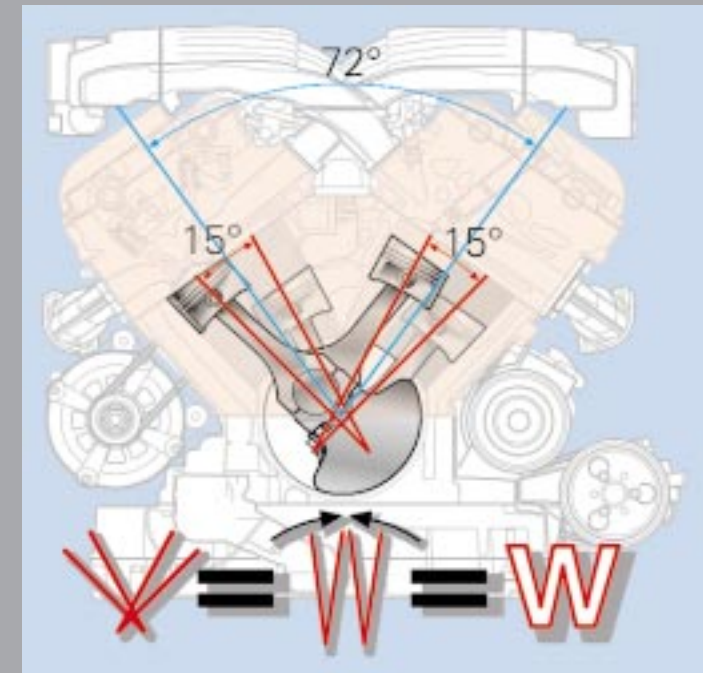


The W Engine Concept



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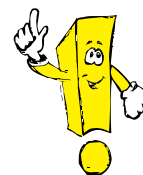
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New !



Important/Note!

The Self-Study Program provides you with information regarding designs and functions.

The Self-Study Program is not a Repair Manual.

For maintenance and repair work, always refer to the current technical literature.



W Engines

The constantly rising demands regarding performance, smooth operation, and fuel economy have led to the advancement of existing engines and the development of new engines.

The new W8 and W12 engines by Volkswagen are representative 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 Program will familiarize you with the mechanical components and their functions in the W engine family.



SSP248/101

Introduction

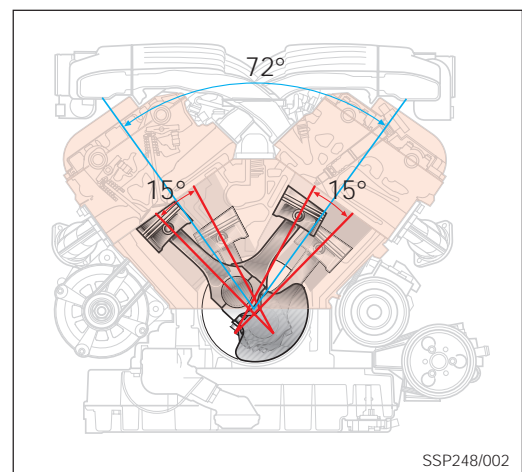
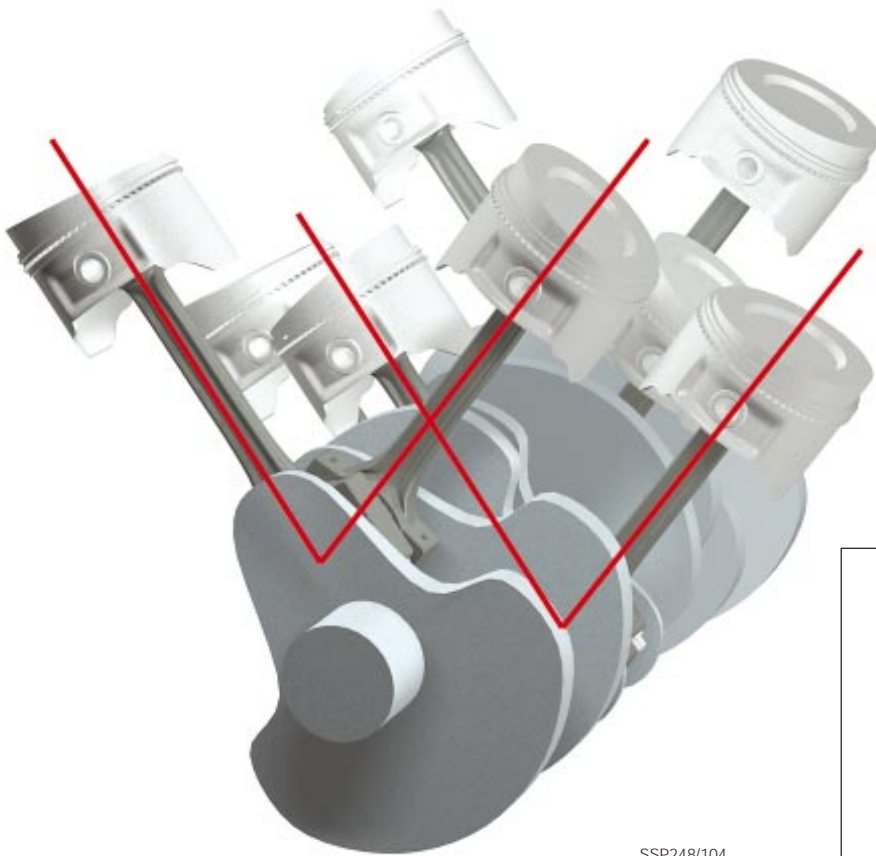
What Does the W Stand For?

With the aim of building even more compact engines 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 degrees in

relation to one another. As in the VR engine, the cylinders within each bank maintain a V-angle of 15 degrees.

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.



The W Principle

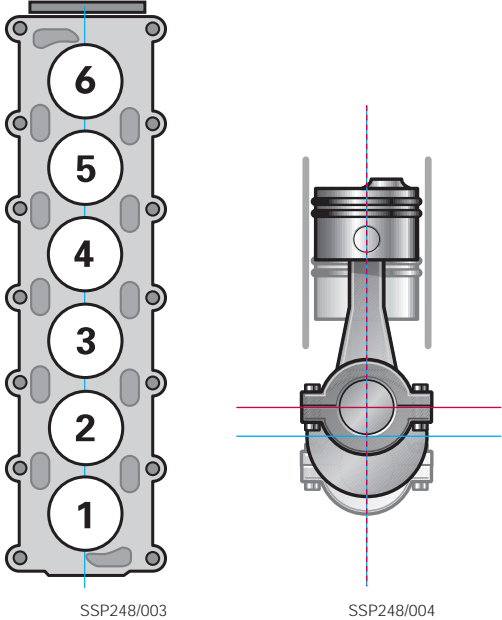
To illustrate the principle of the W engine cylinder arrangement, we will first show you conventional engine types.

Inline Engines

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

Advantage: Simple design.

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

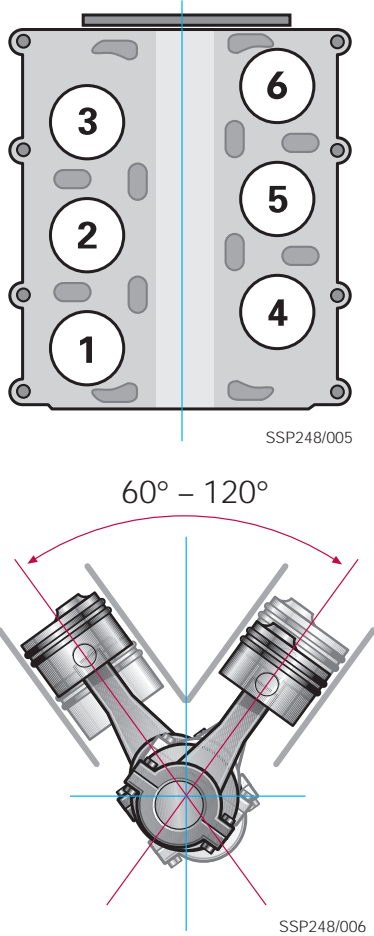


V Engines

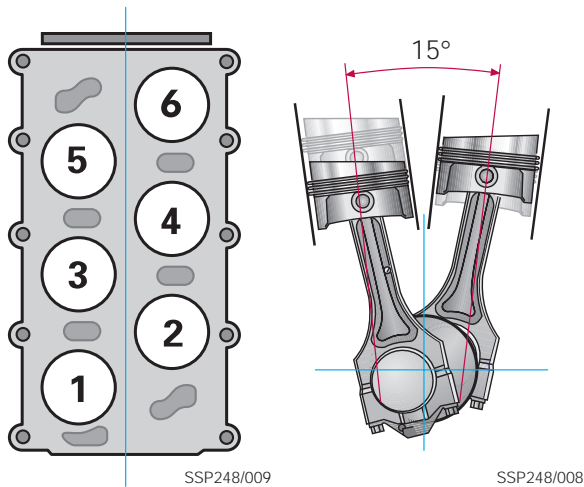
To make engines shorter, the cylinders in the V engines are arranged at an angle of between 60 degrees and 120 degrees, with the centerlines of the cylinders intersecting with the centerline of the crankshaft.

Advantage: Relatively short engines.

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

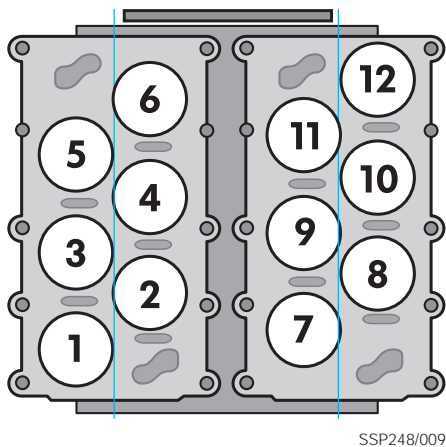


Introduction



VR Engines

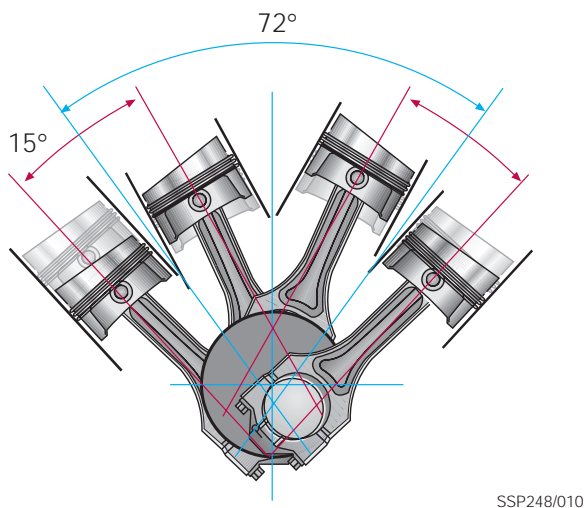
The need for a powerful alternative suitable for transverse mounting for use in small to mid-size vehicles saw the development of the VR engine. Six cylinders, offset at a V-angle of 15 degrees, are accommodated in a fairly slender and very short engine block. Unlike previous designs, the engine only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



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 degrees relative to each other while the two VR banks are arranged at a V-angle of 72 degrees.



W Engine Modular Design

Proven components from the modules of the VR engine family were integrated into the new W engine concept. The principle is very simple.

Two compact engines from the VR series are combined to produce a W engine. The result is a series of compact gasoline engines ranging from the W8 to the W16.

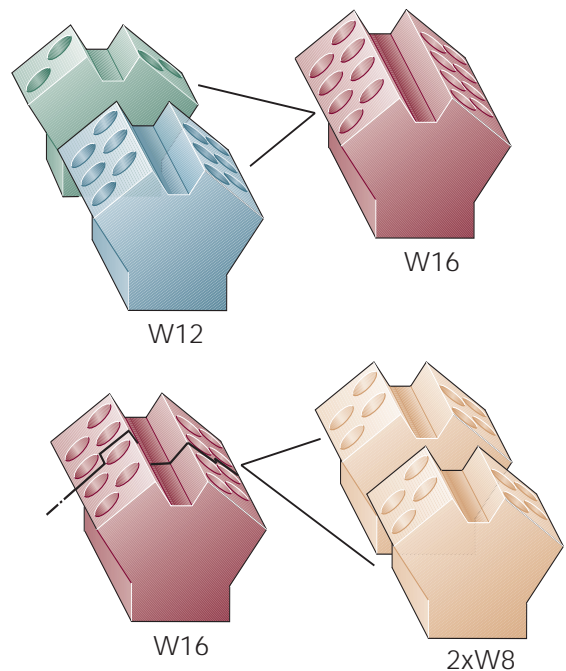
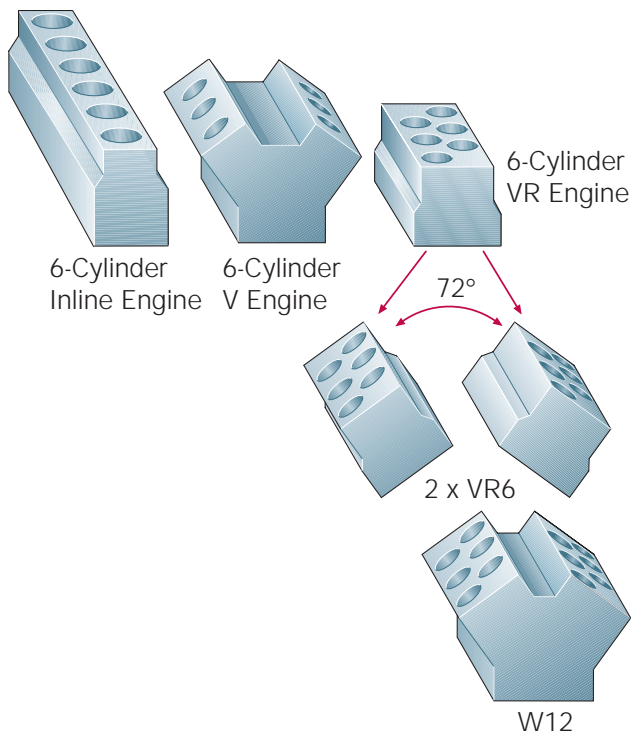
Numerous components of the VR and W series are identical:

- Valves, valve springs and valve seat inserts.
- Roller rocker fingers.
- Valve clearance compensating elements.

This allows Volkswagen to manufacture many parts in high volumes.

In 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 degrees 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.



SSP248/105

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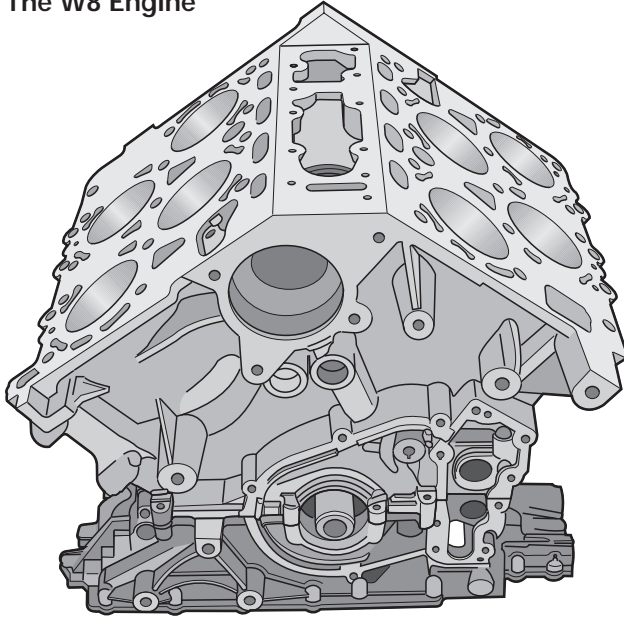
Introduction

A Comparison

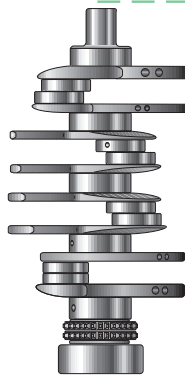
When a conventional 8-cylinder V engine of comparable displacement is compared to an 8-cylinder W engine, the latter particularly stands out due to its compact design and relatively small external dimensions.

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

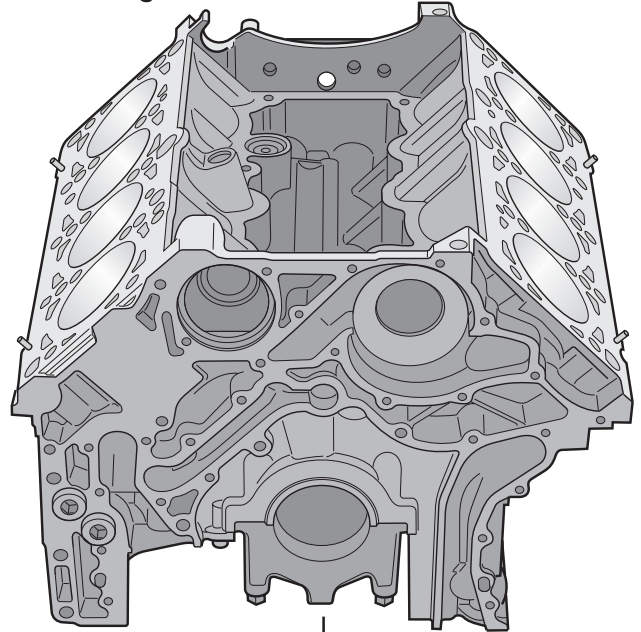


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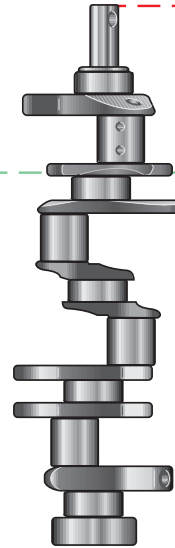


W8 Crankshaft

The V8 Engine



SSP248/012

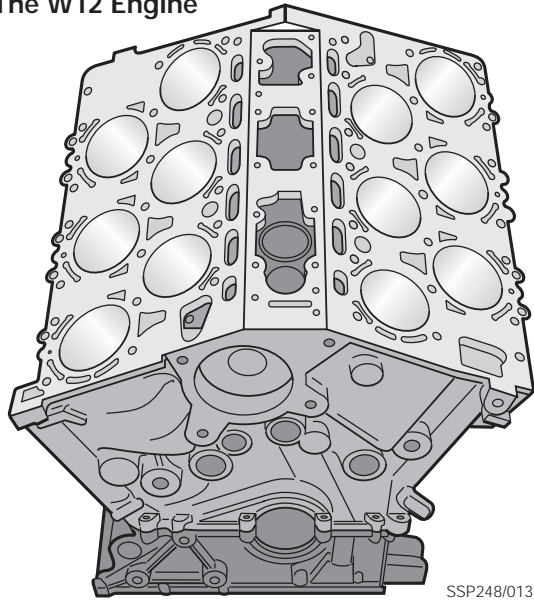


V8 Crankshaft

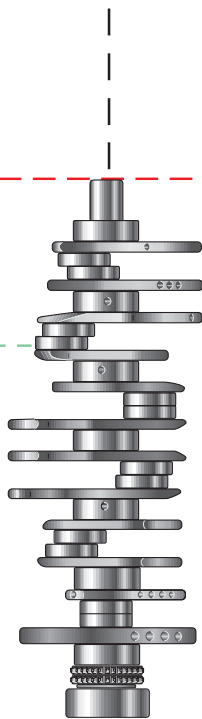
Comparing the crankshaft of a conventional V12 engine with that of a 12-cylinder W engine emphasizes the advantage.

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

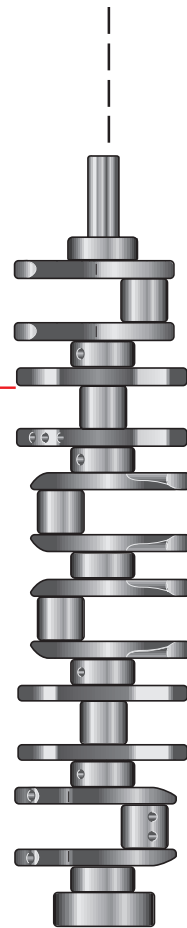
The W12 Engine



The crankshaft of a V12 engine of comparable displacement is shown.



W12 Crankshaft

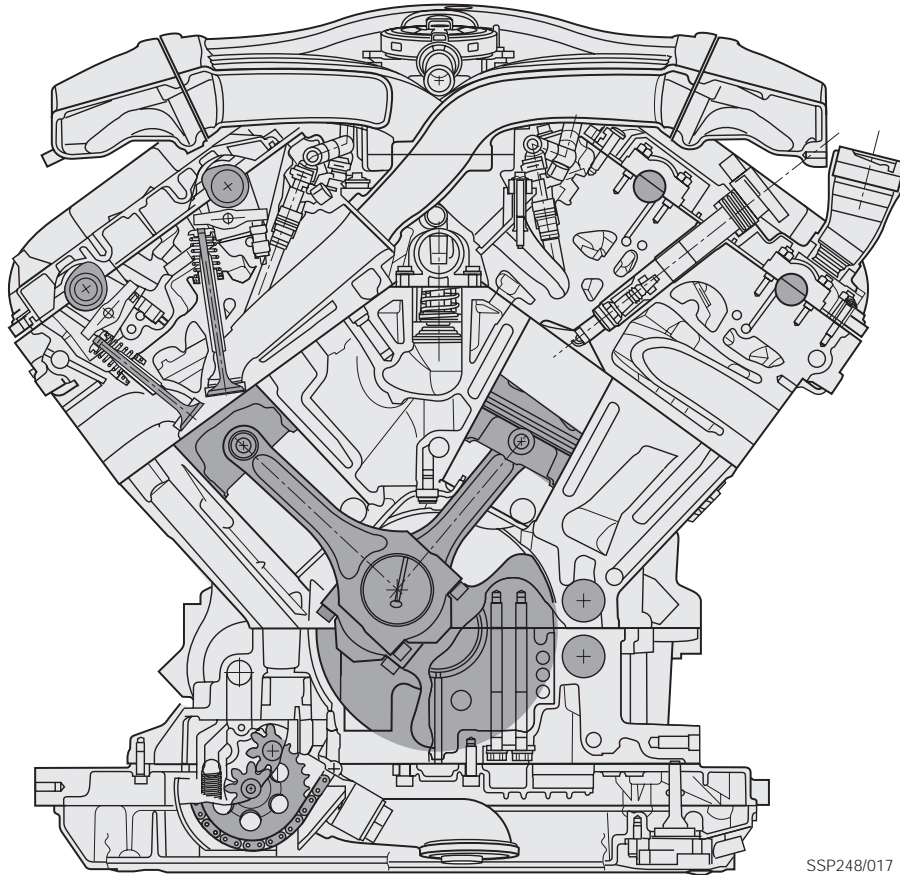


V12 Crankshaft

SSP248/150

Engine — Mechanics

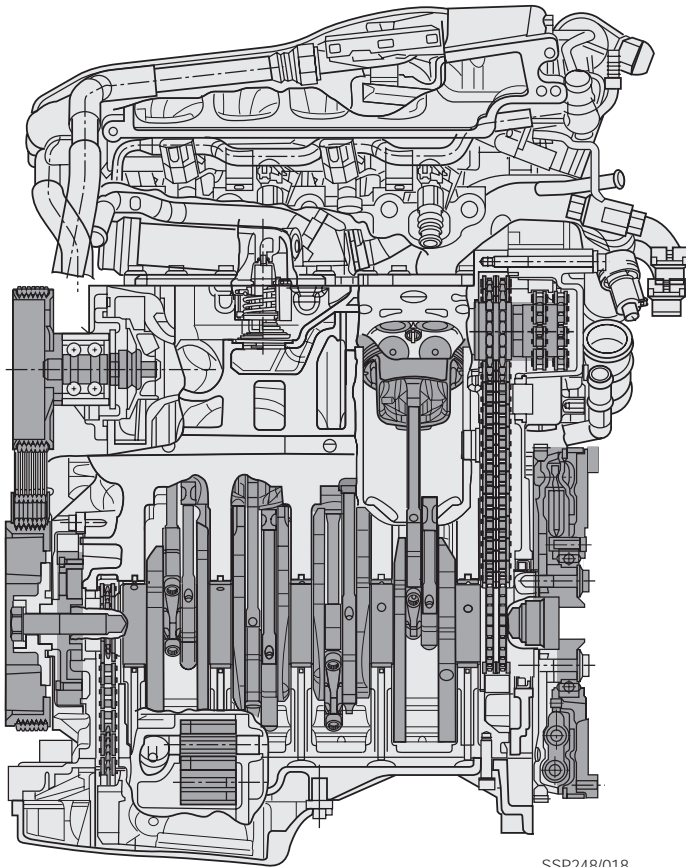
W8 Engine Specifications



SSP248/017

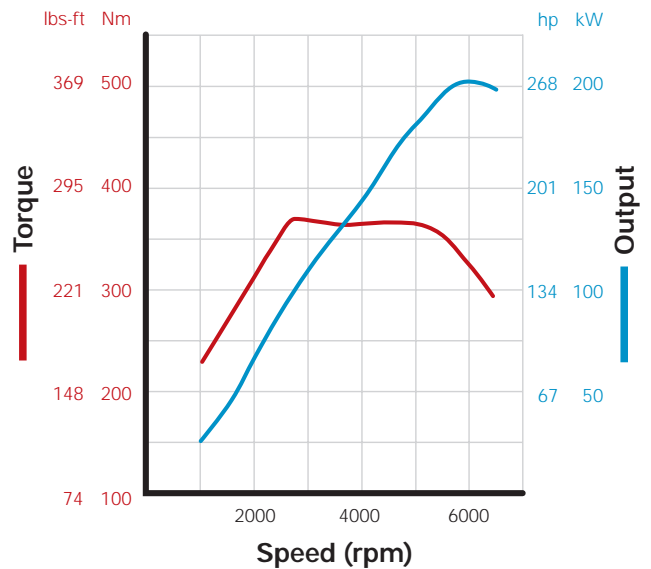
- **Displacement**
244 cu in (3999 cm³)
- **Bore**
3.307 in (84.0 mm)
- **Stroke**
3.550 in (90.168 mm)
- **Number of cylinders**
8
- **Number of cylinder heads**
2
- **Offset**
± 0.492 in (12.5 mm)
- **Bank offset**
0.512 in (13 mm)
- **V-angle of cylinder heads between banks**
72 degrees
- **V-angle of cylinders in a bank**
15 degrees
- **Number of valves**
4 per cylinder
- **Crankshaft journal offset**
–18 degrees
- **Firing order**
1-5-4-8-6-3-7-2

Engine — Mechanics



SSP248/018

Torque and Power Output



SSP248/021

- **Dimensions**

16.5 in (420 mm) long;
28.0 in (710 mm) wide;
26.9 in (683 mm) high

- **Weight**

Approximately 425 lbs (193 kg)

- **Maximum power output**

Approximately 275 bhp (202 kW)

- **Maximum torque**

Approximately 273 lbs-ft (370 Nm)



Horsepower and torque specifications are not final at the time of printing. Please see www.vwwebsitesource.com for the latest specifications.

