

Service Training



Self-Study Program 824803

# The Volkswagen 2.0 Liter Chain-Driven TSI Engine



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**Note**



**Important!**



This Self-Study Program covers information on the Volkswagen 2.0 Liter Chain-Driven TSI Engine. This Self-Study Program is not a Repair Manual. This information will not be updated.

For testing, adjustment and repair procedures, always refer to the latest electronic service information.

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## Technical Description

### Four Cylinder, Four Valve, TSI Turbocharged Gasoline Engine

#### Engine Block

- Cast iron crankcase
- Balancer shafts in crankcase
- Forged steel crankshaft
- Sump-mounted oil pump — chain-driven by crankshaft
- Timing gear chain — front end of engine
- Balancer — chain-driven at front end of engine

#### Cylinder Head

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

#### Intake Manifold

- Tumble flap

#### Fuel Supply

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

#### Engine Management

- MED 17.5 engine control module
- Hot-film air mass flow with integral temperature sensor
- Throttle valve with contactless sensor
- Map-controlled ignition with cylinder-selective, digital knock control
- Single-spark ignition coils

#### Turbocharging

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

#### Exhaust

- Single-chamber exhaust system with close-coupled pre-catalyst

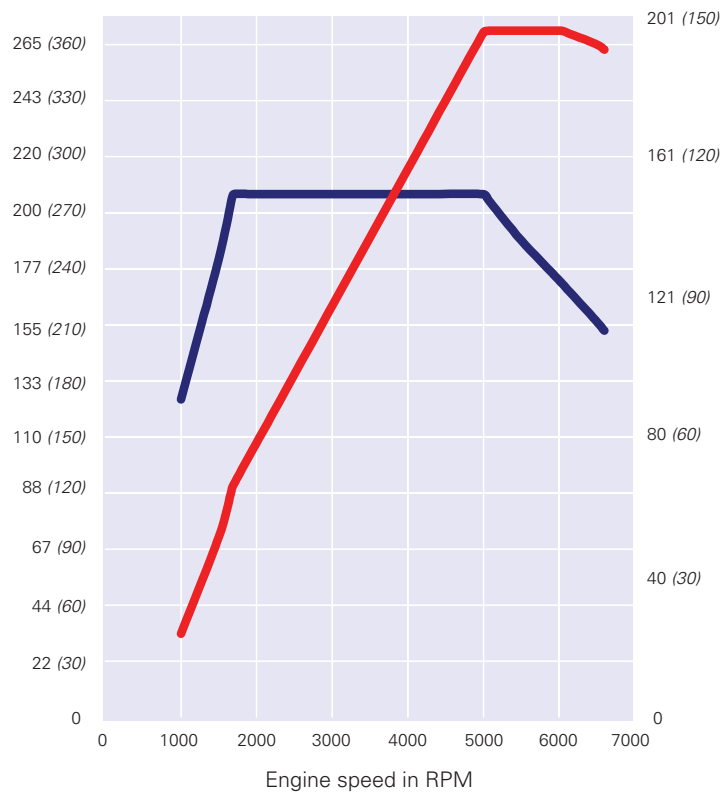
#### Combustion Process

- Fuel straight injection



# Introduction

## 2.0L Chain-Driven TSI Engine



### Specifications

Engine Code	CCTA - CBFA
Type of Engine	Inline 4-Cylinder TSI Engine
Displacement	121 cu in (1984 cm <sup>3</sup> )
Maximum Power	200 hp (147 kW) at 5100 - 6000 rpm
Maximum Torque	206 lb ft (280 Nm) at 1700 - 5000 rpm
Number of Valves Per Cylinder	4
Bore	3.2 in (82.5 mm)
Stroke	3.7 in (92.8 mm)
Compression Ratio	9.6 : 1
Firing Order	1-3-4-2
Engine Weight	317 lb (144 kg)
Engine Management	Bosch MED 17.5
Fuel Grade	95/91 RON
Exhaust Emission Standard	ULEV (CCTA) - SULEV (CBFA)

