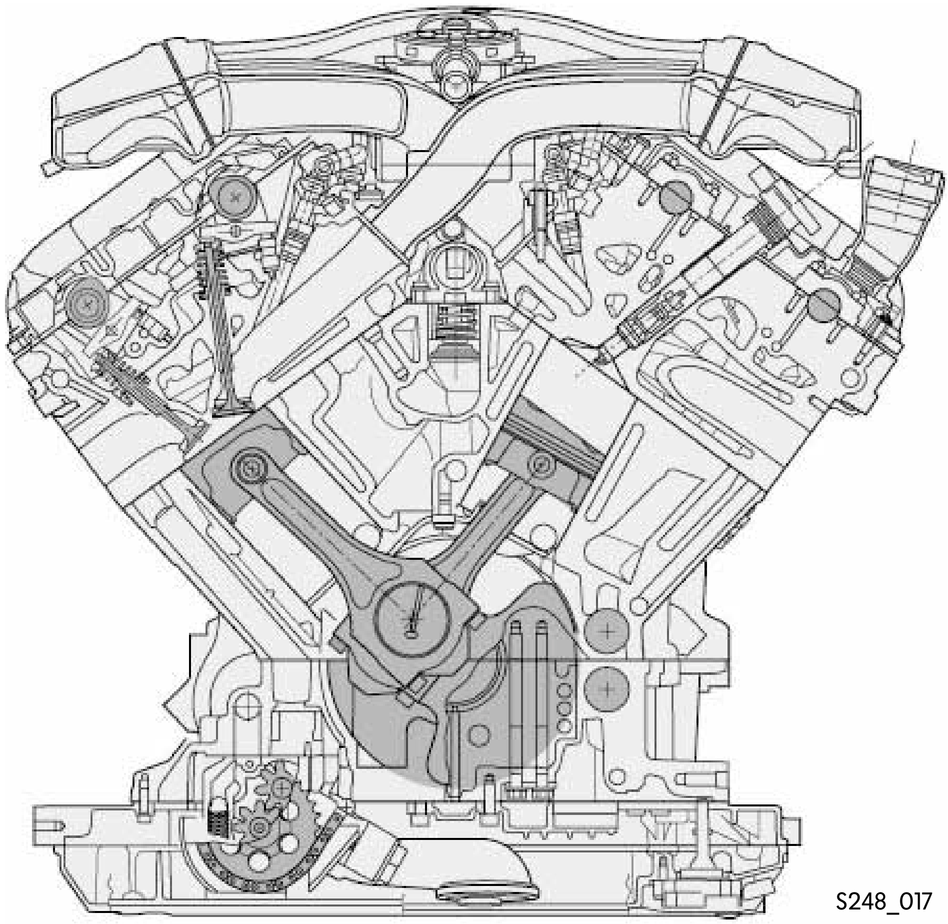
W12 crankshaft

V12 crankshaft

Specifications - the W8 engine



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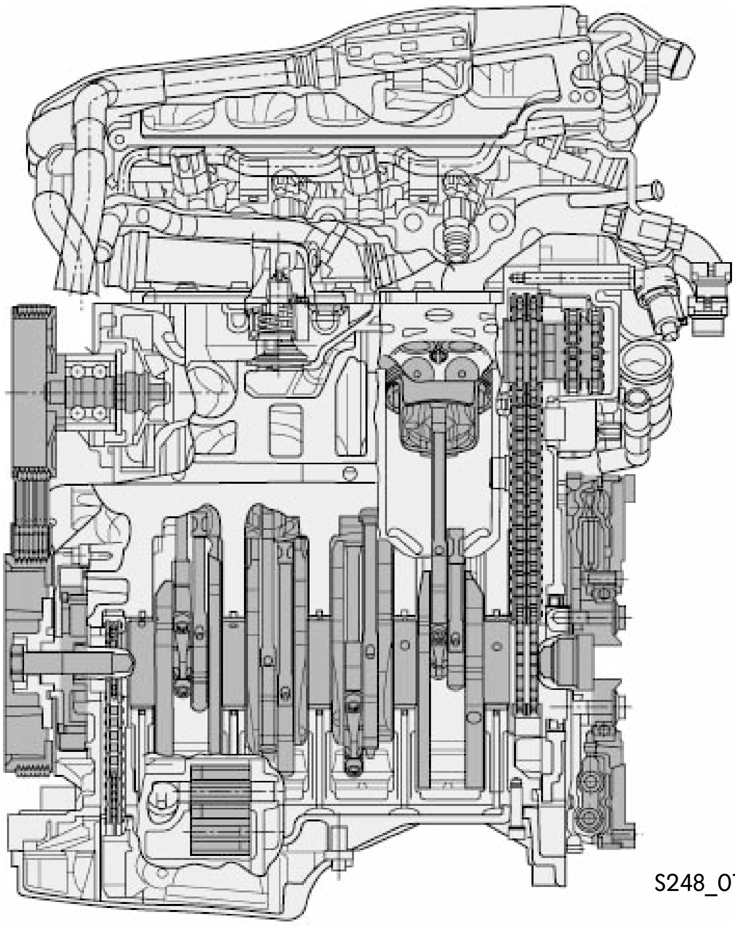
Displacement [cc]	3999
Bore [mm]	84
Stroke [mm]	90.168
Number of cylinders	8
Number of cylinder heads	2
Offset [mm]	± 12.5
Bank offset [mm]	13
V-angle of cylinder heads [°] of both banks	72°
V-angle of cylinders [°] in a bank	15
Number of valves	4 / cylinder
Splitpin (crankshaft journal offset)	-18°
Firing order	1-5-4-8-6-3-7-2



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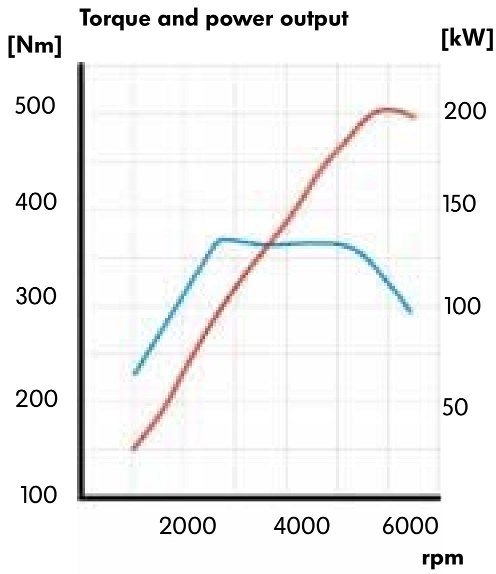

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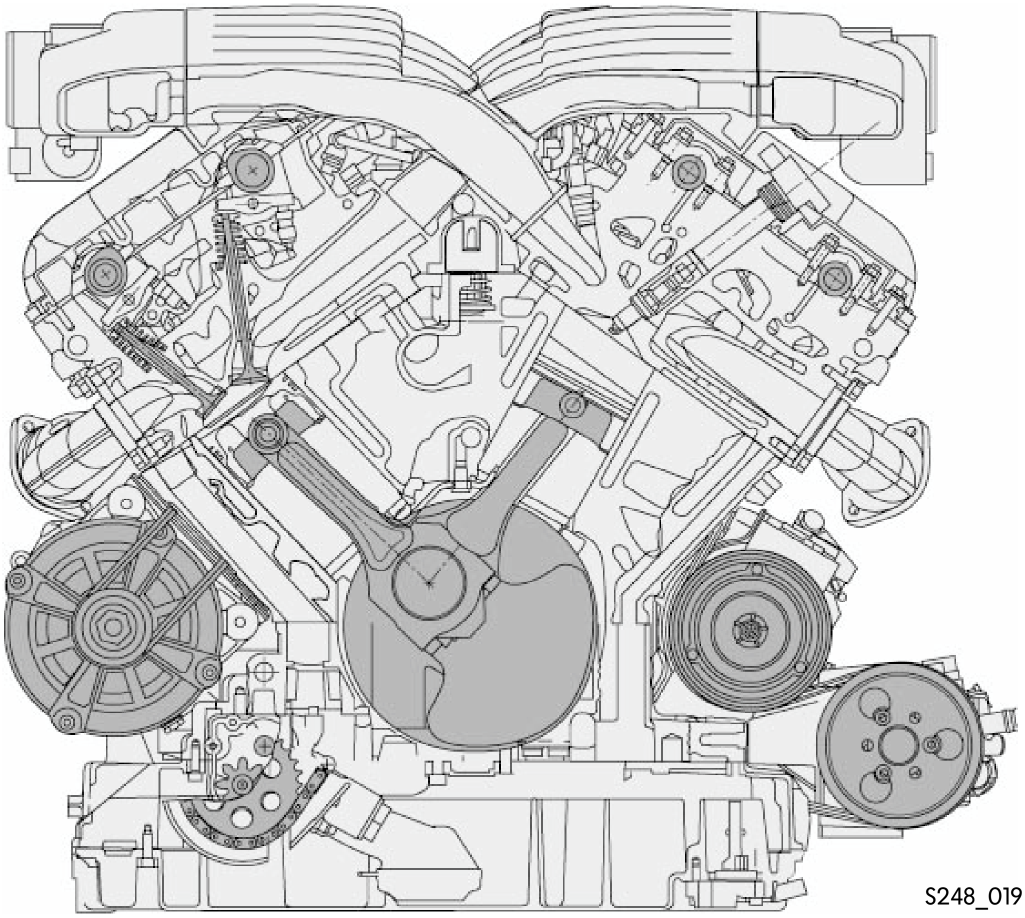
Engine code	BDN
Dimensions (l x w x h) [mm]	420 x 710 x 683
Weight [kg]	approx. 193
Max. output [kW] ([bhp])	202 (275)
Max. torque [Nm]	370
Fuel	98 RON to DIN EN 228 The engine may also be operated alternatively with 95 RON unleaded premium fuel with a slight reduction in performance and torque.
Engine management system	Bosch Motronic ME7.1
Installation position	in-line
Allocated gearbox	5HP19 4-Motion, C90 6-speed 4Motion

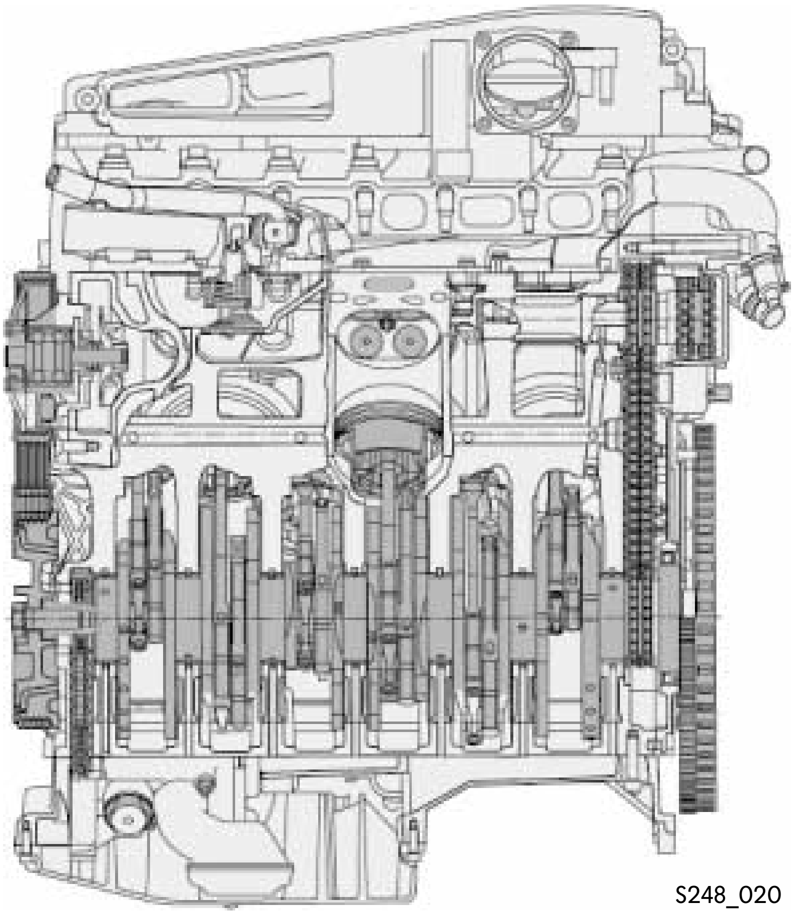
Engine mechanicals

Specifications - the W12 engine



S248_019

Displacement [cm^3]	5998
Bore [mm]	84
Stroke [mm]	90.168
Number of cylinders	12
Number of cylinder heads	2
Offset [mm]	± 12.5
Bank offset [mm]	13
V-angle of cylinder heads [°] of both banks	72°
V-angle of cylinders [°] in a bank	15
Number of valves	4 / cylinder
Splitpin (crankshaft journal offset)	+12°
Firing order	1-12-5-8-3-10-6-7-2-11-4-9



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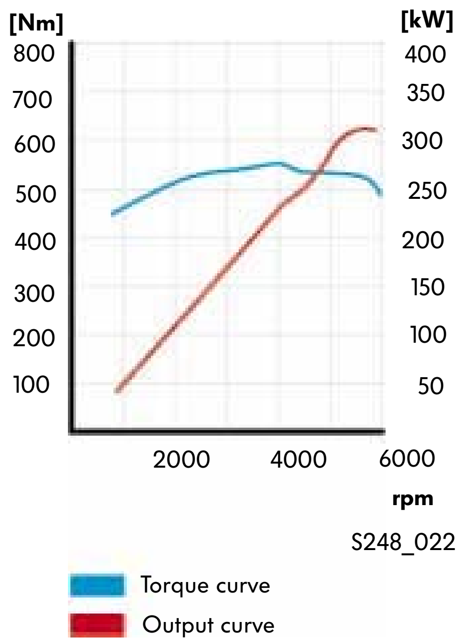
Torque and power output



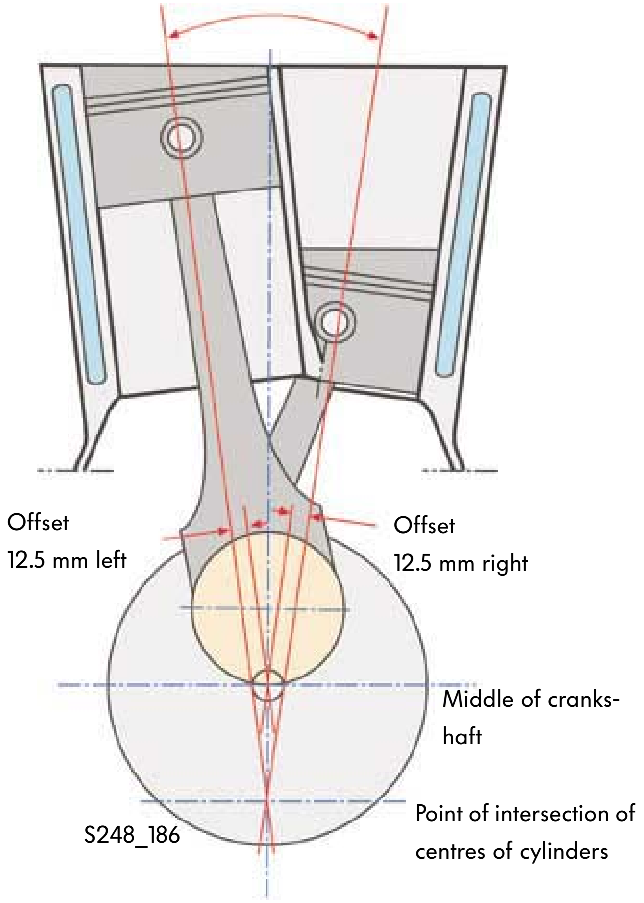
S248_022

Engine code	BAN
Dimensions (l x w x h) [mm]	513 x 710 x 715
Weight [kg]	approx. 245
Max. output [kW] ([bhp])	309 (420)
Max. torque [Nm]	550
Fuel	98 RON to DIN EN 228 The engine may also be operated alternatively with 95 RON unleaded premium fuel with a slight reduction in performance and torque.
Engine management system	Bosch Motronic ME7.1.1 (dual control unit concept)
Installation position	in-line
Allocated gearbox	5HP24 4Motion

The crankshaft drive

The offset

The cylinders of a bank are offset in a tandem arrangement and positioned at a very narrow angle of 15°.
The compact W engine was made possible by arranging two banks at an angle of 72°.
To provide adequate space for the pistons in the bottom dead centre range, it was necessary to offset the crankshaft drive. This means that the cylinders are offset by 12.5 mm outwards relative to the centre of the engine (crankshaft fulcrum).



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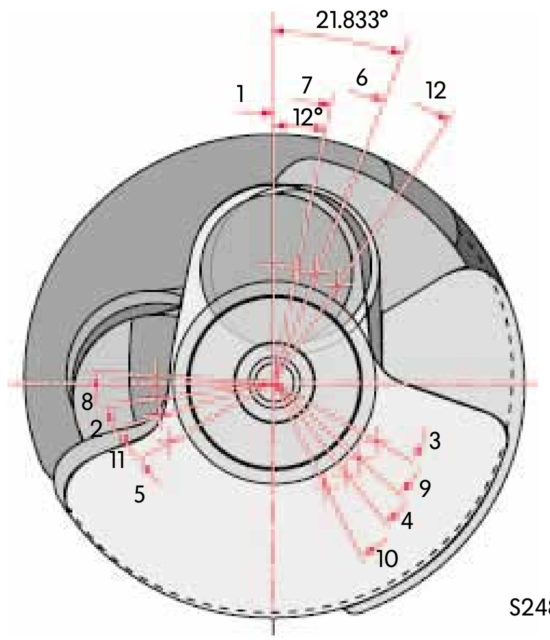
The crank pin offset

A constant spark gap is maintained by the crank pin offset, or what is known as the 'splitpin'.
The layout of the W engine is based on a 10-cylinder engine. All cylinders in a 4-stroke engine fire within a crank angle of 720°.

W10 engine
720° crankshaft : 10 cylinder = 72° bank angle
W8 engine
720° : 8-cylinder = 90° spark gap
72° bank angle - 90° spark gap =
Splitpin -18°
W12 engine
720° : 12 cylinder = 60° spark gap
72° bank angle - 60° spark gap =
Splitpin +12°

W12 engine



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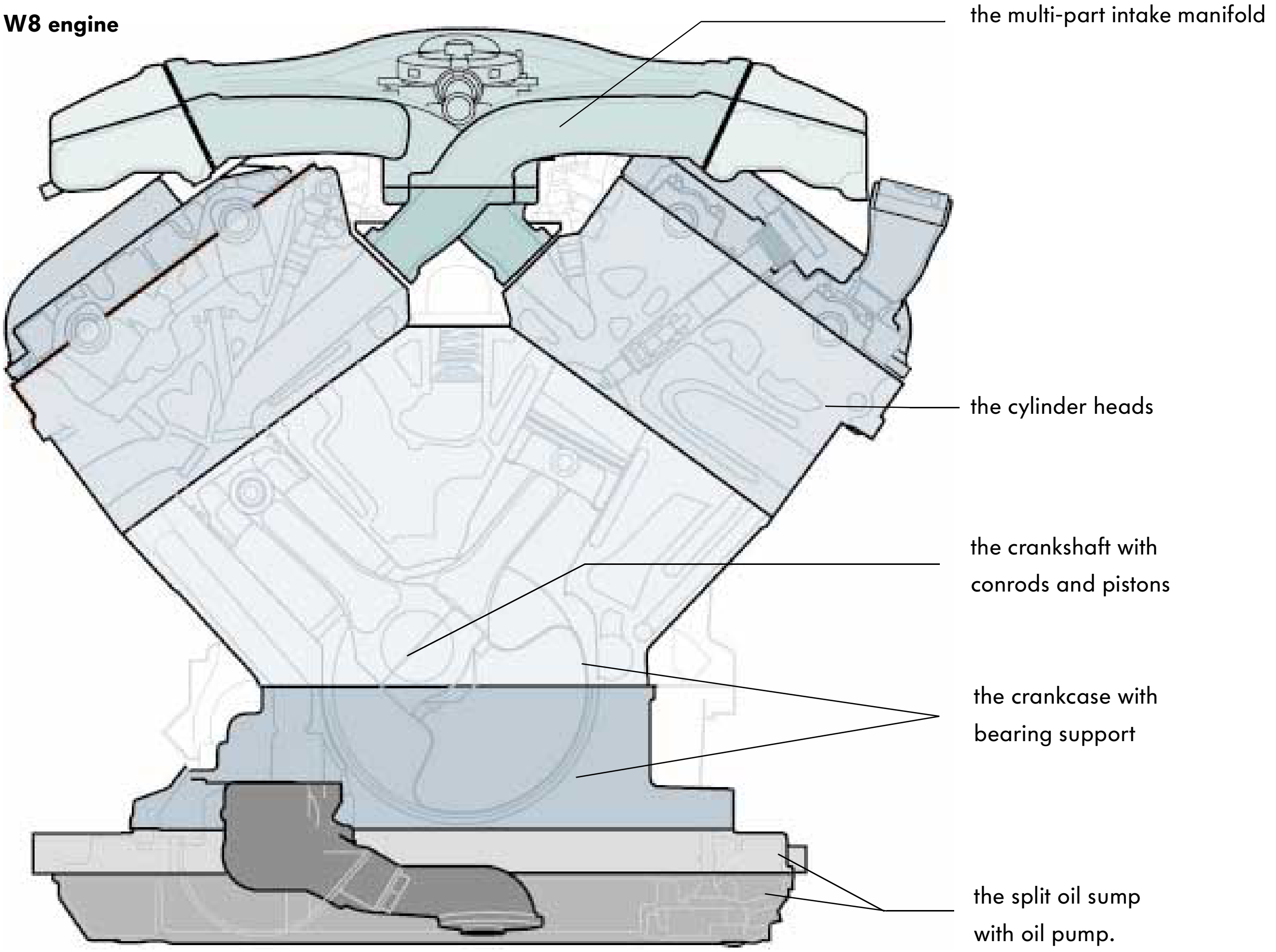
The engine in detail

To familiarise you thoroughly with the mechanical construction of the W8 and W12 engines, we will now describe the main modules of both engines in succession.