- **Fuel type recommendation**

Premium unleaded gasoline (91 AKI)

- **Engine management system**

Bosch Motronic ME 7.1

- **Installation position**

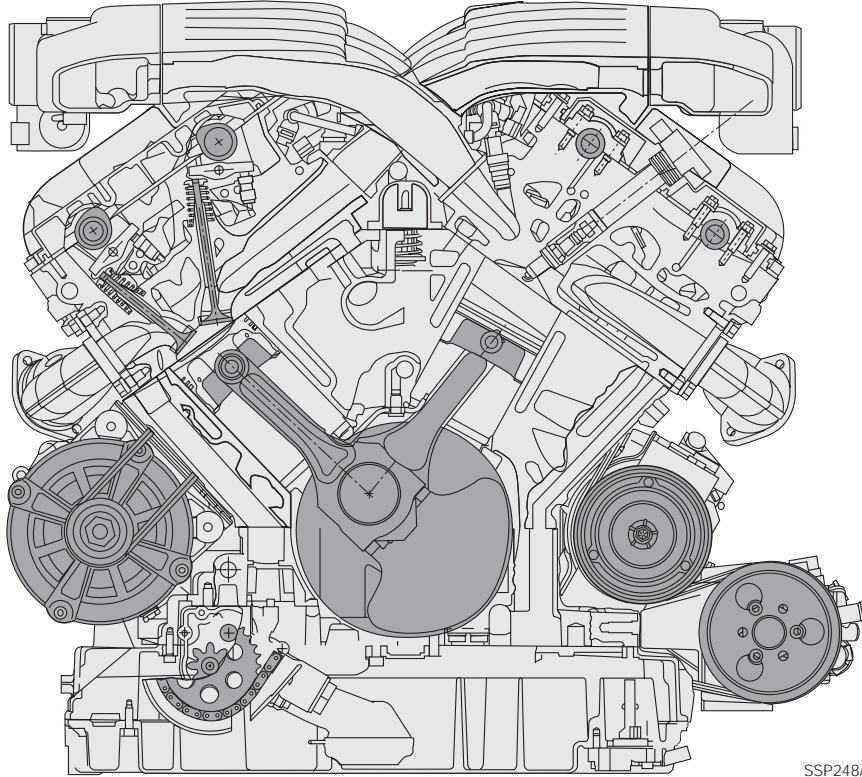
In-line

- **Allocated transmissions**

5HP19 4Motion, C90 6-speed 4Motion

Engine — Mechanics

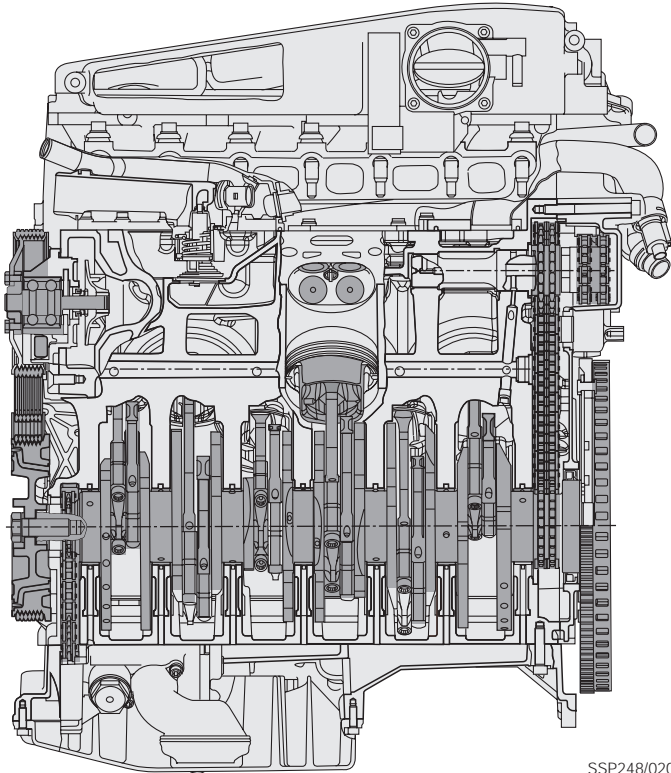
W12 Engine Specifications



SSP248/019

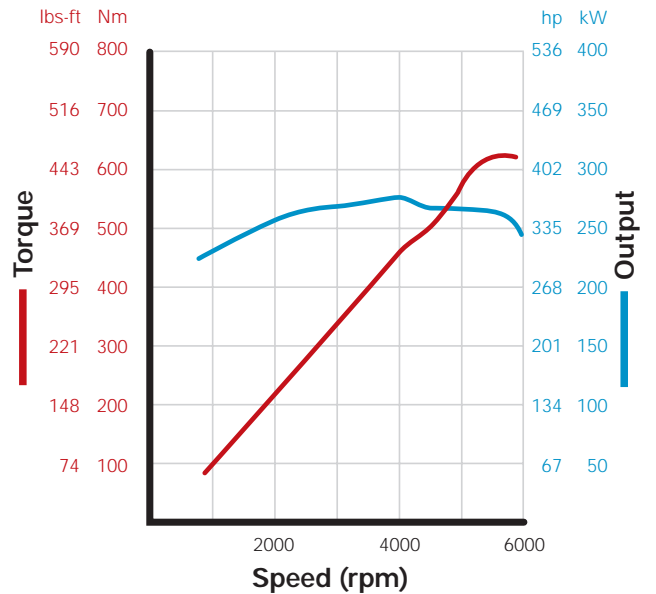
- **Displacement**
366 cu in (5998 cm³)
- **Bore**
3.307 in (84.0 mm)
- **Stroke**
3.550 in (90.168 mm)
- **Number of cylinders**
12
- **Number of cylinder heads**
2
- **Offset**
± 0.492 in (12.5 mm)
- **Bank offset**
0.512 in (13 mm)
- **V-angle of cylinder heads between banks**
72 degrees
- **V-angle of cylinders in a bank**
15 degrees
- **Number of valves**
4 per cylinder
- **Crankshaft journal offset**
+12 degrees
- **Firing order**
1-12-5-8-3-10-6-7-2-11-4-9

Engine — Mechanics



SSP248/020

Torque and Power Output



SSP248/022

- **Dimensions**

20.2 in (513 mm) long;
28.0 in (710 mm) wide;
28.1 in (715 mm) high

- **Weight**

Approximately 541 lbs (245 kg)

- **Maximum power output**

Approximately 420 bhp (309 kW)

- **Maximum torque**

Approximately 406 lbs-ft (550 Nm)

- **Fuel type recommendation**

Premium unleaded gasoline (91 AKI)

- **Engine management system**

Bosch Motronic ME 7.1.1 (Dual Control Module Concept)

- **Installation position**

In-line

- **Allocated transmission**

5HP24 4Motion



Horsepower and torque specifications are not final at the time of printing. Please see www.vwwebsites.com for the latest specifications.

Engine — Mechanics

Cylinder and Crankshaft Configuration

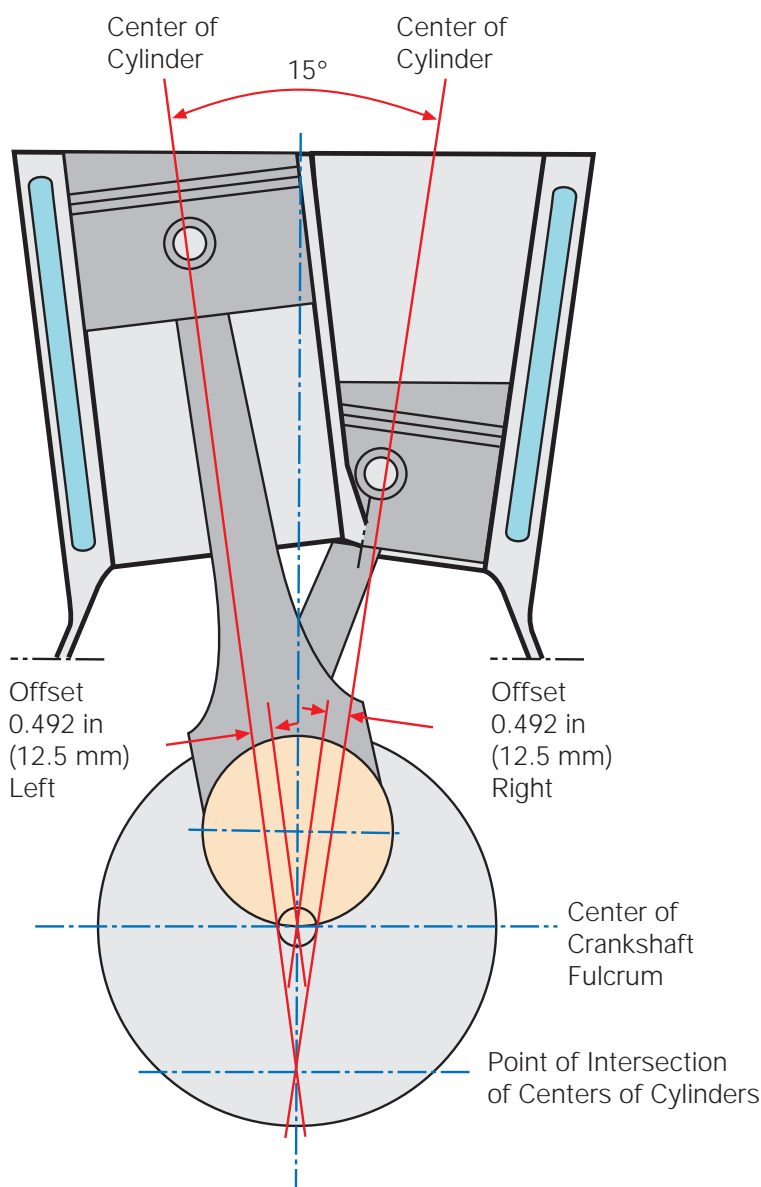
Cylinder Offset

The alternate cylinders of a bank are offset from the centerline of the crankshaft and positioned at a very narrow V-angle of 15 degrees.

The compact W engine was made possible by arranging two banks of cylinders at a V-angle of 72 degrees.

To provide adequate space for the pistons in the bottom-dead-center range, it was necessary to offset the crankshaft drive. This means that the cylinders are offset by 0.492 in (12.5 mm) outward relative to the center of the crankshaft fulcrum.

This configuration was first used in the VR6 engine.



SSP248/186

Crankpin Offset

Crankpin offset controls the relative positions of the pistons in the cylinders for an evenly timed firing sequence.

The configuration of all Volkswagen W engines is based on a 10-cylinder engine model. All four-cycle internal combustion engines complete their cylinder firing sequences within two complete revolutions. This amounts to a crankshaft rotation of 720 degrees.

The W10 engine needs no crankpin offset.

With 720 degrees of crankshaft rotation in a 10-cylinder engine, the optimum V-angle between the two cylinder banks is 72 degrees ($720 \div 10 = 72$). In the 10-cylinder model engine there is no need for crankpin offset to achieve ideal relative piston positions for the equally timed firing of each cylinder.

The W8 engine has a crankpin offset of -18 degrees.

To achieve the same kind of ideal firing sequence timing as the 10-cylinder model, an 8-cylinder W engine requires 90 degrees of crankshaft rotation between the

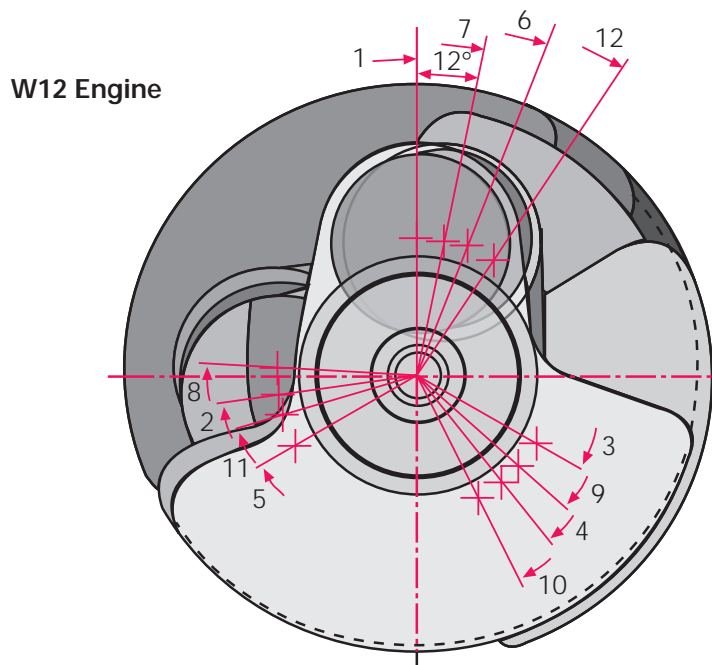
ignition cycle of each cylinder through 720 degrees of crankshaft rotation ($720 \div 8 = 90$). To determine the optimum crankpin offset of -18 degrees for this engine, the 90 degrees of crankshaft rotation between ignition cycles is subtracted from the 72-degree V-angle of the cylinder banks.

$$72 - 90 = -18$$

The W12 engine has a crankpin offset of +12 degrees.

Similarly, a 12-cylinder engine requires 60 degrees of crankshaft rotation between the ignition cycle of each cylinder through 720 degrees of crankshaft rotation ($720 \div 12 = 60$). For this configuration, to determine the optimum crankpin offset of +12 degrees, the 60 degrees of crankshaft rotation between ignition cycles is subtracted from the 72-degree V-angle of the cylinder banks.

$$72 - 60 = +12$$



SSP248/026

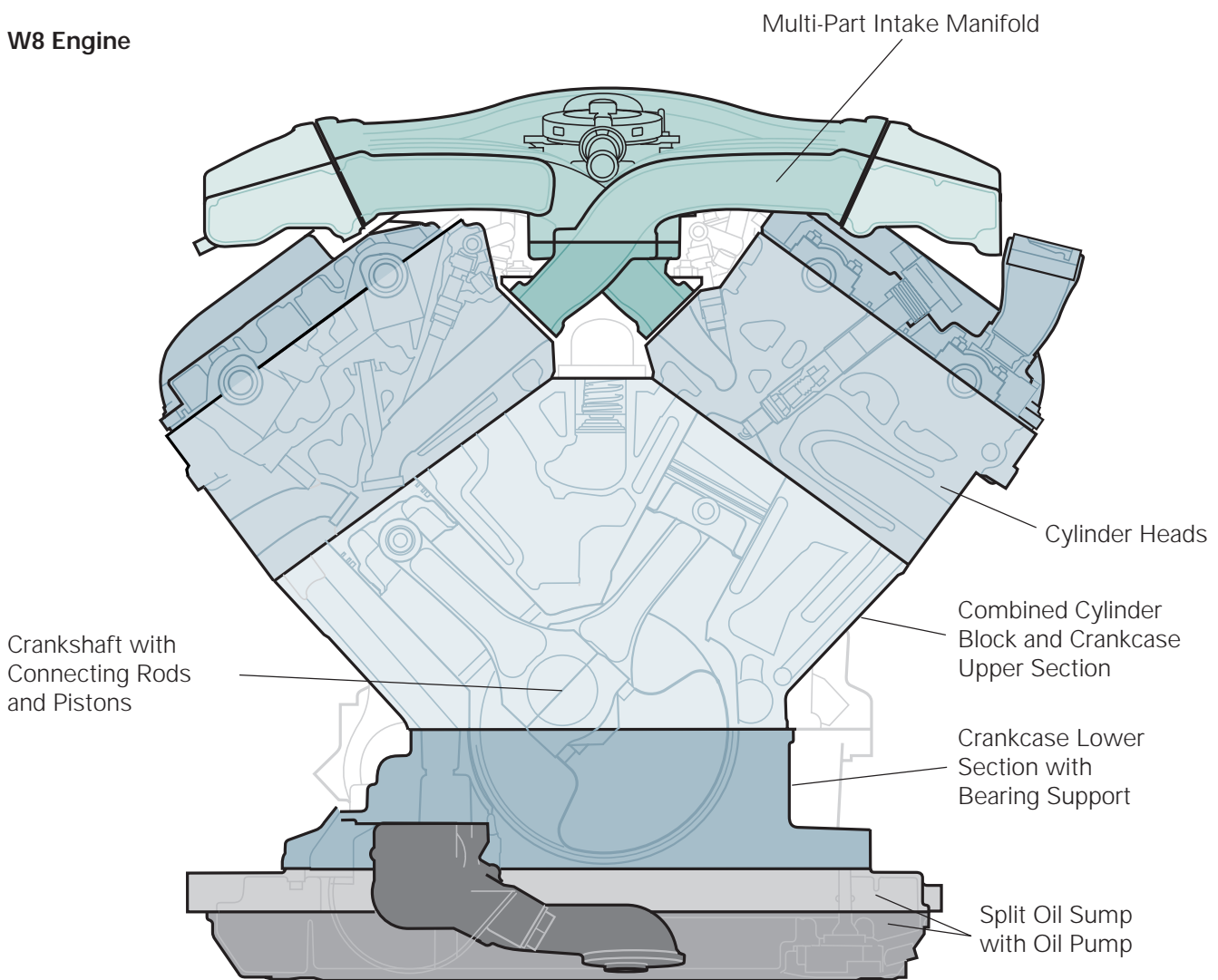
Engine — Mechanics

Engine Components

W engines include the following components:

- Cylinder block
- Crankcase lower section with bearing support
- Crankshaft with connecting rods and pistons
- Balancing shafts
- Cylinder heads
- Oil sump and oil pump
- Crankshaft drive
- Timing chain drive
- Belt drive for auxiliary components
- Multi-part intake manifold

W8 Engine



SSP248/025

Cylinder Block and Crankcase

The W engines include two main components: the combined cylinder block and crankcase upper section, and the crankcase lower section.

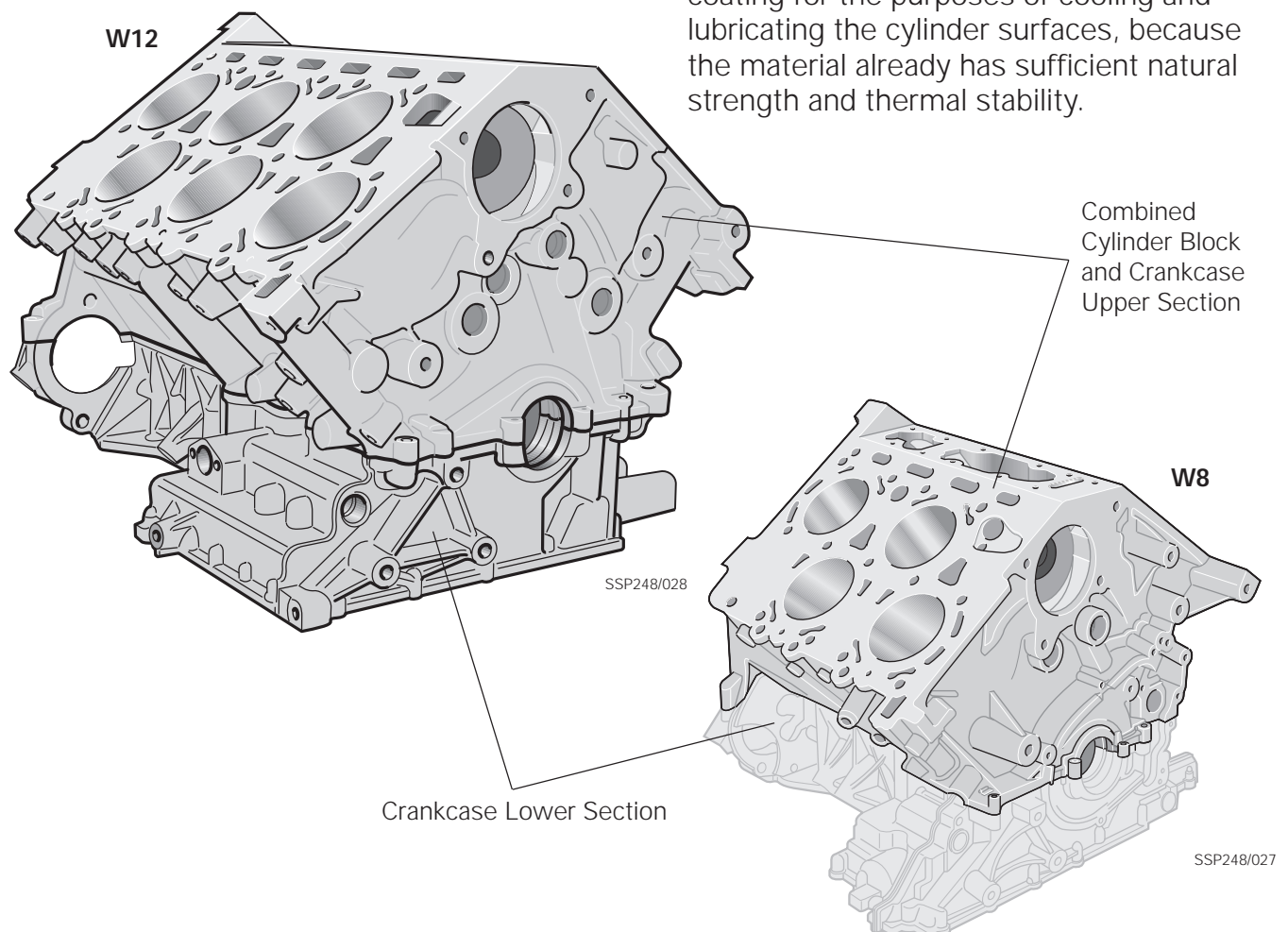
The upper section includes the cylinders and the upper main bearing caps. The crankcase lower section is designed as a bearing support and carries the lower main bearing caps.

Combined Cylinder Block and Crankcase Upper Section

The “aluminum” crankcase upper section is made of a hypereutectic aluminum-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, because the material already has sufficient natural strength and thermal stability.



Engine — Mechanics

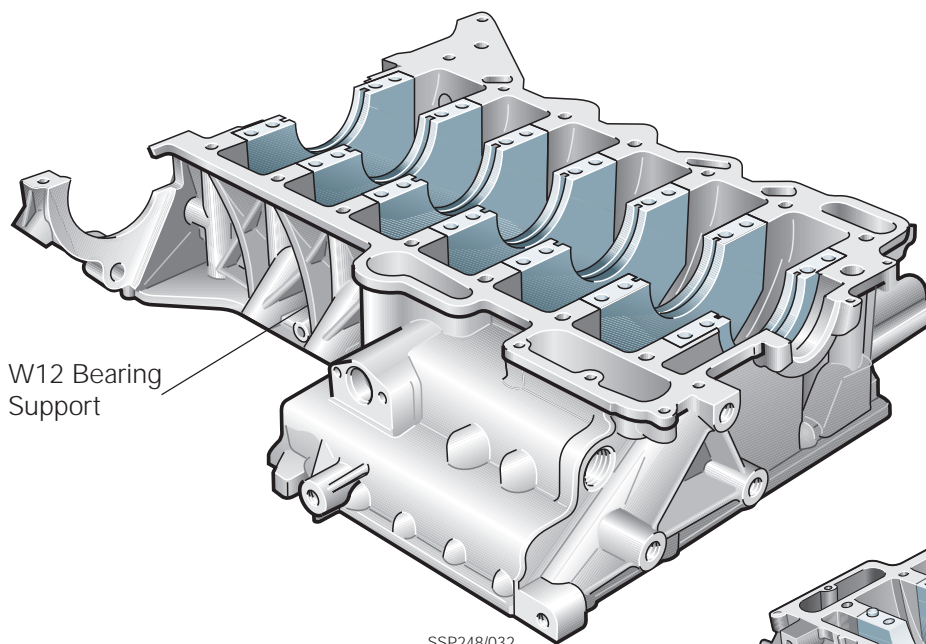
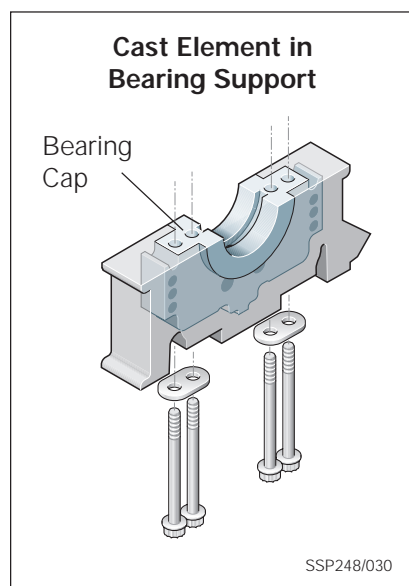
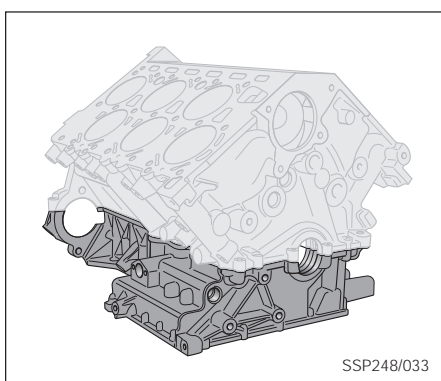
Crankcase Lower Section

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

The bearing support is also made of an aluminum alloy. It serves as a frame structure for the lower crankshaft main bearing caps. These bearing caps are made of grey cast iron and are embedded in the bearing support when it is cast.

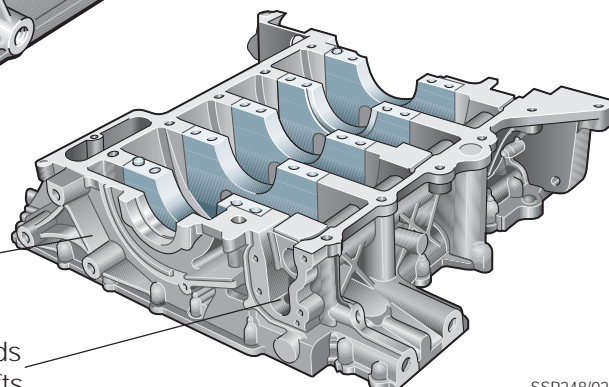
They are located on the thrust side of the crankshaft and give the crankshaft bearings the strength they require.

The bearing support is attached to the crankcase upper section by four bolts per bearing cap.



W8 Bearing Support

Casing Opening Towards Drive of Balancing Shafts



Crankshaft

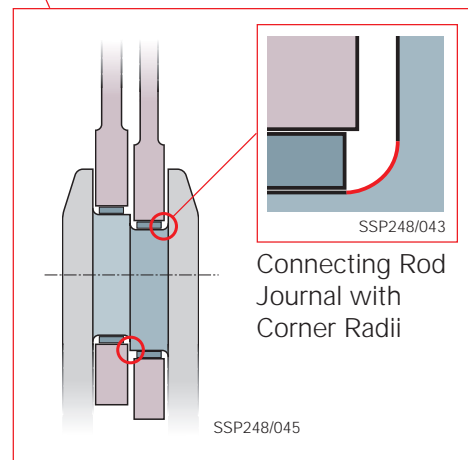
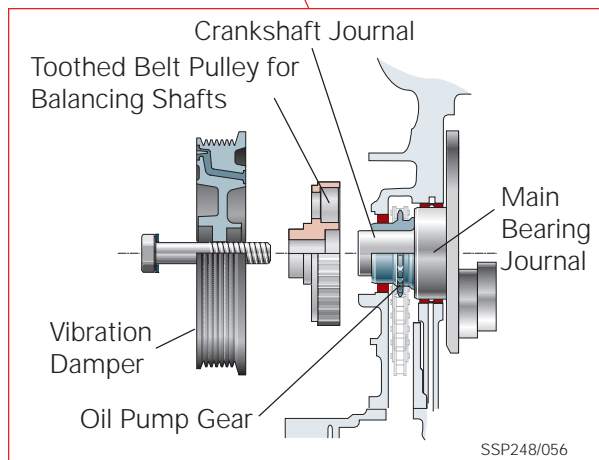
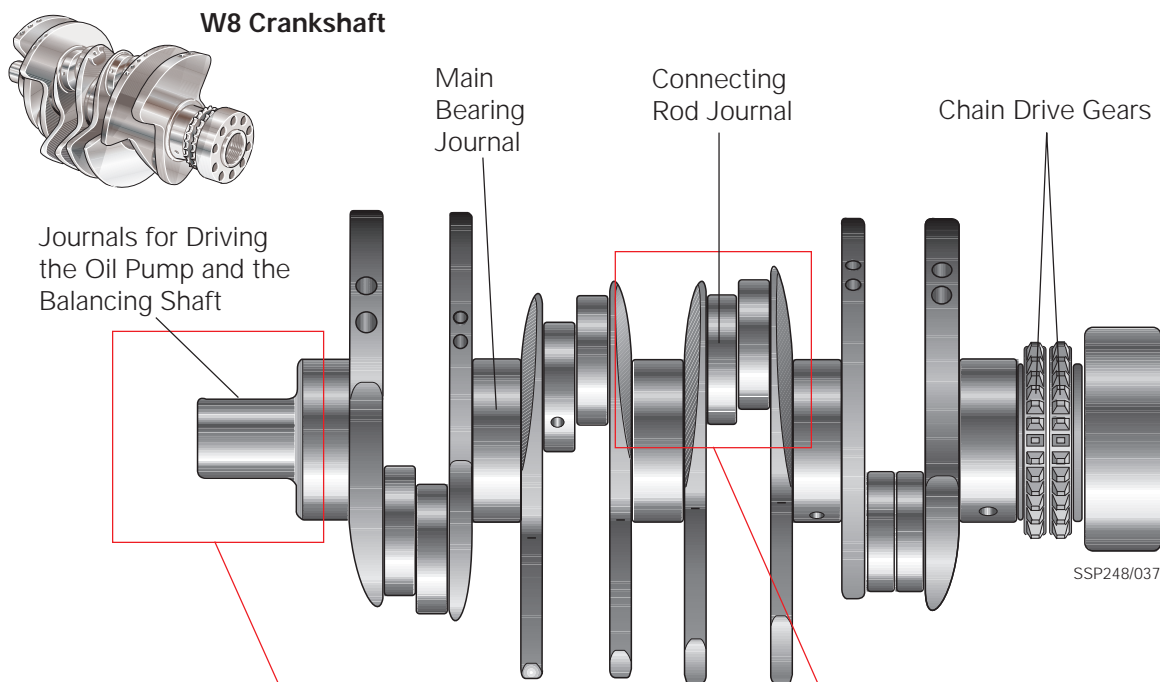
The crankshafts used in the W engines are manufactured from forged tempered steel. Each pair of connecting rods runs between two main bearings.