# Engine Mechanicals

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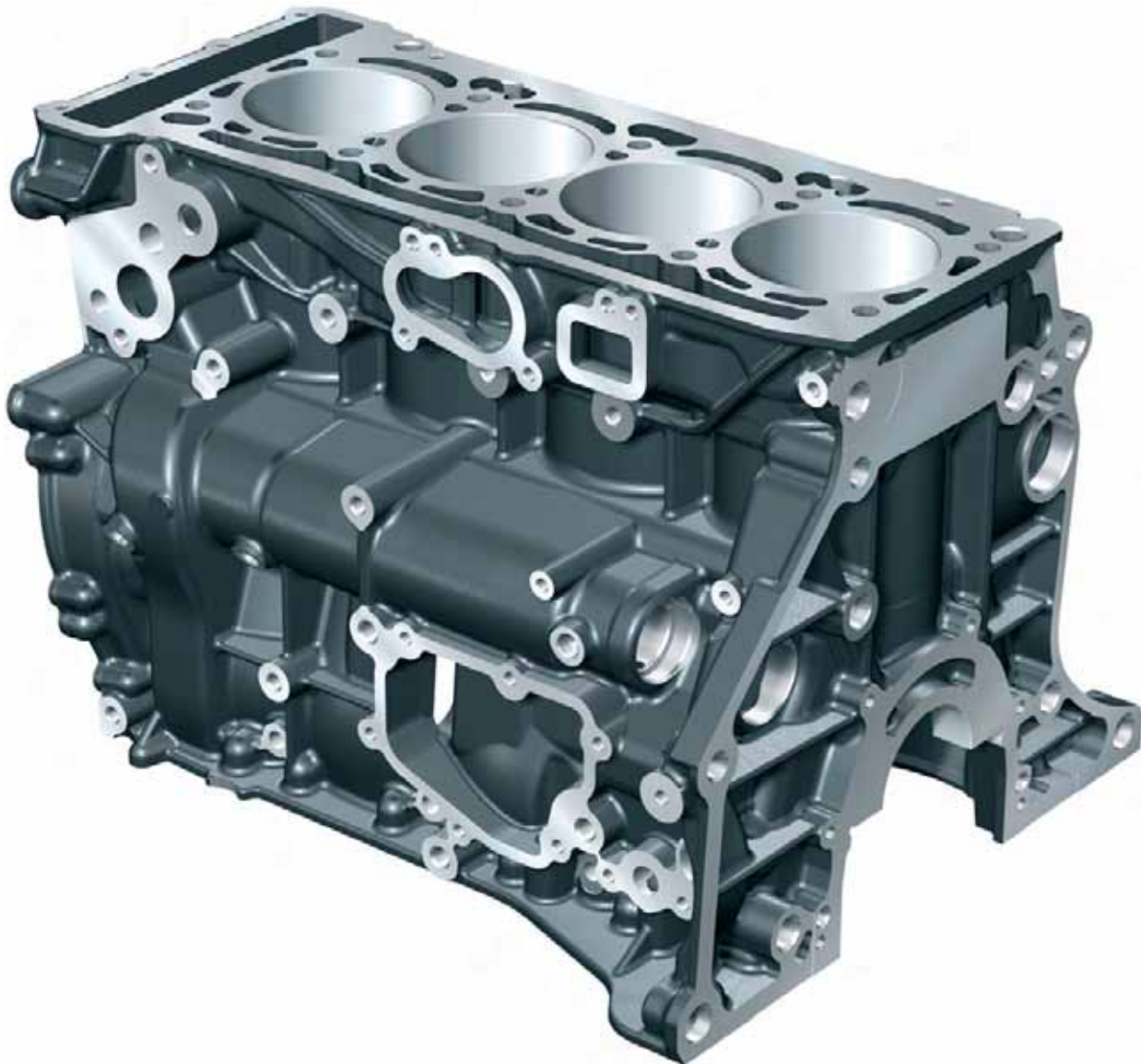
## Cylinder Block

The cylinder block has a closed-deck configuration and is made of cast iron. It houses the five-bearing crankshaft assembly and the two balancer shafts.

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

The undersides of the pistons are cooled by engine oil supplied by spray jets mounted on the cylinder block.

The cylinder block is sealed on the transmission side by a sealing flange and gasket.





# Engine Mechanicals

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## Oil Pan

The oil pan consists of two sections.

The upper section is made of an aluminum alloy (*AlSi12Cu*) and reinforces the crankcase through a bedplate effect. It also houses the oil pump.

The upper section is bolted to the crankcase and sealed with a liquid sealant.

The bottom section is made of sheet steel (*deep drawn, punched, and catalytically coated*). It houses Oil Level Sensor G12 and the drain plug.

The bottom section is bolted to the upper section and sealed with a liquid sealant.

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



**Aluminum Alloy Oil Pan Top Section**



**Polyamide Honeycomb Insert**



**Stamped Steel Oil Pan Bottom Section**



# Engine Mechanicals

## Crankshaft

The five main bearing crankshaft is made of forged steel and induction hardened. Optimal balancing is achieved by using eight counterweights.