The following topics will be dealt with:

- the crankcase with bearing support,
- the crankshaft with conrods and pistons,
- the balancing shafts,
- the cylinder heads,
- the oil sump and oil pump,
- the crankshaft drive,
- the timing chain drive,
- the belt drive for auxiliary components and
- the multi-part intake manifold

W8 engine



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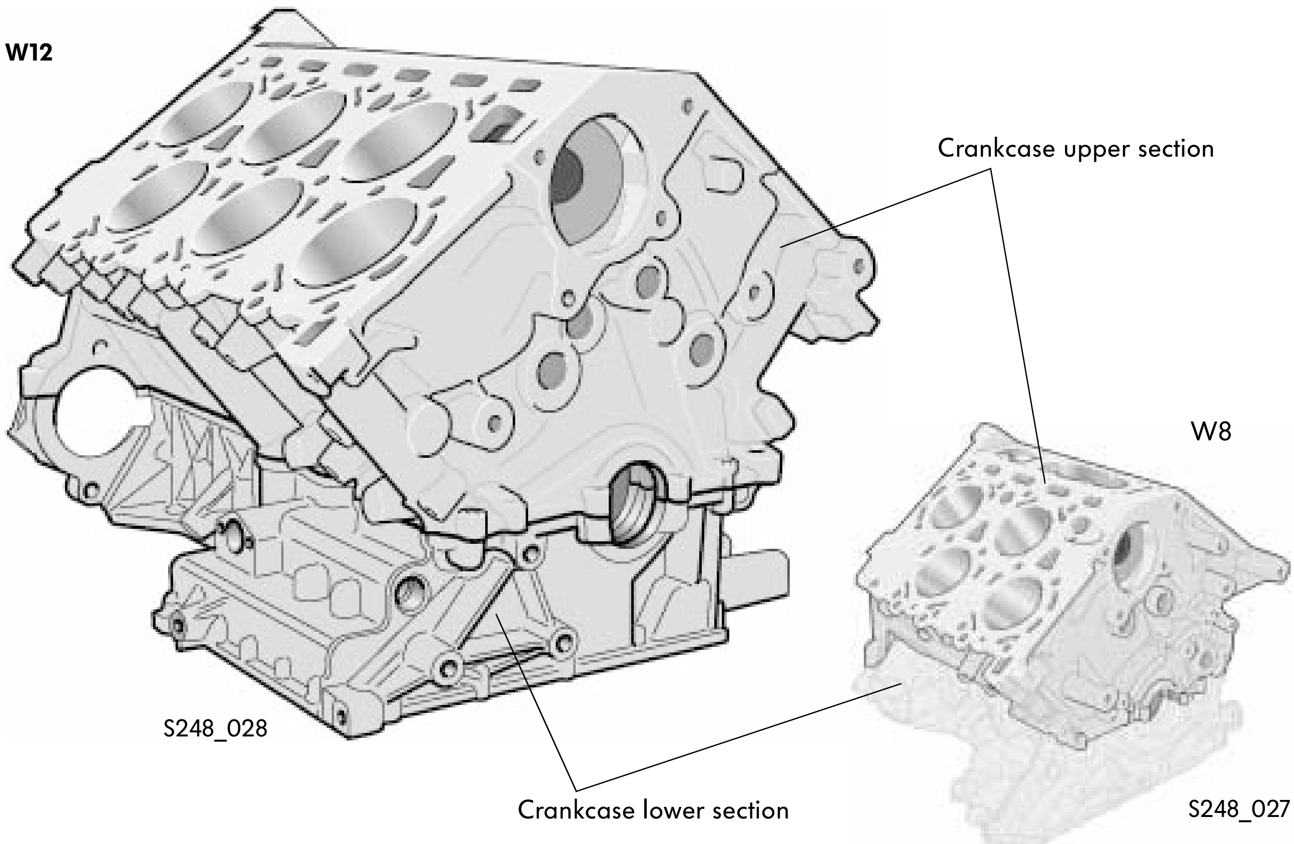
Engine mechanicals

The crankcase

The crankcase comprises two components: the crankcase upper section and the crankcase lower section. The upper section contains, among other things, the cylinders and the upper bearing cover halves of the crankshaft. The crankcase lower section is designed as a bearing support and carries the lower bearing cover halves.



The crankcase upper section

The "aluminium" crankcase upper section is made of a hypereutectic aluminium-silicon alloy (AlSi17CuMg).

Hypereutectic means that pure silicon crystals initially precipitate out of the aluminium-silicon melt while it cools before aluminium/silicon crystals form. Due to the presence of these silicon crystals within the metal microstructure, the cooled melt is harder than a eutectic Al-Si alloy.

Use of this alloy eliminates the need for additional cylinder liners or a plasma coating for the purposes of cooling and lubricating the cylinder surfaces as the material already has sufficient natural strength and thermal stability.

The crankcase lower section

The crankcase lower section is a bearing support with integral bearing seats

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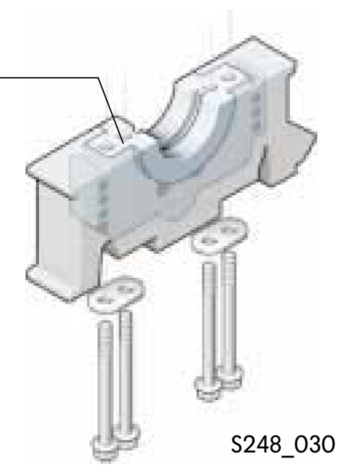

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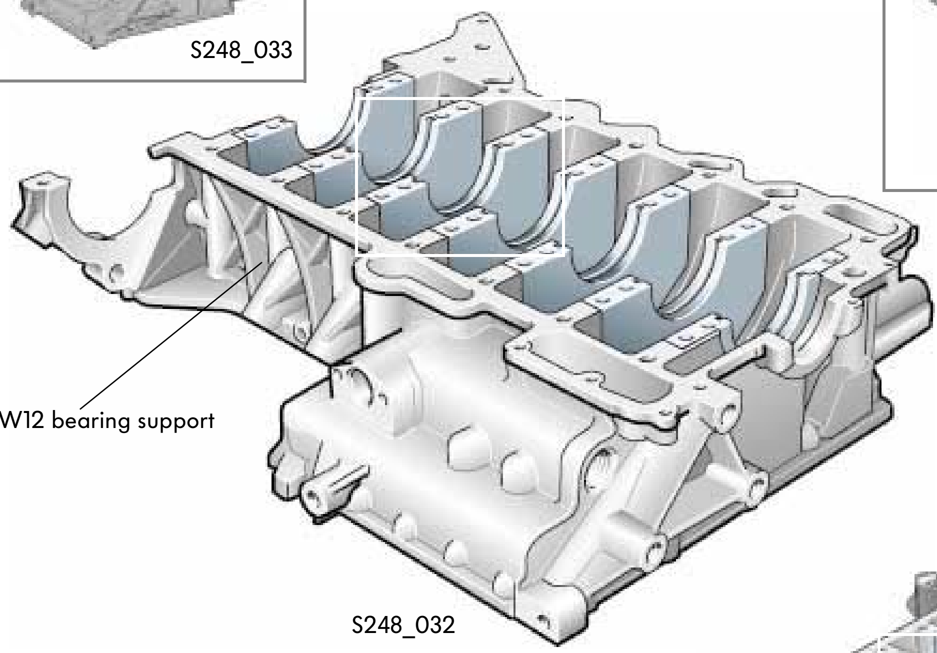

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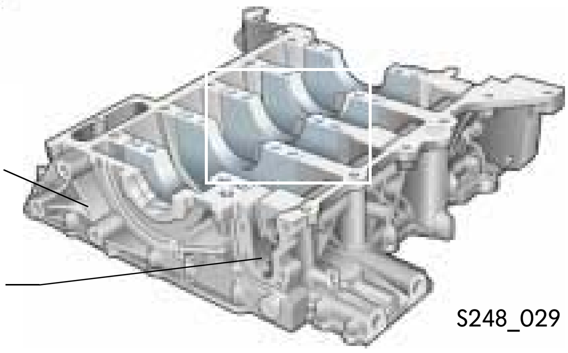

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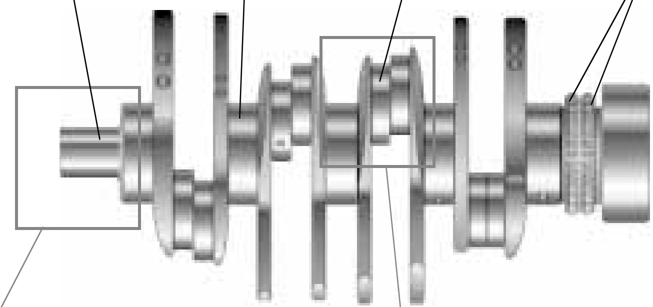
The bearing support is also made of aluminium. It serves as a frame structure for the lower crankshaft bearing covers. These bearing covers are made of grey cast iron and are also embedded when the bearing support is cast.

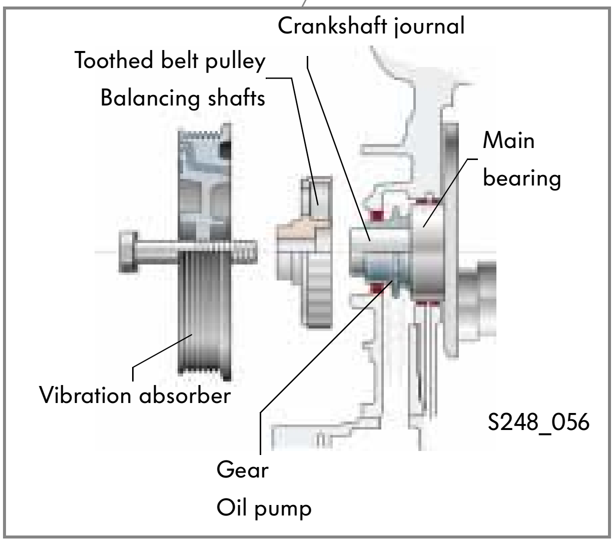
They are located on the pressure side of the crankshaft and give the crankshaft bearing the strength it requires.
The bearing support is attached to the crankcase upper section by 4 bolts per bearing cover.

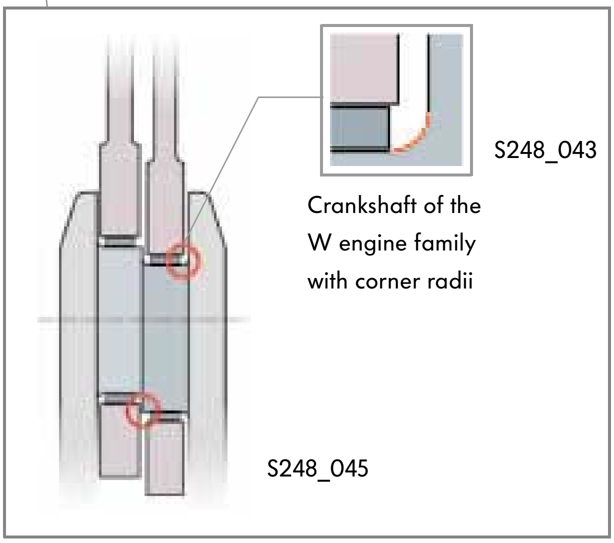
Engine mechanicals

The crankshaft

The crankshafts used in the W engines are manufactured from forged tempered steel.
In each case, two conrods run between two main bearings.



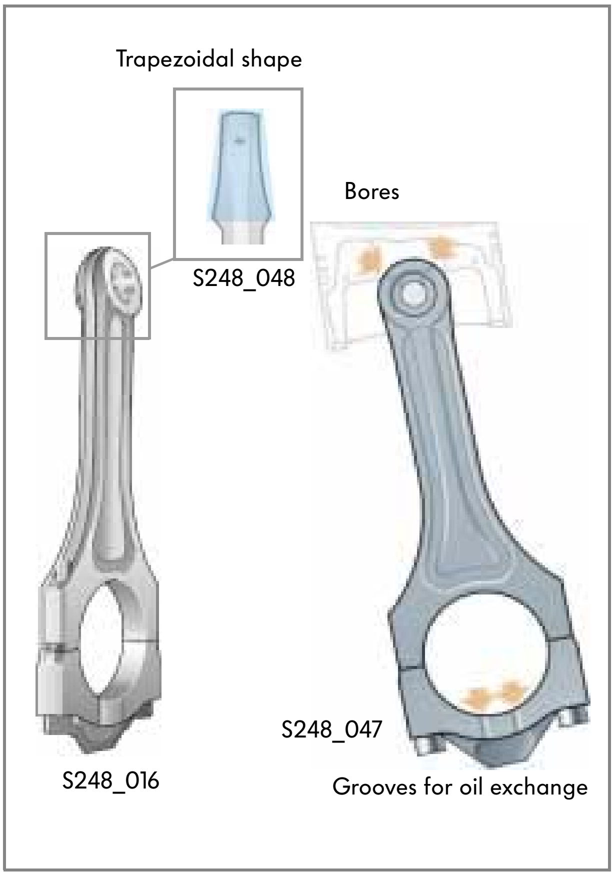




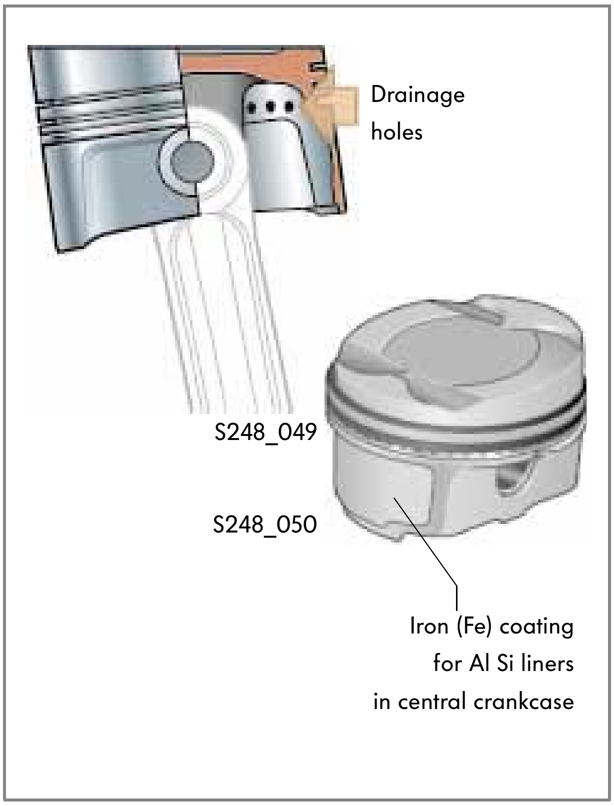
The drive gear of the oil pump, together with the toothed belt pulley for the balancing shafts (on the W8 engine only), is pressed against the outer main bearing and fixed in place by the vibration absorber.

The conrod journals are arranged in pairs and in accordance with the crankshaft throw.
When the conrods are installed, the bearing cups must not contact the radii or the edge between the two conrod faces (use tool).

Conrods and pistons



The conrods are made of forged steel and are only 13 mm thick. They are of a trapezoidal construction and are cut during the production process.
To ensure better oil exchange, two grooves are milled in the side faces of the conrod lower sections. The conrod pin is lubricated through two inclined bores in the conrod head.



The pistons are made of an aluminium-silicon (Al Si) alloy. The recess in the piston surface is very shallow as the cylinder head takes up most of the combustion chamber volume. The inclined piston surface is necessary because of the V-position adopted by the pistons.

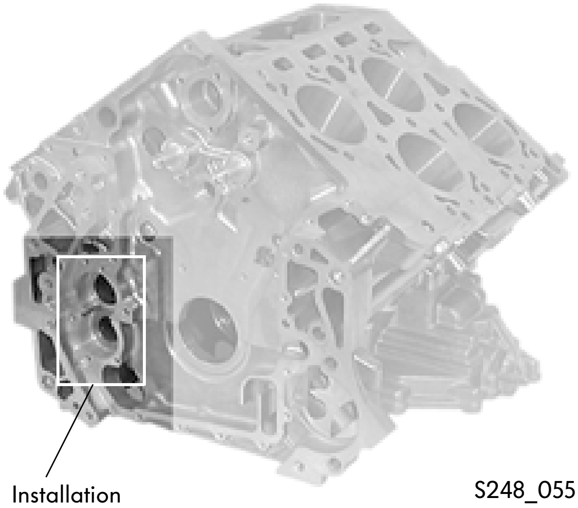
Each piston carries 2 piston rings and an oil taper ring. To drain off the oil which collects in the scraper ring, small drainage holes lead into the piston ring groove towards the inside of the piston

Engine mechanicals

The balancing shaft of the W8 engine

The W8 engine has two balancing shafts for compensating the forces of inertia. The two shafts are housed in the crankcase. The upper balancing shaft is driven by the crankshaft by means of a toothed belt. A gear located at the end of the upper balancing shaft drives the lower balancing shaft.

The balancing shafts are mounted in two location holes on the clutch side of the crankcase.



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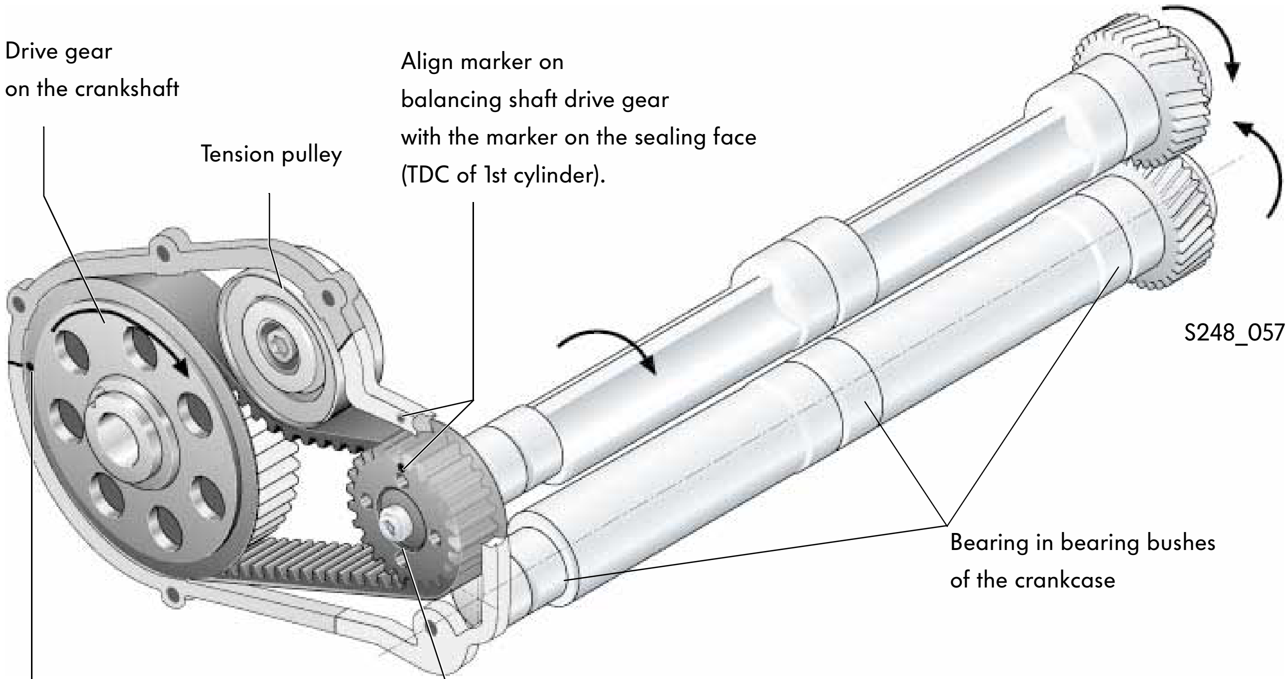

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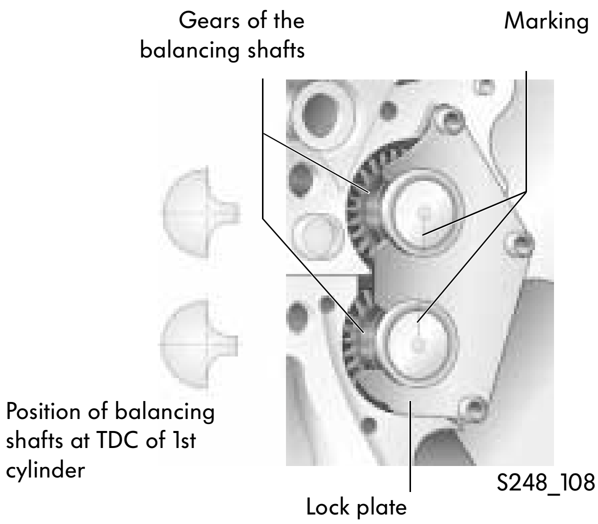
There is a groove at the gear wheel end of the balancing shaft. The lock plate engages into this groove, locating the balancing shafts axially. During installation, the balancing shafts must be aligned with regard to the TDC position of the 1st cylinder.
The balancing shafts must be rotated so that the markings on the balancing shafts are opposite each other.



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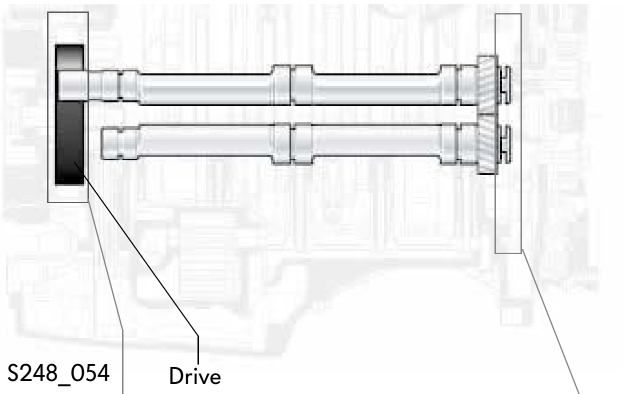

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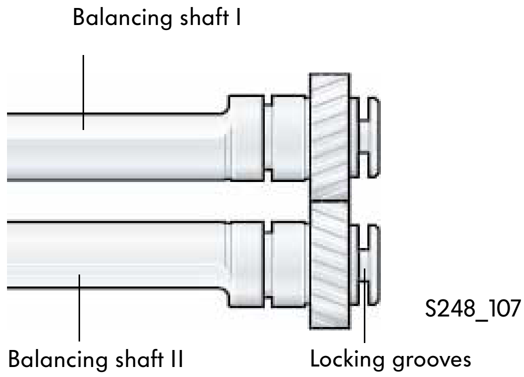

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S248_058

The balancing shaft drive is protected on the belt drive side by a plastic housing cover.

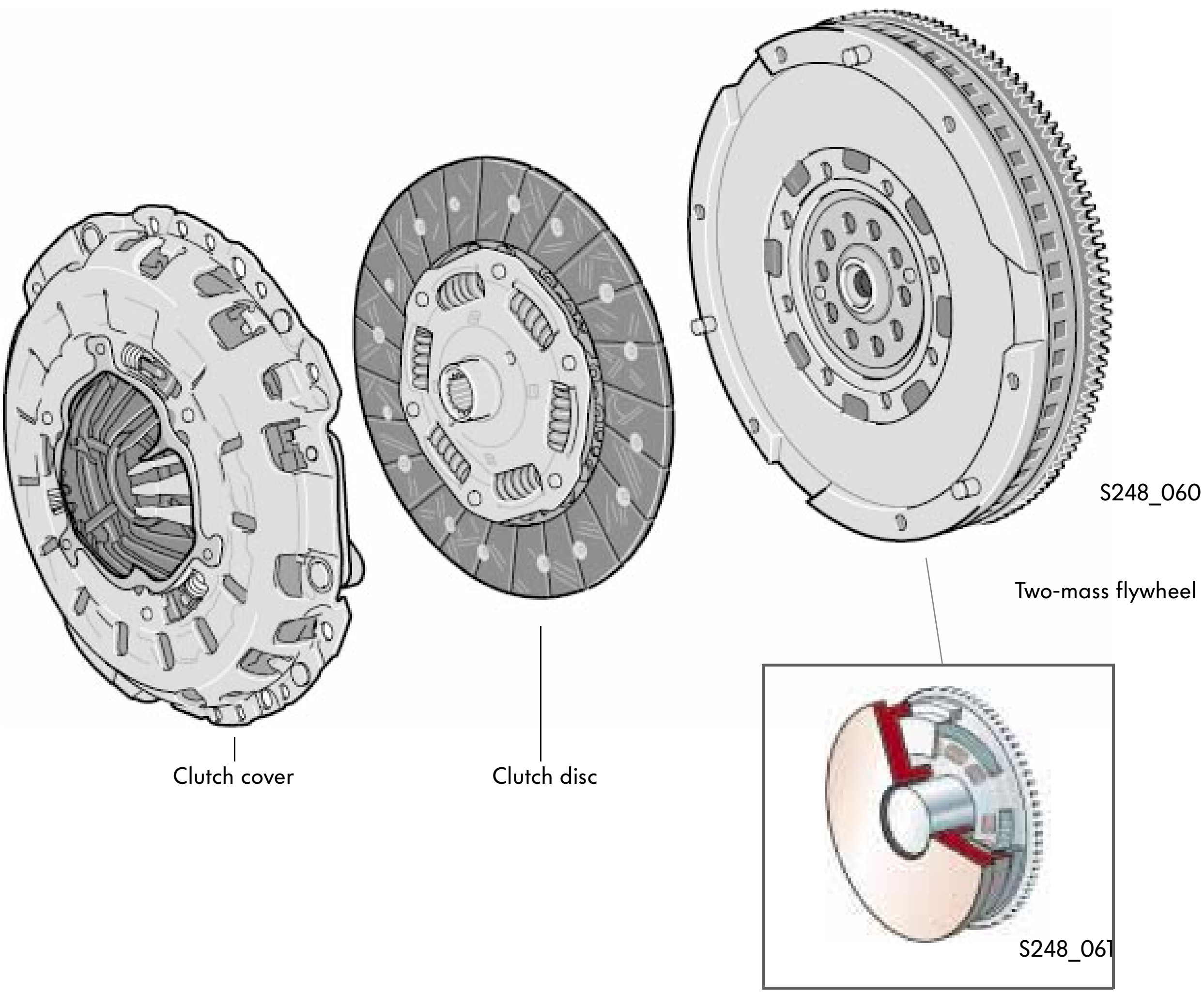
S248_059

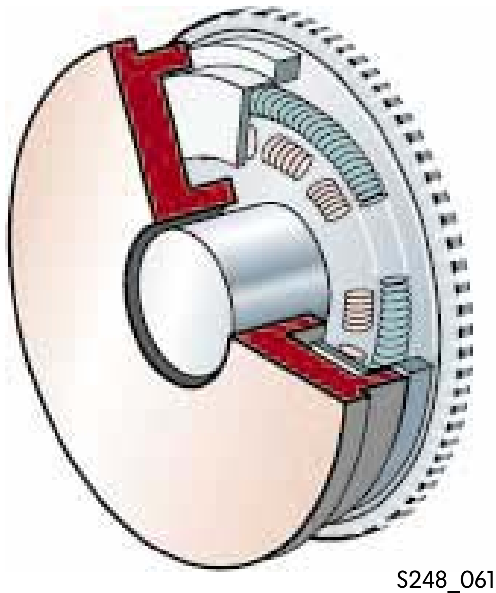
On the clutch side, the openings for inserting the balancing shafts, together with the chain drive, are sealed by an aluminium cover.