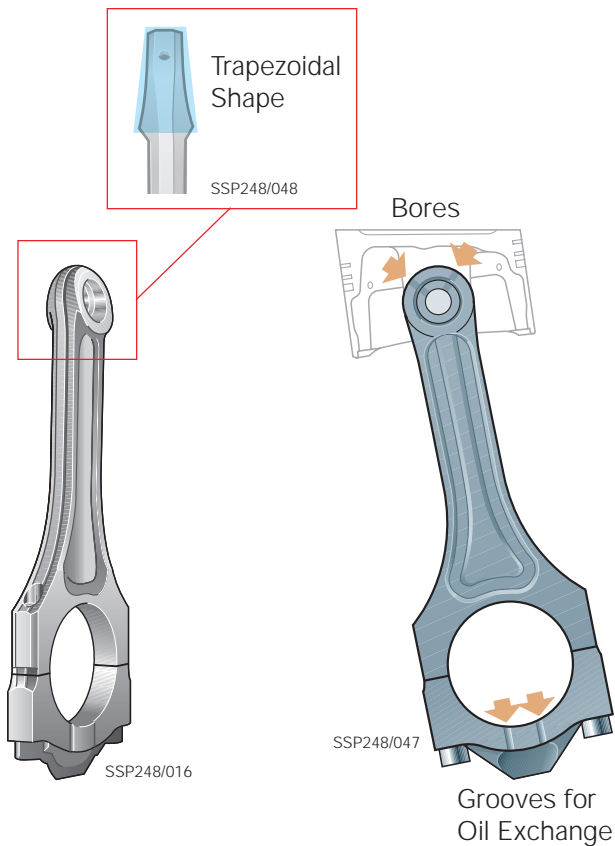
The drive gear of the oil pump (together with the toothed belt pulley for the balancing shafts on the W8 engine only) is pressed against the outer main bearing and held in place by the vibration damper.

The connecting rod journals are arranged in pairs and in accordance with the crankshaft throw.



When the connecting rods are installed, the bearing shells must not contact the radii or the edge between the two connecting rod faces.

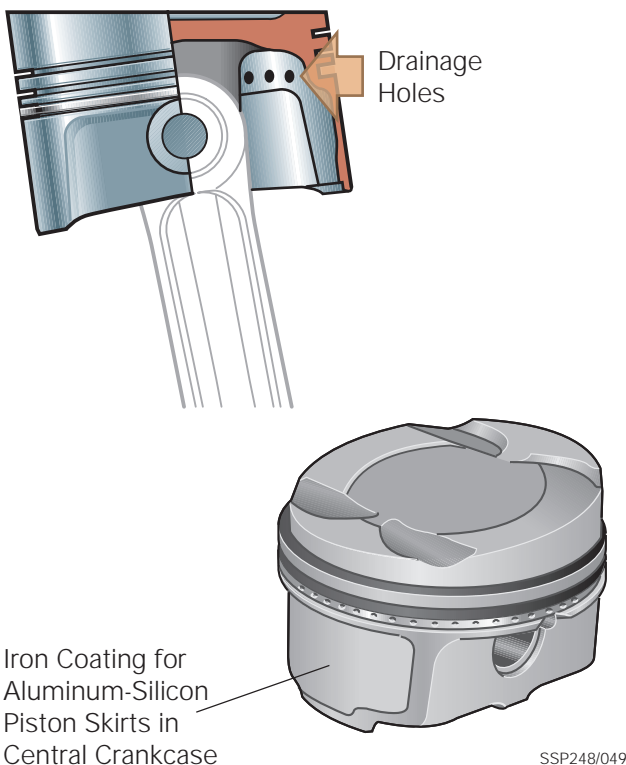




Connecting Rods and Pistons

The connecting rods are made of forged steel and are only 0.512 inch (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 connecting rod bearing caps. The piston pin is lubricated through two inclined bores in the connecting rod head.



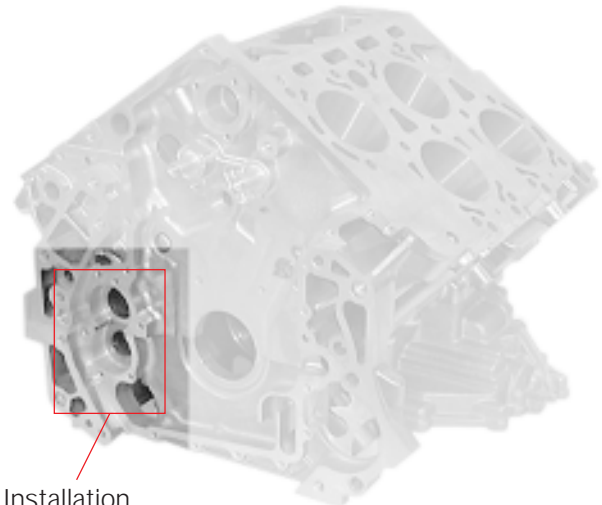
The pistons are made of an aluminum-silicon (Al Si) alloy. The recess in the piston top surface is very shallow since the cylinder head provides most of the combustion chamber volume. The angle of the piston top surface is necessary to accommodate the positions of the pistons in their V configuration.

Each piston carries two compression rings and an oil control ring. To drain off the oil which collects at the oil control ring, small drainage holes lead from the piston ring groove to the inside of the piston.

W8 Engine Balancing Shafts

The W8 engine has two balancing shafts to compensate for the forces of inertia. The two shafts are housed in the crankcase. The upper balancing shaft is driven by the crankshaft and a toothed belt. A gear on the end of the upper balancing shaft drives the lower balancing shaft.

The balancing shafts are installed through two holes on the clutch side of the crankcase.



Installation Openings

SSP248/055

Align mark on crankshaft drive gear with the joint (TDC of 1st cylinder).

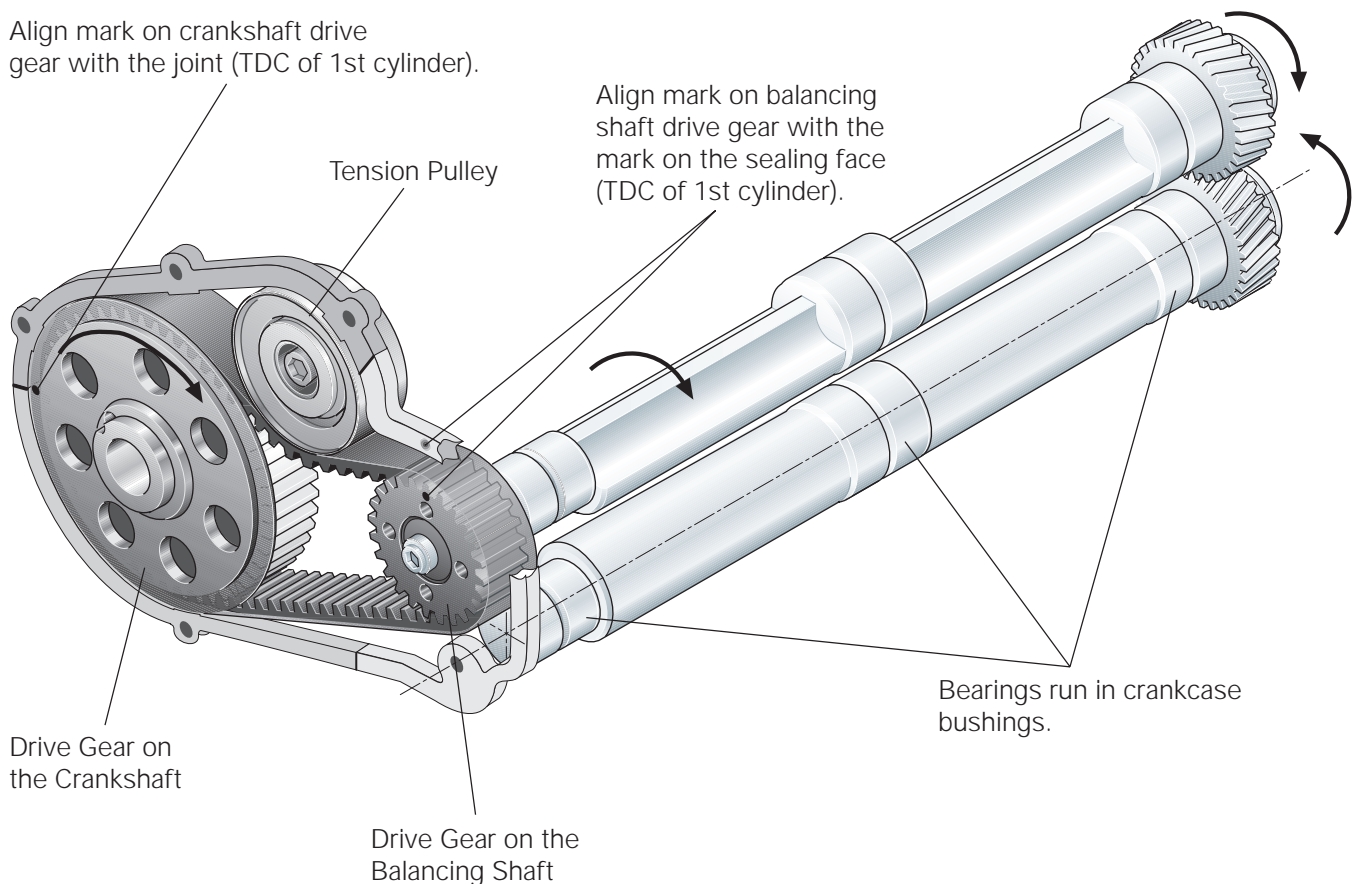
Tension Pulley

Align mark on balancing shaft drive gear with the mark on the sealing face (TDC of 1st cylinder).

Drive Gear on the Crankshaft

Drive Gear on the Balancing Shaft

Bearings run in crankcase bushings.



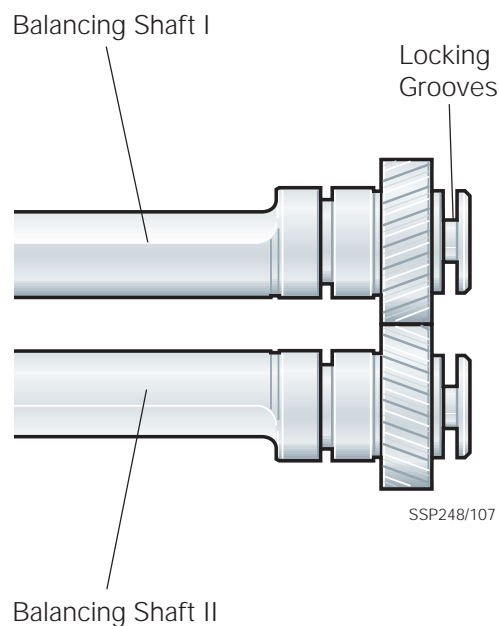
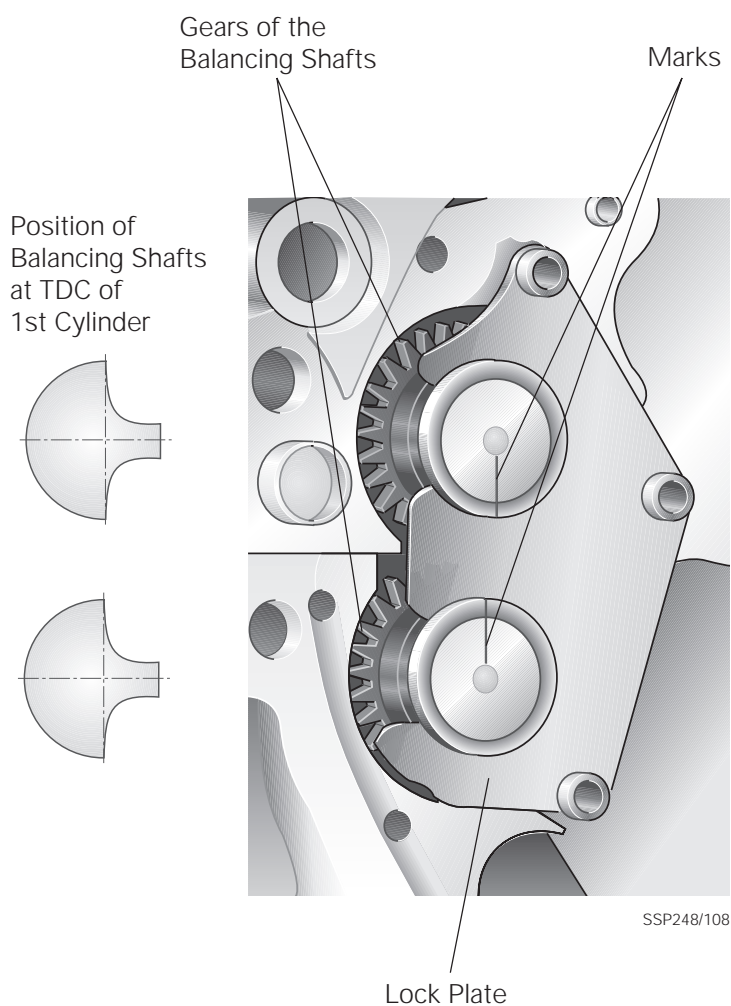
SSP248/057

Engine — Mechanics

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.

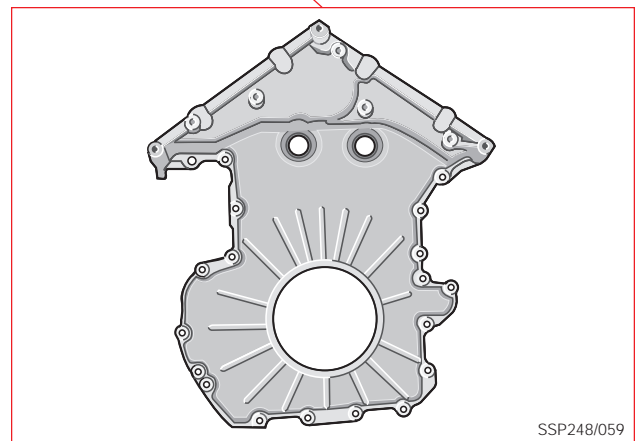
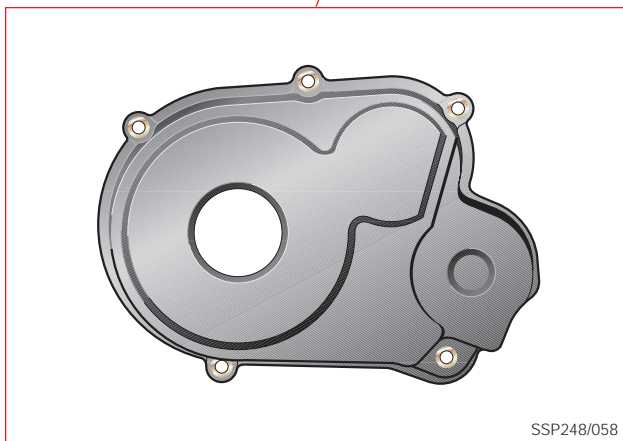
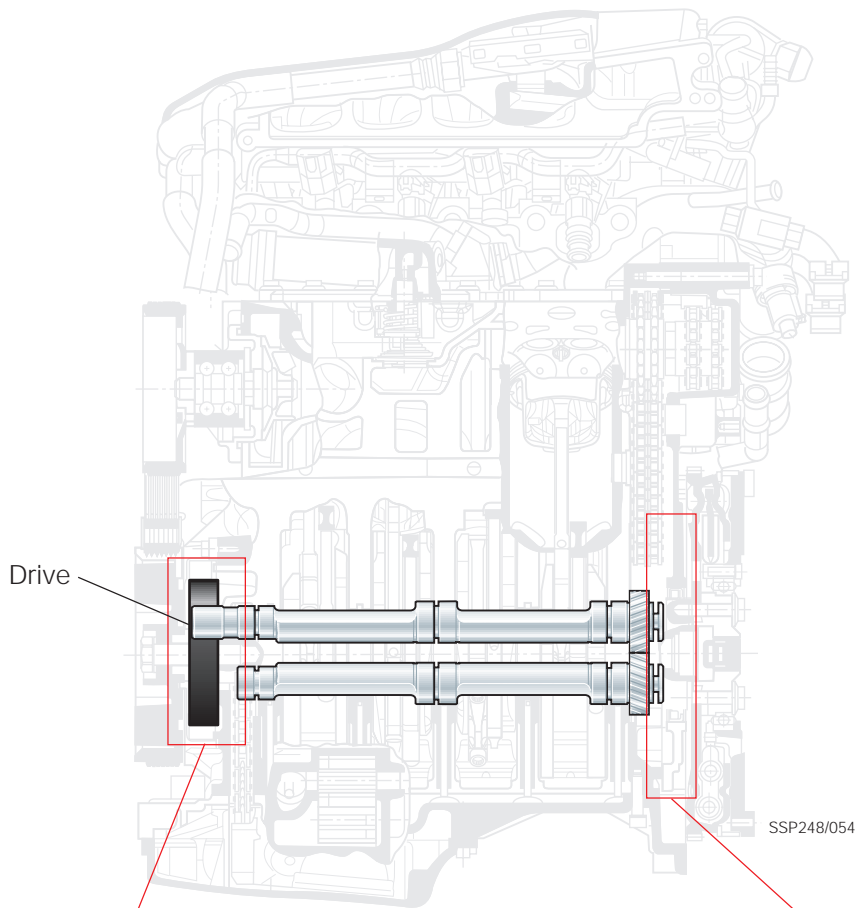
The balancing shafts must be rotated so that the marks on the balancing shafts are opposite each other.



Engine — Mechanics

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

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



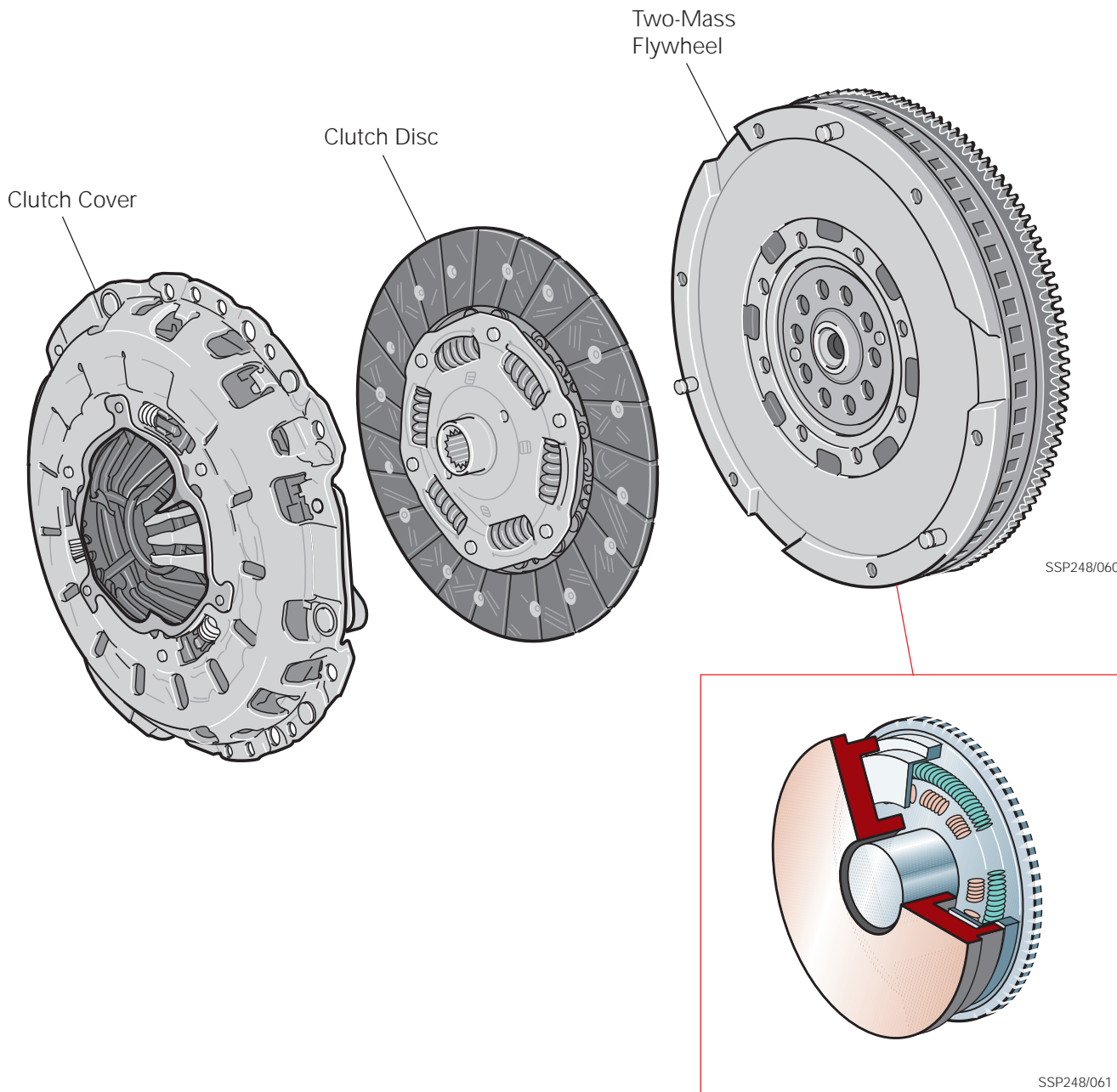
Engine — Mechanics

Two-Mass Flywheel with Clutch

W engines equipped with a manual transmission generally have a two-mass flywheel.

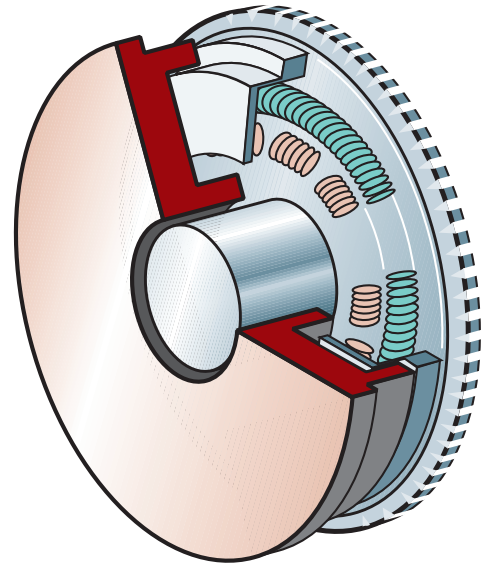
This flywheel design prevents torsional vibration from being transmitted from the

crankshaft to the transmission through the flywheel. If not eliminated, this vibration would adversely affect performance.



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

The two-mass flywheel also serves as a sender wheel for Engine Speed (RPM) Sensor G28. Its job is to determine the engine speed and recognize cylinder number 1 together with the Camshaft Position (CMP) Sensor G40, Camshaft Position (CMP) Sensor 2 G163, Camshaft Position (CMP) Sensor 3 G300, and Camshaft Position (CMP) Sensor 4 G301. It has a larger tooth gap which serves as a marker point. This point is registered by the Engine Speed (RPM) Sensor G28 located in the transmission housing during each revolution of the two-mass flywheel.

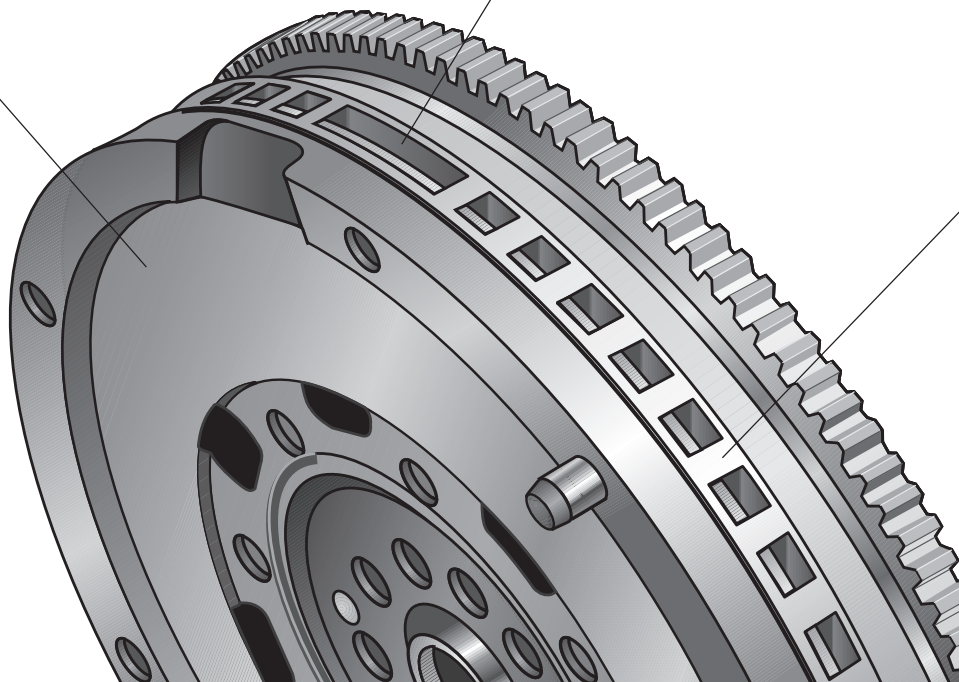


SSP248/061

Two-Mass
Flywheel

Larger
Tooth Gap

Pulse Sensor
Wheel



SSP248/062

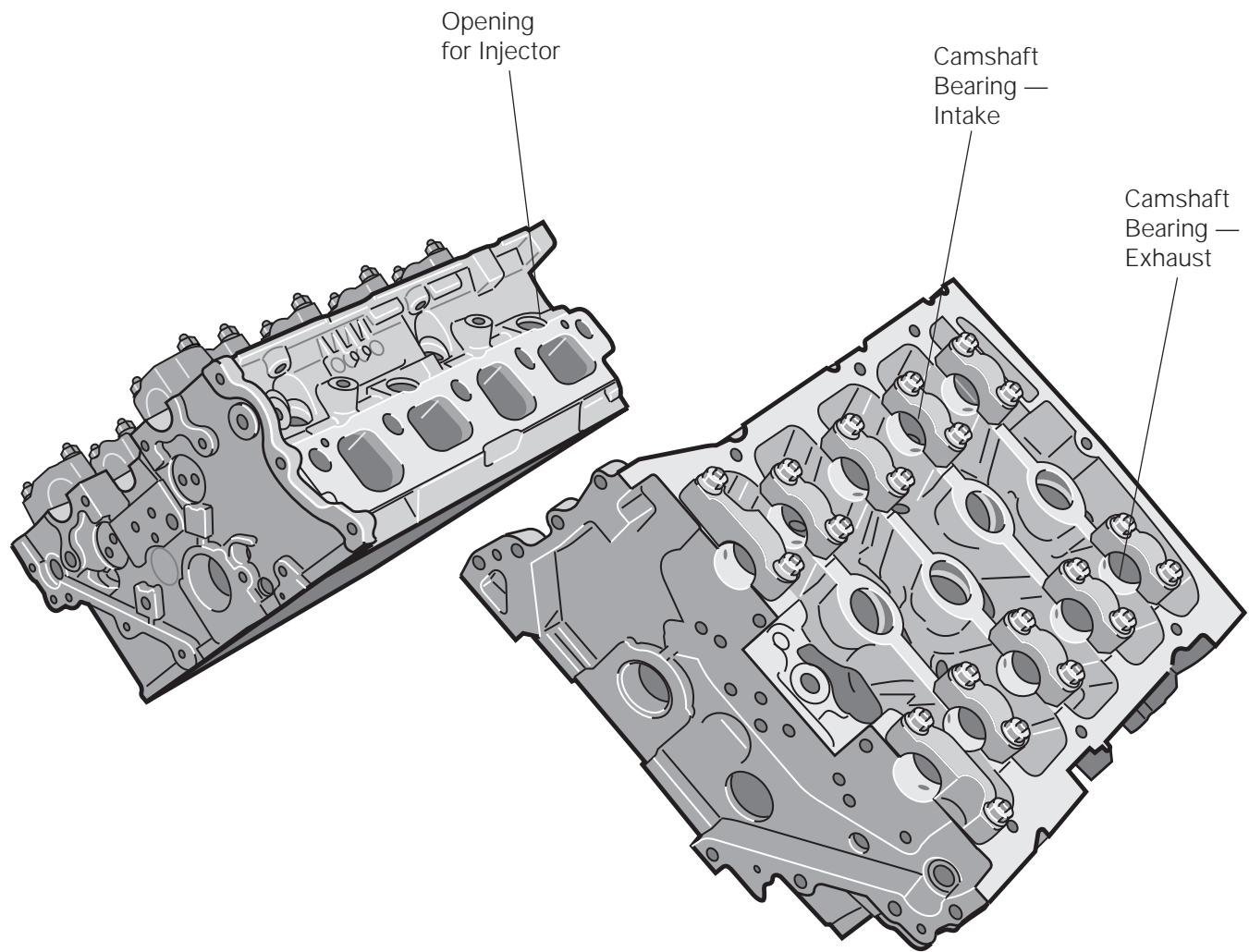
Engine — Mechanics

Cylinder Heads

The W engines have two aluminium cylinder heads with two overhead camshafts apiece.