To additionally reinforce the crankshaft assembly, three inner main bearing caps are cross-bolted to the cylinder block.

### Trapezoidal Connecting Rod (Small End)

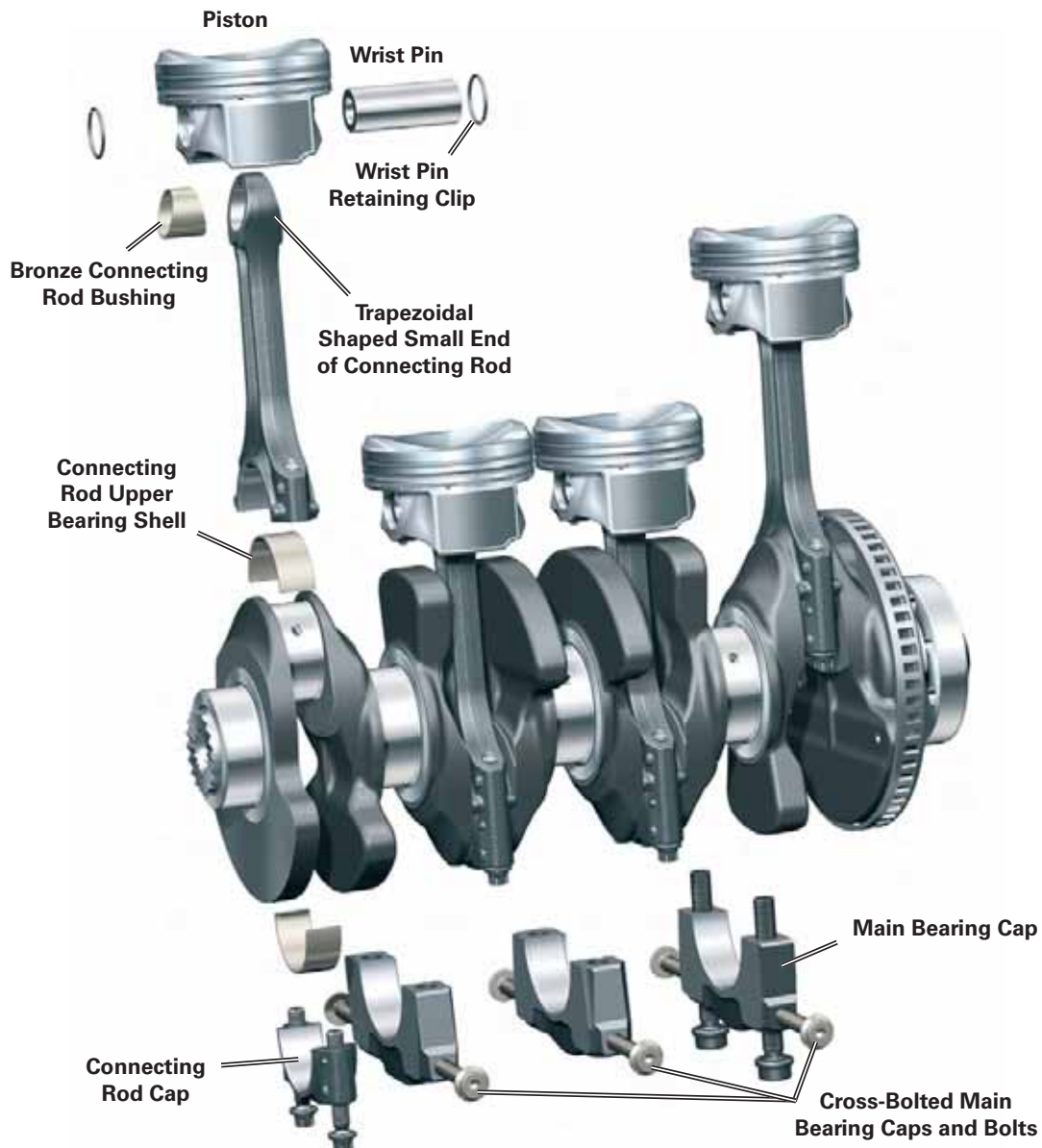
Material:	36MnVS4
Length:	5.82 in (148 mm)
Big-End Bearing:	1.88 in (47.8 mm)
Small-End Bearing:	0.82 in (21 mm)

The crankshaft main bearings are a two component type. Axial play of the crankshaft is controlled by thrust washers at the middle support bearing.