Engine mechanicals

Two-mass flywheel with clutch

W engines fitted with a manual gearbox generally have a two-mass flywheel.
This flywheel prevents torsional vibration from being transmitted by the crankshaft to the gearbox via the flywheel. This would otherwise adversely affect handling performance.





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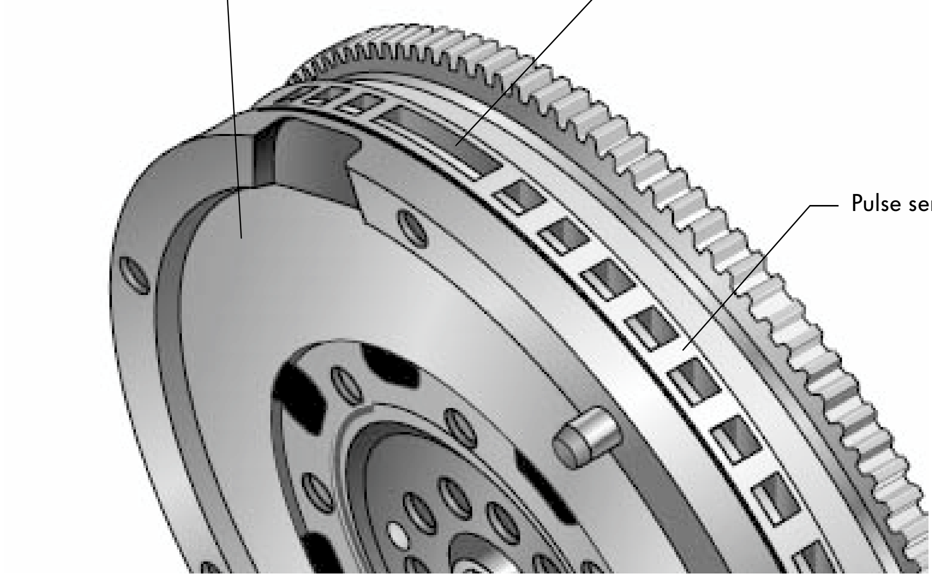
A spring damper system within the two-mass flywheel separates the primary inertia mass from the secondary inertia mass so that the torsional vibration produced by the engine is not transmitted to the gearbox.

On W engines with automatic transmission, the two-mass flywheel is substituted by a converter plate.



S248_062

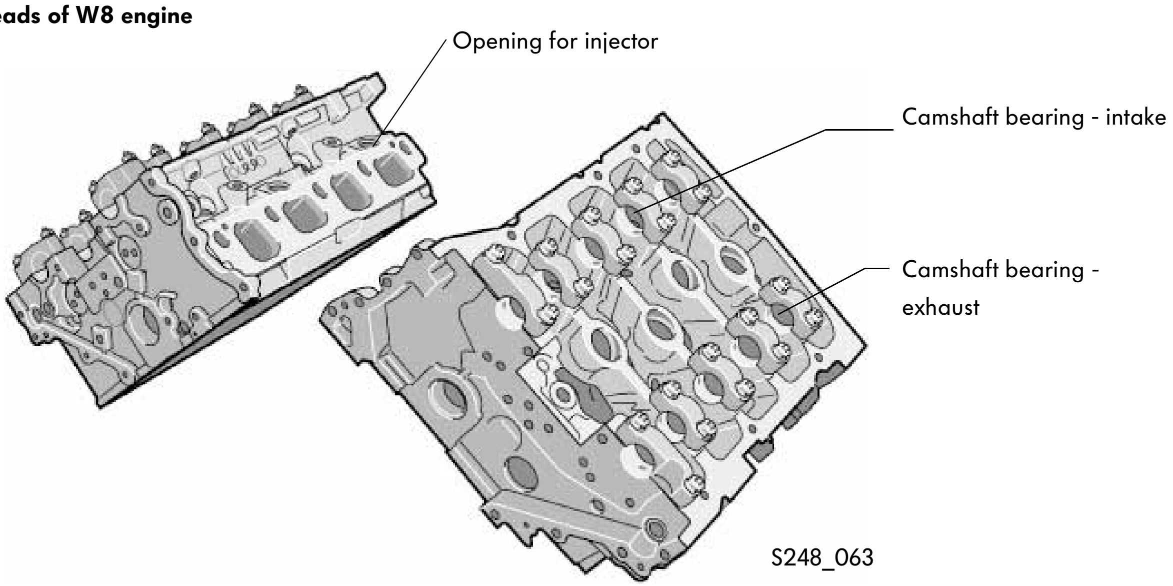
The two-mass flywheel also serves as a sender wheel. Its job is to determine the engine speed and recognise cylinder No. 1 together with the Hall senders of the camshafts. It has a larger tooth gap which serves as a marker point. This point is registered by the engine speed sender located in the gearbox housing during each revolution of the two-mass flywheel.

Engine mechanicals

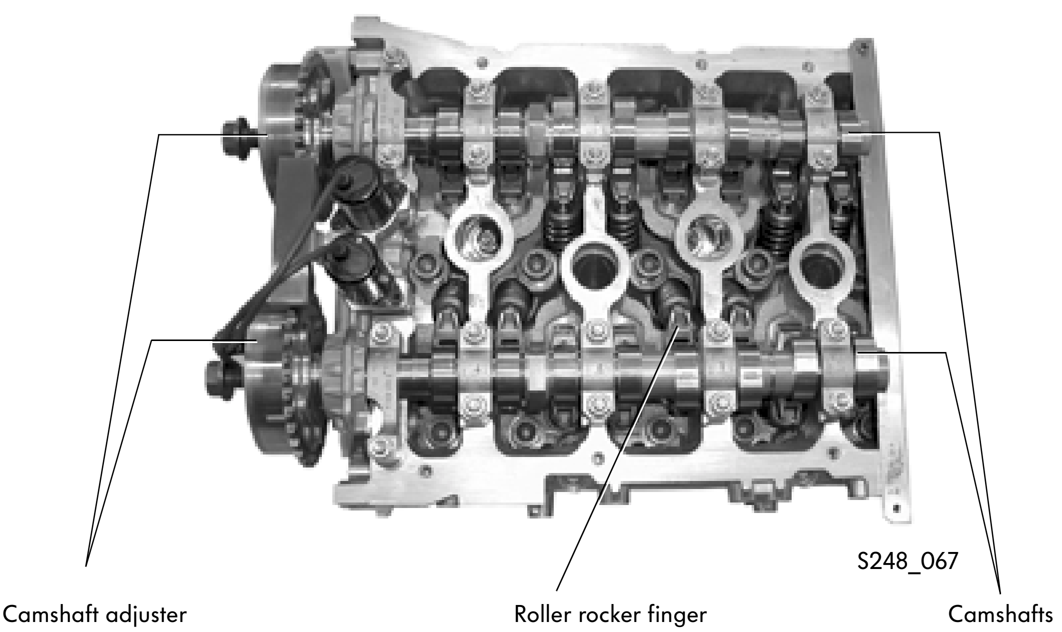
The cylinder heads

The W engines have two aluminium cylinder heads with two overhead camshafts apiece.
The injectors are inserted into the cylinder heads.

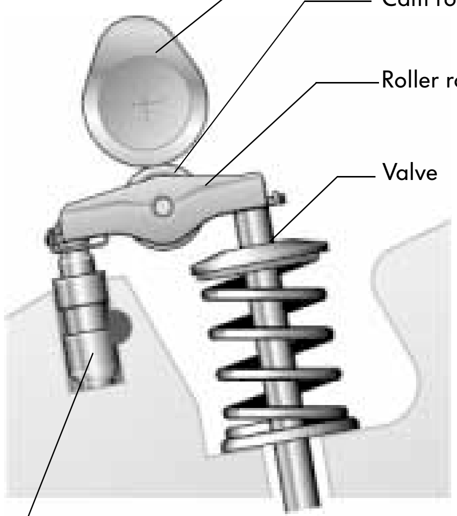
Cylinder heads of W8 engine



Each of the cylinder heads in the two W engines has an intake camshaft and an exhaust camshaft with camshaft adjusters attached to their end faces.



The 4 valves in each cylinder are actuated by low-friction roller rocker fingers. Valve clearance is compensated by hydraulic support elements.



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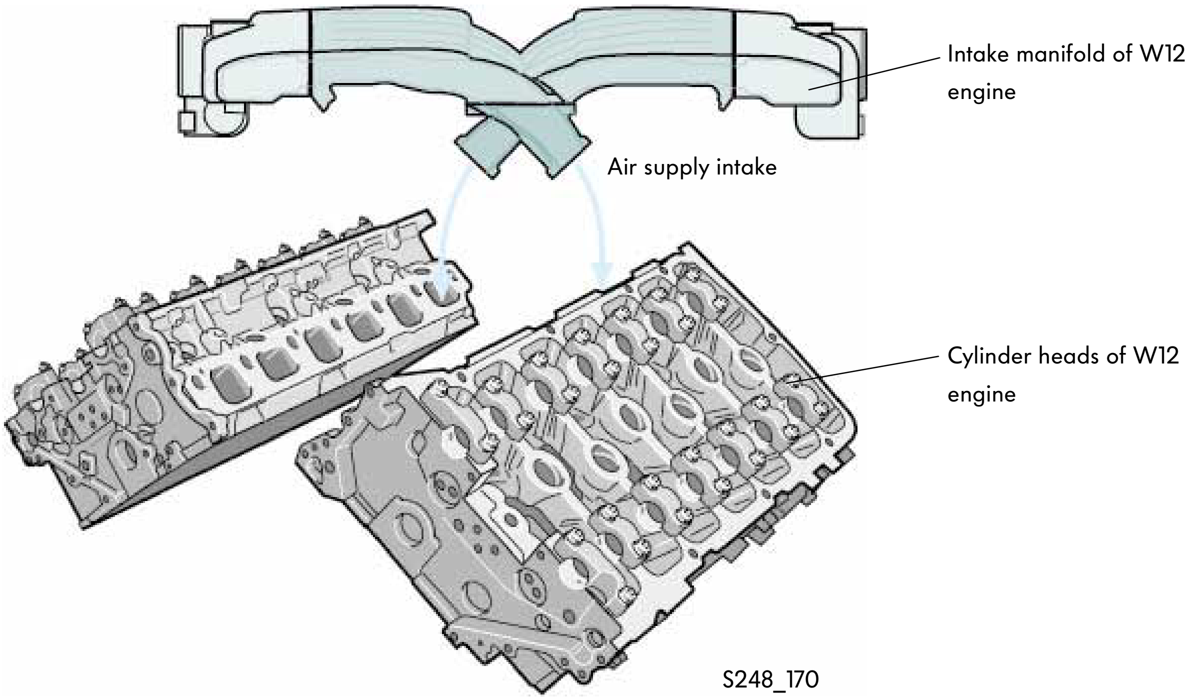
S248_161

Due to the cylinder arrangement, short and long valves as well as short and long inlet and exhaust ports alternate with one another.

Engine mechanicals



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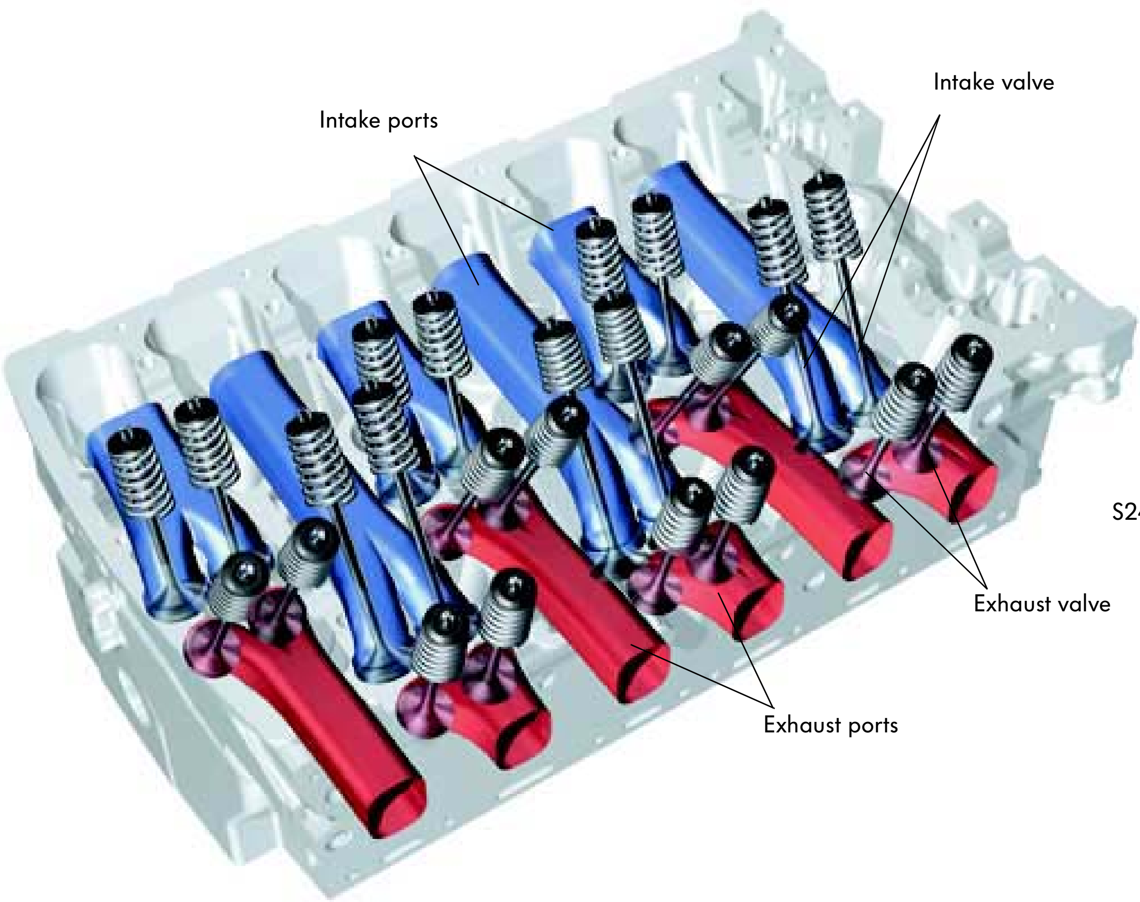
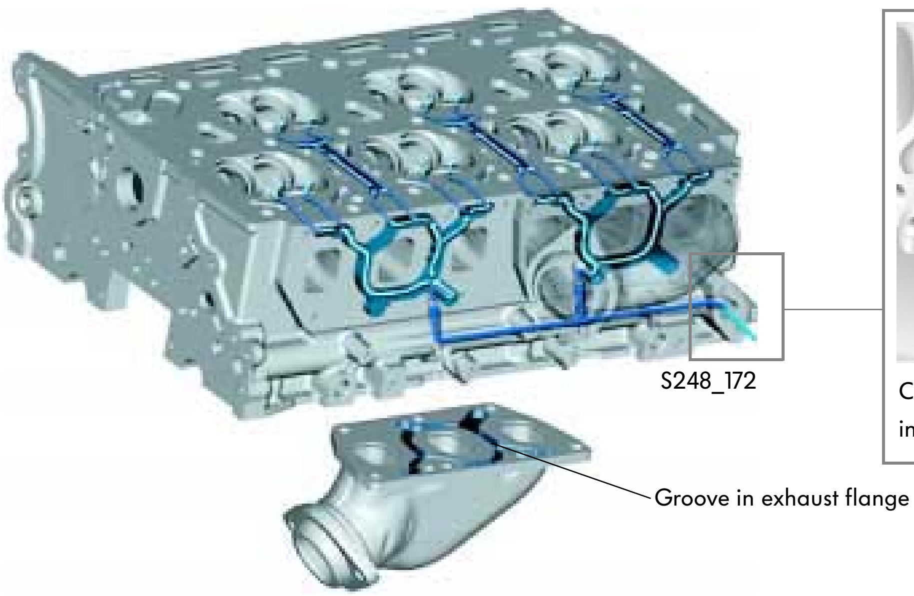


S248_171

The secondary air ducting system

Beside the coolant and oil ducts, the secondary air is guided via ducts and bores into the exhaust ducts near the exhaust valves. The secondary air flows into a duct in the cylinder head via a secondary air inlet valve.

From here the secondary air is guided back into the cylinder head via grooves in the exhaust flange. The secondary air then flows via ducts and bores to the exhaust valves.



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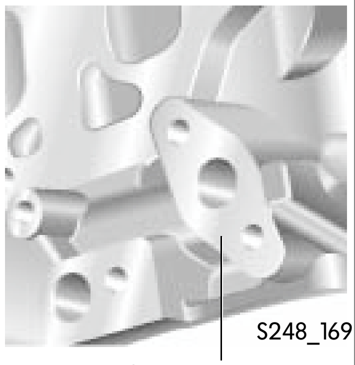
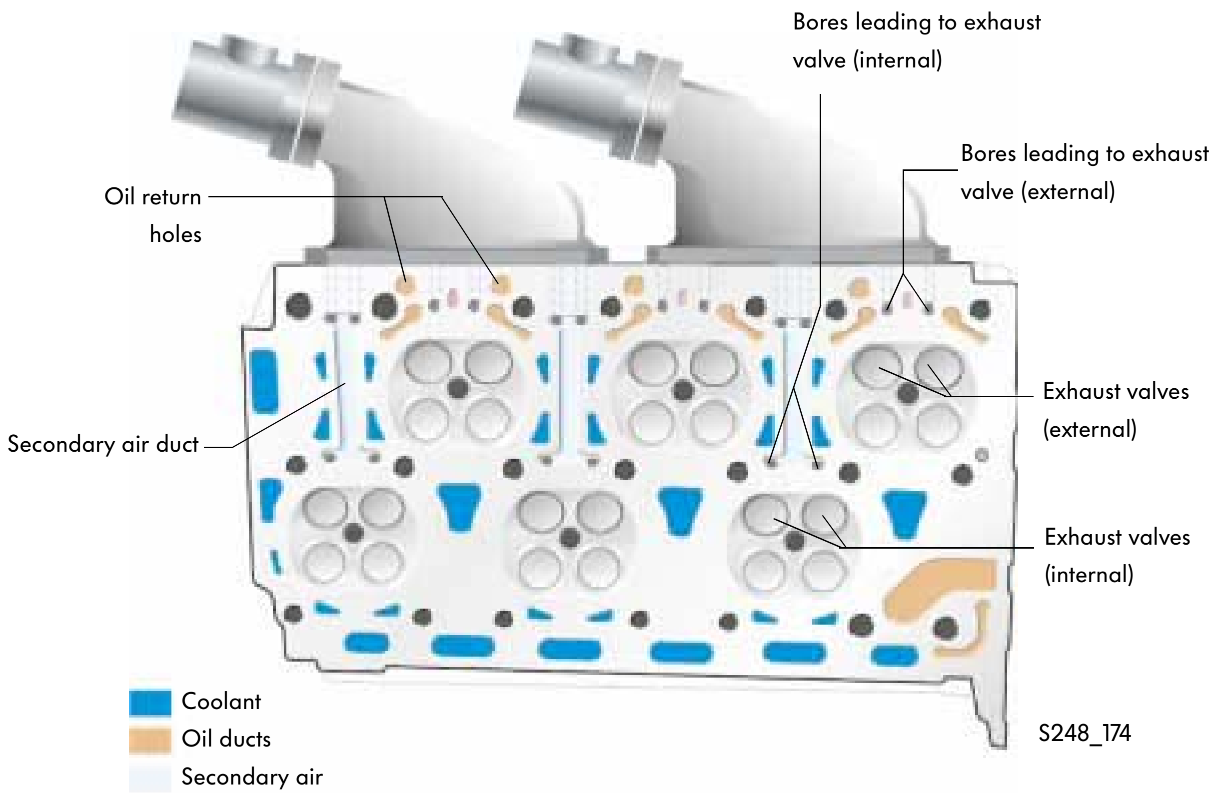


S248_169



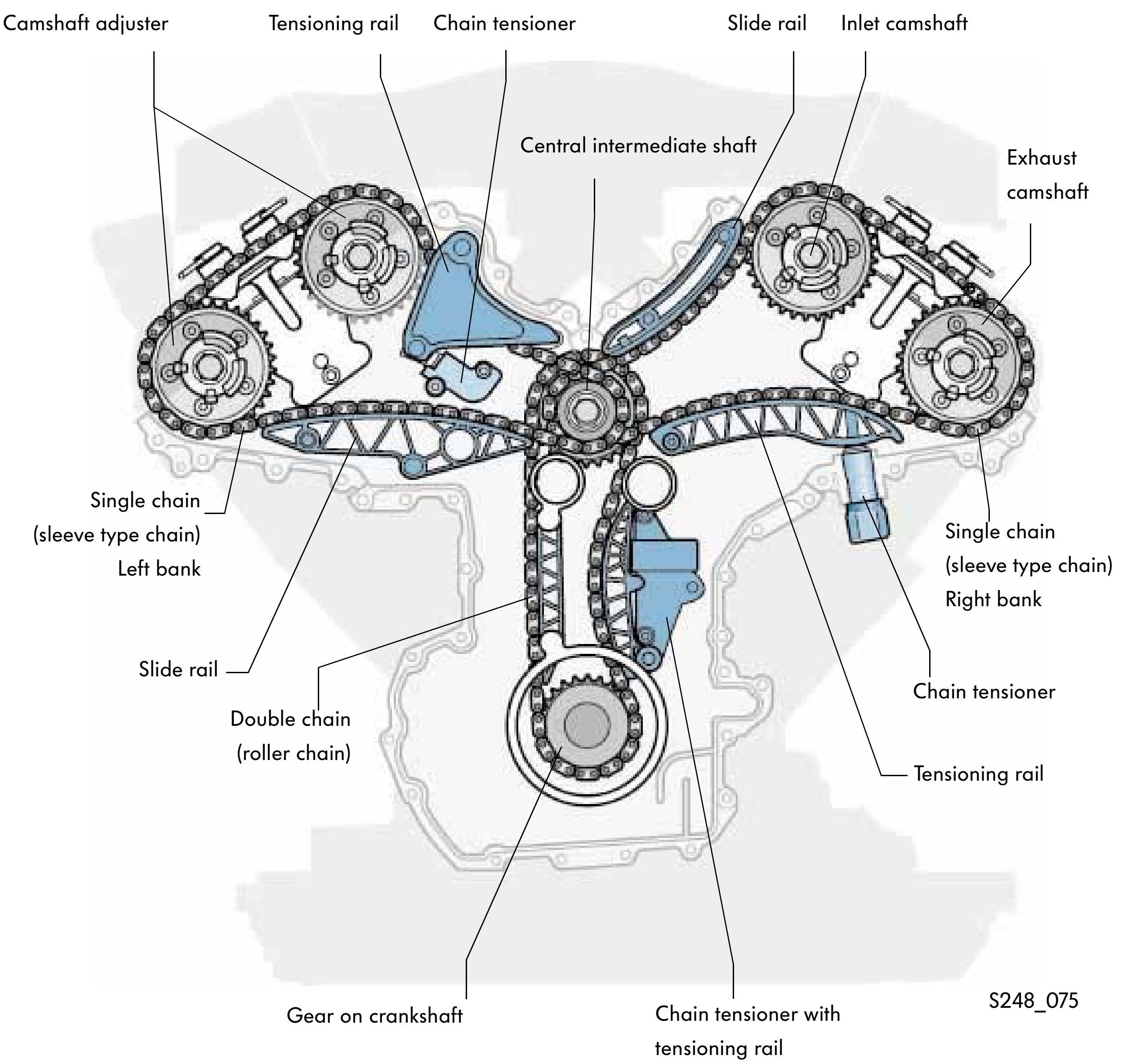
S248_174

Engine mechanicals

The chain drive

The chain drive is mounted at the flywheel end of the engine. Engine power is transmitted by a gear on the crankshaft to the gears of the central intermediate shaft by means of a double-chain.
At this point, each of the camshafts of the two cylinder heads is driven by means of a single chain. Three hydraulic chain tensioners ensure that an optimal chain tension is maintained.