The injectors are inserted into the cylinder heads.

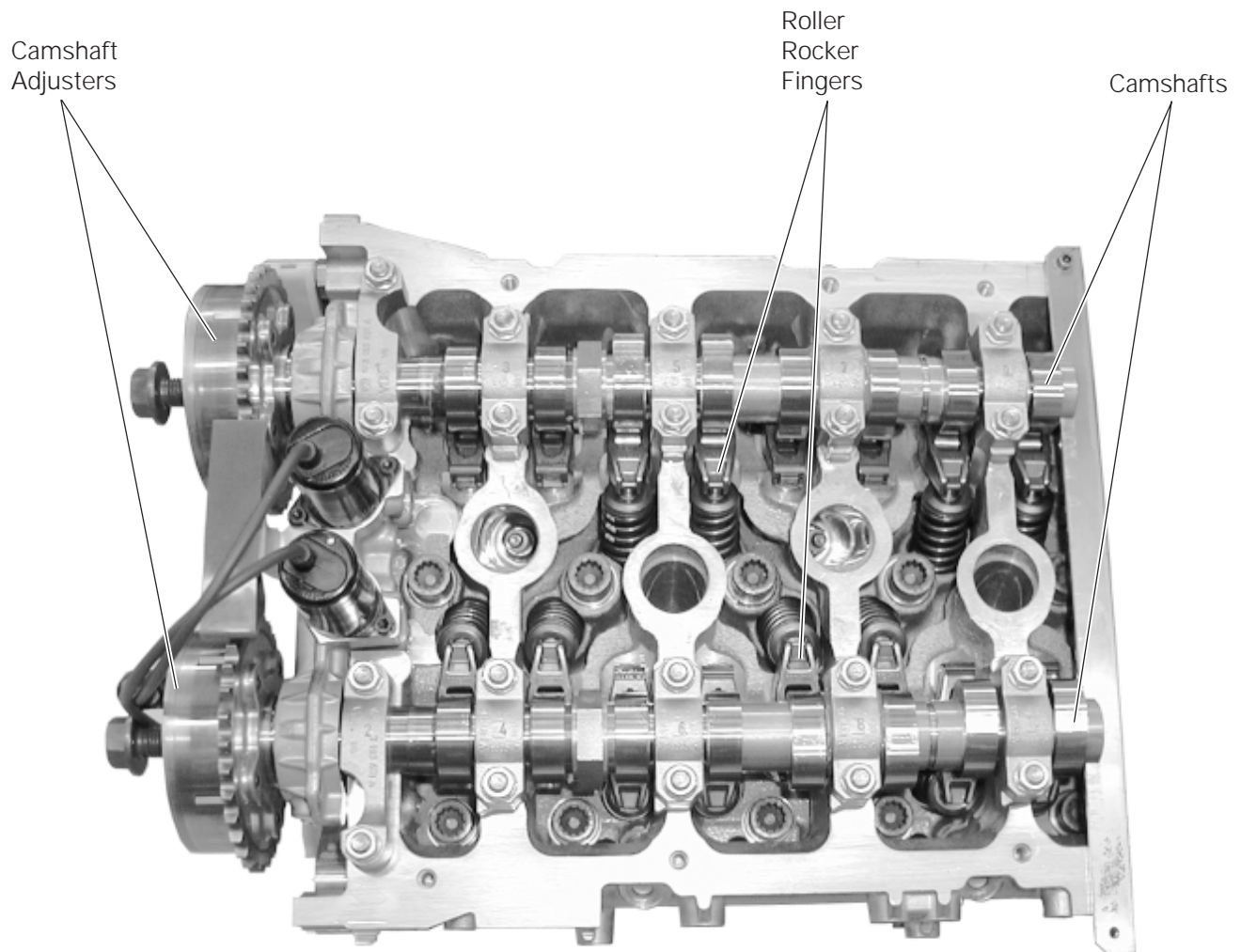
Cylinder Heads of W8 Engine



Engine — Mechanics

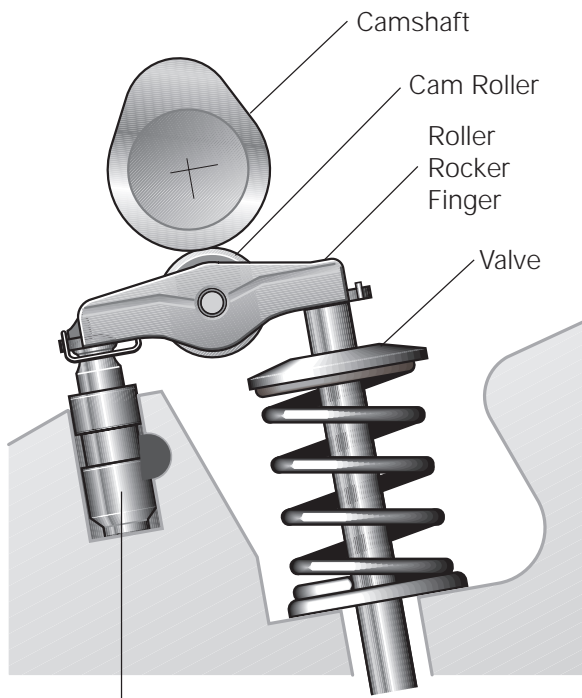
Each of the cylinder heads in the two W engines has an intake camshaft and an

exhaust camshaft with camshaft adjusters attached to their end faces.



SSP248/067

Engine — Mechanics

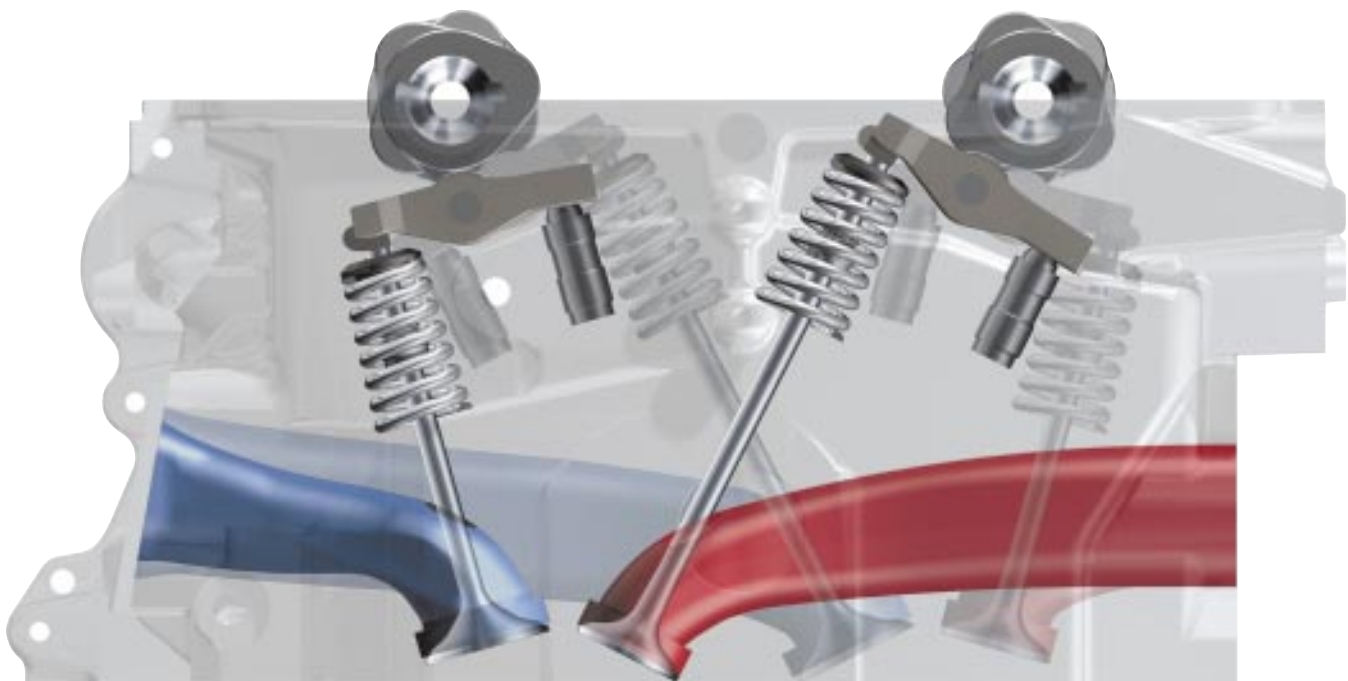


Hydraulic Support Element

SSP248/160

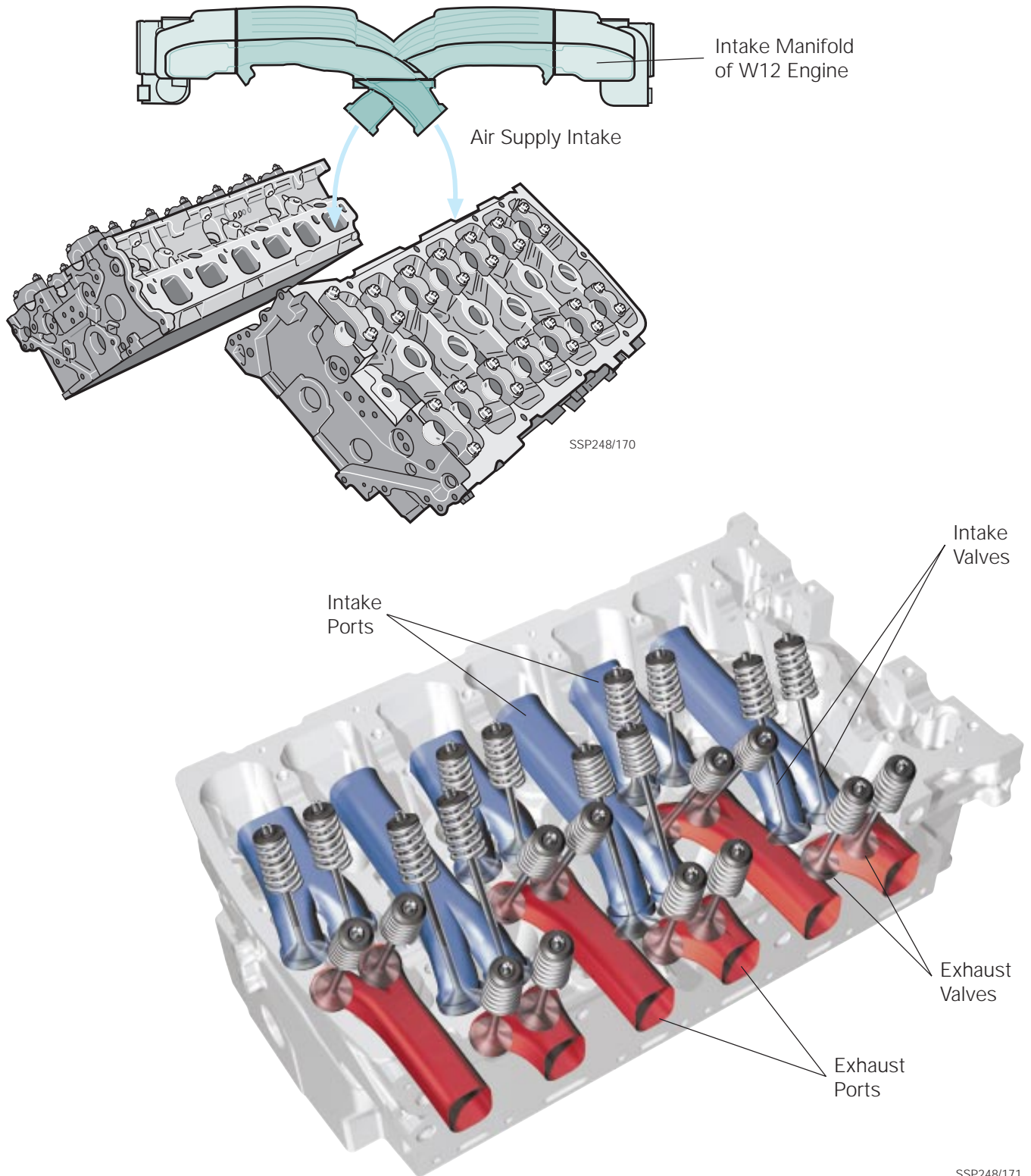
The four valves in each cylinder are actuated by low-friction roller rocker fingers. Valve clearance is compensated by hydraulic support elements.

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



SSP248/161

Cylinder Heads of W12 Engine

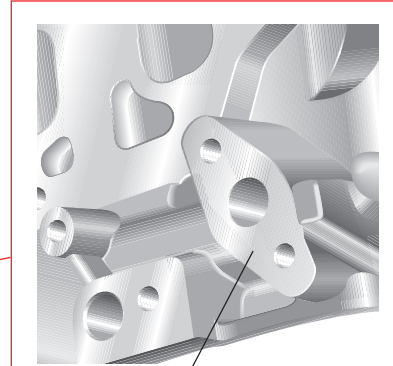


Engine — Mechanics

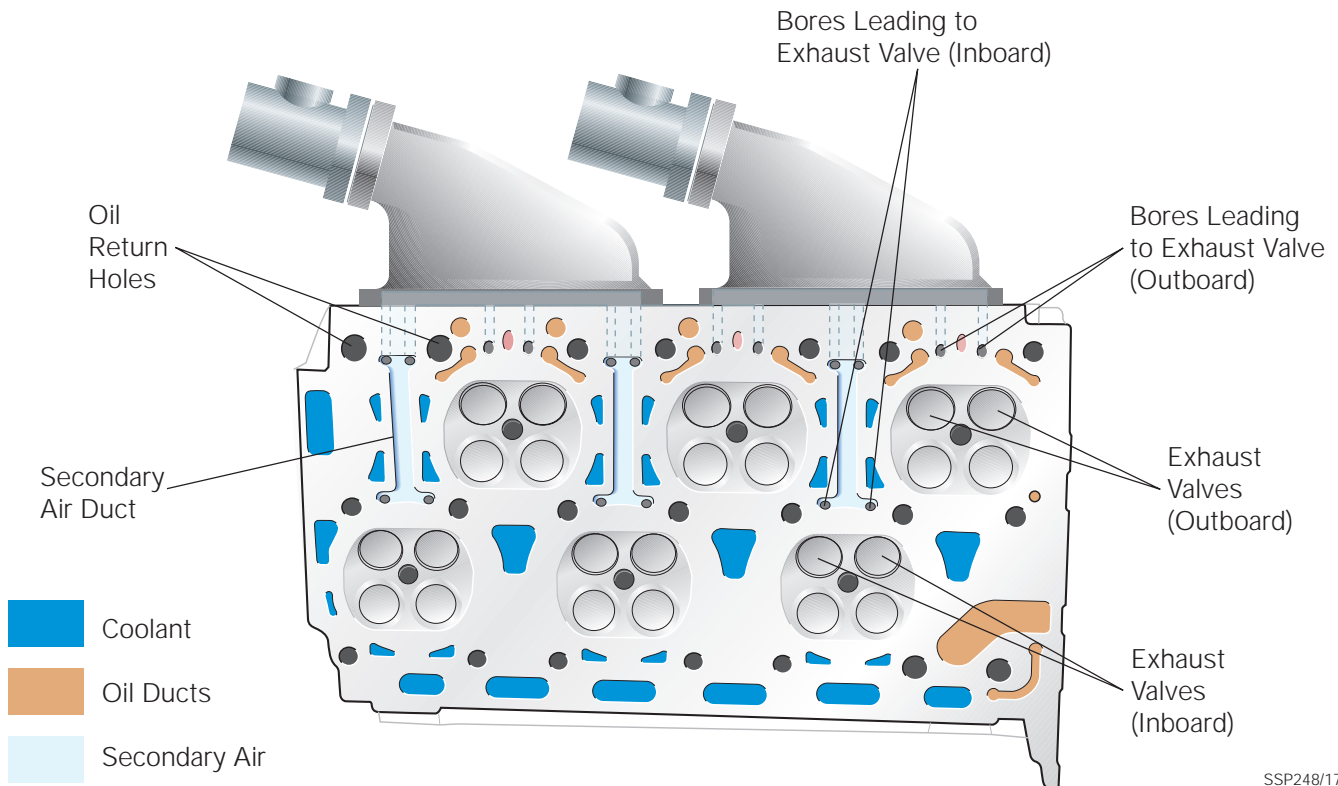
Secondary Air Ducting System

Besides the coolant and oil ducts in the cylinder heads, the secondary air is guided through ducts and bores into the exhaust ducts near the exhaust valves. The secondary air flows into a duct in the cylinder head through a Secondary Air Injection (AIR) Solenoid Valve N112.

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



Connection for Secondary Air Injection (AIR) Solenoid Valve N112

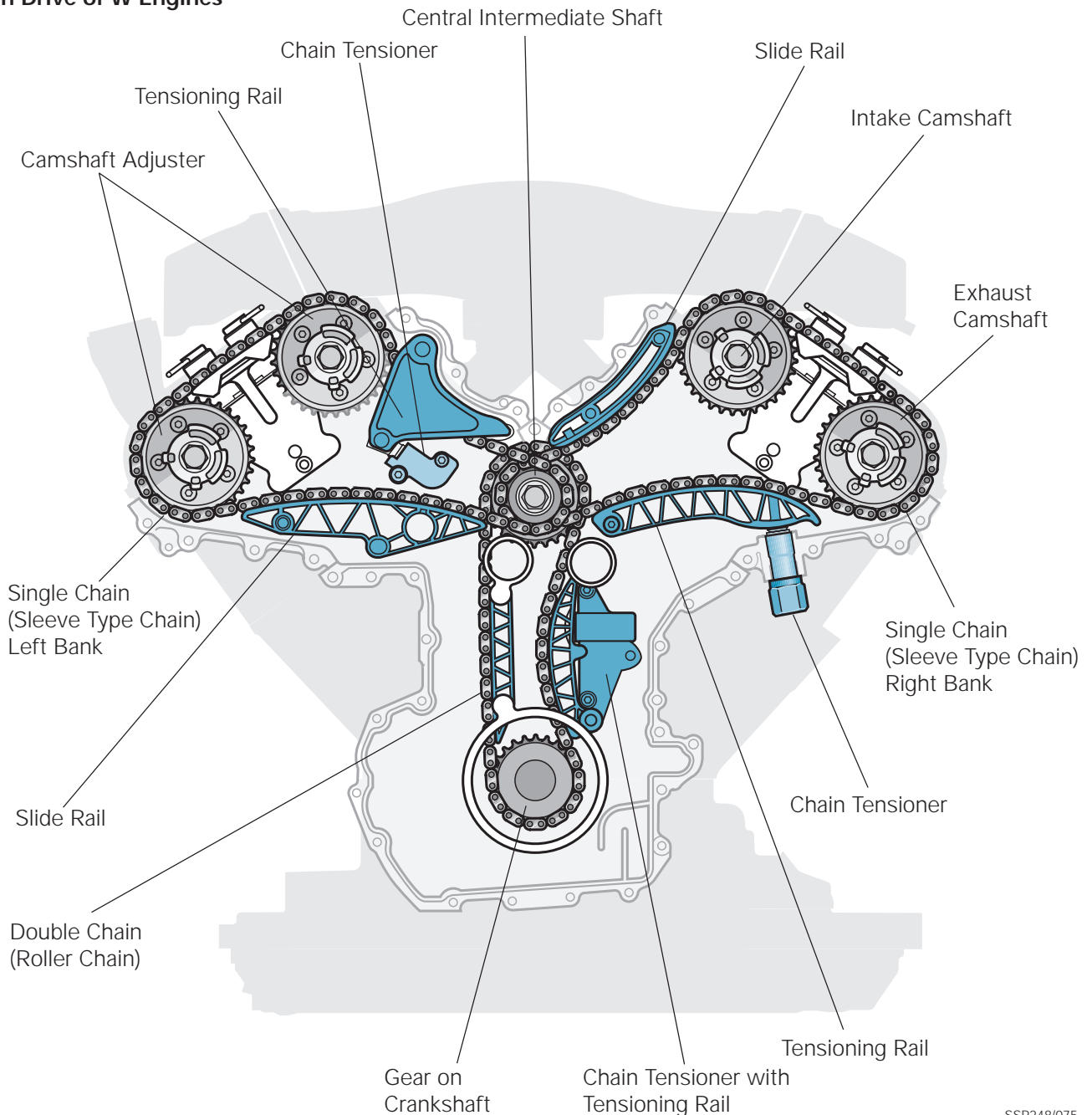


Chain Drive

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 a single chain. Three hydraulic chain tensioners ensure that an optimal chain tension is maintained.

Chain Drive of W Engines



SSP248/075

Engine — Mechanics

Camshaft Timing Control

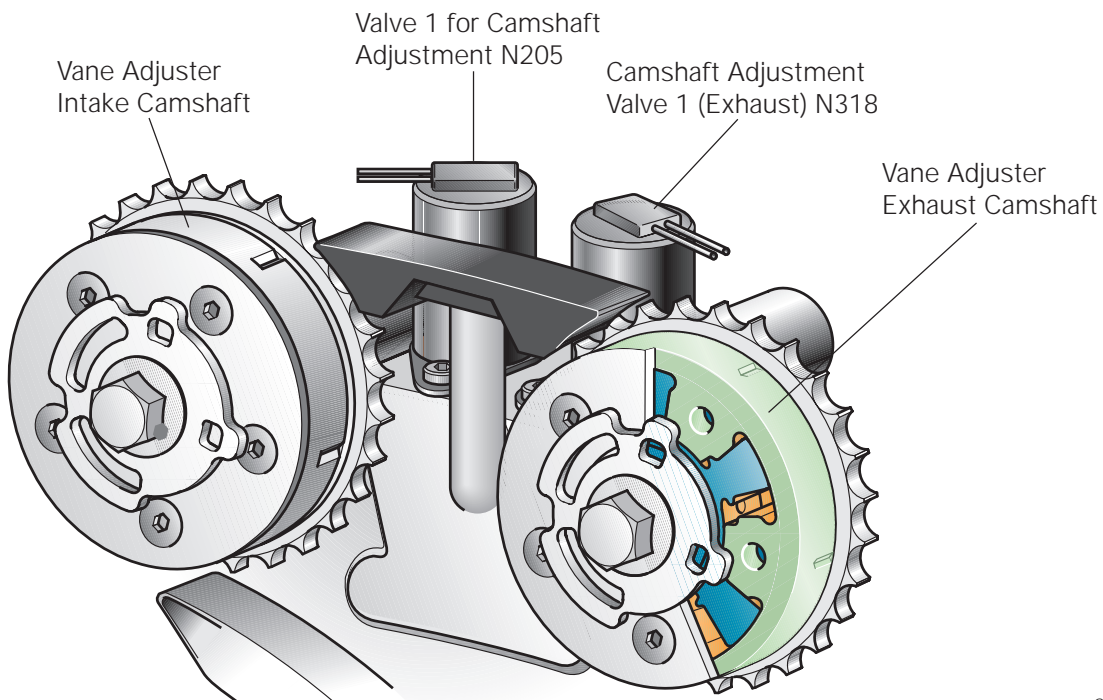
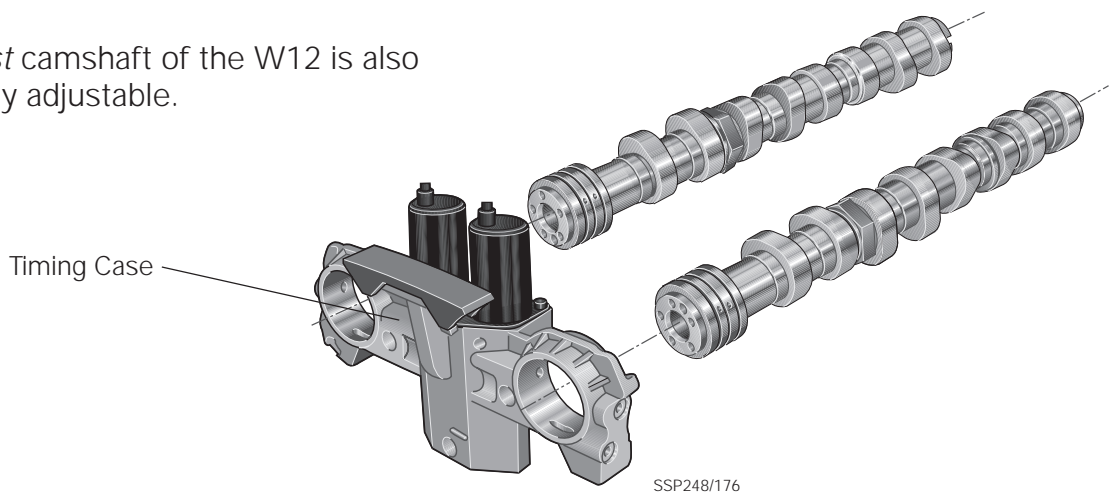
Both the W12 engine and the W8 engine have continuously adjustable intake camshaft timing. In this case, continuously adjustable means that the intake camshaft can be advanced or retarded relative to its neutral position at any angle within a range of 52 degrees.

The camshafts are adjusted by hydraulic camshaft positioners bolted to their end faces.

The *exhaust* camshaft of the W12 is also continuously adjustable.