Chain drive of W engines

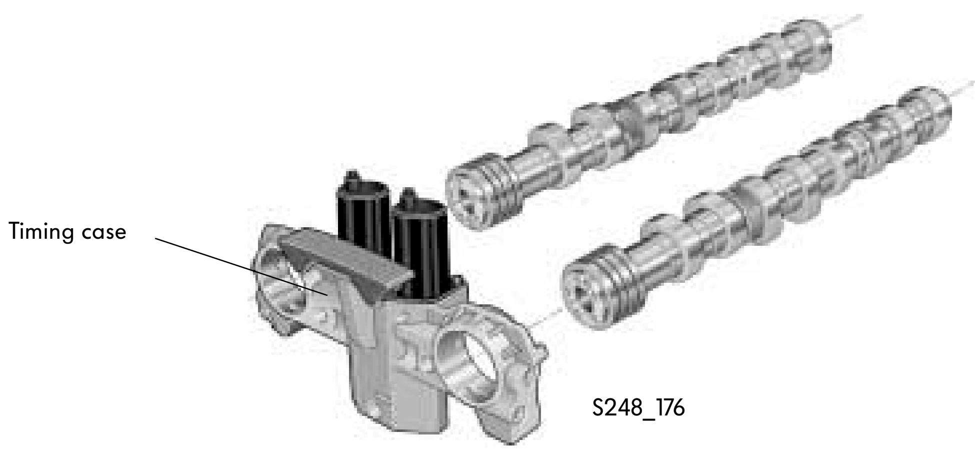


The camshaft timing control

Like the W12 engine, the W8 engine has continuous camshaft engine timing control.

In this case, "continuous" means that the inlet camshaft can be advanced/retarded relative to its neutral position at any angle within a range of 52°.

The camshaft is adjusted by hydraulic camshaft positioners bolted to the end face of each camshaft. The exhaust camshaft of the W8 engine is an exception. It can only be adjusted to the "advance" or "retard" position within a range of 22°. The engine control unit regulates the oil supply to the camshaft positioners via the solenoid valves.



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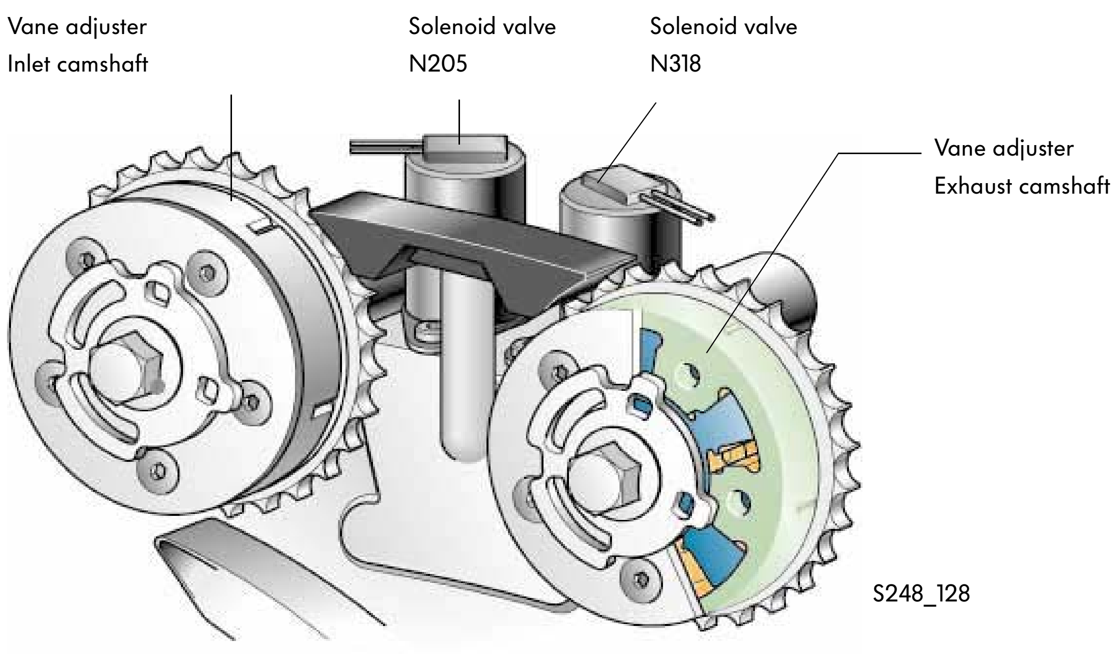

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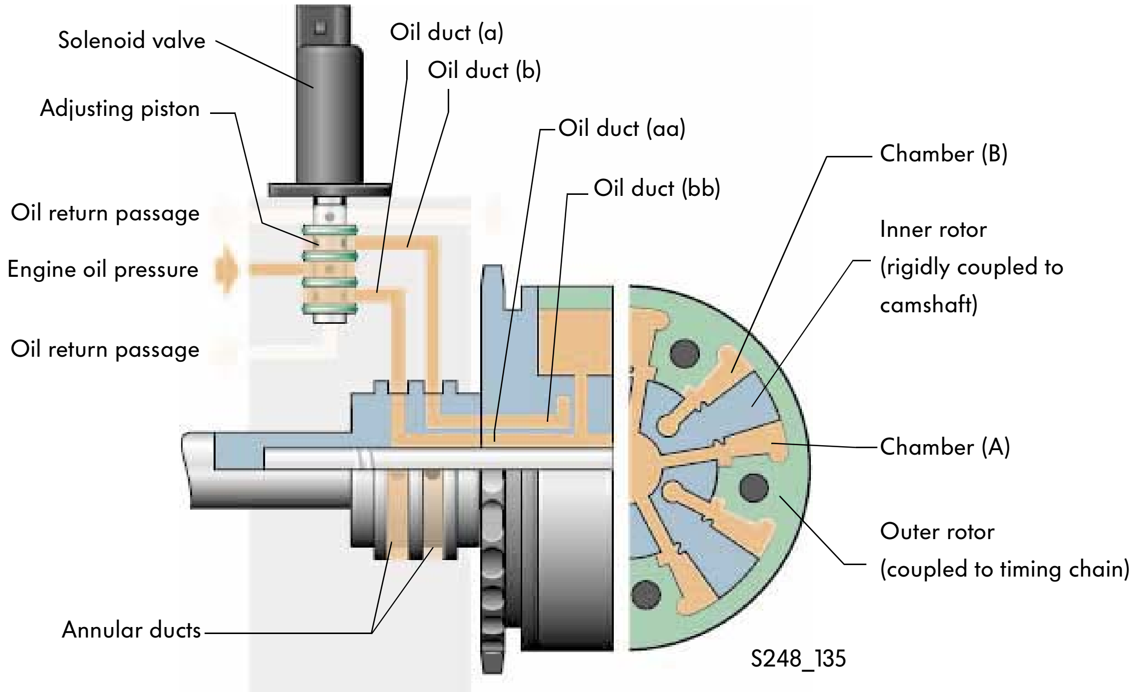
Engine mechanicals

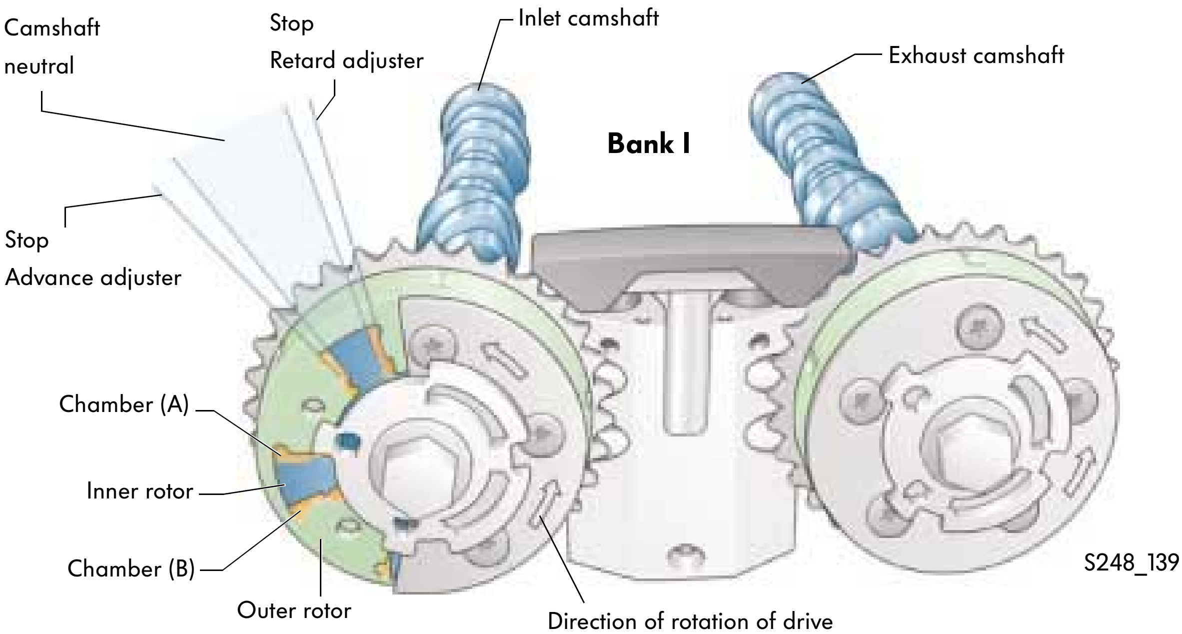
System design

Neutral position

When the solenoid valve moves the adjusting piston into a central position, this causes both oil ducts (a+b) - and hence the chambers (A+B) on either side of the inner rotor - to fill with oil. The inner rotor, together with the camshaft which it is rigidly coupled to, now adopts a position in the middle of the adjustment range.



S248_135

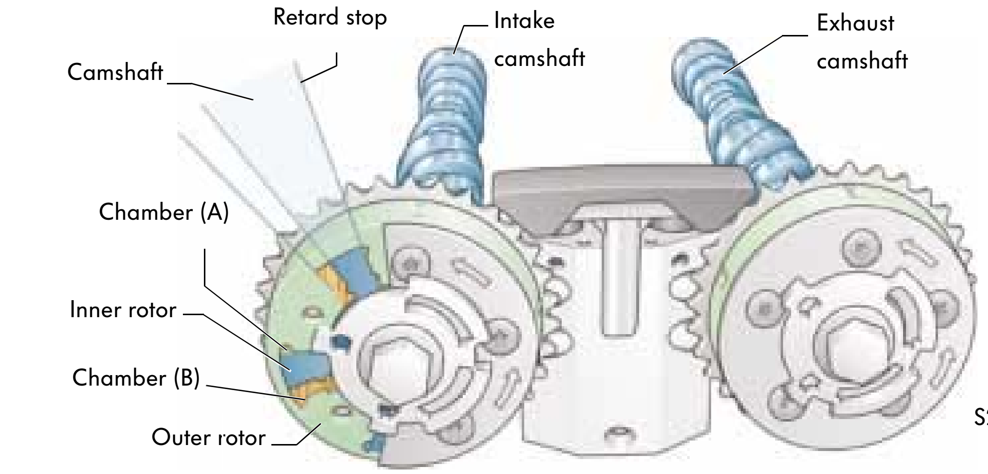


S248_139

Retard adjustment

The solenoid valve guides the oil into the oil duct (b). The oil flows from channel (b) through the annular groove and camshaft and via the bores (bb) to the chambers (B) of the camshaft adjuster. When the oil enters the chambers (B), the inner rotor is rotated against the direction of rotation of the drive, thus adjusting the camshaft in the retard direction. The oil is forced out of the chambers (A) through the bores (aa). It flows back into the cylinder head via the camshaft and duct (a).

Bank I

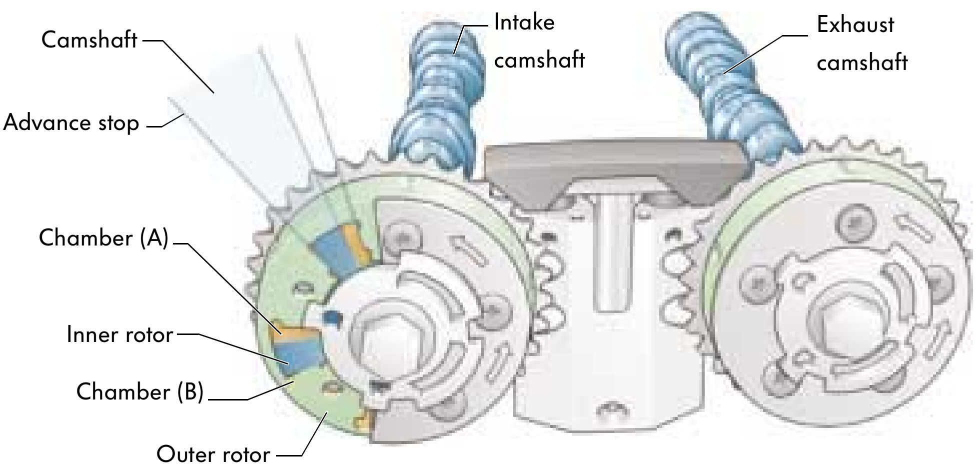


S248_138

Advance adjustment

To rotate the inner rotor forwards, the adjusting piston housed within the solenoid valve adjusts itself so that the oil duct (a) is put under oil pressure. As a result, the oil flows in the chamber (A), thus advancing the inner rotor. Chamber B is simultaneously bled via the solenoid valve so as to ensure a quick response.

Bank I



S248_137

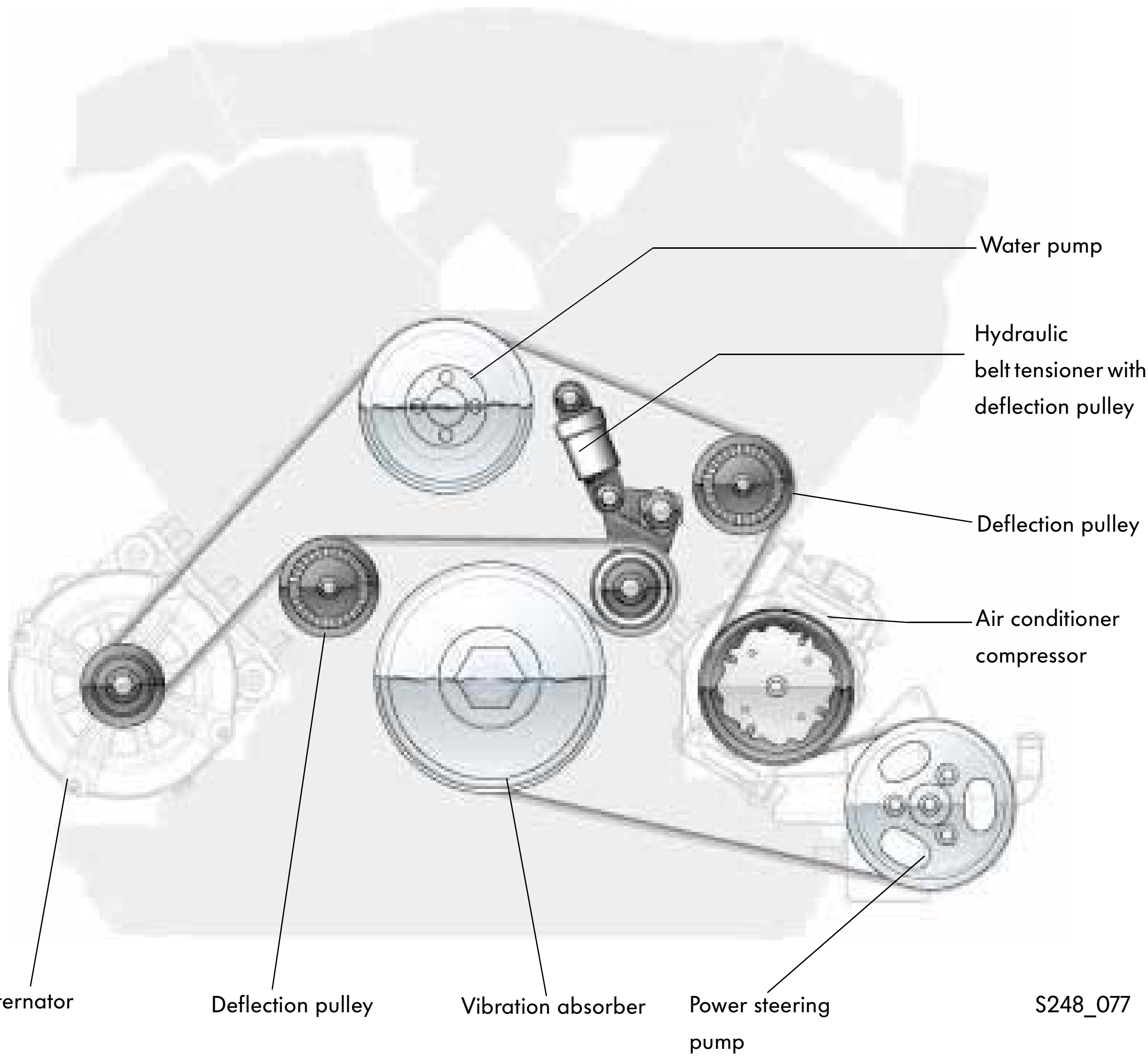
The belt drive

The following units and devices are driven by the belt drive:

- the coolant pump
- the alternator
- the power steering pump
- the air conditioner compressor

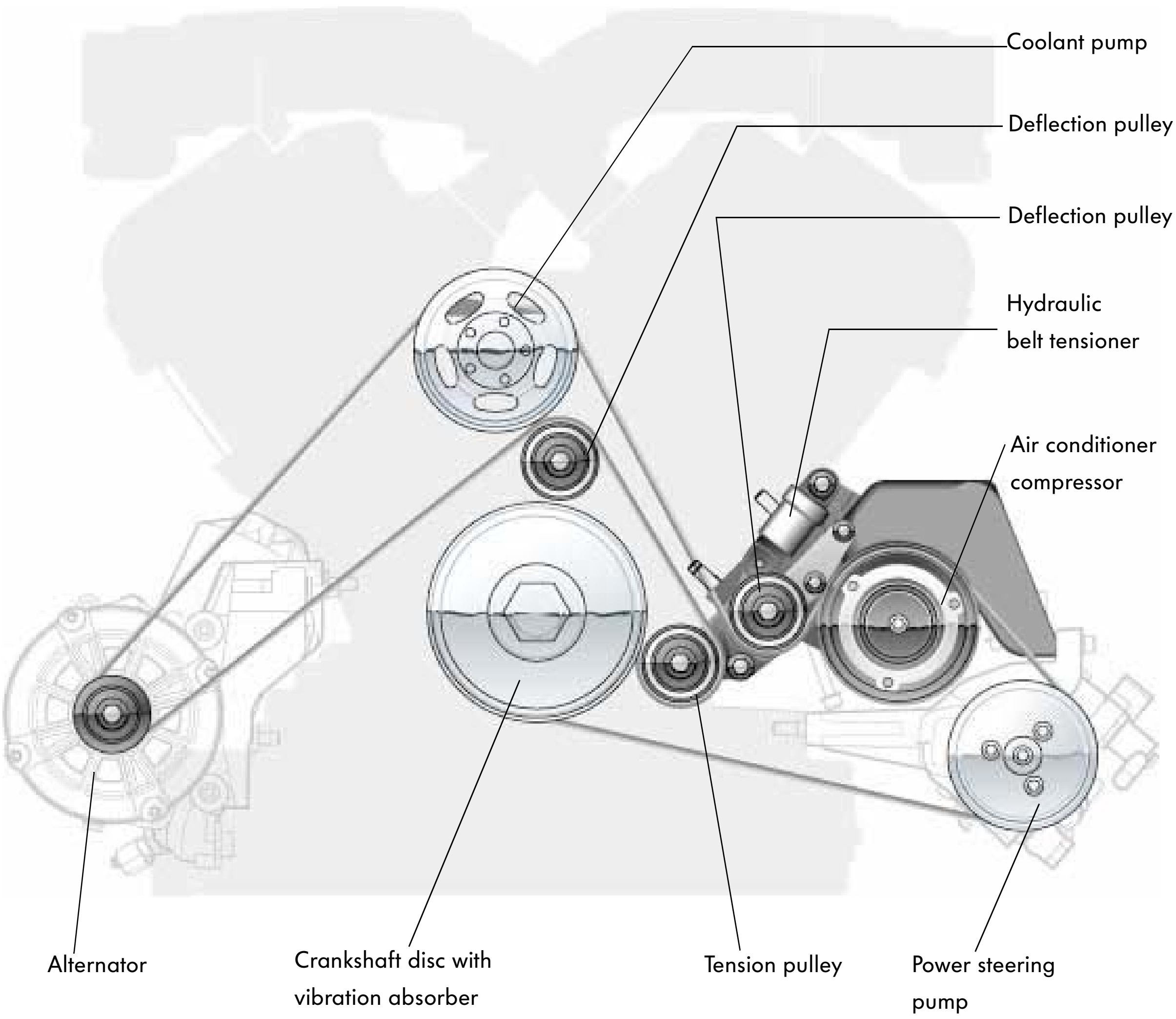
The poly-V-ribbed belt is tensioned by a hydraulic tensioning and deflection pulley. 2 deflection pulleys ensure that all units to be driven can be reached.

Belt drive of the W8 engine and W12 engine in the VW "D1"



In the W12 engine, the hydraulic belt tensioner and deflection pulley are fixed to the air conditioner compressor bracket.

Belt drive of the W12 engine in the Audi A8



S248_078

The oil circuit

The oil is drawn out of the oil pan by the oil pump and flows to the central oil passage via the external
oil filter/cooler module.

The main crankshaft bearings are supplied with pressurised oil via the central oil passage; the central oil duct is supplied with pressurised oil via a riser.

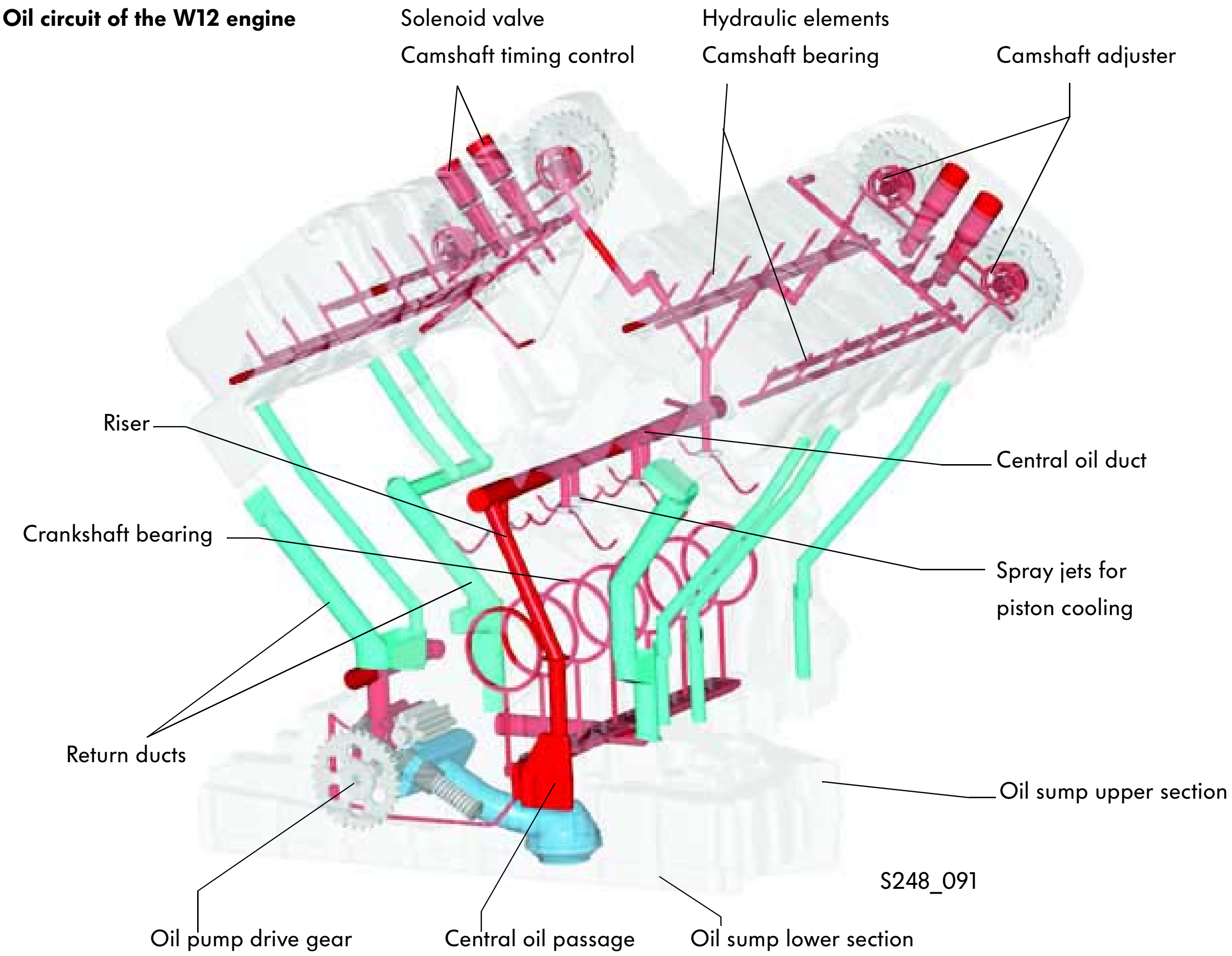
The oil from flows from the central oil duct to the spray jets for piston cooling, and then from there to the cylinder heads via risers fitted with non-return restrictors.

The oil also flows to the intermediate shaft, to the entire engine timing gear and to the chain tensioner.

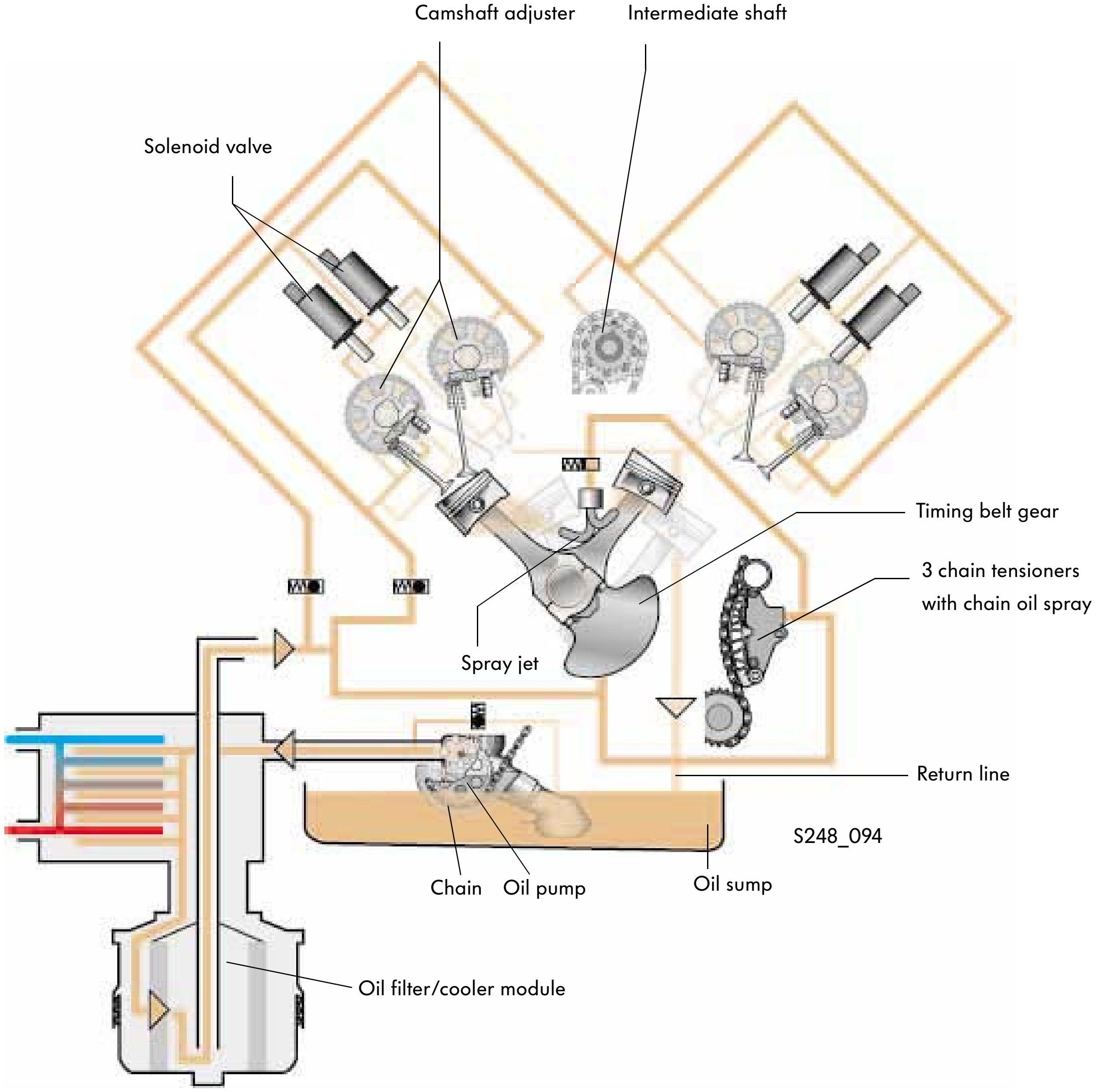
In the cylinder heads, the oil flows along ducts to the camshaft adjusters and the camshaft bearings.

The return lines guide the oil back into the oil sump.

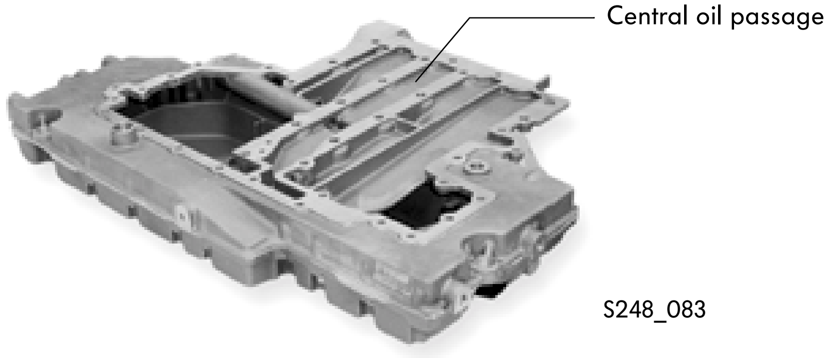
Oil circuit of the W12 engine



Schematic diagram of the oil circuit of the W engines



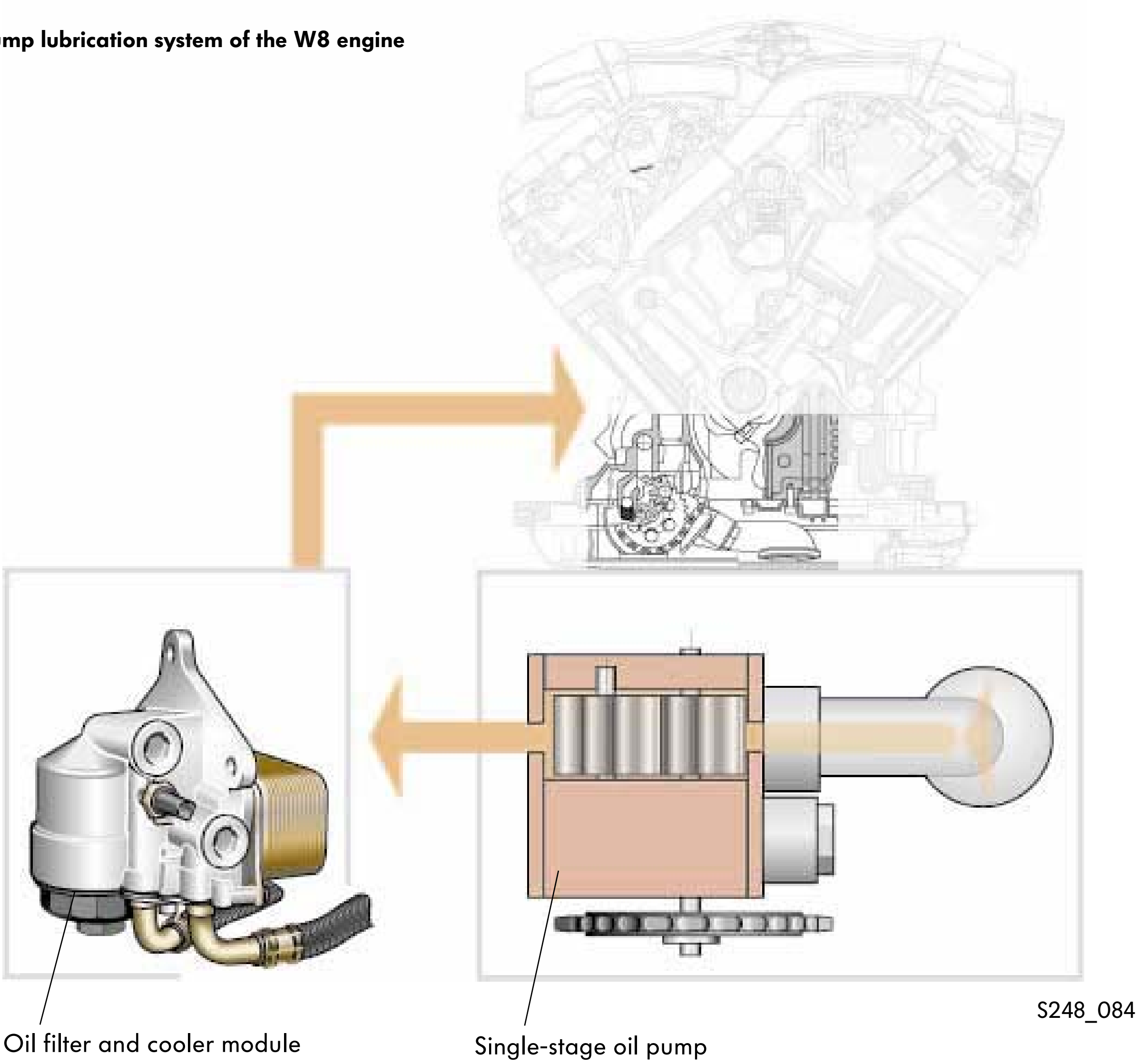
Oil sump of the W8 engine



The oil circuit based on the wet-sump principle

The W8 and W12 engine for VW models have a wet-sump lubrication system. The W12 engine for Audi models has a dry-sump lubrication system.

Wet-sump lubrication system of the W8 engine

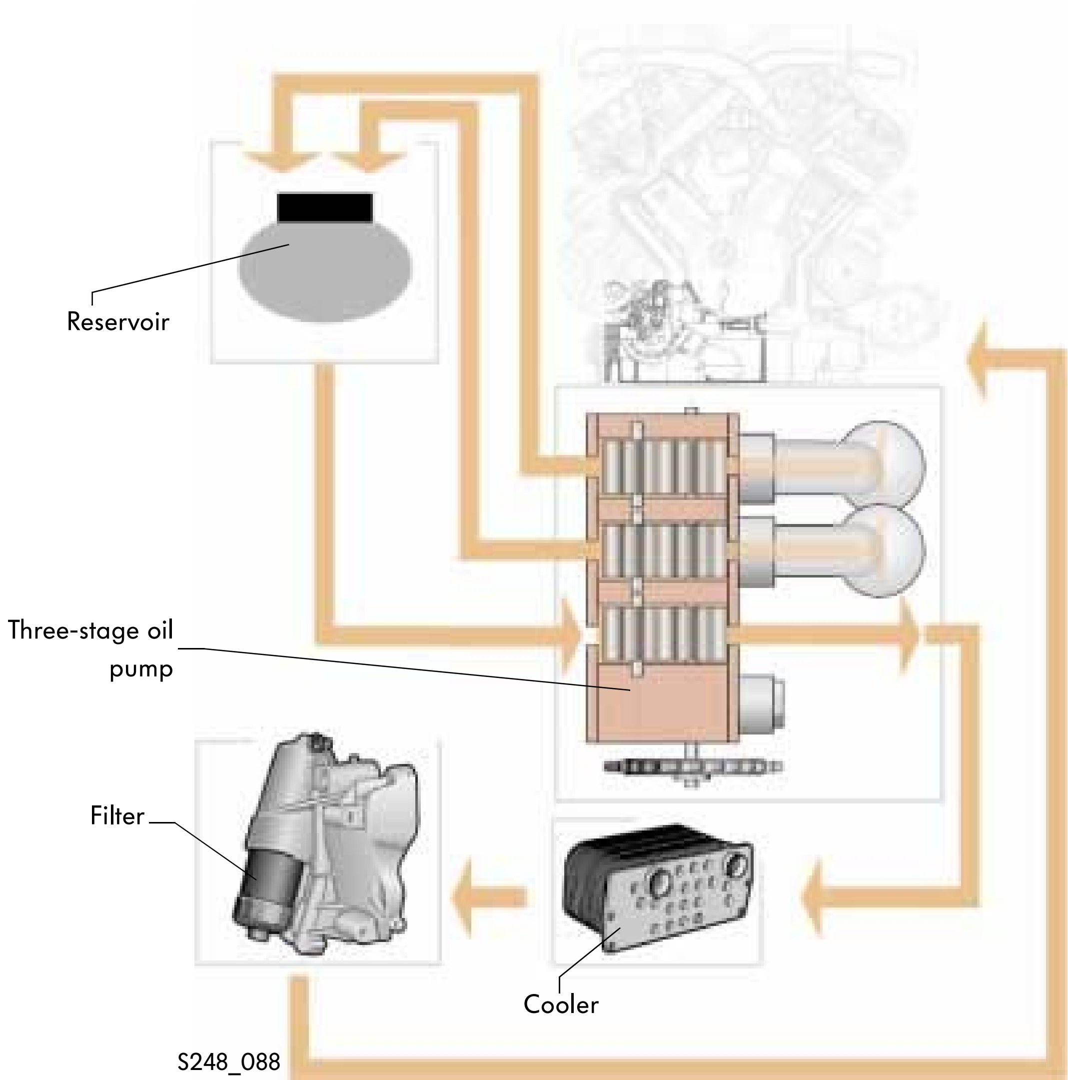


In the case of the wet-sump lubrication system, the entire oil supply is retained in the oil sump. The single-stage oil pump draws the oil out of the wet sump via the intake line and immediately returns it to the engine after it has cooled down and has been filtered.

In contrast to the dry-sump, the job of the oil sump with wet sump is to retain the entire oil supply. As a result, it has a larger volume which affects the overall height of the engine.

The oil circuit based on the dry-sump principle

Dry-sump lubrication system of the W12 engine in the Audi A8



S248_088

In the case of the dry-sump lubrication system, the entire oil supply is retained in an additional, external reservoir, and not in the oil sump.

To facilitate this, the oil pump is of three-stage design. Two stages draw the oil out of the oil sump at various points and pump it into the reservoir.

The third stage (discharge stage) returns the oil from the reservoir to the engine via the oil cooler and the oil filter. The oil sump can be kept small and flat due to its lower oil volume, with the result that the engine has a smaller overall height.

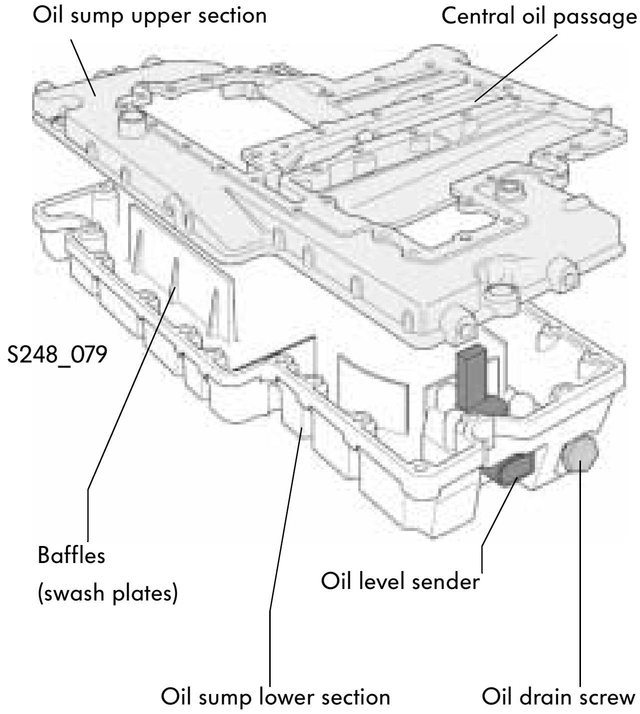
This requires a slightly more complex design.

The oil sump

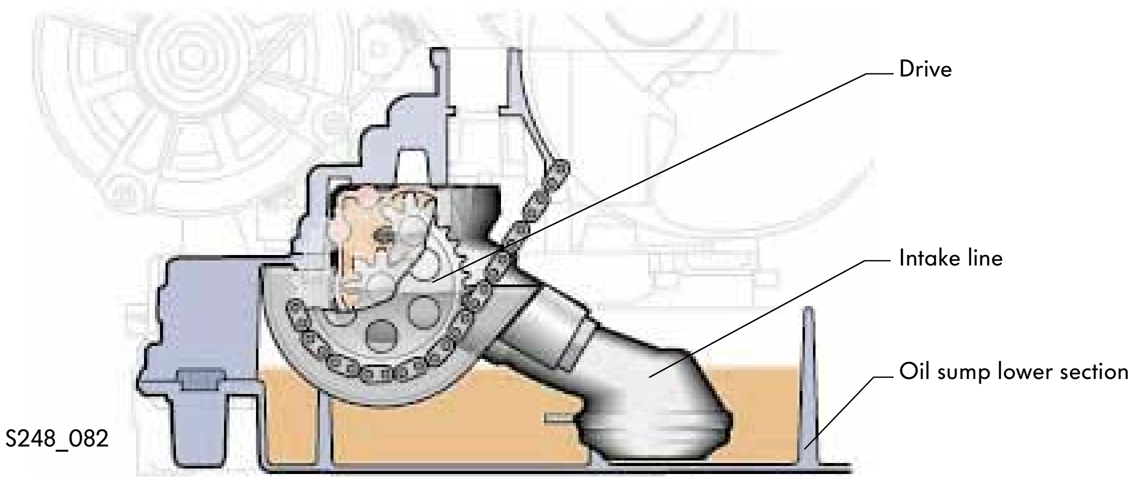
The oil sump comprises two diecast aluminium parts. The oil sump lower section forms the oil sump. The central oil passage is accommodated in the upper section of the oil sump.

Special baffles settle the oil in the oil sump.

The sender which informs the engine control unit of the oil level is inserted into the oil sump lower section from below near the oil drain screw, and then bolted.

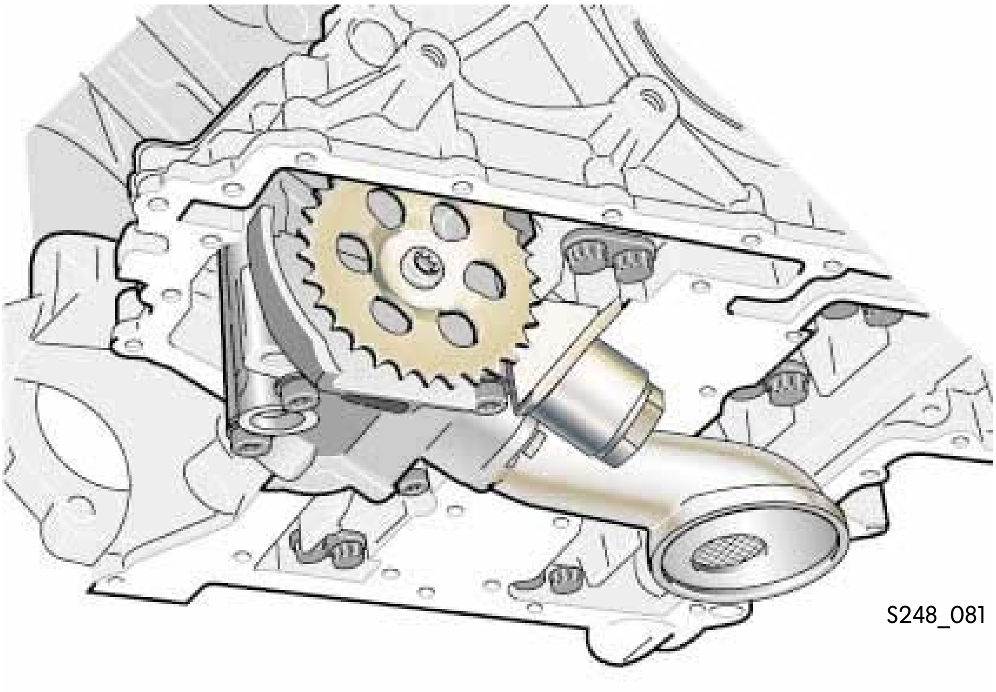


The oil pump



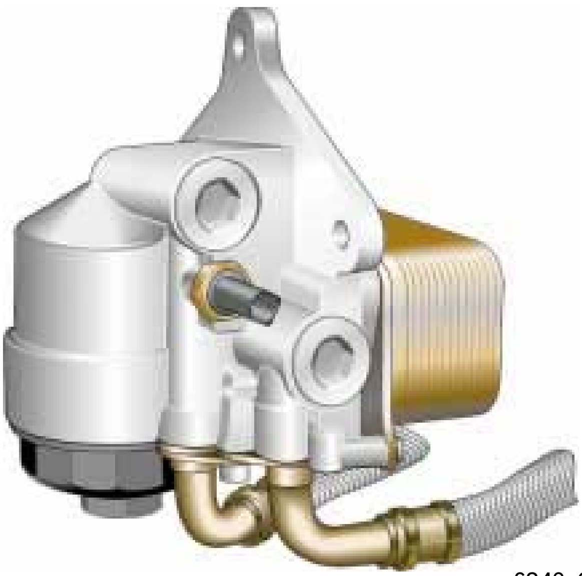
The oil is extracted from the sump by the oil pump via the intake line, and pumped into the oil circuit.

The single-stage oil pump is driven by the crankshaft by means of a separate chain in the crankcase.


S248_081

The oil pump is mounted from below and bolted to the bearing support.