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 degrees.

The Motronic Engine Control Module J220 regulates the oil supply to the camshaft positioners by controlling the Valve 1 for Camshaft Adjustment N205 and Camshaft Adjustment Valve 1 (Exhaust) N318.



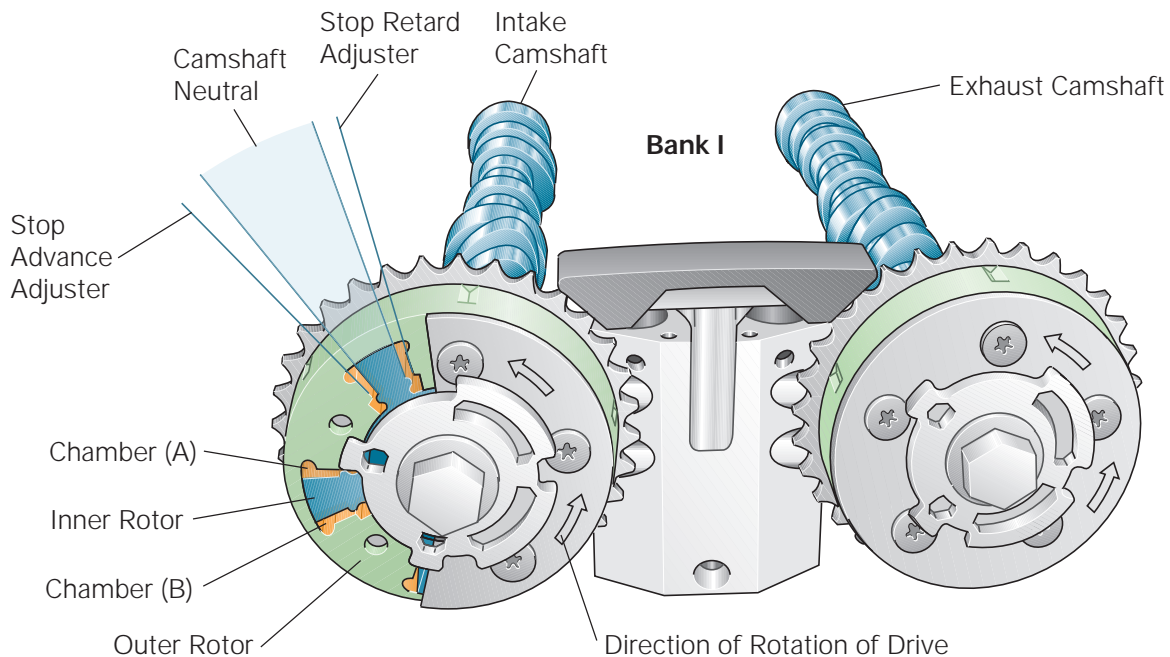
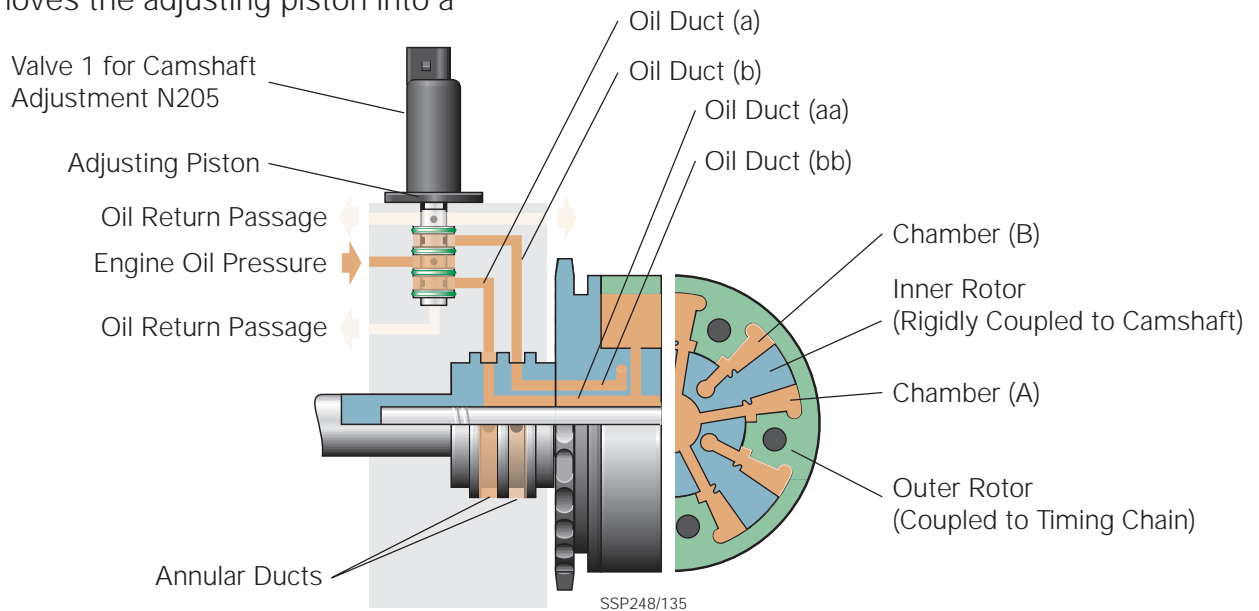
System Operation

The following examples show the operation of the intake camshaft adjuster for the right bank (bank I).

Neutral position

When the Valve 1 for Camshaft Adjustment N205 moves the adjusting piston into a

central position, this causes both oil ducts (a and b) — and hence the chambers (A and 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.



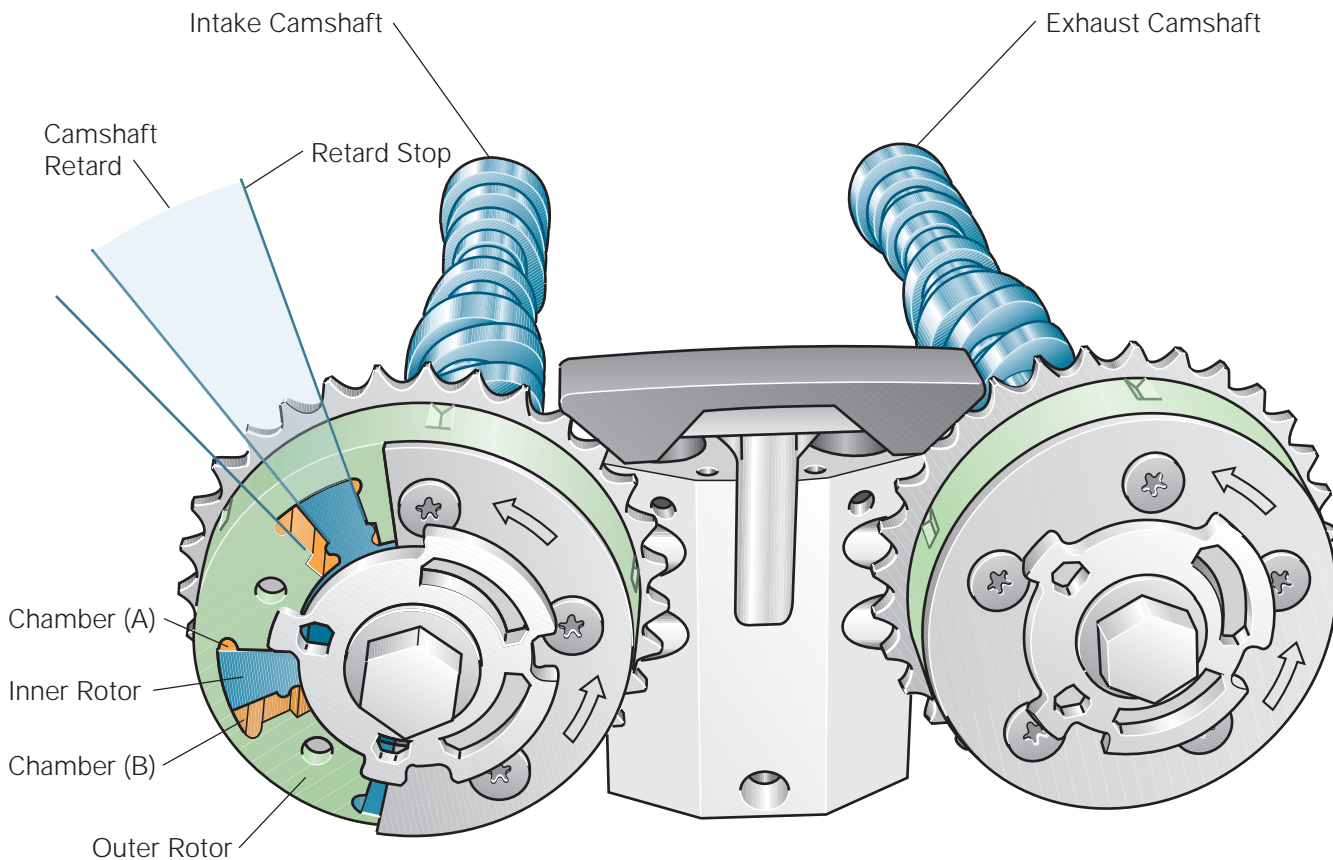
Engine — Mechanics

Retard adjustment

The Valve 1 for Camshaft Adjustment N205 guides the oil into the oil duct (b). The oil flows from channel (b) through the annular groove and camshaft and 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, 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 through the camshaft and duct (a).

Bank I



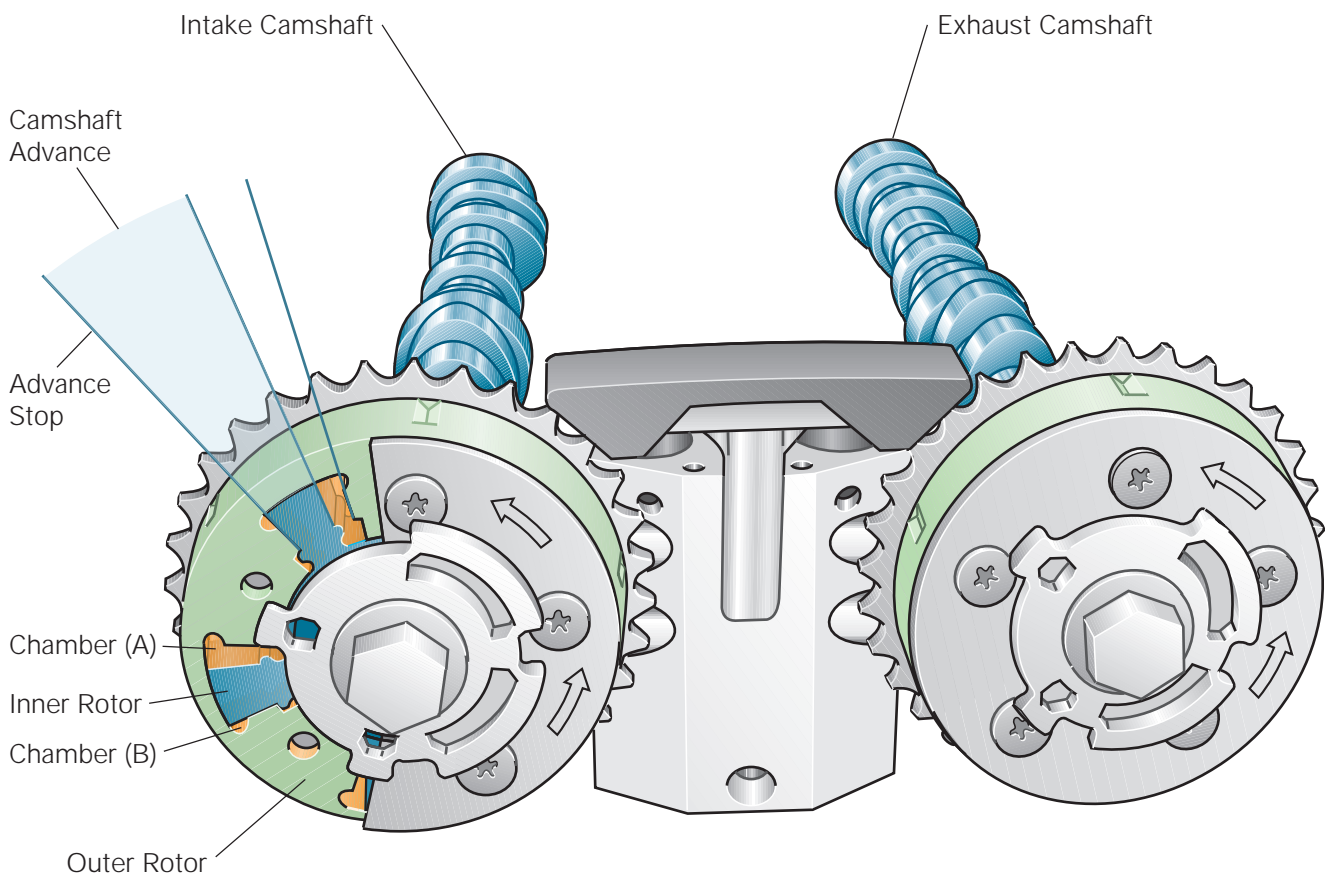
SSP248/138

Advance adjustment

To rotate the inner rotor forward, the adjusting piston housed within the Valve 1 for Camshaft Adjustment N205 adjusts itself so that the oil duct (a) is put under oil

pressure. As a result, the oil flows into the chamber (A), advancing the inner rotor. Chamber B is simultaneously bled through oil ducts (bb and b) to ensure a quick response.

Bank I



SSP248/137

Engine — Mechanics

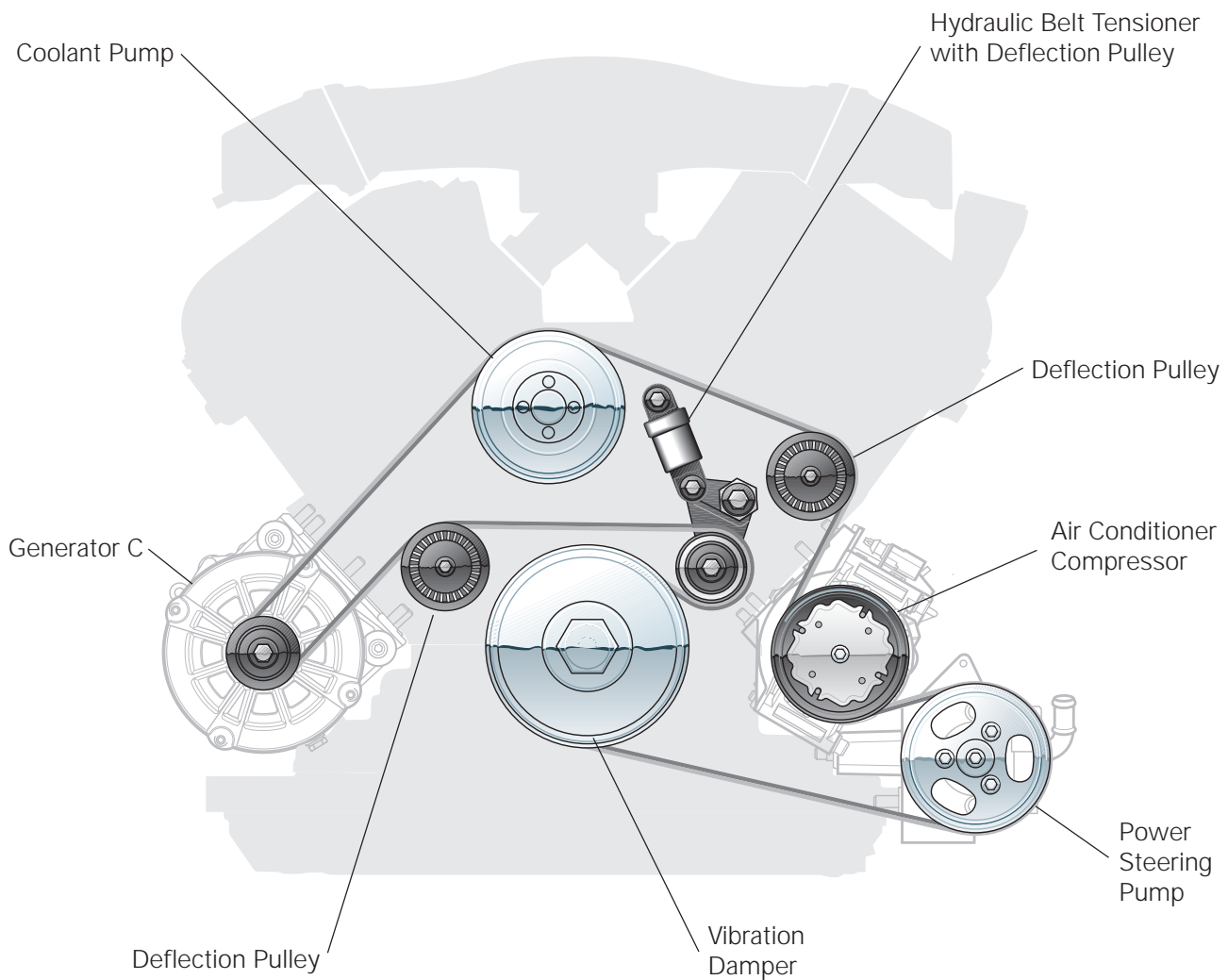
Belt Drive

The following components are driven by the belt drive:

- Coolant pump
- Generator C
- Power steering pump
- Air conditioner compressor

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

Belt Drive of the W8 Engine and W12 Engine used by Volkswagen

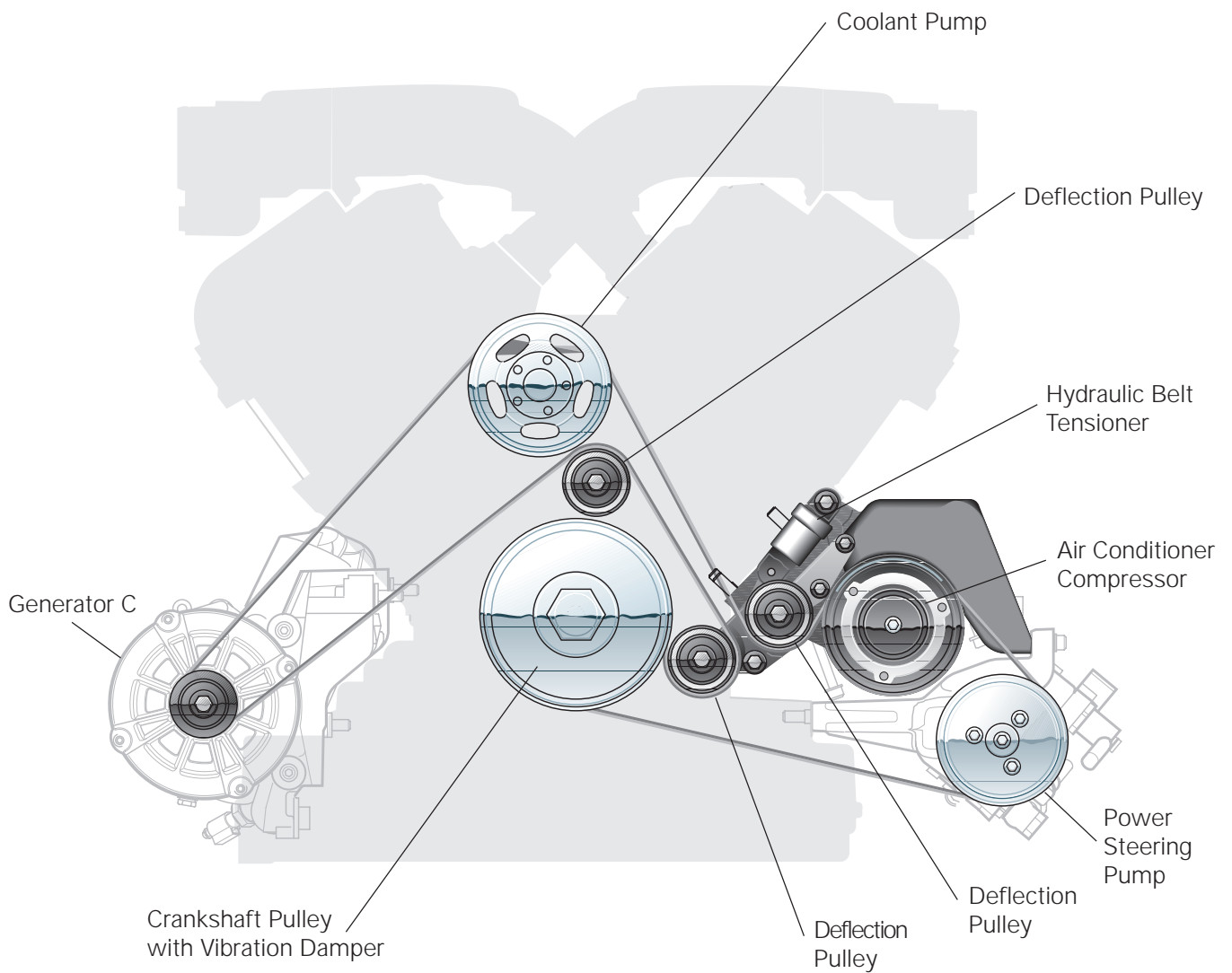


SSP248/137

Engine — Mechanics

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

Belt Drive of the W12 Engine used by Audi



SSP248/078

Engine — Mechanics

Engine Lubrication

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

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

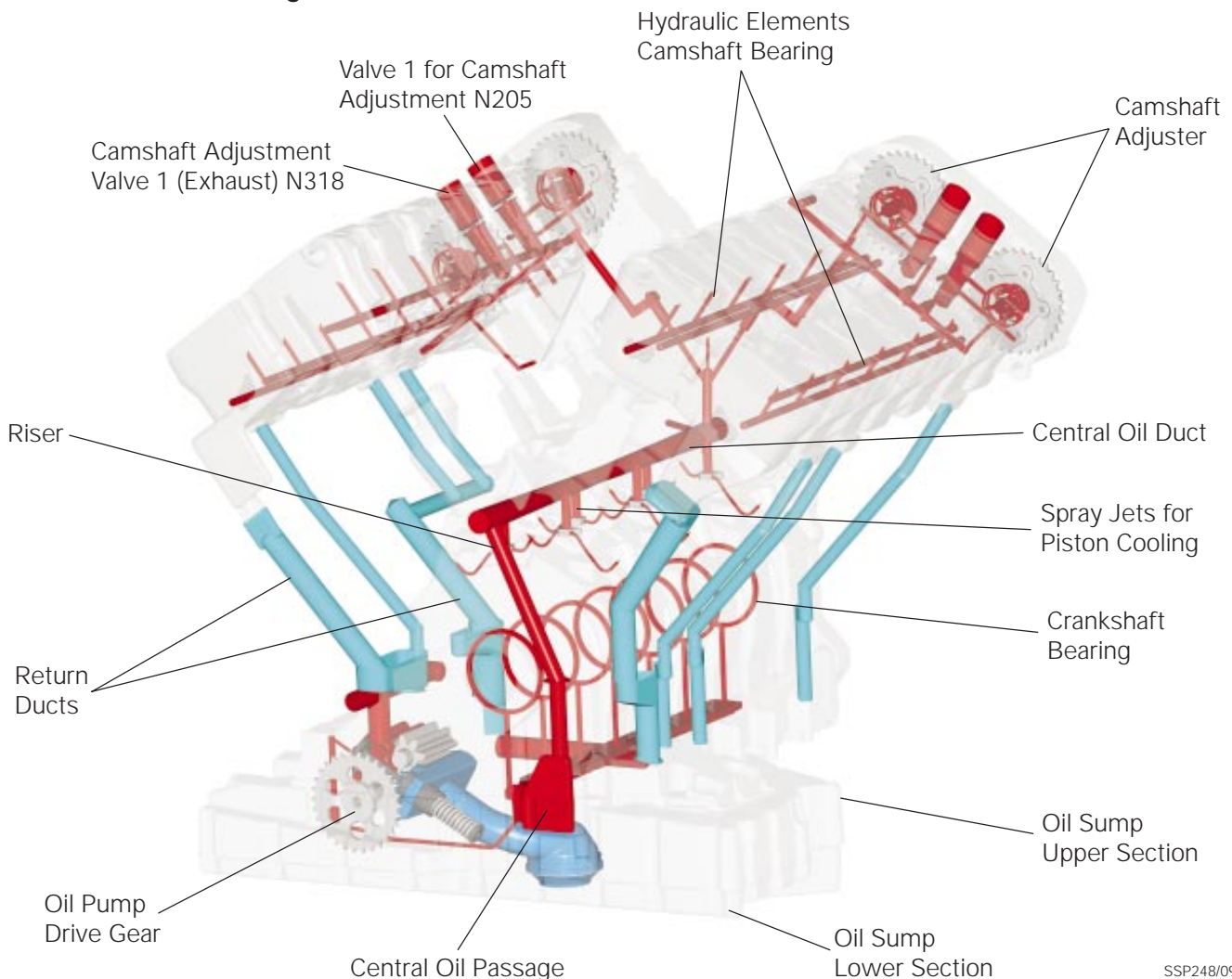
The oil flows from the central oil duct to the spray jets for piston cooling, and then from there to the cylinder heads through risers equipped with non-return valves.

The oil also flows to the intermediate shaft, to the 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.

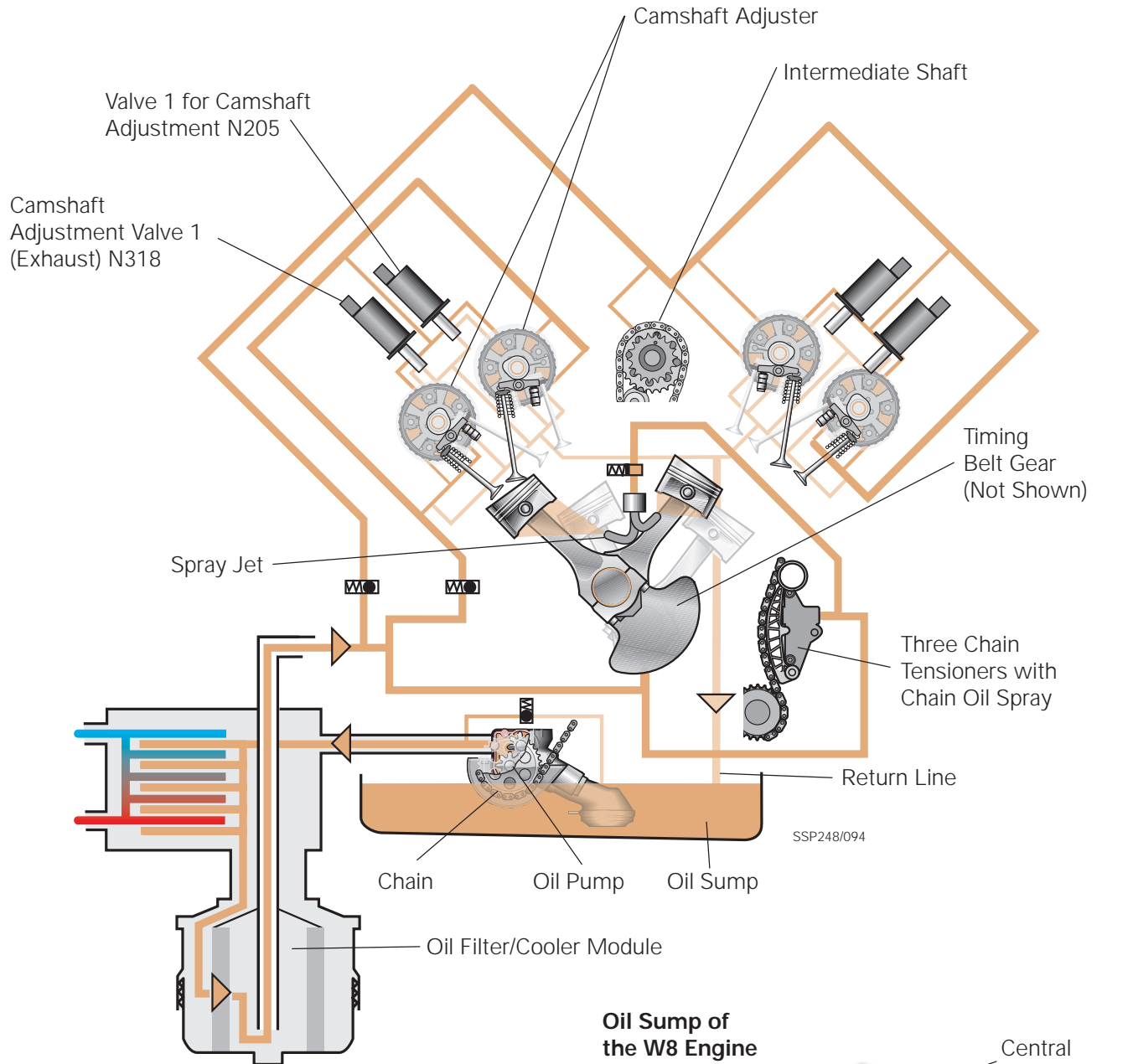
The return lines guide the oil back into the oil sump.