The oil filter and cooler module


Oil filter/cooler module of the W8

S248_095

The oil circuit of the W engine has an external oil filter and cooler module. This allows the engine to be more easily adaptable to the varying amounts of space available in the various vehicle models. The oil filter is designed so that a filter element can be replaced by service personnel.

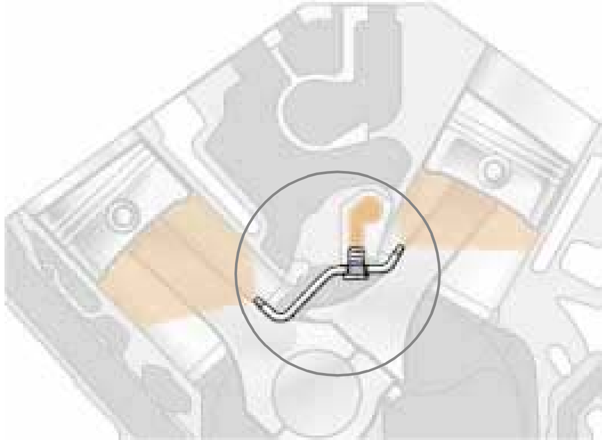
Engine mechanicals

The lubrication system

The oil in the oil circuit has a lubricating and cooling function. The W engines are filled with type 0W30 3.5 engine oil.

The piston spray jets

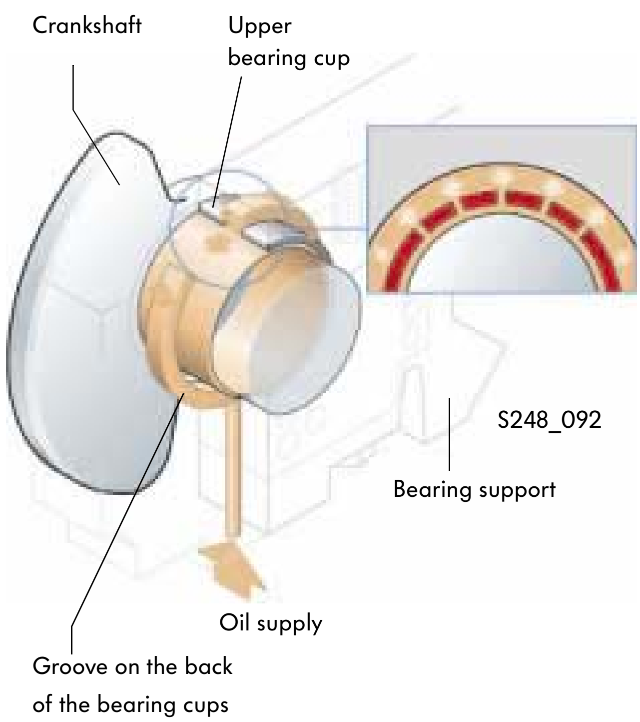
The oil is guided from the central oil duct of the crankcase upper section to small nozzles on the underside of the cylinder bores. Here, the oil is sprayed below the pistons in order to lubricate the piston contact faces and piston pins as well as to cool the pistons.



S248_093

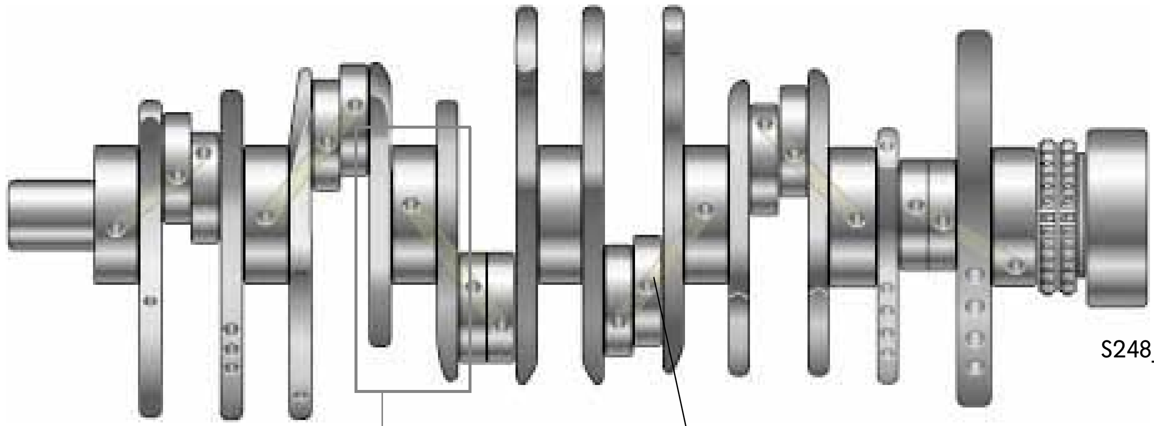
The crankshaft bearing lubrication system

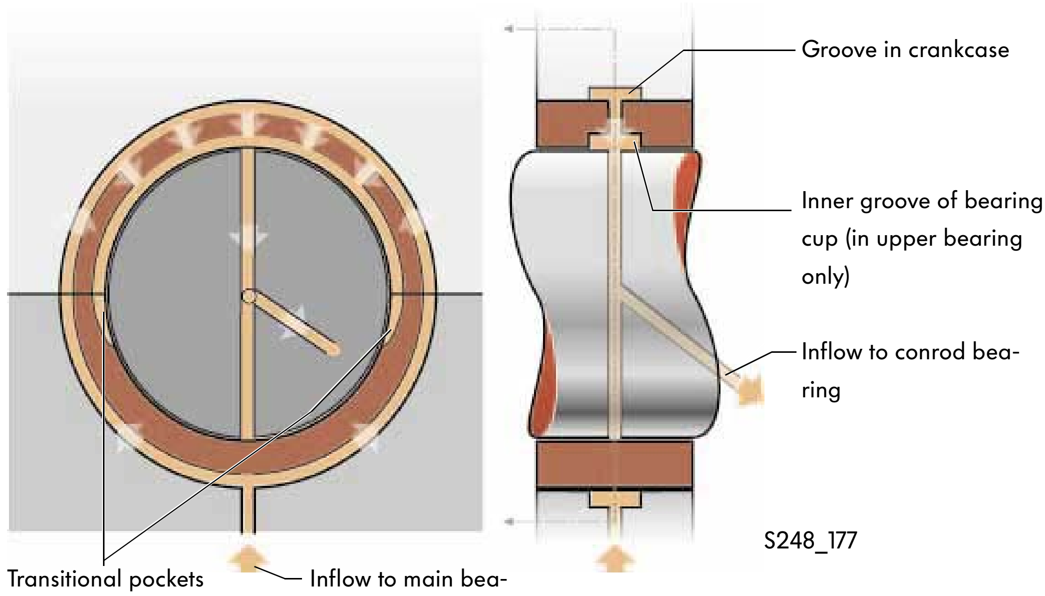
The oil is ducted through bore holes from the central oil passage to the crankshaft. Then it is pumped via a groove on the back of the bearing cups to the upper bearing cup. There it reaches the crankshaft through five bores in the upper bearing cup.



S248_092

Lubrication of the conrod bearings





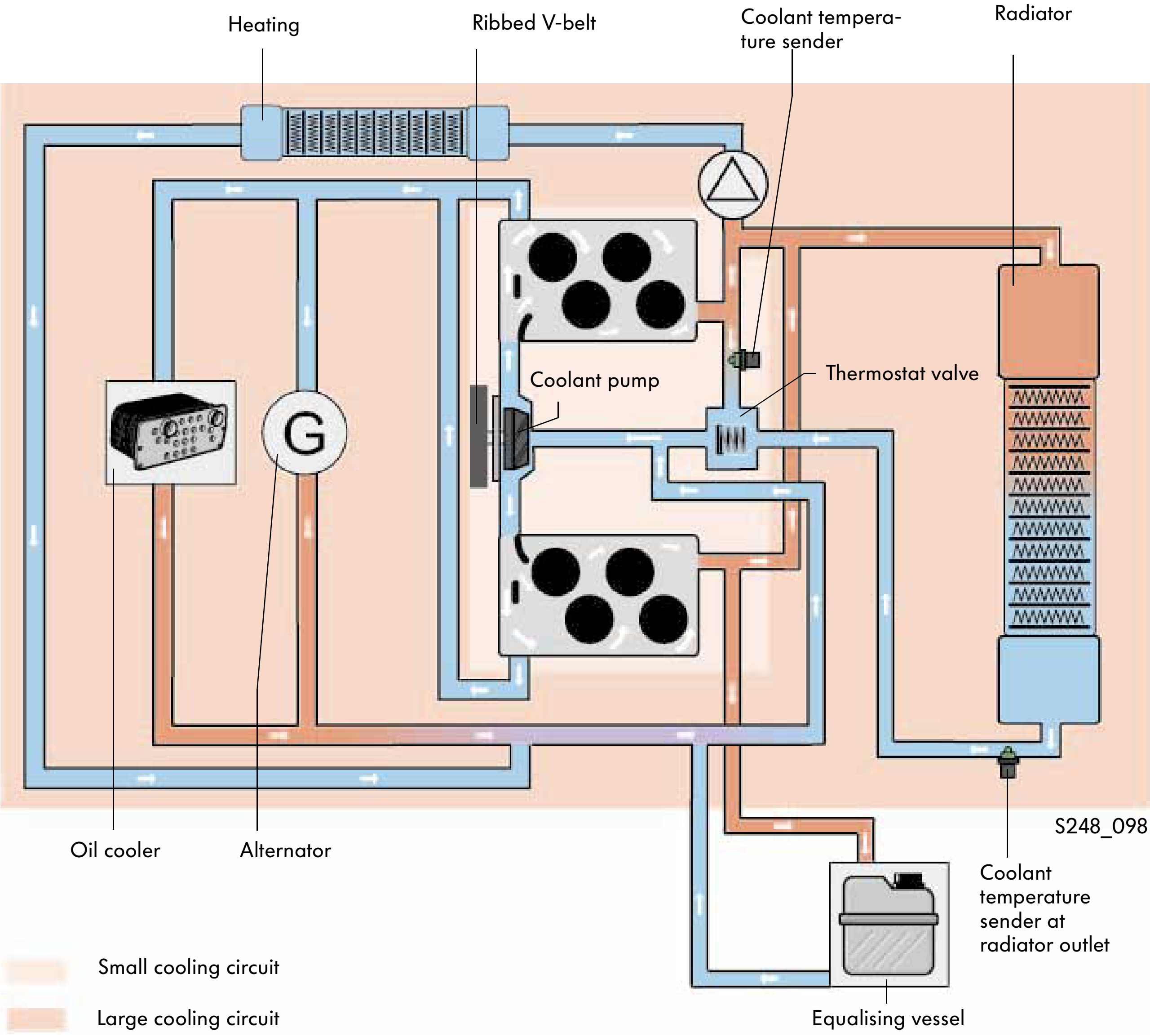
The oil flows from the outer circumferential groove into the inner groove of the upper bearing cup through five bores. The bore ensures that an even oil film forms.
Integrated pockets at the transition to the lower bearing cup ensure a steady supply of oil to the conrod bearings via bores in the crankshaft.

The coolant circuit

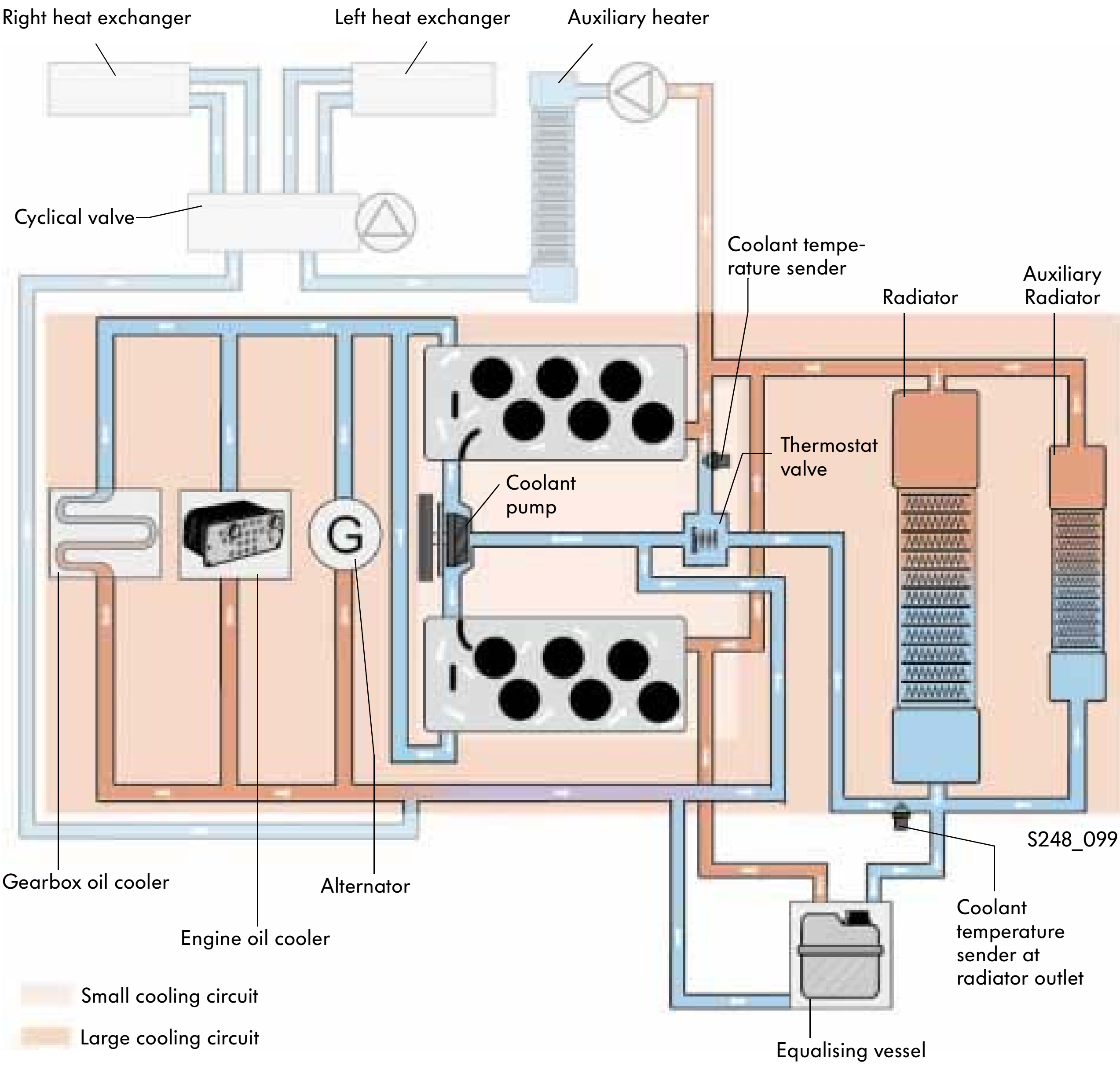
The coolant circuit is filled with VW G12 coolant. The coolant is channelled out of the central coolant duct in the crankcase upper section and into the cylinder heads. Baffles ensure that all cylinders are swept evenly. At the same time, the coolant flow is redirected from the exhaust side of the combustion chambers towards the intake side.

The coolant circuit is subdivided into a small circuit, in which the coolant is only ducted within the engine block. An outer circuit is located above the radiator.

Coolant circuit of W8 engine



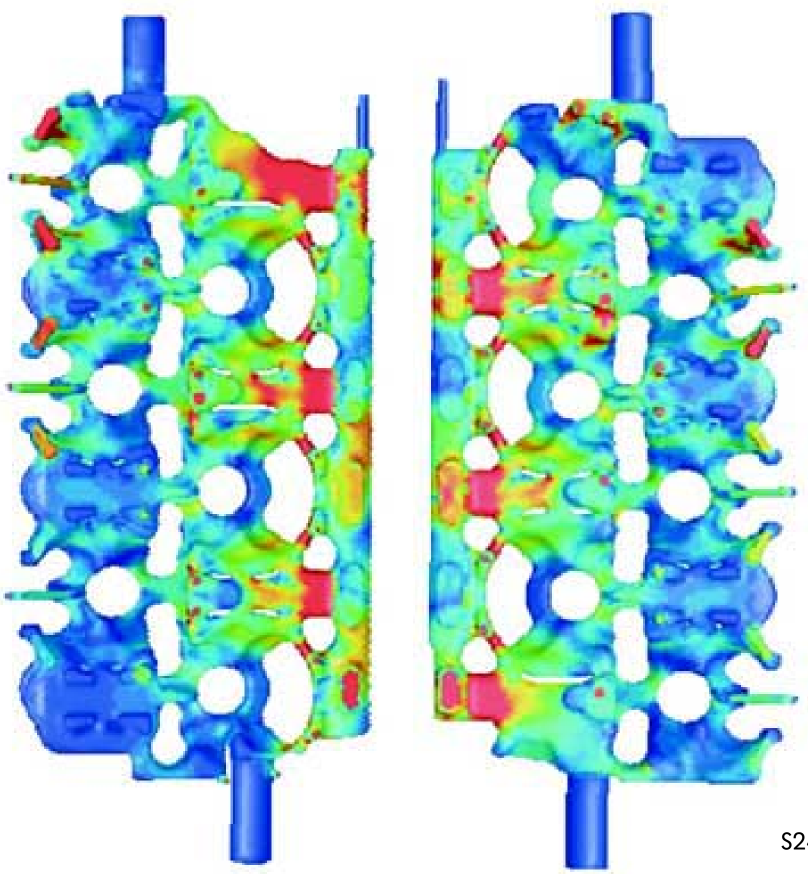
Coolant circuit of W12 engine



The coolant flow flows from the coolant duct to the crankcase and into the two cylinder heads. In the process, two thirds of the volumetric flow is guided to the outside and one third to the inside of the cylinder head in question. This principle helps to provide even cooling, and is known as cross-cooling.

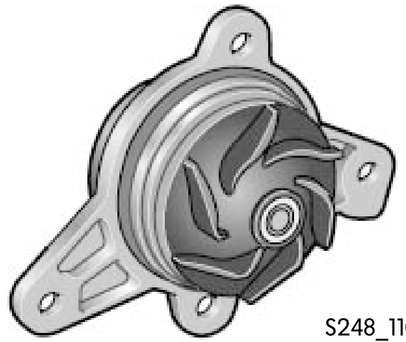
S248_114

Coolant flows into the cylinder heads



S248_115

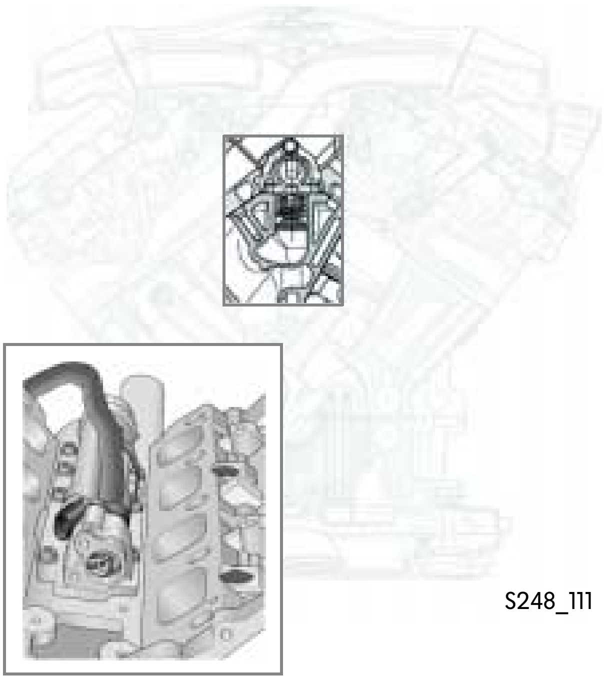
Coolant flows through the cylinder heads from the exhaust side to the intake side. This results in very good temperature equalisation as well as effective cooling of the outlet webs and spark plugs.



S248_110

Coolant pump with pump gear

In both W engines, the coolant pump is located in the cylinder block at the face end. It is mounted directly upstream of the central coolant duct and is driven by the ribbed V-belt.

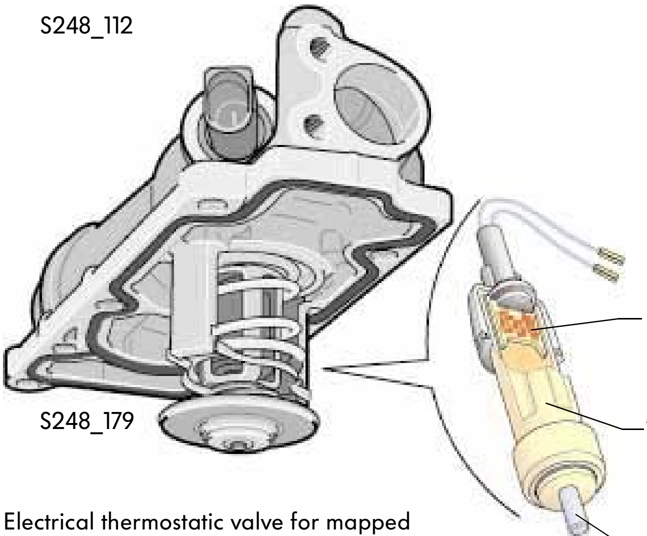


S248_111

S248_112

Switching over is affected by an electrically actuated thermostat valve. In the W8 and W12 engine, this valve is installed in the crankcase upper section from above. To replace this valve, it is necessary to remove the intake manifold.

By electrically activating the thermostat valve, it is possible to control the switching point and coolant temperature. Characteristic maps are stored in the engine control unit. They make it possible for the engine to reach the desired temperature in accordance with the engine's operating requirements.



S248_179

Electrical thermostatic valve for mapped cooling

For detailed information, please refer to SSP 222.

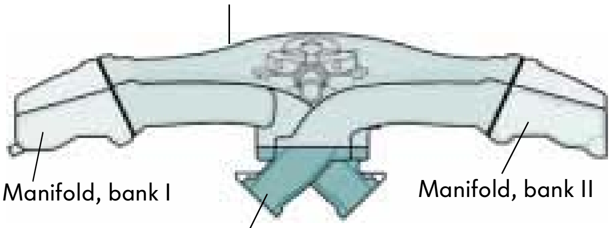
The air supply

Air is supplied through a tapered intake pipe. It is of a four-part design and is made of an aluminium alloy.

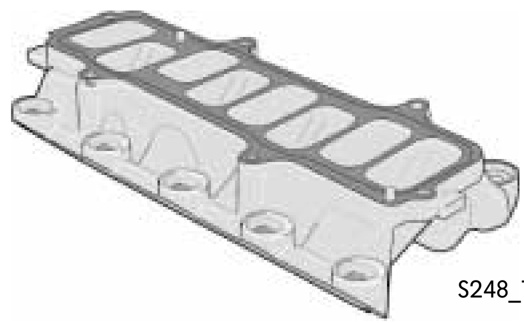
The intake manifold lower section is bolted to the cylinder heads between the two cylinder banks. The larger intake manifold upper section is mounted to the lower section. The intake manifold upper section is designed so that the manifolds for bank I and II can be detached separately. The makes it easier to gain access to the individual ignition coils and spark plugs, for example.

In the W8 engine, the intake air for both manifolds is guided by a throttle valve control unit.

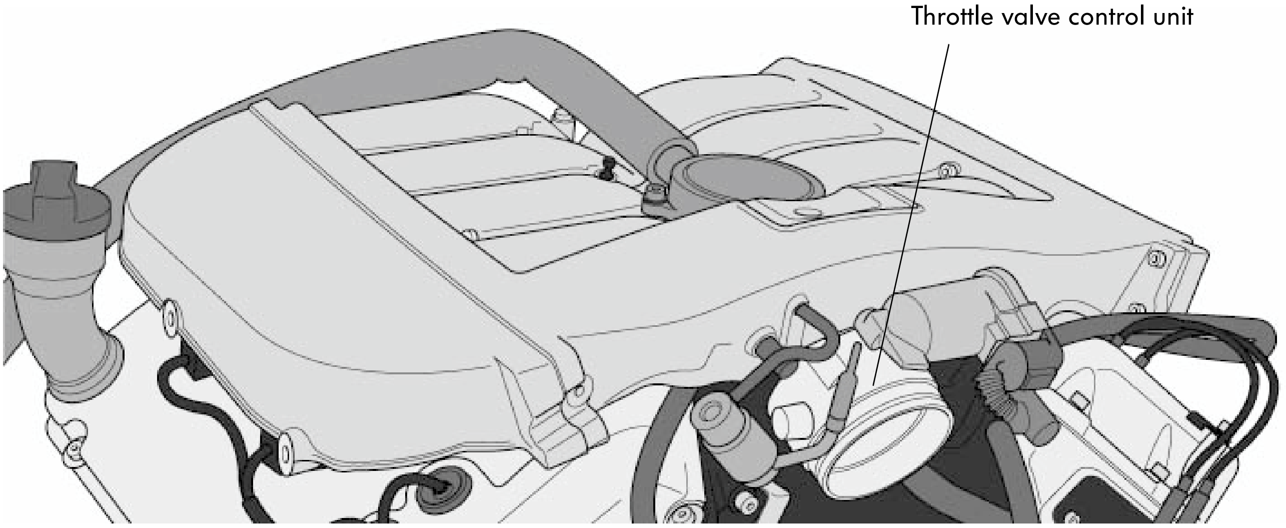
W8 engine



S248_116



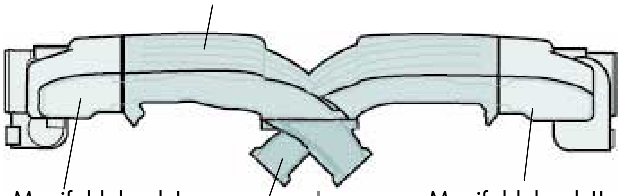
S248_117



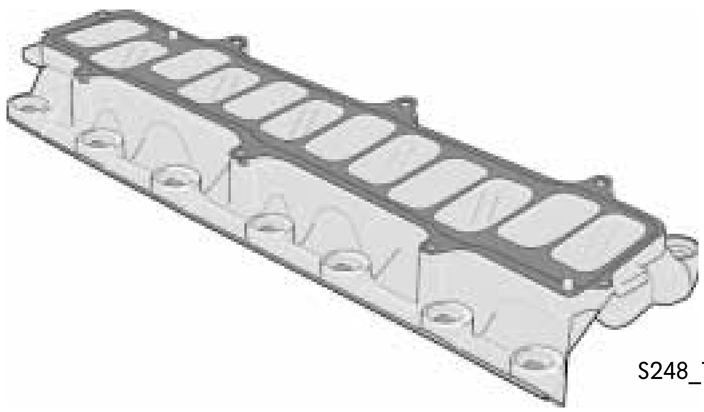
S248_118

W12 engine

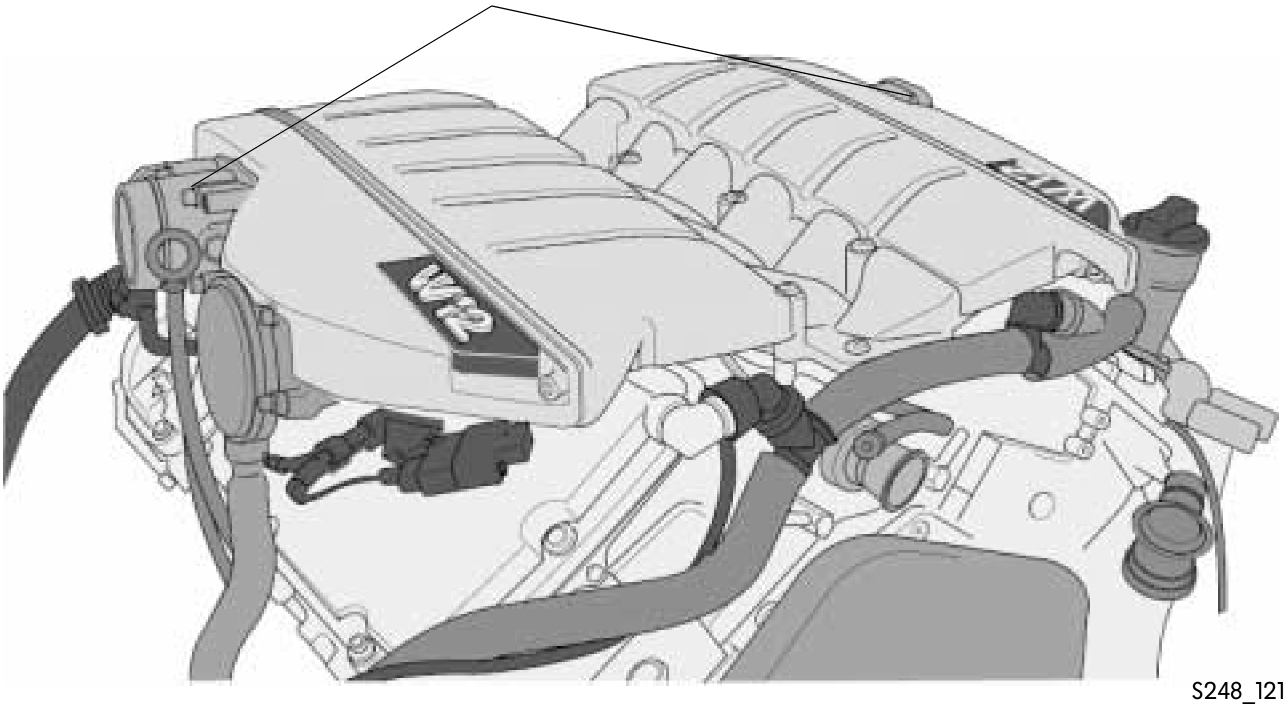
The intake manifold used in the W 12 engine is made of magnesium alloy. Unlike the W8 engine, each of the manifolds is coupled to a throttle valve control unit.



S248_119



S248_120

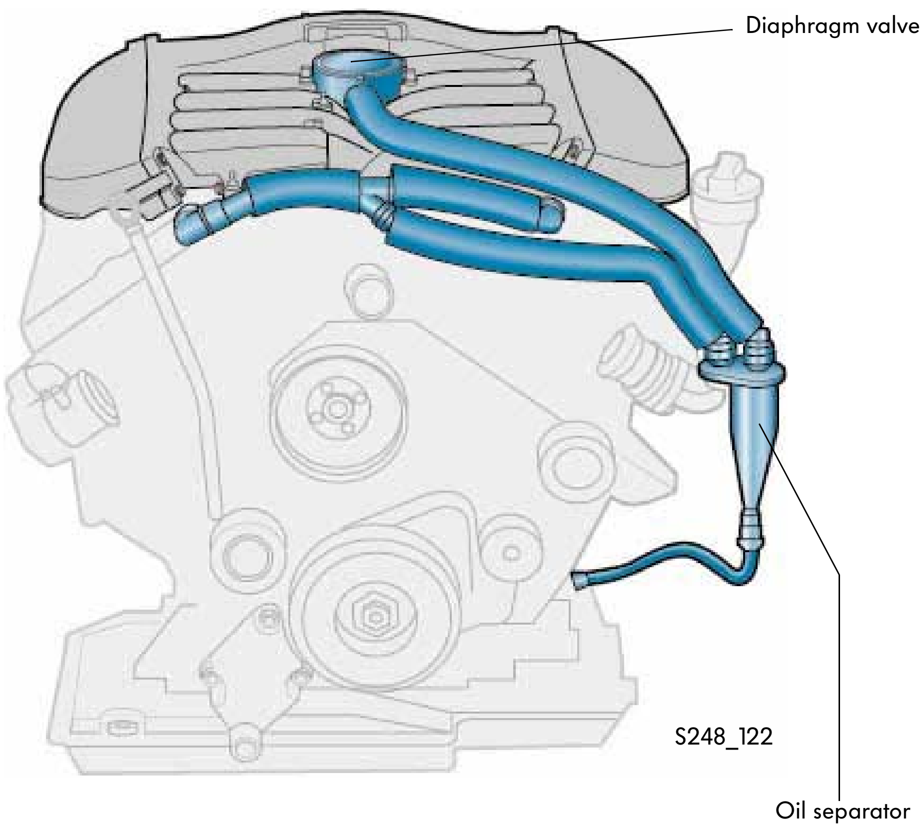


S248_121

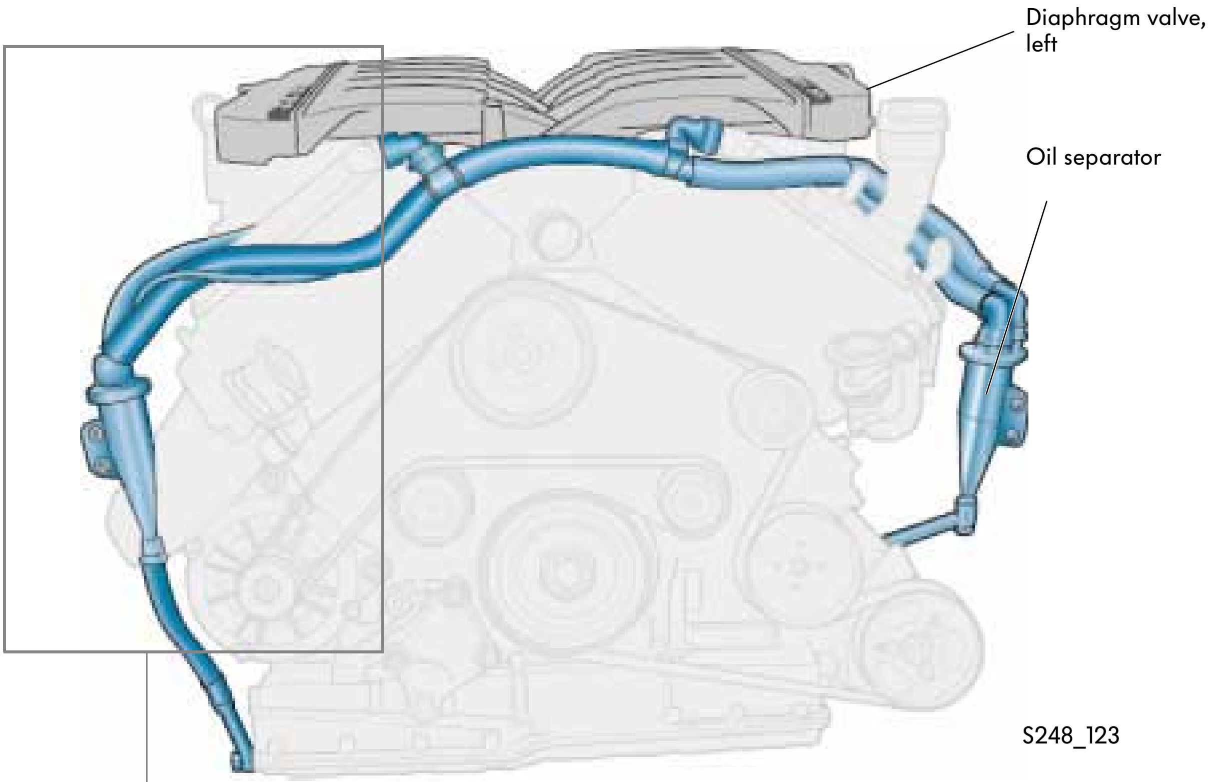
The crankcase breather

The diaphragm valve limits the vacuum in the crankcase irrespective of the intake pipe vacuum, allowing the cleaned crankcase exhaust gases (blow-by) to be abducted continuously into the intake manifold and burnt in the engine. No oil is entrained in the process. The oil separator segregates the oil particles from the blow-by gas. The separated oil is then returned to the oil sump.

W8 engine



W12 engine



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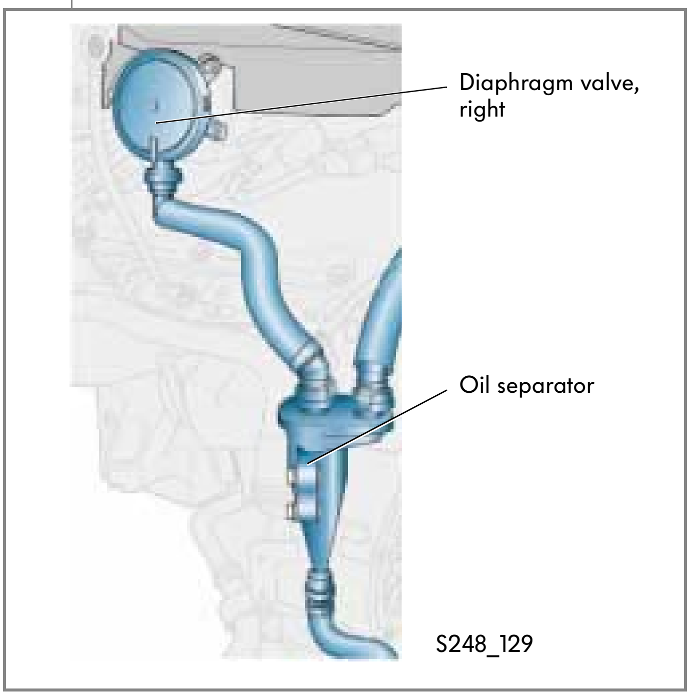


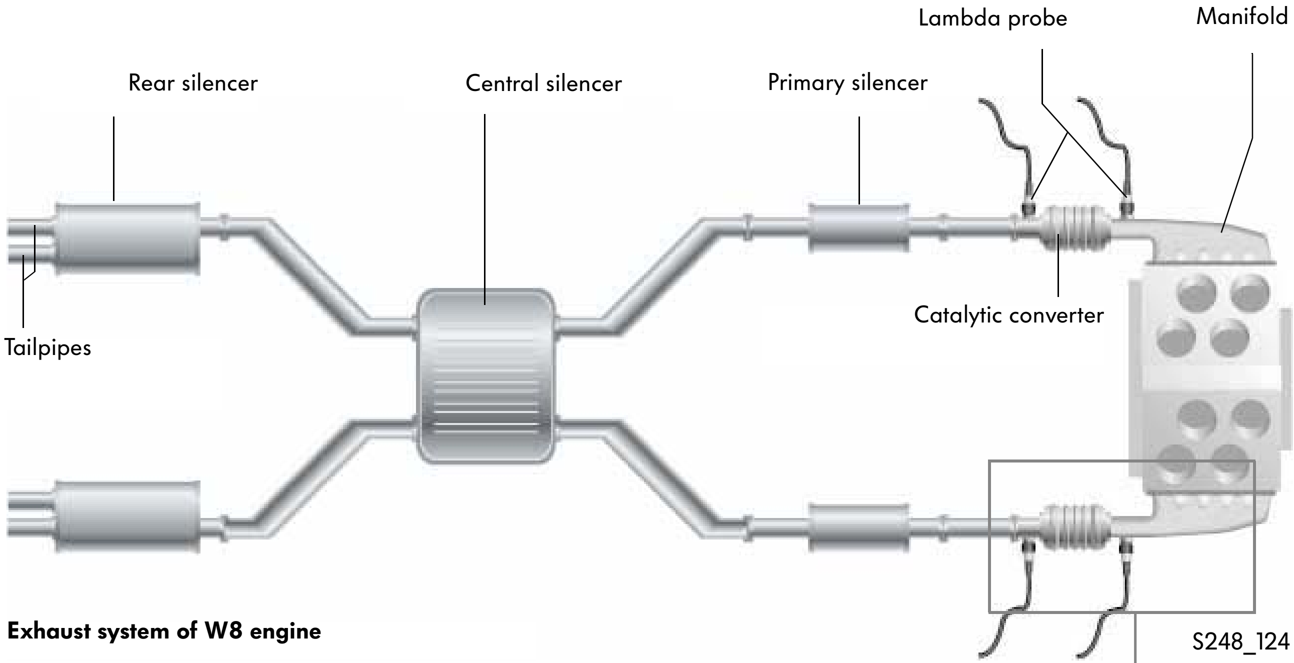
S248_129

As the W12 engine has a double flow intake manifold, each bank has a side diaphragm valve and an oil separator.

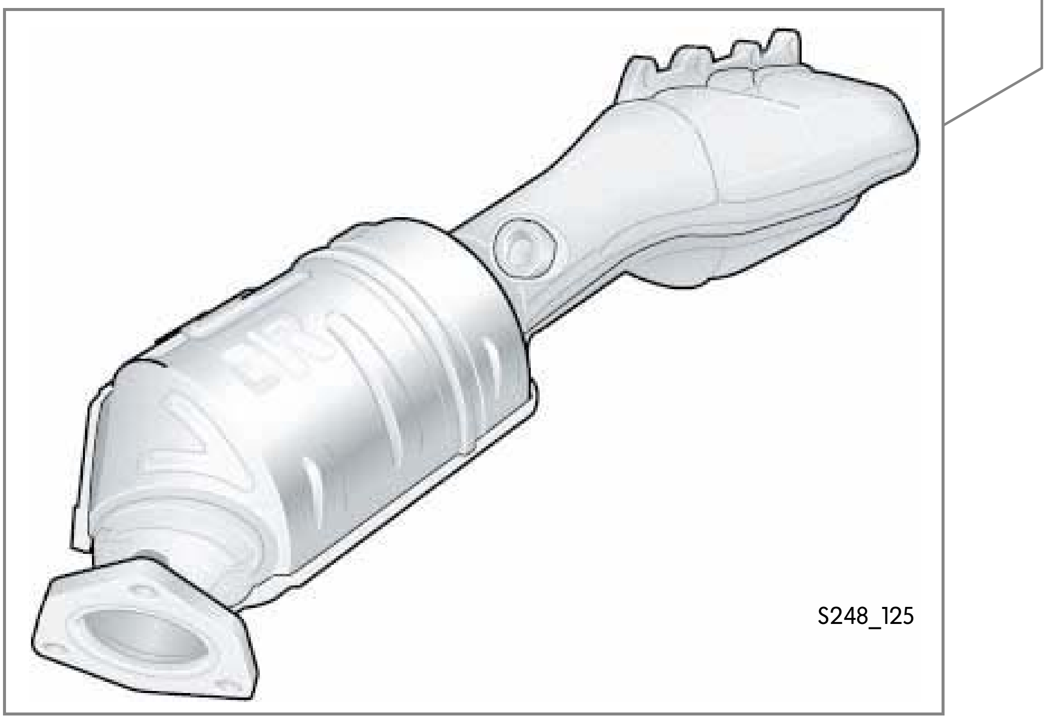
The exhaust system

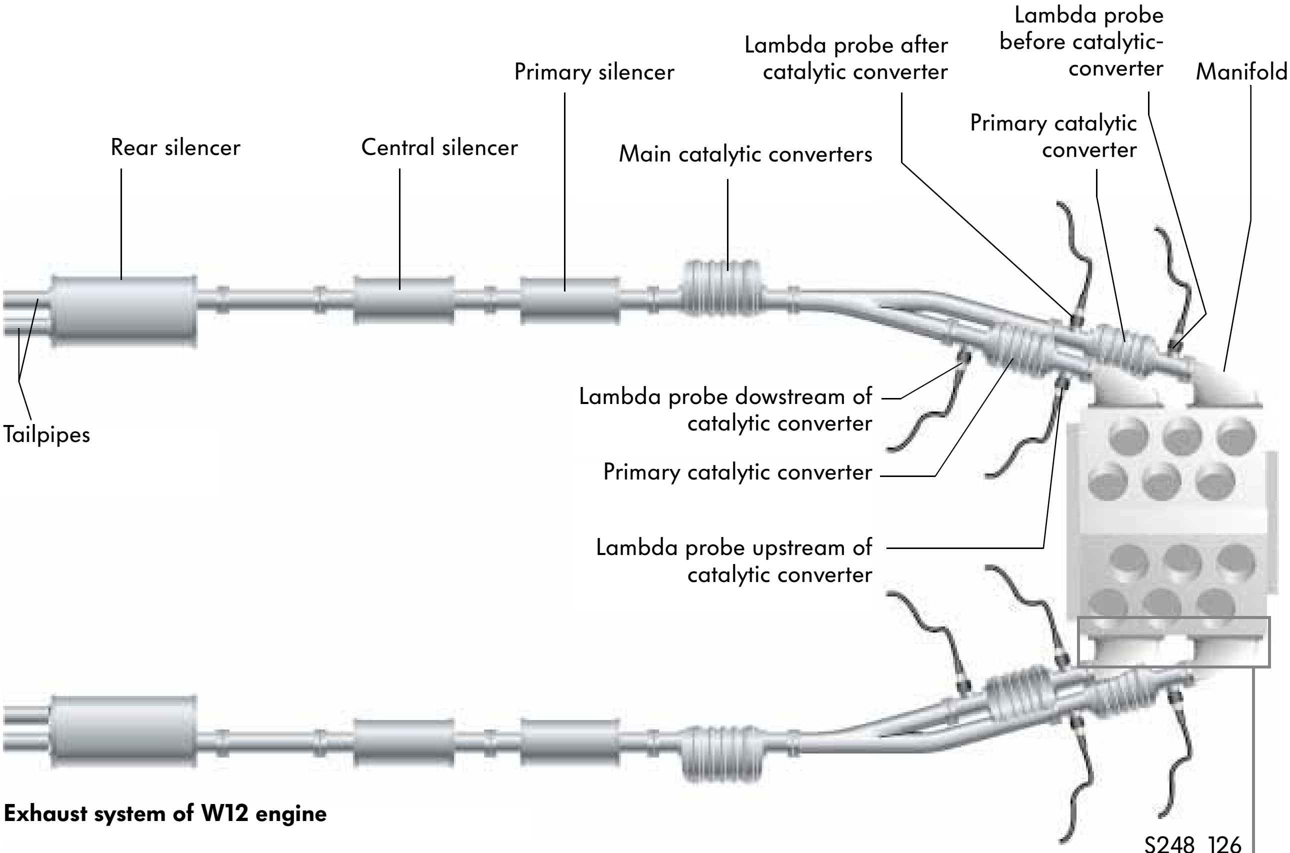
The W8 engine has an exhaust manifold with a permanently assigned catalytic converter for each cylinder head. A total of four lambda probes are therefore required for emission control.

The exhaust system has primary silencer and a rear silencer for each bank, as well as a common central silencer.

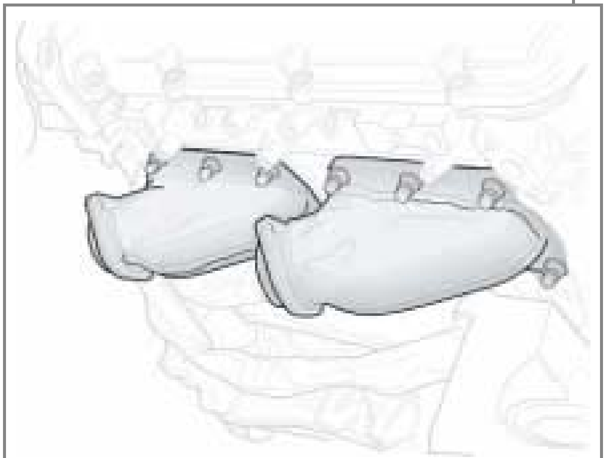


Exhaust system of W8 engine





Exhaust system of W12 engine



Exhaust manifold

The W12 engine has two exhaust manifolds for each cylinder head.
Each of these exhaust manifolds is connected to its own primary catalytic converter located near the engine. The two exhaust pipes of each bank then merge on a main catalytic converter. The exhaust system has a primary silencer, an intermediate silencer and a rear silencer for each bank.