Oil Circuit of the W12 Engine

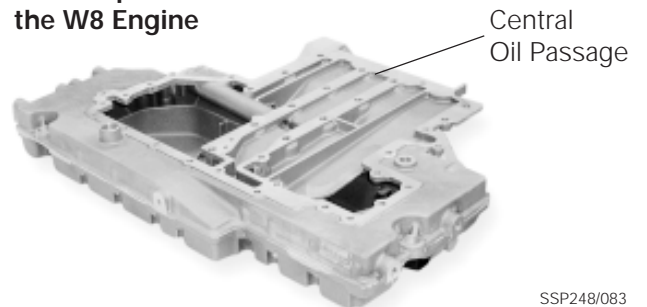


SSP248/091

W Engine Oil Circuit Schematic Diagram



Oil Sump of the W8 Engine



SSP248/083

Engine — Mechanics

The Wet-Sump Principle

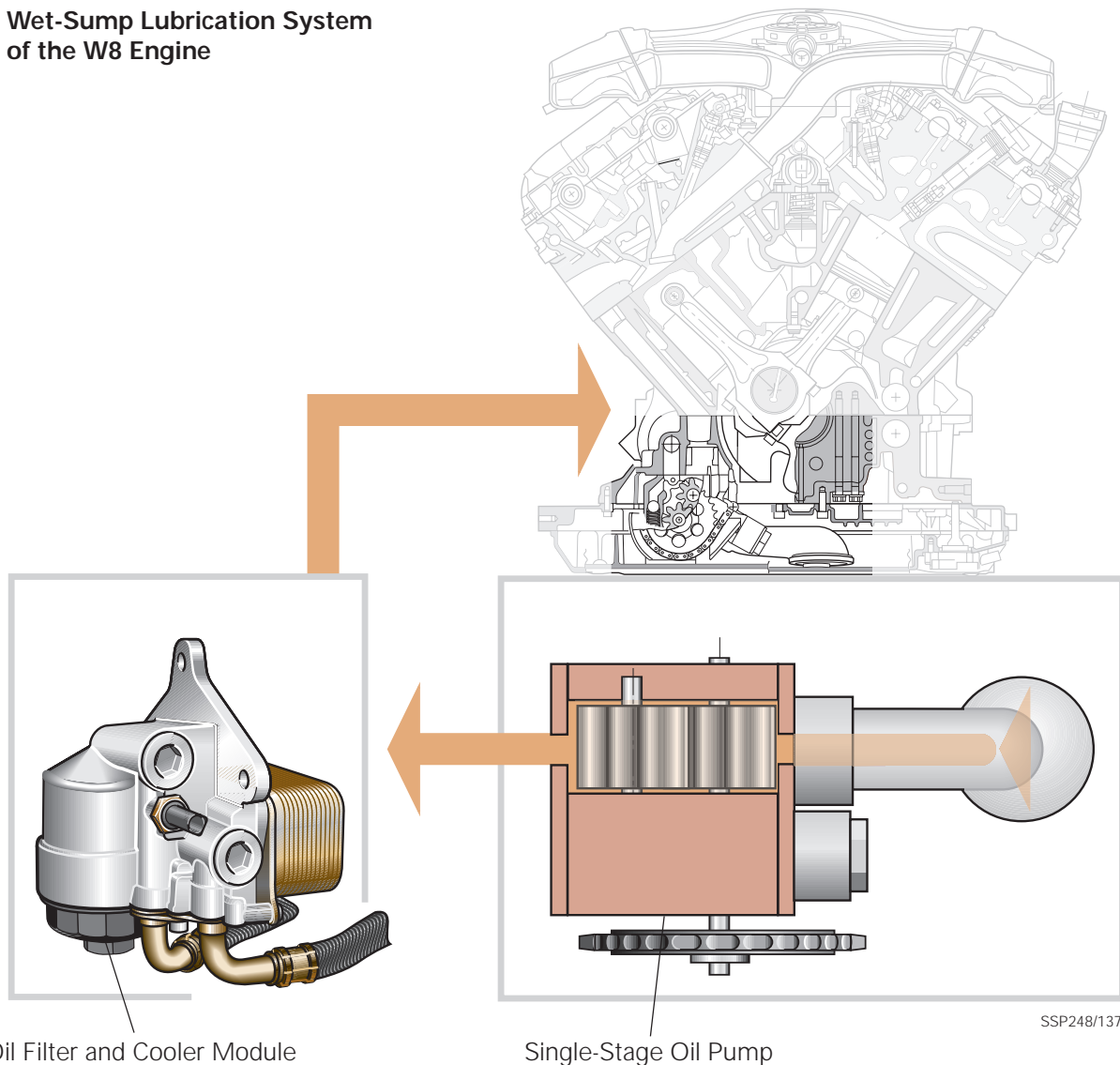
The W8 and W12 engine for VW models have a wet-sump lubrication system. The W12 engine for Audi models has a dry-sump lubrication system.

In 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 through 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.

Wet-Sump Lubrication System of the W8 Engine



The Dry-Sump Principle (Audi only)

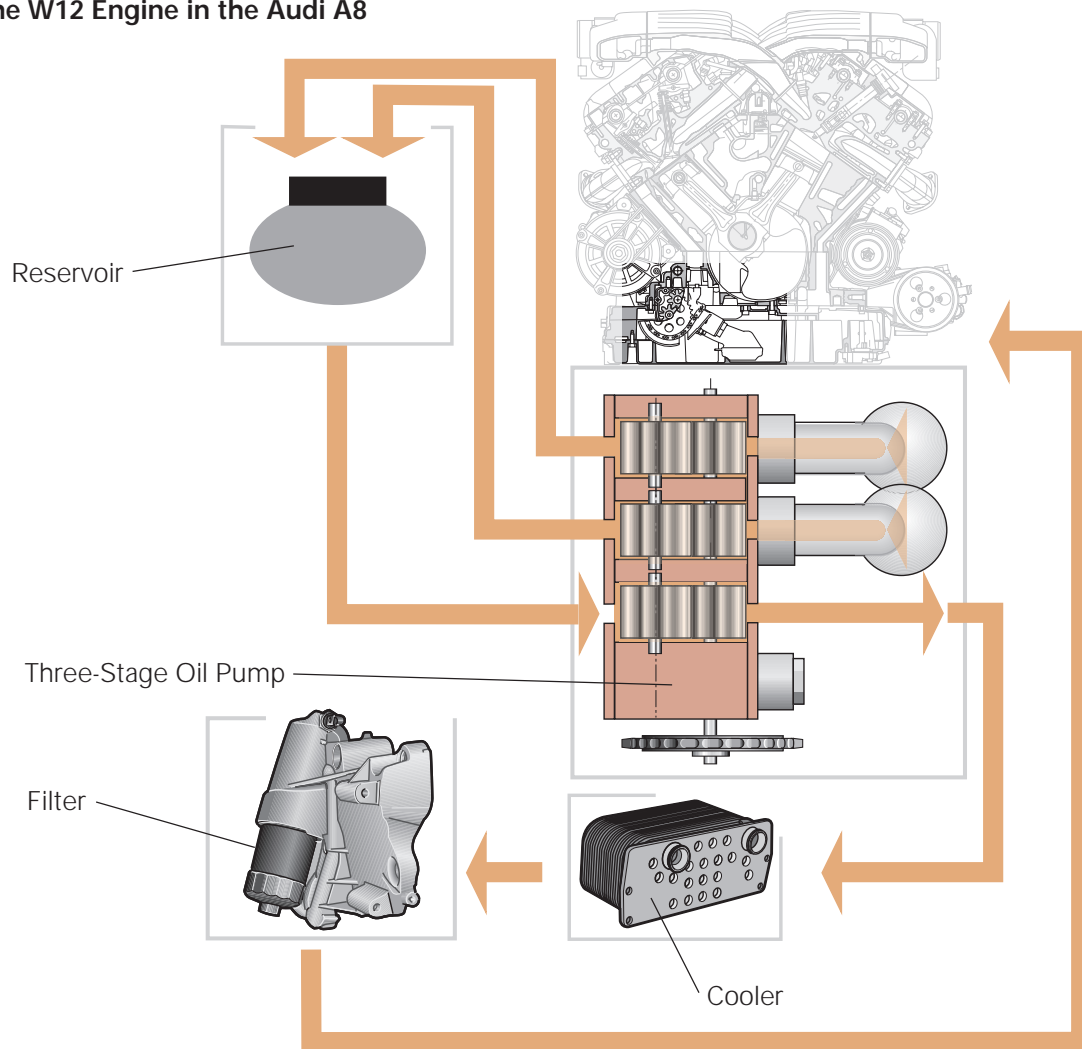
In the dry-sump lubrication system, the entire oil supply is retained in an external reservoir, and not in the oil sump.

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 through 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.

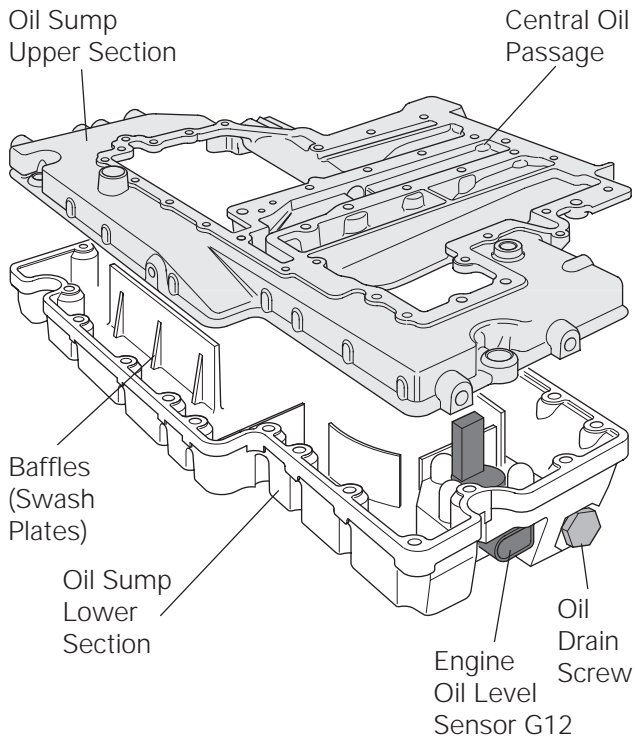
This requires a slightly more complex design.

Dry-Sump Lubrication System of the W12 Engine in the Audi A8



SSP248/088

Engine — Mechanics



SSP248/079

Oil Sump

The oil sump is comprised of two diecast aluminium parts. The oil sump lower section forms the oil reservoir. The central oil passage is located in the upper section of the oil sump.

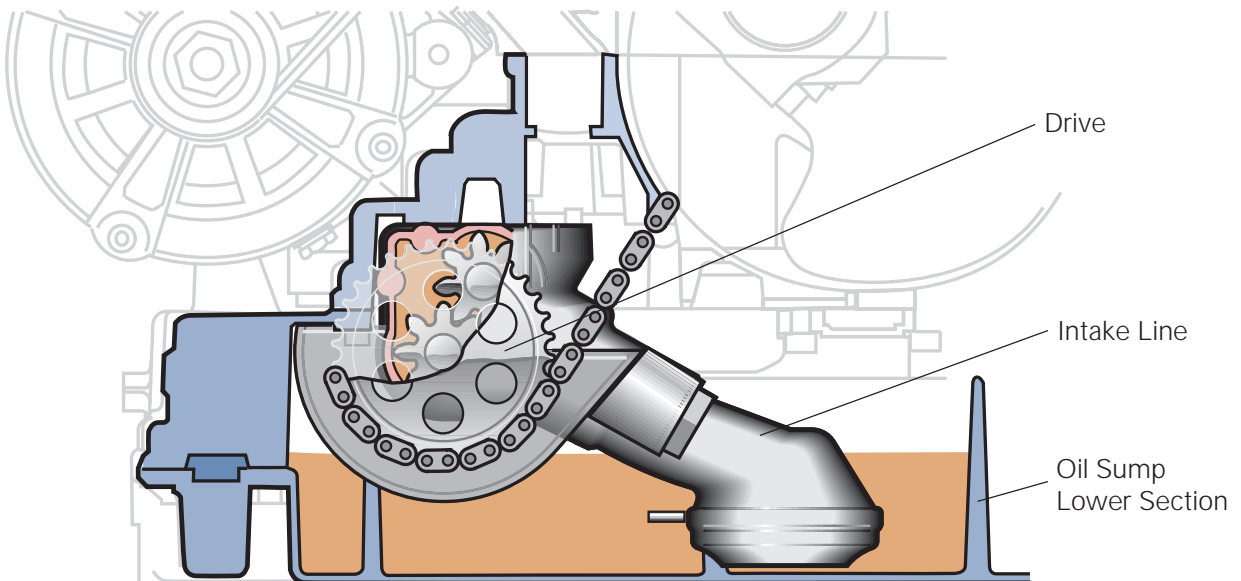
Special baffles settle the oil in the oil sump.

The Engine Oil Level Sensor G12 which informs the Motronic Engine Control Module J220 of the oil level, is inserted into the oil sump lower section from below, near the oil drain screw, and then bolted into place.

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

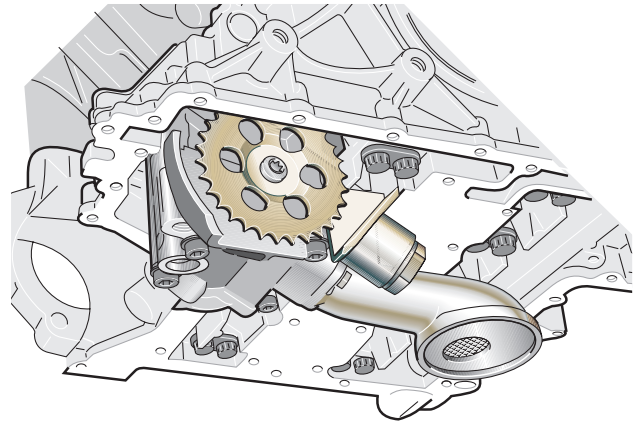
The single-stage oil pump is driven by the crankshaft by a separate chain in the crankcase.

The Oil Pump



SSP248/082

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

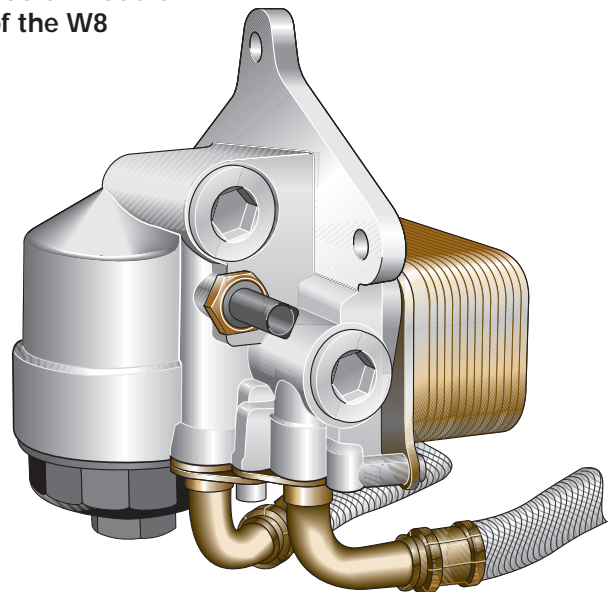


SSP248/081

Oil Filter and Cooler Module

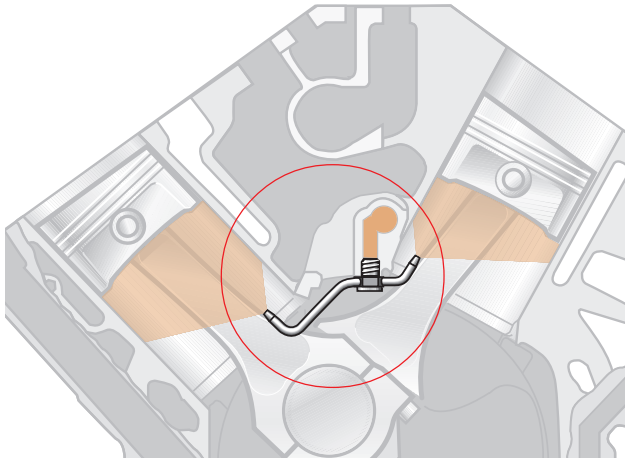
The oil circuit of the W engine has an external oil filter and cooler module. This allows the engine to be more easily adaptable to the varying amounts of space available in the various vehicle models. The oil filter is designed so that a filter element can be replaced by service personnel.

Oil Filter and Cooler Module of the W8



SSP248/095

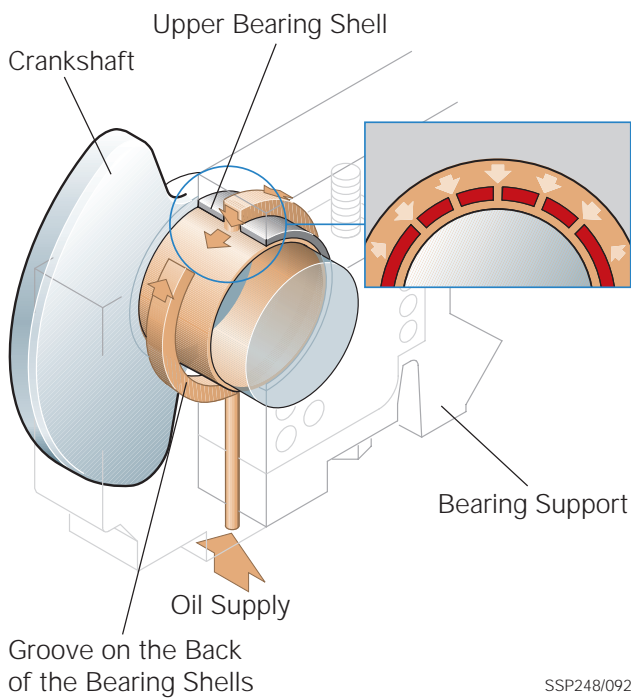
Engine — Mechanics



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Piston Spray Jets

The oil is guided from the central oil passage of the crankcase upper section to small nozzles at the base of the cylinder bores. Here, the oil is sprayed below the pistons to lubricate the piston contact faces and piston pins, and cool the pistons.



SSP248/092

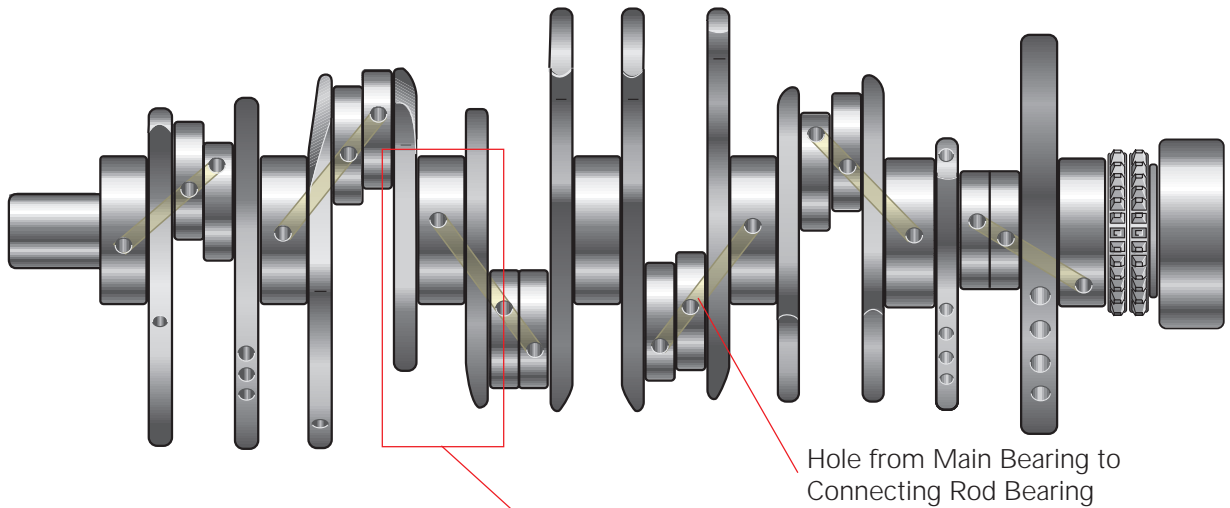
Crankshaft Bearing Lubrication

The oil is routed through holes from the central oil passage to the crankshaft. Then it is forced through grooves in the backs of the lower bearing shells to the upper bearing shells. There it reaches the crankshaft through five holes in the upper bearing shell.

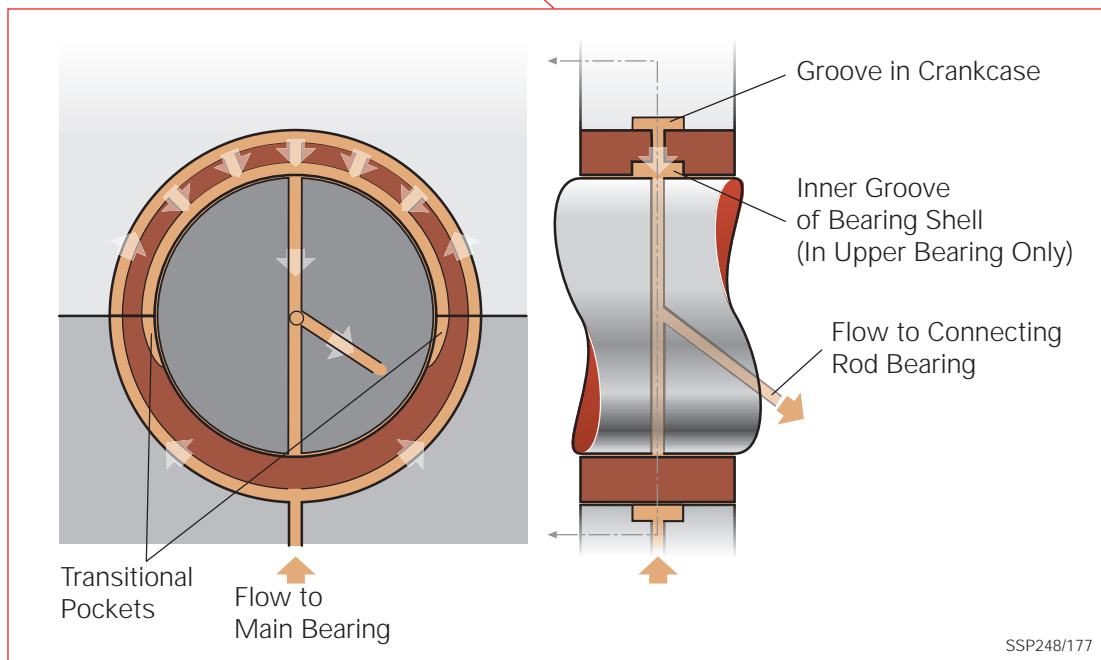
Connecting Rod Bearing Lubrication

The oil flows from the outer circumferential groove into the inner groove of the upper bearing shell through five holes. The holes ensure that an even oil film forms.

Integrated pockets at the transition to the lower bearing shell ensure a steady supply of oil to the connecting rod bearings through holes in the crankshaft.



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SSP248/177

Engine — Mechanics

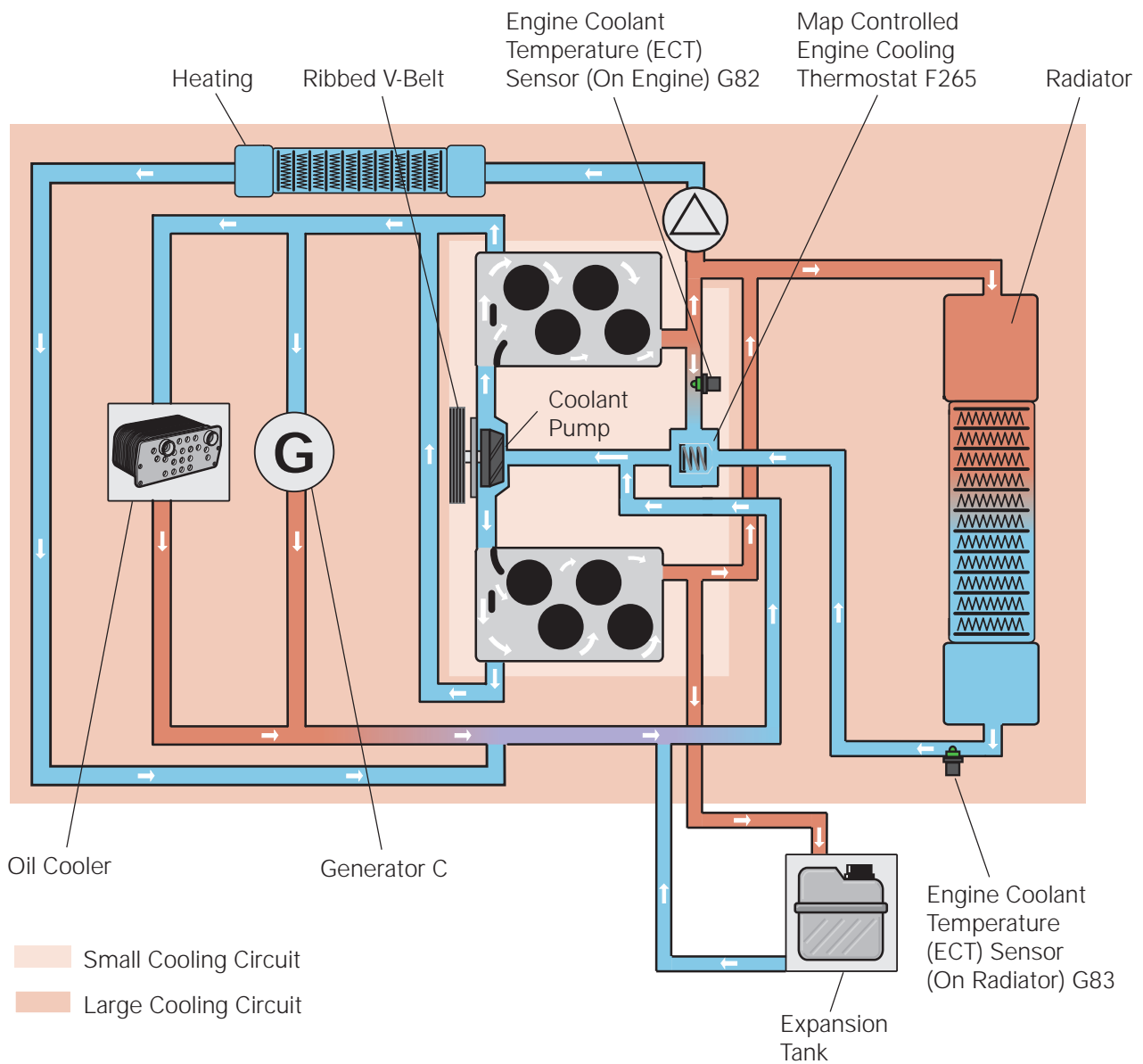
Engine Cooling

The coolant circuit is filled with VW G12 coolant. The coolant is pumped from 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.