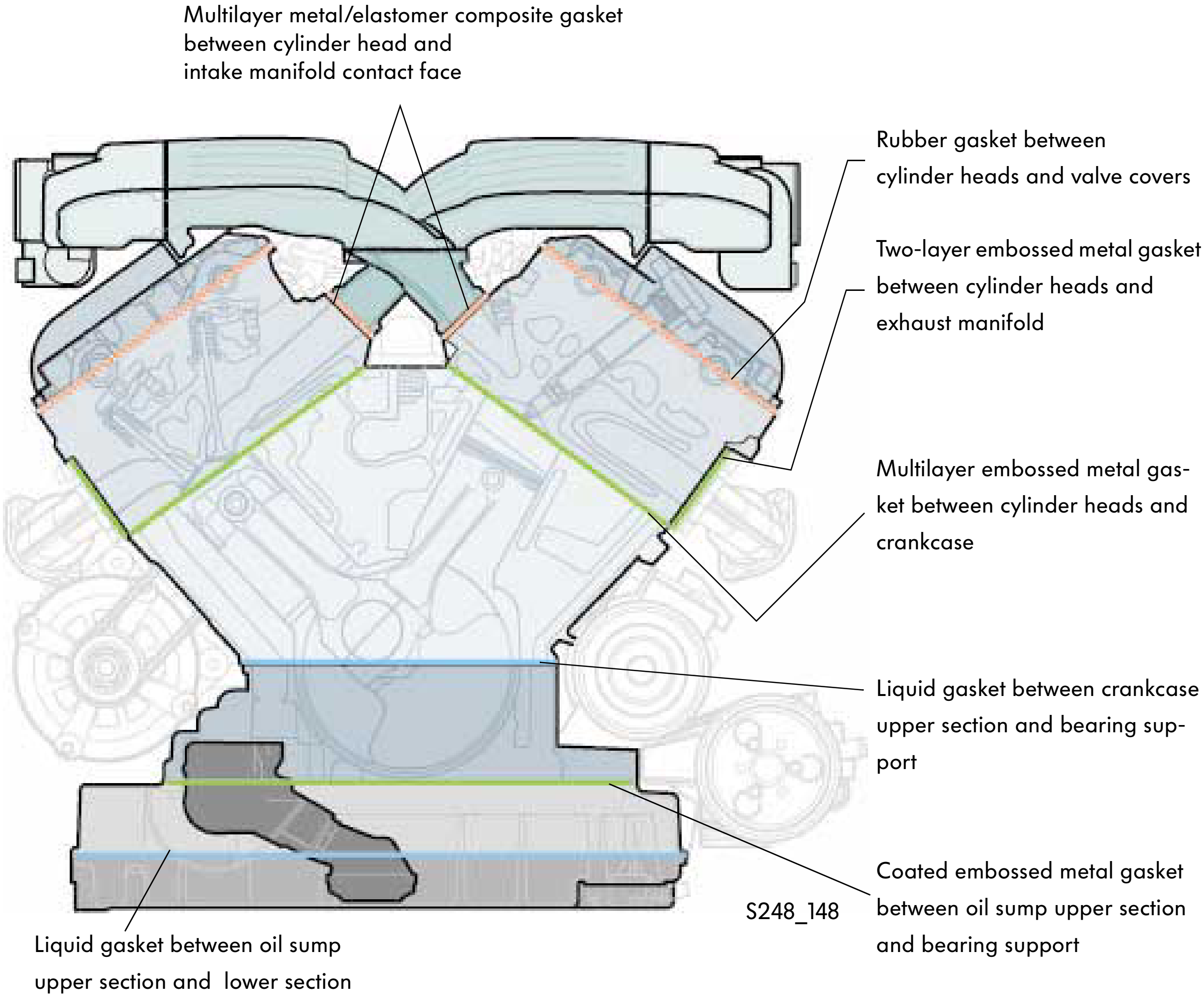
Four primary catalytic converters and two main catalytic converters help to achieve an effective reduction in emissions.
To monitor mixture combustion and to optimise pollutant emission reduction, use is made of four lambda probes before the catalytic converter and after the catalytic converter

Sealing concept

Each of the cylinder heads is sealed off from the valve covers by a rubber gasket, from the contact faces of the intake manifold by an elastomer gasket, from the exhaust manifolds by a two layer embossed metal gasket and from the crankcase by a multilayer embossed metal gasket.

The gasket between the bearing support and the oil sump upper section is also designed as a single layer embossed metal gasket.

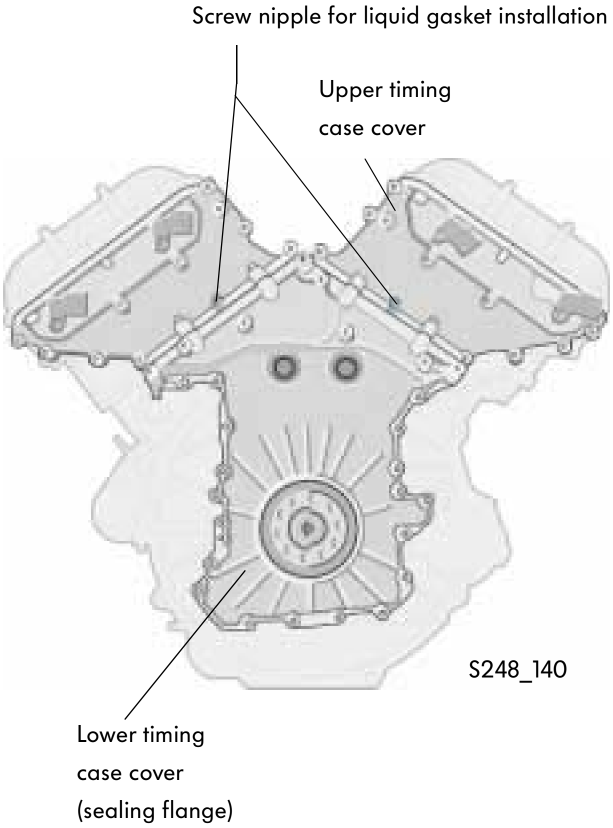
The oil pan upper section and lower section as well as the crankcase upper section and the bearing support are sealed by means of a liquid gasket.



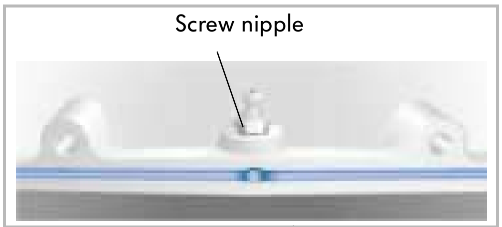
Liquid gaskets

Application of the liquid gasket sealant is CNC-controlled in order to ensure a constant sealant supply. The liquid gasket between the lower timing case cover and the upper timing case cover is applied according to a different principle. In this case, the parts are first bolted, then the sealant is injected into the groove in the upper timing case cover via screw nipples (Sealing Injection System).

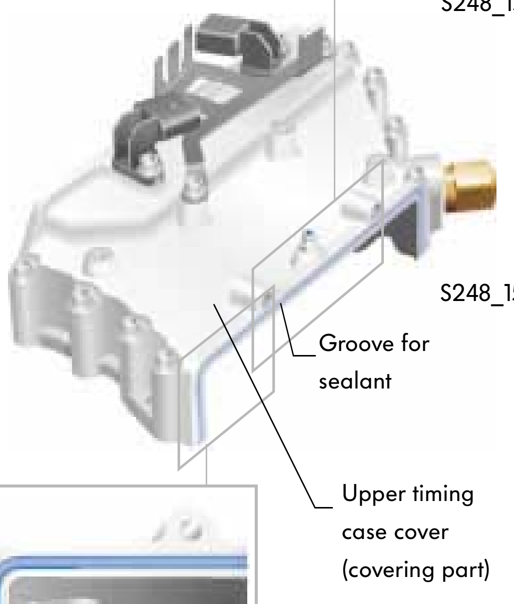
When enough liquid sealant has been injected, the excess sealant is discharged from the openings on the end of the timing case cover. The screw nipples remain in the housing after injecting the sealant. However, they have to be replaced when repairing the gasket.



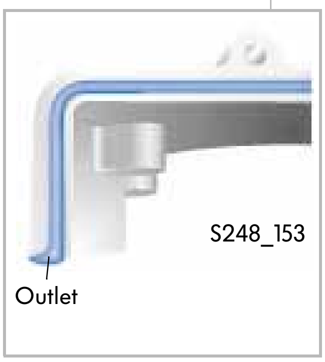
S248_140



S248_152



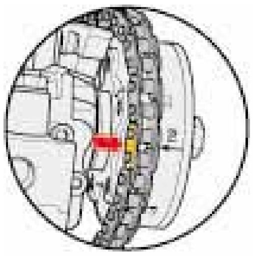
S248_151



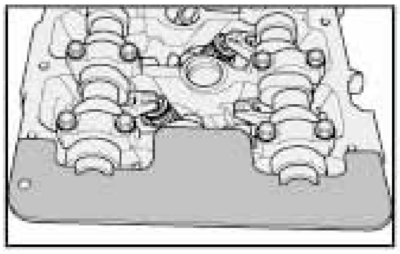
S248_153

Engine timing overview

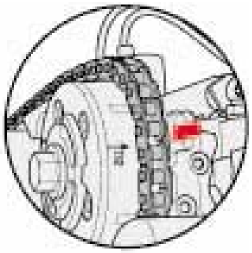
If it is necessary to disassemble the cylinder heads, the engine timing must be reset.
These are the important markers when the piston of the first cylinder is at top dead centre.



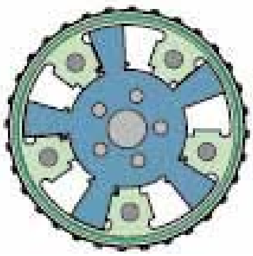
Put copper coloured chain link on arrow of bank II



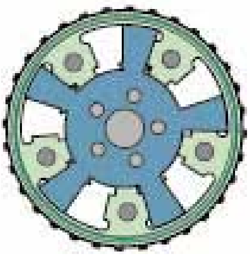
S248_192



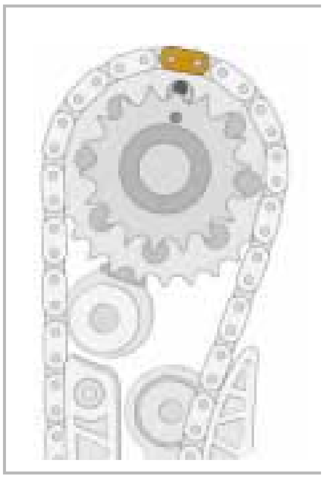
Put copper coloured chain link on arrow of bank II



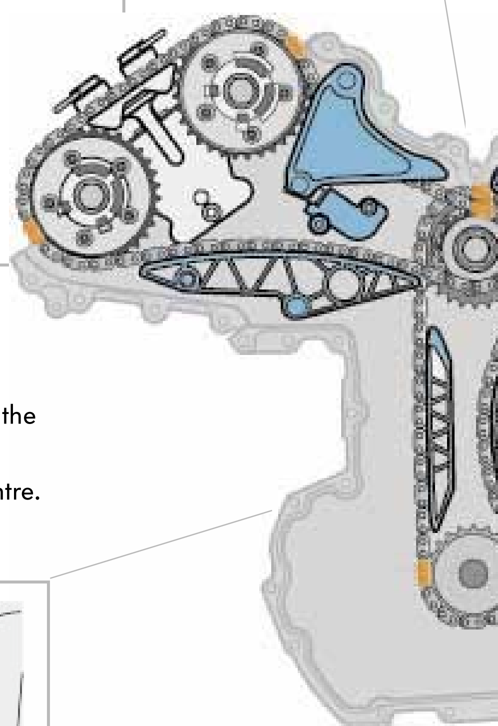
Adjust exhaust camshaft to advance



Adjust inlet camshaft to retard



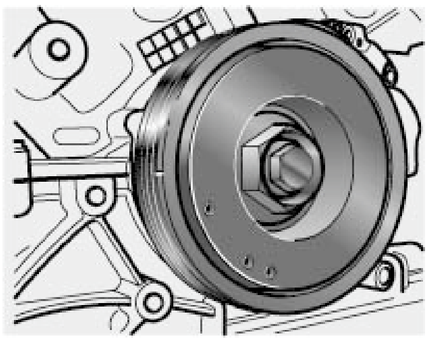
S248_144



Bank II

Position the marker on the vibration damper on the housing joint:

piston in 1st cylinder at top dead centre.



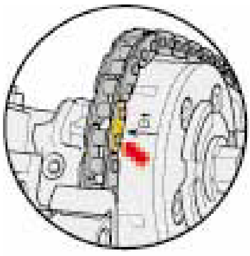
S248_191

Insert the mandrel for fixing the crankshaft into the threaded hole in the housing:
piston in 1st cylinder at top dead centre.

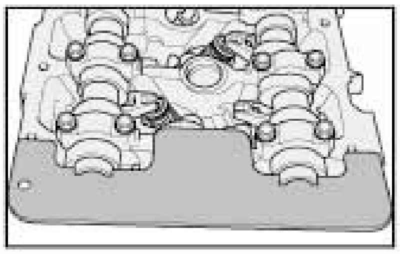
S248_190

Insert camshaft rule for aligning the camshafts.

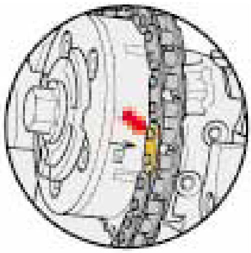
Place the copper coloured chain link on the marked tooth of the intermediate shaft and the bore hole in the housing



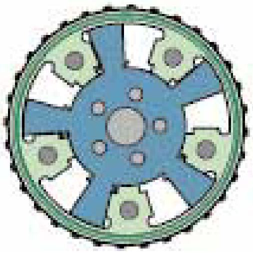
Place copper coloured chain link on arrow of bank I



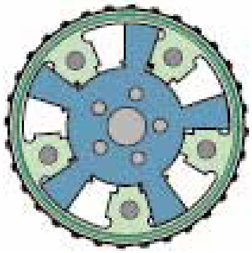
S248_193



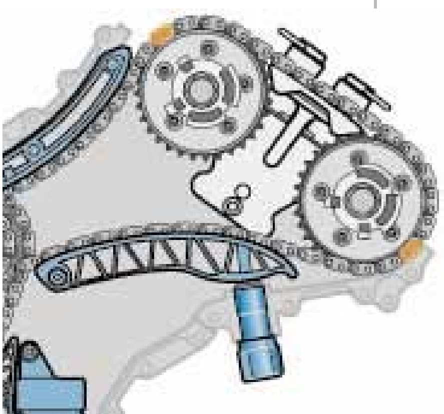
Place copper coloured chain link on arrow of bank II



Inlet camshaft advance adjustment

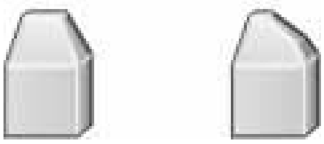


Exhaust camshaft retard adjustment



Bank I

S248_178



S248_194

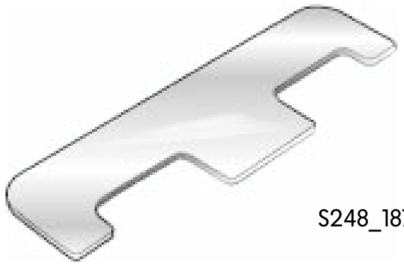
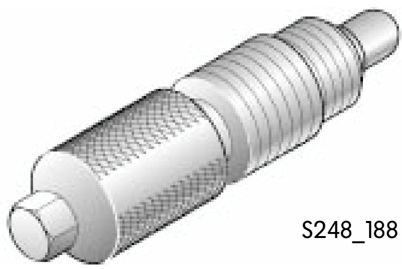
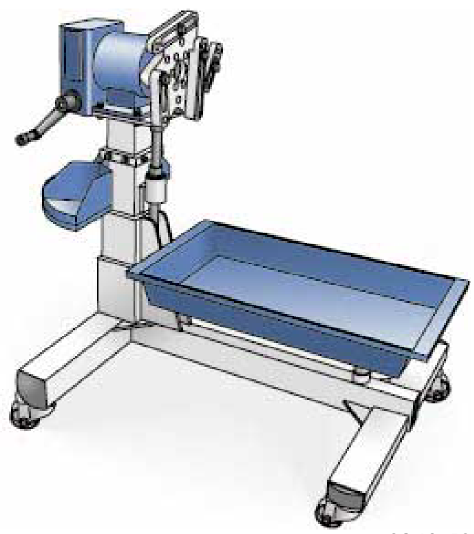
Normal tooth

Marked tooth

When placing on the lower timing chain copper, set the coloured chain link on the marked tooth and the marked tooth on the housing joint:
piston in 1st cylinder at top dead centre.

For a description of the exact procedure for setting the engine timing, please refer to the relevant Workshop Manual.

Special tools

Designation	Tool	Use
Camshaft alignment rule Tool No..: T 10068	 S248_187	For aligning the camshafts when setting the engine timing
Mandrel Tool No.: 3242	 S248_188	For locating the crankshaft
Engine and transmission holder Tool No.: VAS 6095	 S248_195	For removing and installing engines and gearboxes

Test your knowledge

1. The cylinders in the W engine are arranged according to the follow principle:

- ☐ a. two in-line engines arranged in tandem
- ☐ b. two in-line engines arranged side by side
- ☐ c. two V engines arranged side by side

2. The W engine has left and right cylinder banks. They are aligned at an angle of:

- ☐ a. 15°
- ☐ b. 60°
- ☐ c. 72°
- ☐ d. 120°

3. The maximum possible number of cylinders in an engine based on the W engine principle is:

- ☐ a. W18.
- ☐ b. W16.
- ☐ c. W12.
- ☐ d. W10.
- ☐ e. W8.

4. What does splitpin mean?

- ☐ a. an offset amounting to 12.5 mm.
- ☐ b. a crank pin offset which facilitates a regular firing interval.
- ☐ c. The centre of the crankshaft (fulcrum) is located below the point of intersection of the intersecting centres of the cylinders.

5. Why does the W8 engine have a balancing shaft?

- [ ] a. to prevent rotary vibrations being transmitted from the crankshaft to the gearbox
- [ ] b. to compensate for torsional vibration
- [ ] c. to compensate for forces of inertia
- [ ] d. to determine the engine speed

6. A pulse sensor wheel is used to determine the engine speed

- [ ] a. it is press-fitted onto the crankshaft.
- [ ] b. it is integrated in the two-mass flywheel.
- [ ] c. it is located on the gear side of the balancing shafts

7. Which ducts are routed through the cylinder heads?

1.) ______________________________

2.) ______________________________

3.) ______________________________

8. How are the camshafts adjusted?

- [ ] a. pneumatically
- [ ] b. hydraulically
- [ ] c. mechanically

Test your knowledge

9. The adjustment ranges of the camshaft adjuster between the inlet camshaft and the exhaust camshaft are different. The exhaust camshaft of the W8 engine can

- ☐ a. be adjusted continuously!
- ☐ b. only be adjusted to the advance or retard position!

10. The following units are driven by the pulley drive:

- ☐ a. the coolant pump
- ☐ b. the alternator
- ☐ c. the fuel pump
- ☐ d. the power-steering pump
- ☐ e. the air-conditioning compressor

11. Which of the following statements is true?

- ☐ a. the W8 engine has a wet-sump lubrication system.
- ☐ b. the W12 engine for VW models has a dry-sump lubrication system.
- ☐ c. the W12 engine for VW models has a wet-sump lubrication system.

12. Characteristic maps which allow the desired engine temperature to be reached in accor dance with theengine's operating requirements are stored in the engine control unit. Which of the following statements is applicable?

- ☐ a. There is only one temperature sensor in the cooling circuit, and it is located at the radiator outlet.
- ☐ b. There are two temperature sensors in the cooling circuit.
- ☐ c. there is only one temperature sensor in the cooling circuit, and it is located at the engine block outlet.

13. Which of the following statements is true?

☐ a. The coolant flows through the cylinder heads from the exhaust end to the intake end. This ensures very good temperature equalisation as well as effective cooling of the outlet webs and spark plugs.

☐ b. Coolant flows through the cylinder heads from the intake side to the exhaust side. This ensures very good temperature equalisation as well as effective cooling of the outlet webs andspark plugs.

14. A new liquid sealing method is used to seal the upper timing case cover. The liquid gasket is injected through screw nipples.

☐ a. The screw nipples have to be replaced when repairing the gasket.

☐ b. The screw nipple can be reused any number of times.

☐ c. The screw nipples must be unscrewed after repairing the gasket.

Notes

Solutions

1.) c

2.) c

3.) b, c, d, e

4.) b

5.) c

6.) b

7.) 1 Oil ducts
2 Coolant ducts
3 Secondary air ducts

8.) b

9.) b

10.) a, b, d, e

11.) a, c

12.) b

13.) a

14.) a

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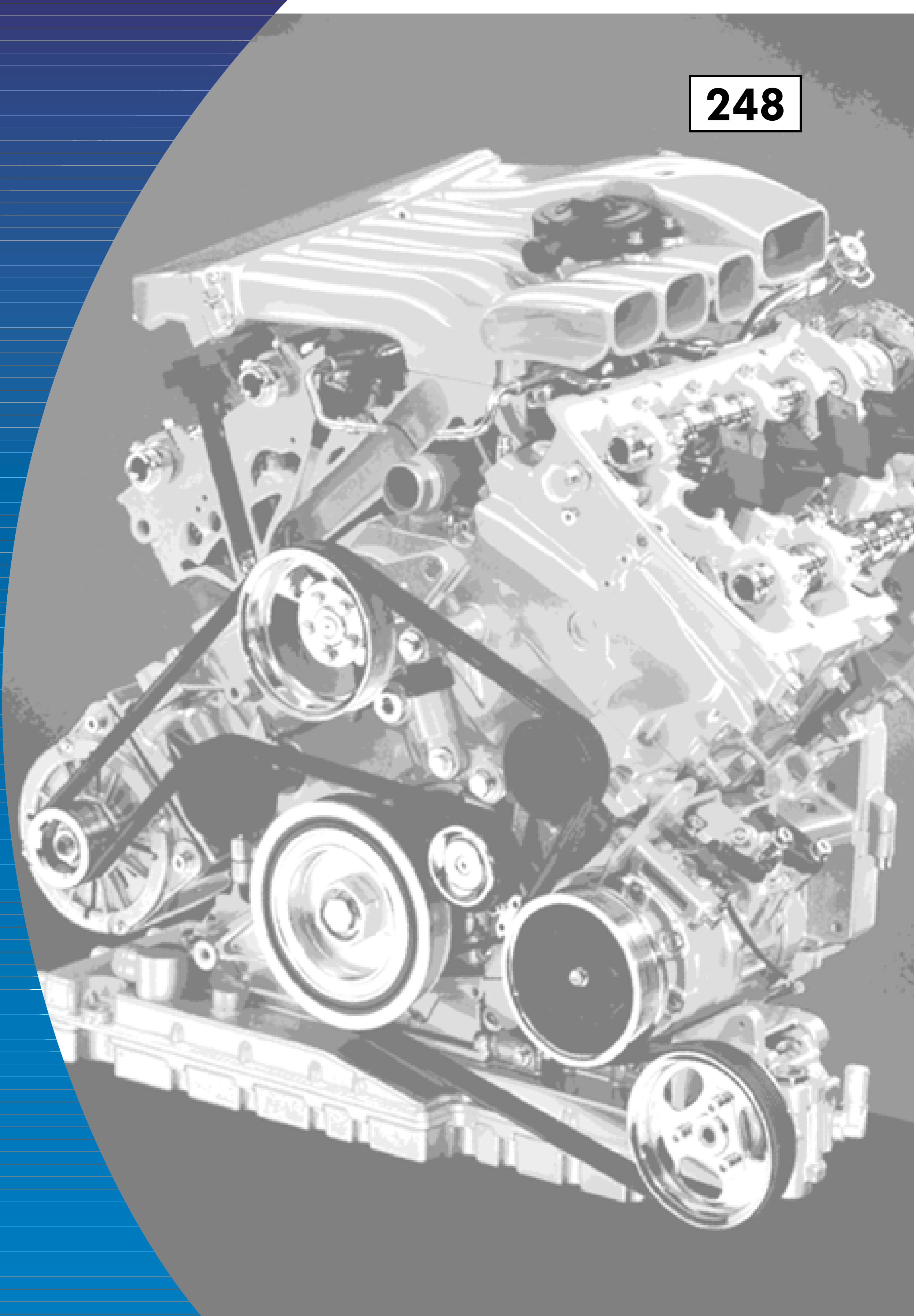

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