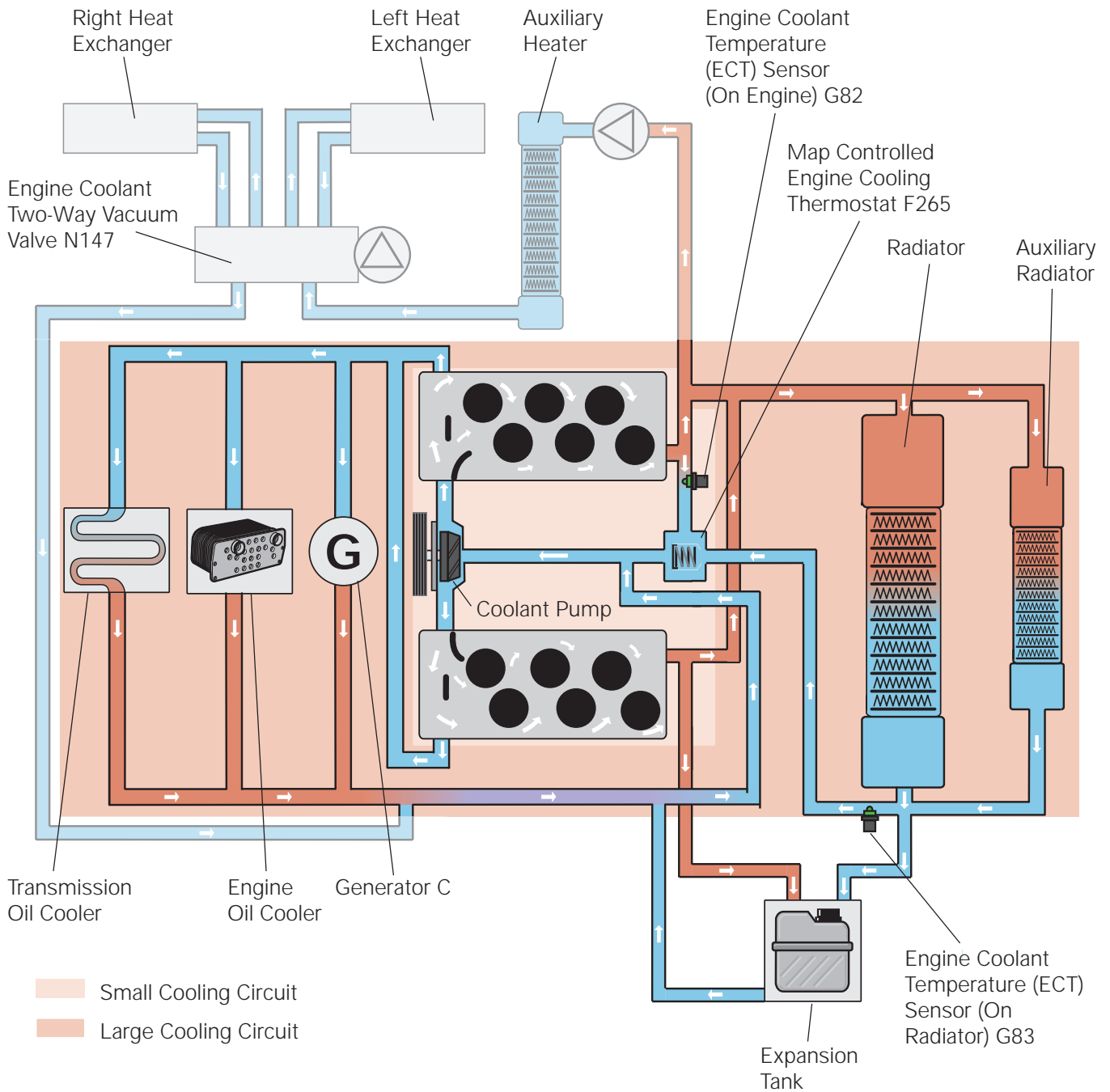
The coolant circuit is subdivided into a small cooling circuit, in which the coolant is only routed within the engine block, and a large cooling circuit that includes the radiator and engine oil cooler.

Coolant Circuit of W8 Engine

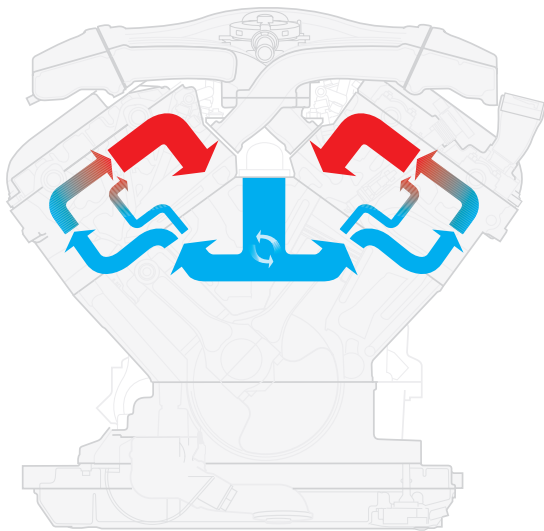


SSP248/098

Coolant Circuit of W12 Engine



SSP248/099



SSP248/114

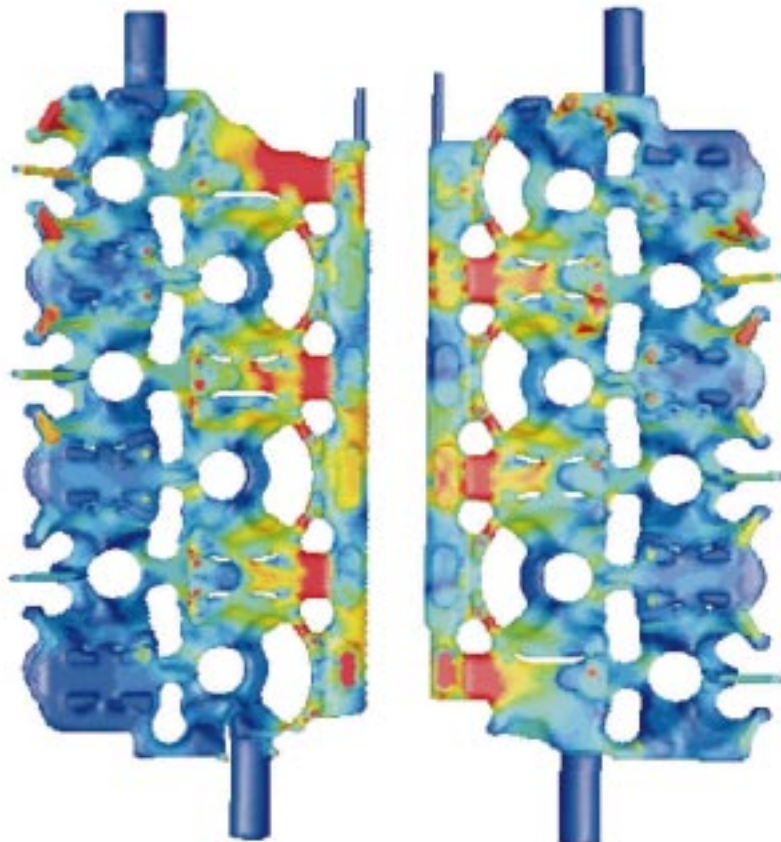
Coolant Flow in the Cylinder Heads

When the coolant moves through the crankcase and into the two cylinder heads, two thirds of the coolant volume is guided to the outside and one third to the inside of the cylinder heads.



This principle helps to provide even cooling, and is known as cross-cooling.

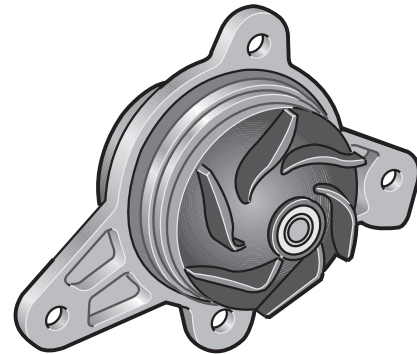
Coolant flows through the cylinder heads from the exhaust side to the intake side. This results in very good temperature equalization as well as effective cooling of the outlet webs and spark plugs.



SSP248/115

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.

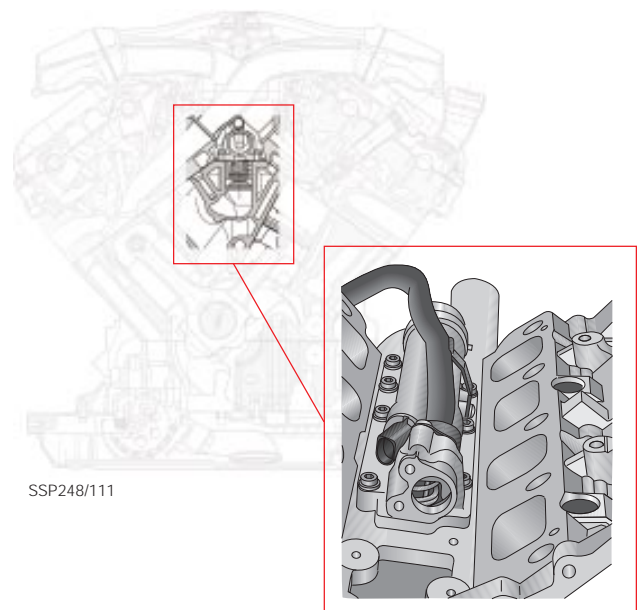


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Electronically Controlled Engine Cooling

Switching from the small cooling circuit to the large cooling circuit is controlled by an electrically actuated Map Controlled Engine Cooling Thermostat F265 in the thermostat housing. 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.

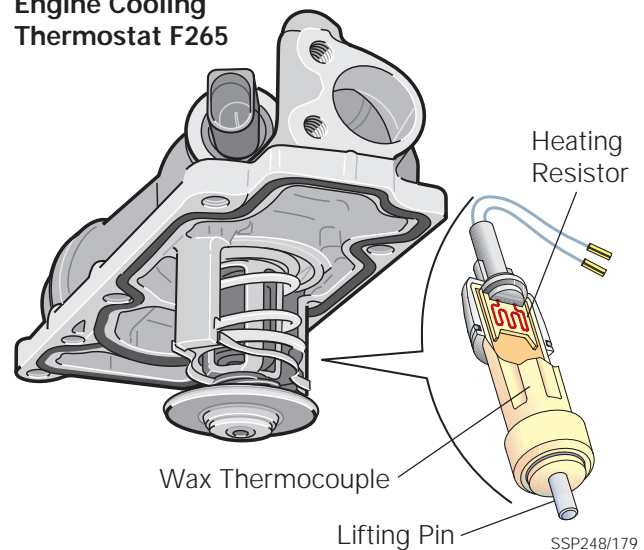
By electrically heating the wax thermocouple in the Map Controlled Engine Cooling Thermostat F265, it is possible to control the switching point and coolant temperature. Characteristic control maps are stored in the Motronic Engine Control Module J220. They make it possible for the engine to reach the desired temperature in accordance with the engine's operating requirements.



SSP248/111

SSP248/112

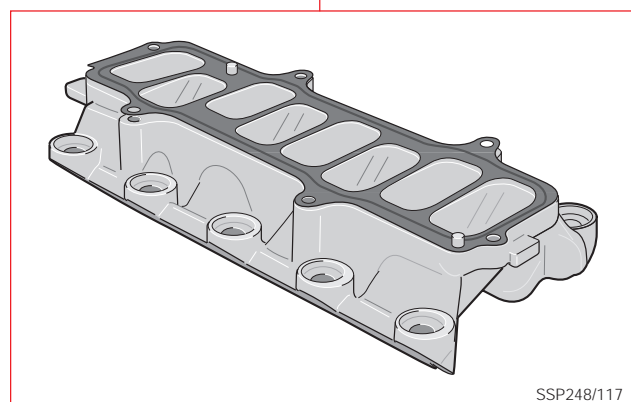
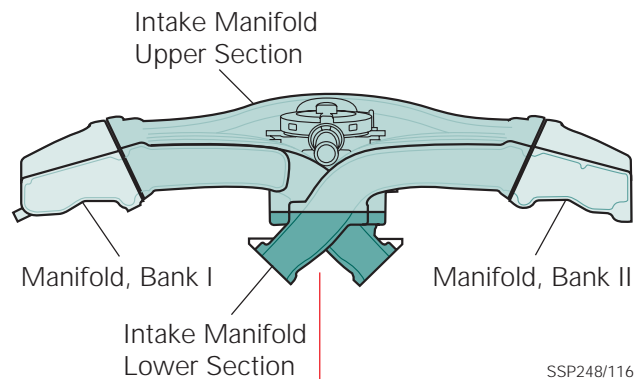
Map Controlled Engine Cooling Thermostat F265



SSP248/179

Engine — Mechanics

W8 Engine

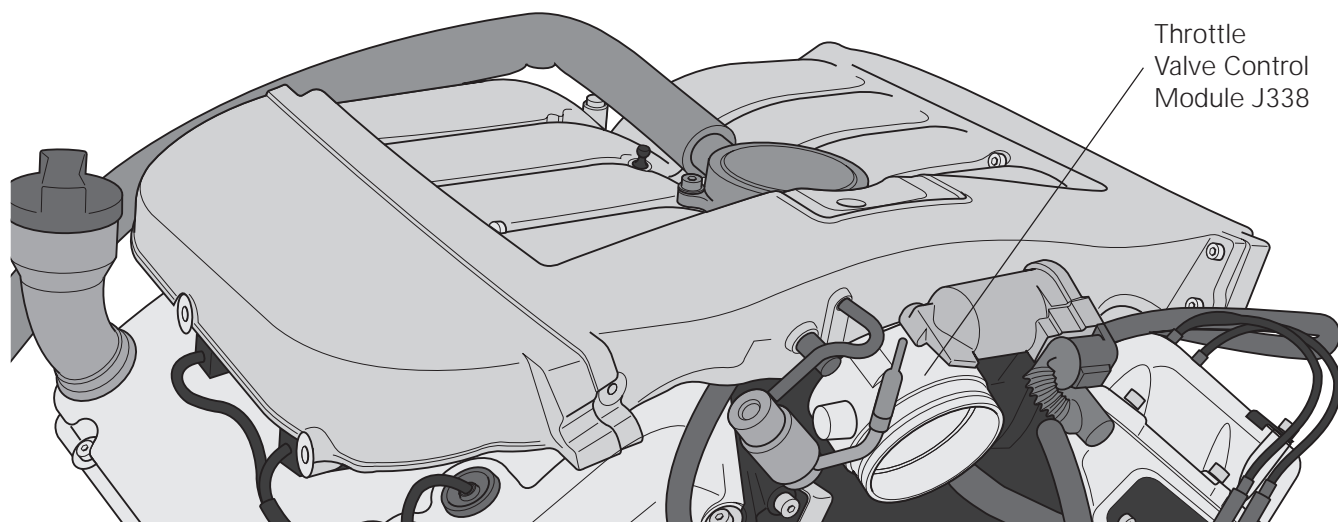


Air Supply

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 removed separately. This makes it easier to gain access to the individual ignition coils and spark plugs, for example.

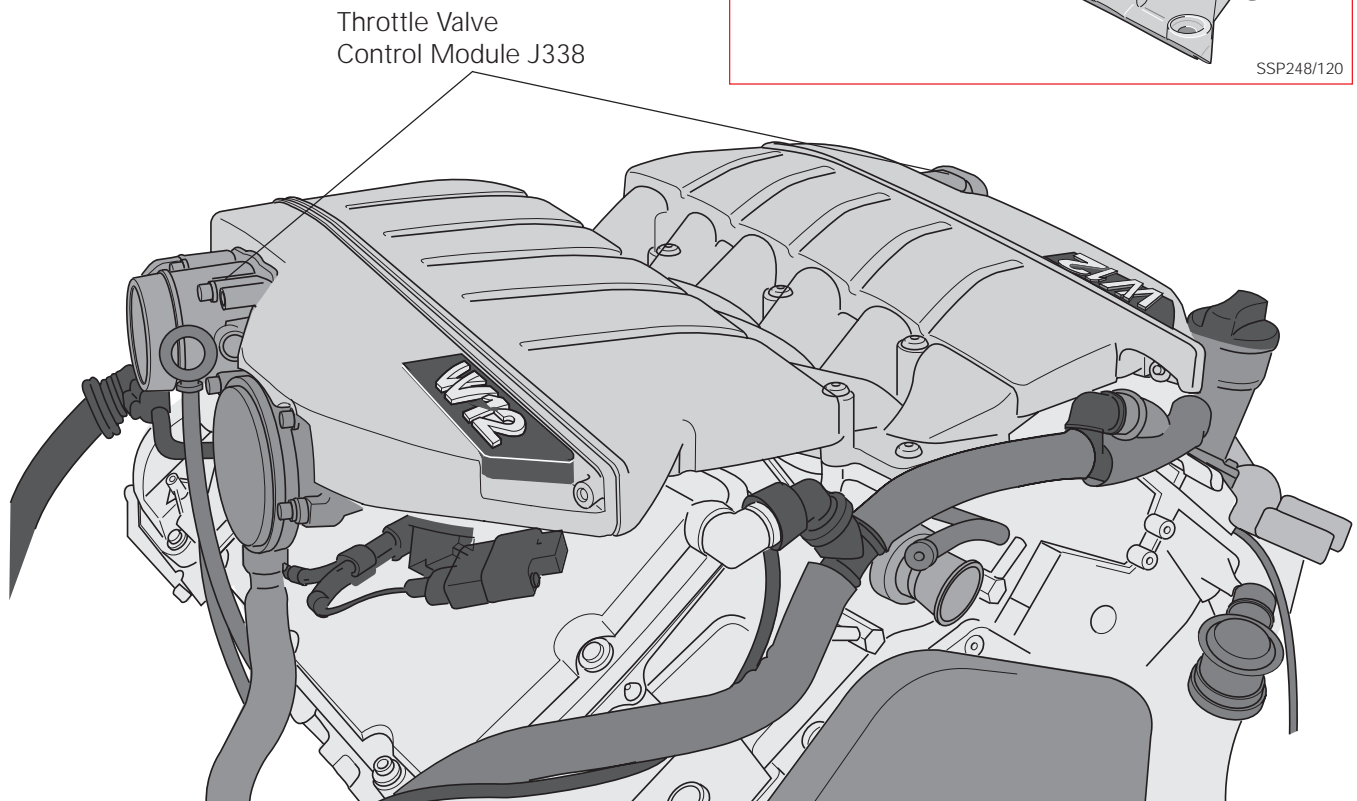
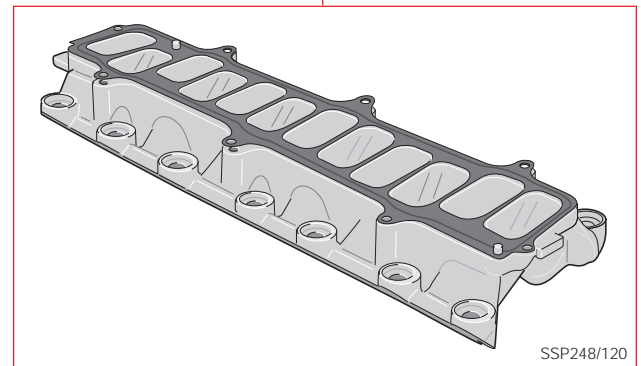
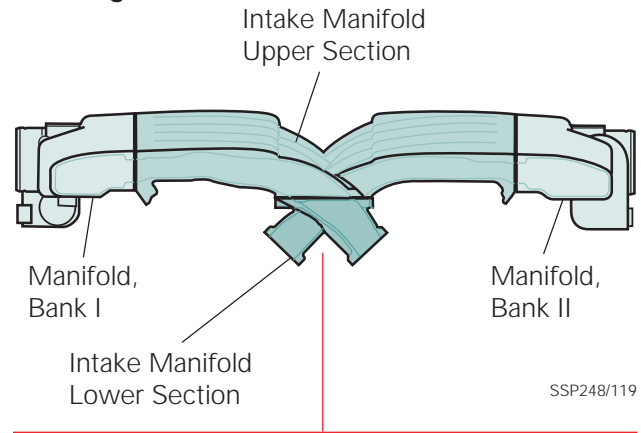
In the W8 engine, the intake air for both manifolds is guided by a Throttle Valve Control Module J338.



Engine — Mechanics

The intake manifold used in the W12 engine is made of magnesium alloy. Unlike the W8 engine, each of the manifolds is coupled to a separate Throttle Valve Control Module J338.

W12 Engine



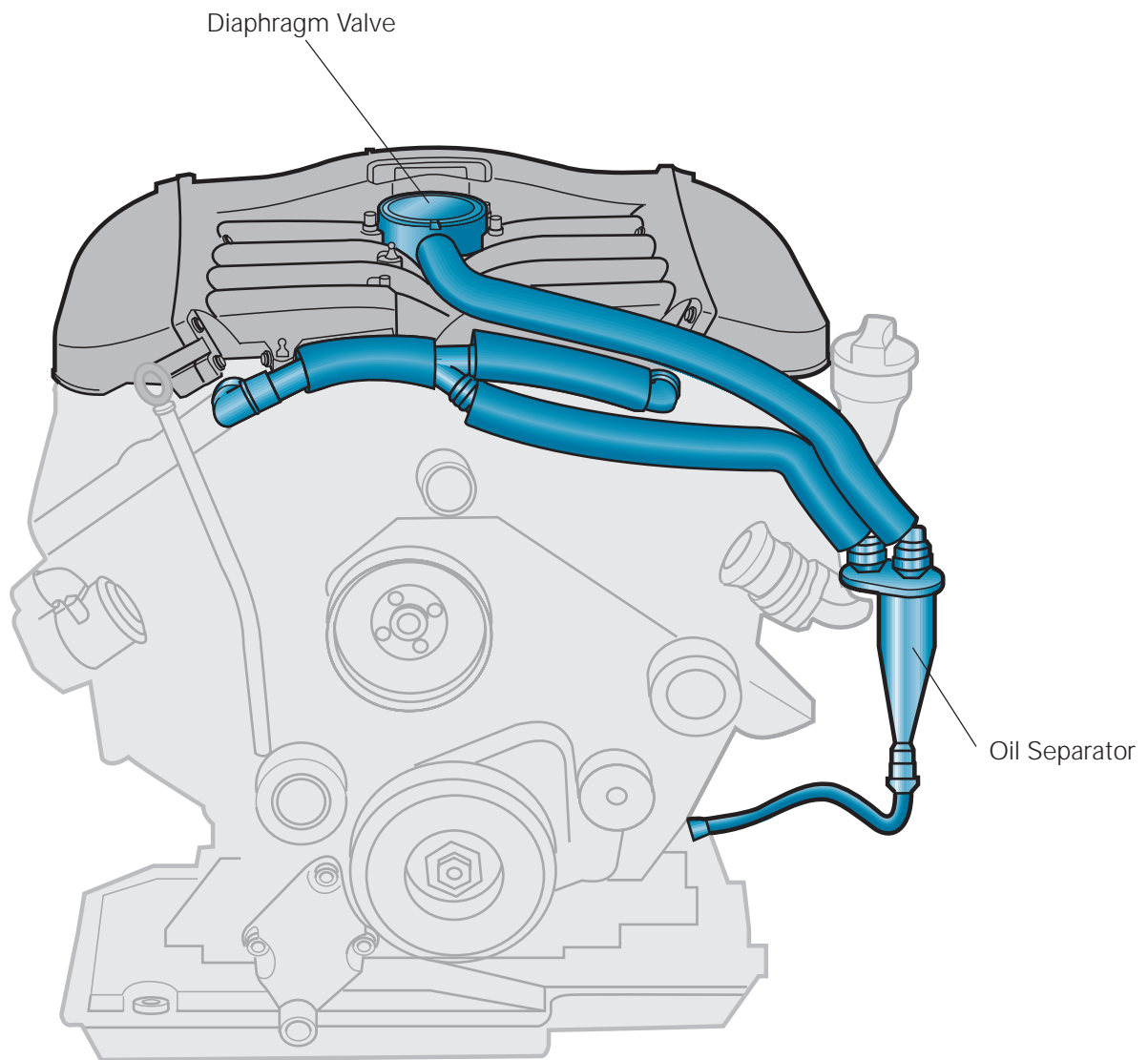
Engine — Mechanics

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 routed continuously into the intake manifold

and burned in the cylinders during the combustion cycle. No oil is entrained in the process. The oil separator removes the oil particles from the blow-by gas. The separated oil is then returned to the oil sump.

W8 Engine

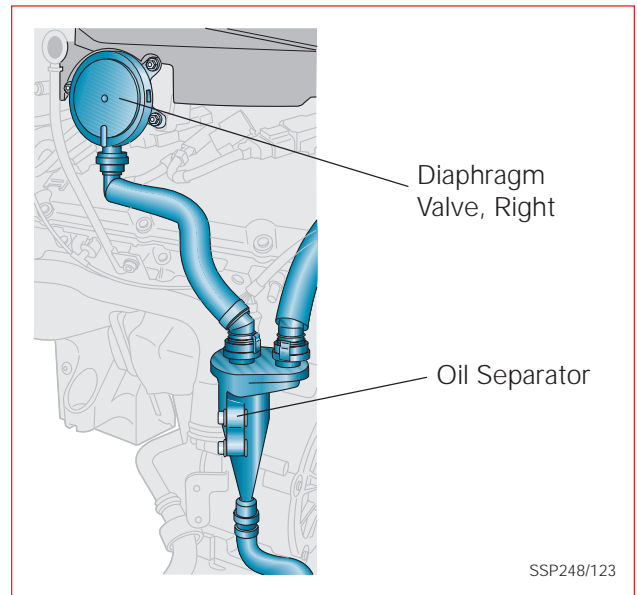


SSP248/122

Engine — Mechanics

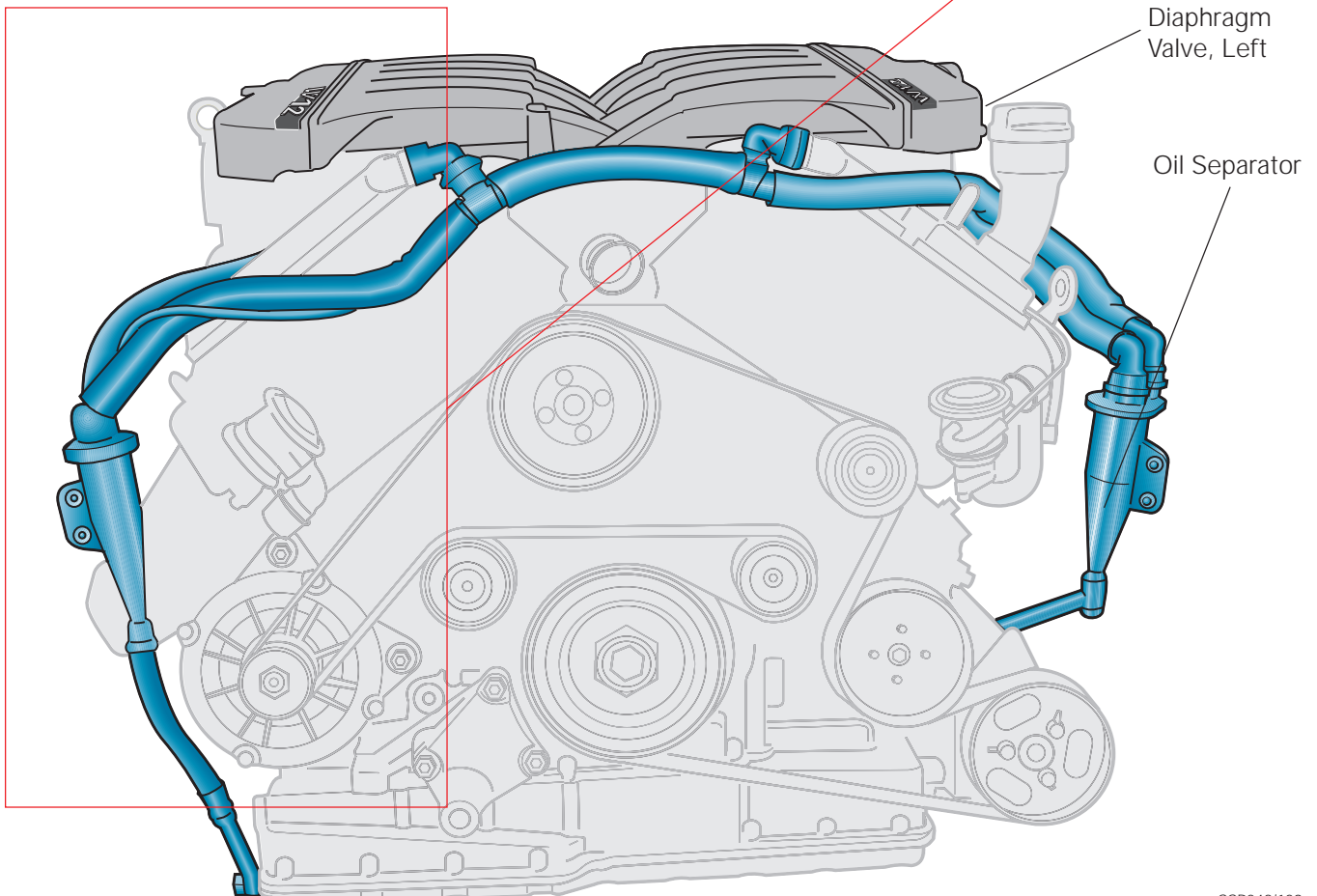


Because the W12 engine has a double flow intake manifold, each bank has a side diaphragm valve and an oil separator.



SSP248/123

W12 Engine



SSP248/129

Engine — Mechanics

Exhaust System

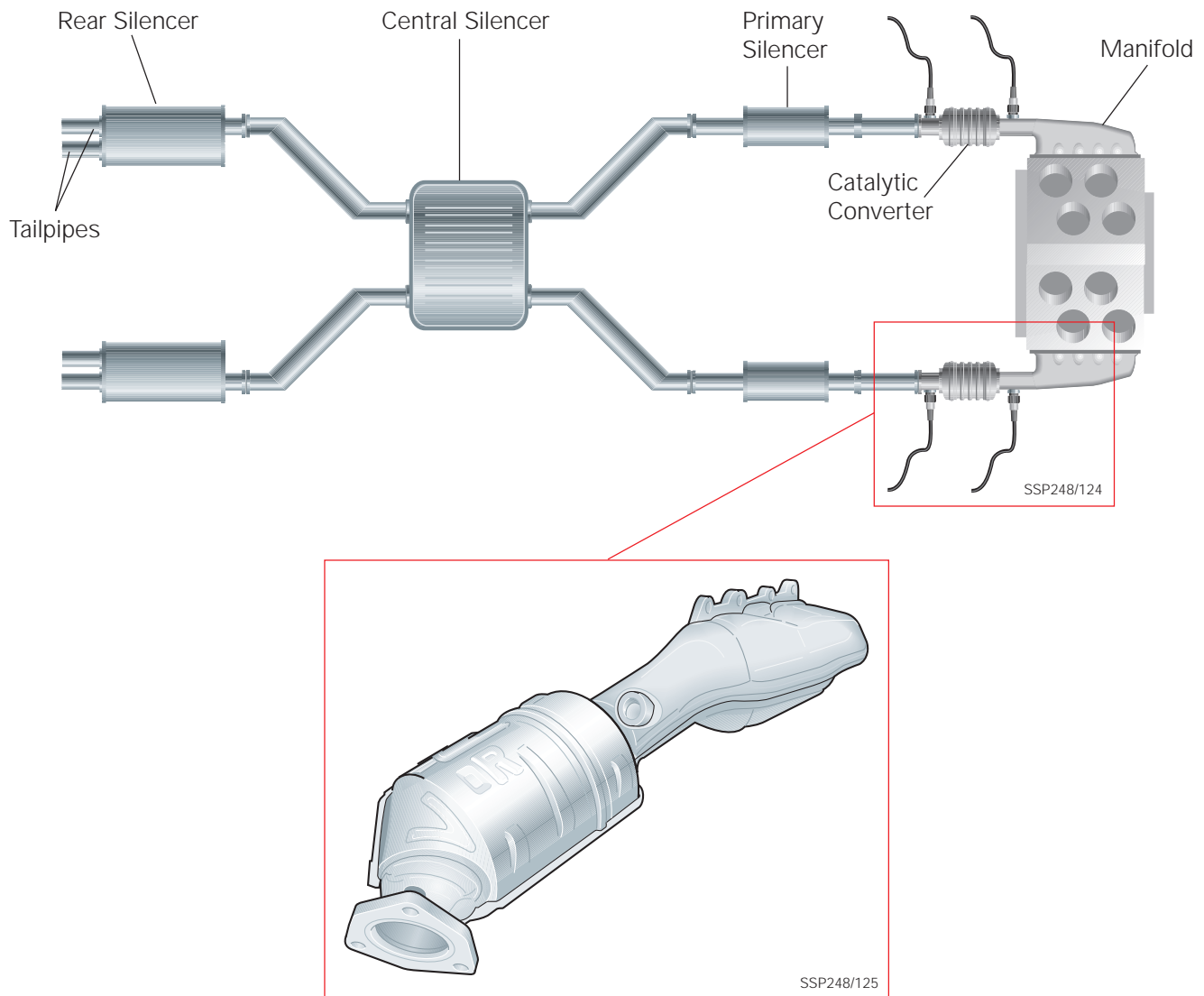
The W8 engine has an exhaust manifold with a catalytic converter for each cylinder head. A total of four oxygen sensors are therefore required for emission control.

- Heated Oxygen Sensor (HO2S) G39
- Heated Oxygen Sensor (HO2S) 2 G108

- Oxygen Sensor (O2S) Behind Three-Way Catalytic Converter (TWC) G130
- Oxygen Sensor (O2S) 2 Behind Three-Way Catalytic Converter (TWC) G131

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

Exhaust System of W8 Engine



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.

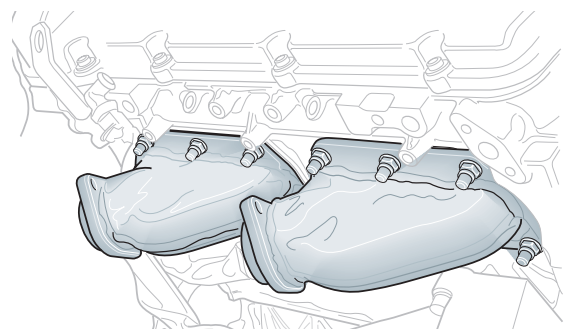
Four primary catalytic converters and two main catalytic converters help to achieve an effective reduction in emissions.

To monitor mixture combustion and to optimize pollutant emission reduction, use is made of a total of eight oxygen sensors, four each before and after the primary catalytic converters.

- Heated Oxygen Sensor (HO2S) G39
- Heated Oxygen Sensor (HO2S) 2 G108

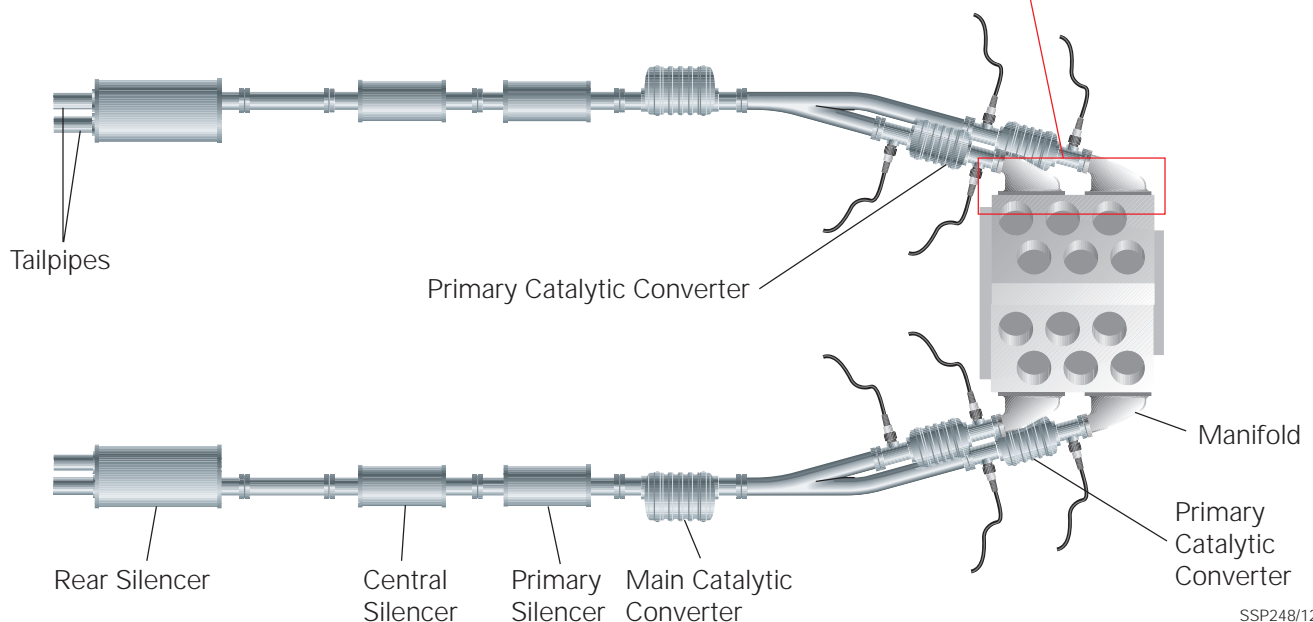
- Oxygen Sensor (O2S) Behind Three-Way Catalytic Converter (TWC) G130
- Oxygen Sensor (O2S) 2 Behind Three-Way Catalytic Converter (TWC) G131
- Heated Oxygen Sensor (HO2S) 3 G285
- Heated Oxygen Sensor (HO2S) 4 G286
- Oxygen Sensor (O2S) 3 Behind Three-Way Catalytic Converter (TWC) G287
- Oxygen Sensor (O2S) 4 Behind Three-Way Catalytic Converter (TWC) G288

Exhaust Manifold



SSP248/127

Exhaust System of W12 Engine



SSP248/126

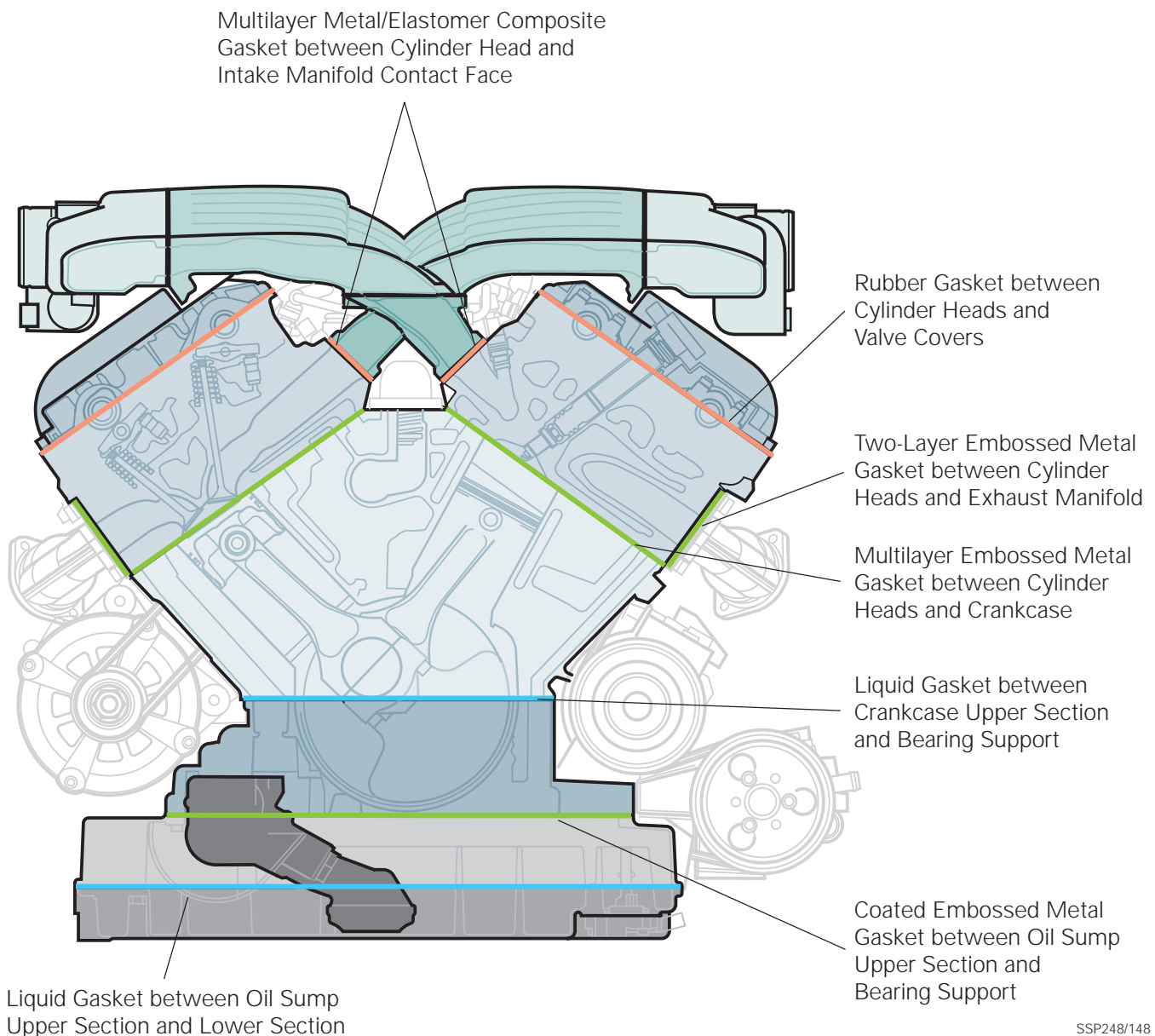
Service

Engine Sealing

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 a liquid gasket.



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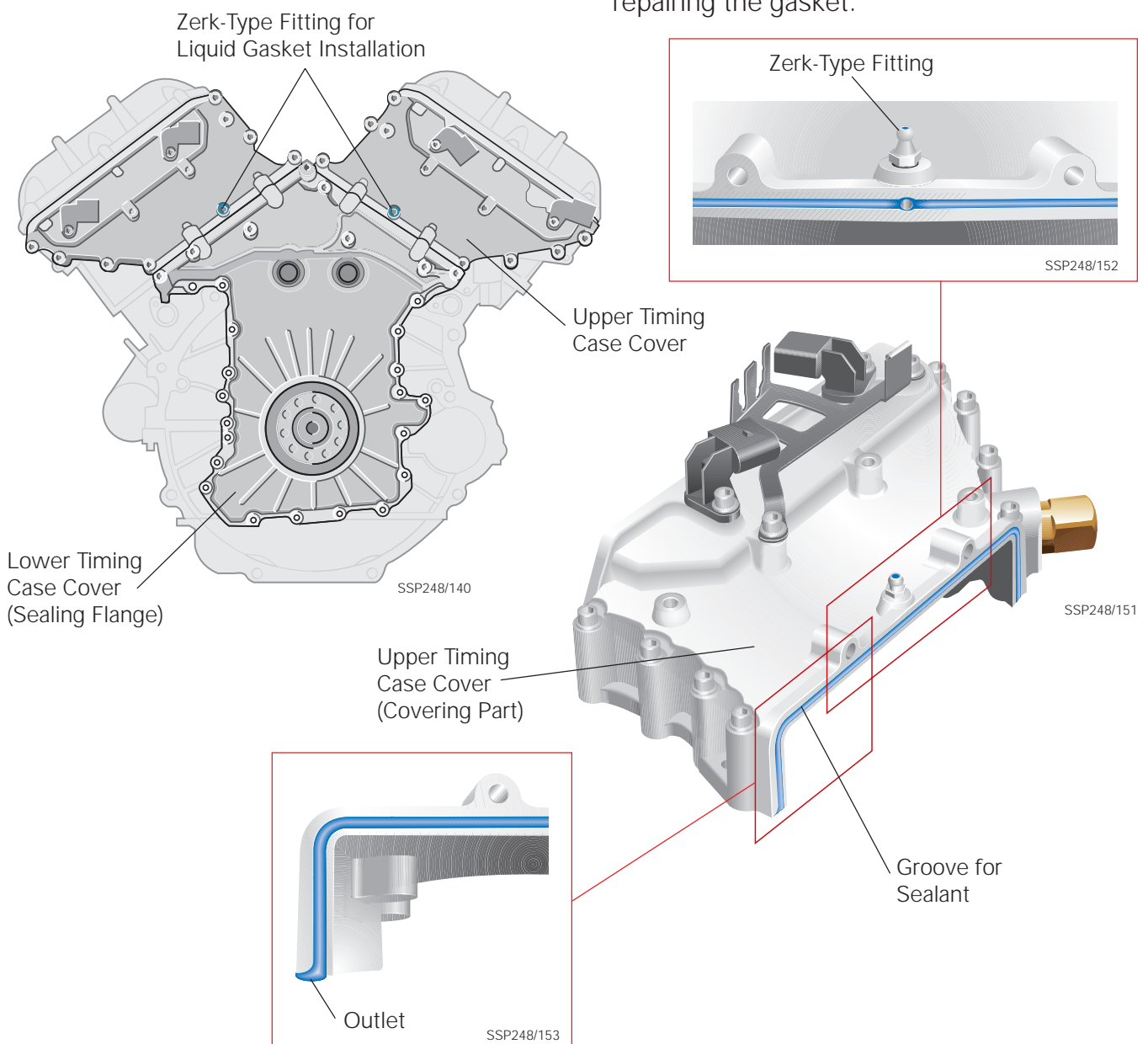
Liquid Gaskets

Application of the liquid gasket sealant to most surfaces 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 through zerk-type fittings (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 zerk-type fittings remain in the housing after injecting the sealant. However, they have to be replaced when repairing the gasket.



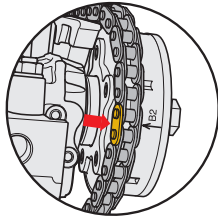
Service

Engine Timing Overview

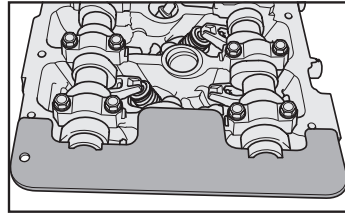
If it is necessary to disassemble the cylinder heads, the engine timing must be reset. These are the important markers when the piston of the first cylinder is at top dead center.



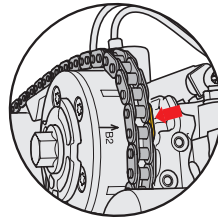
For a description of the exact procedure for setting the engine timing, please refer to the relevant Repair Manual.



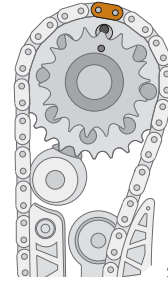
Put copper colored chain link on arrow of bank II.



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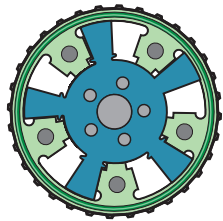


Put copper colored chain link on arrow of bank II.

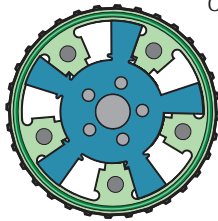


Place the copper colored chain link on the marked tooth of the intermediate shaft and the bore hole in the housing.

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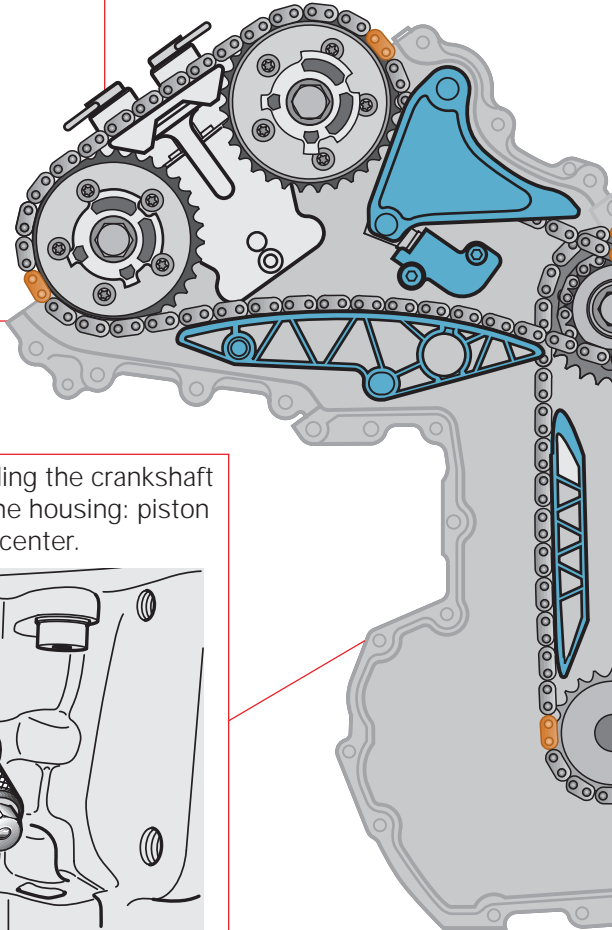


Adjust exhaust camshaft to advance.

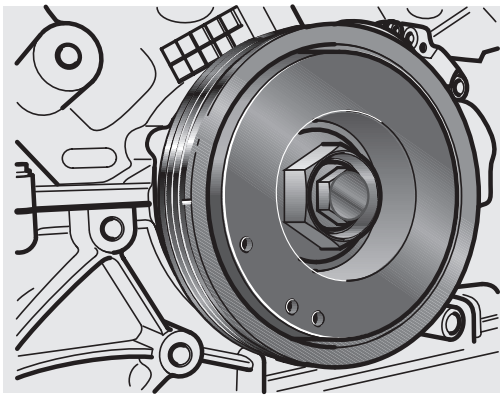


Adjust intake camshaft to retard.

Bank II

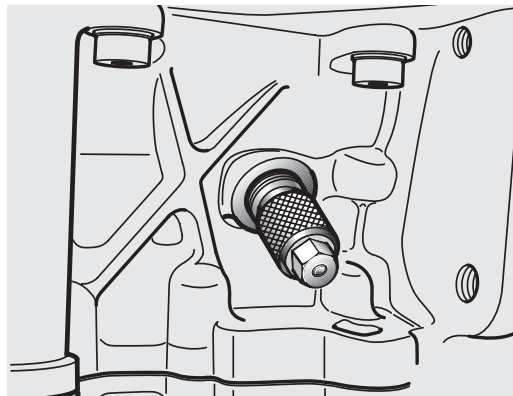


Position the marker on the vibration damper on the housing joint: piston in 1st cylinder at top dead center.

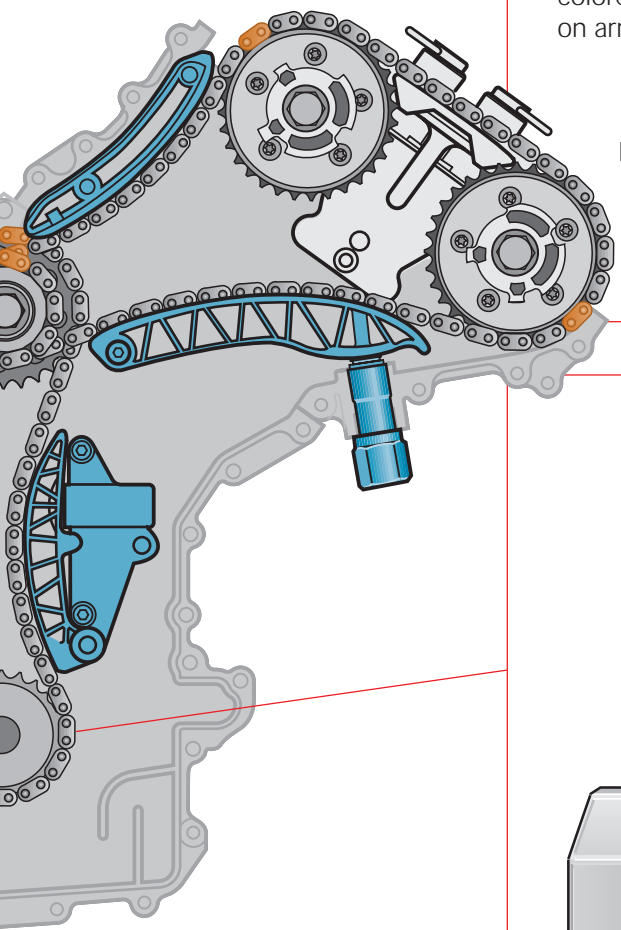


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Insert the mandrel for holding the crankshaft into the threaded hole in the housing: piston in 1st cylinder at top dead center.



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Insert camshaft rule for aligning the camshafts.

Place copper colored chain link on arrow of bank I.

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Place copper colored chain link on arrow of bank II.

Bank I

Intake camshaft advance adjustment.

Exhaust camshaft retard adjustment.

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

Normal Tooth

Marked Tooth

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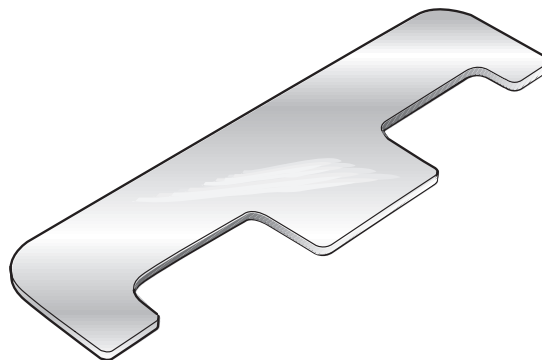
Service

Special Tools

Camshaft Alignment Rule

For aligning the camshafts when setting the engine timing.

T10068

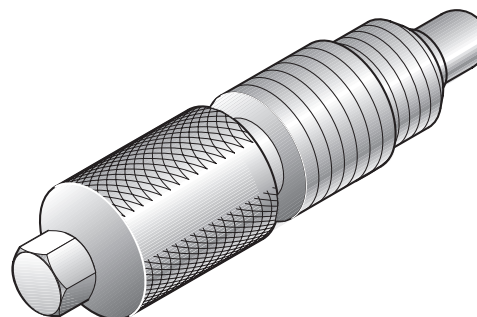


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Mandrel

For locating the crankshaft.

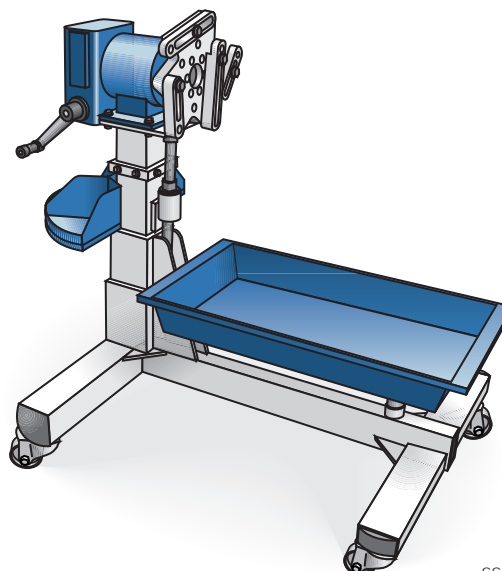
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Engine and Transmission Holder

VAS 6095



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Notes

Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program.

This Knowledge Assessment may or may not be required for Certification. You can find this Knowledge Assessment under the Certification tab at:

www.vwwebservice.com

For assistance please call:

Certification Program Headquarters

1-877-CU4-CERT (1-877-284-2378)

(8:00 a.m. to 8:00 p.m. EST)

Or email: Comments@VWCertification.com