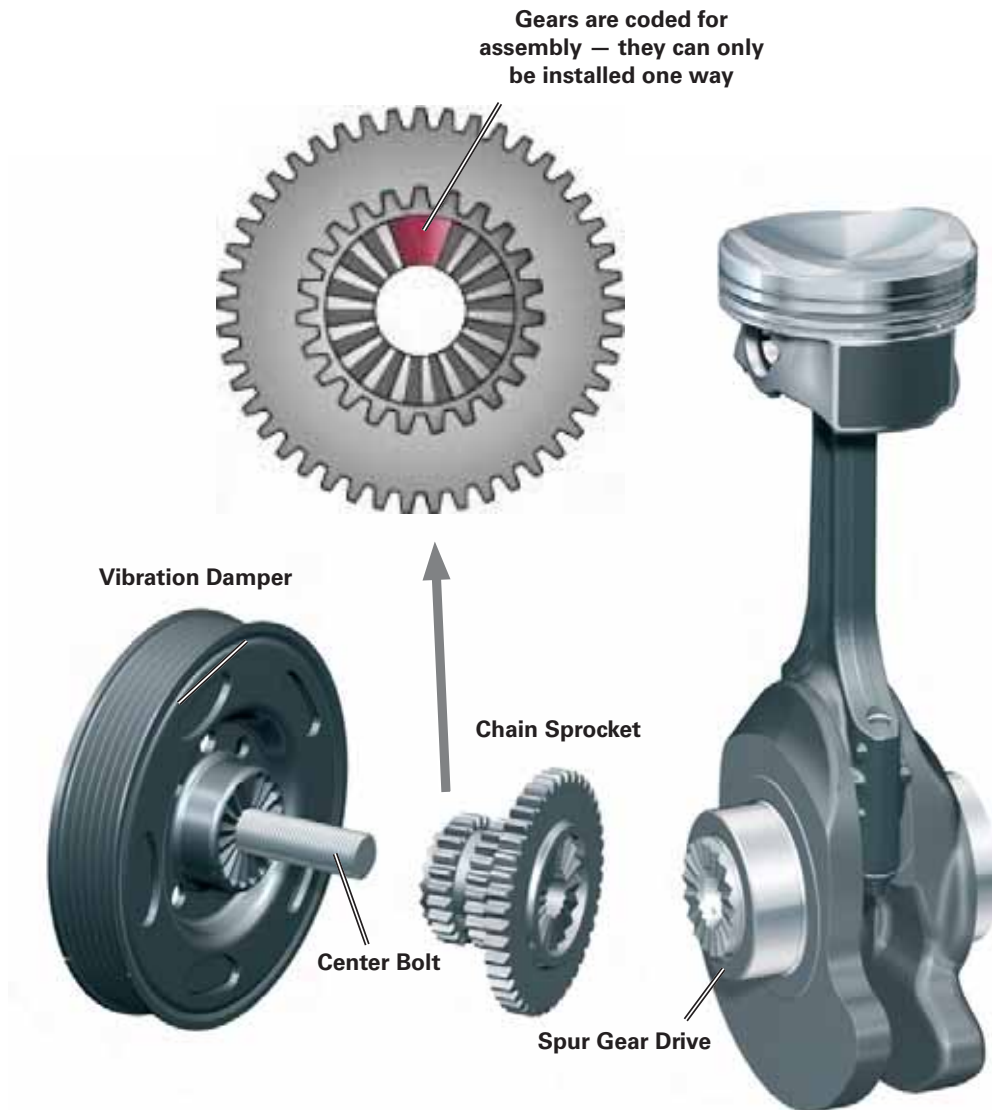
Bronze bushings are press-fit into the small trapezoidal upper end of the connecting rods.

The lower end of the connecting rods are cracked to ensure a precision fit and reduce movement of the bearing cap under load.

The upper and lower bearing shells of the connecting rod are not identical in composition. The upper bearing shell is a two-component composite bearing while the lower shell is a three-component composite bearing.



# Engine Mechanicals



The chain drive sprocket is mounted to the crankshaft face and driven by a spur gear forged in the crankshaft. The other end of the chain sprocket also has a spur gear surface which drives the vibration damper. This method of joining allows high torque to be transmitted to the chain sprocket and vibration damper while keeping the diameter of the components small. This allows better sealing by the radial shaft seal at the vibration damper hub. Special tools are required during disassembly/assembly of these components to prevent damage to the gears.

On the transmission side of the engine, a dual mass flywheel or torque converter (*depending on transmission*) is mounted to the crankshaft with eight bolts.

# Engine Mechanicals

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## Pistons

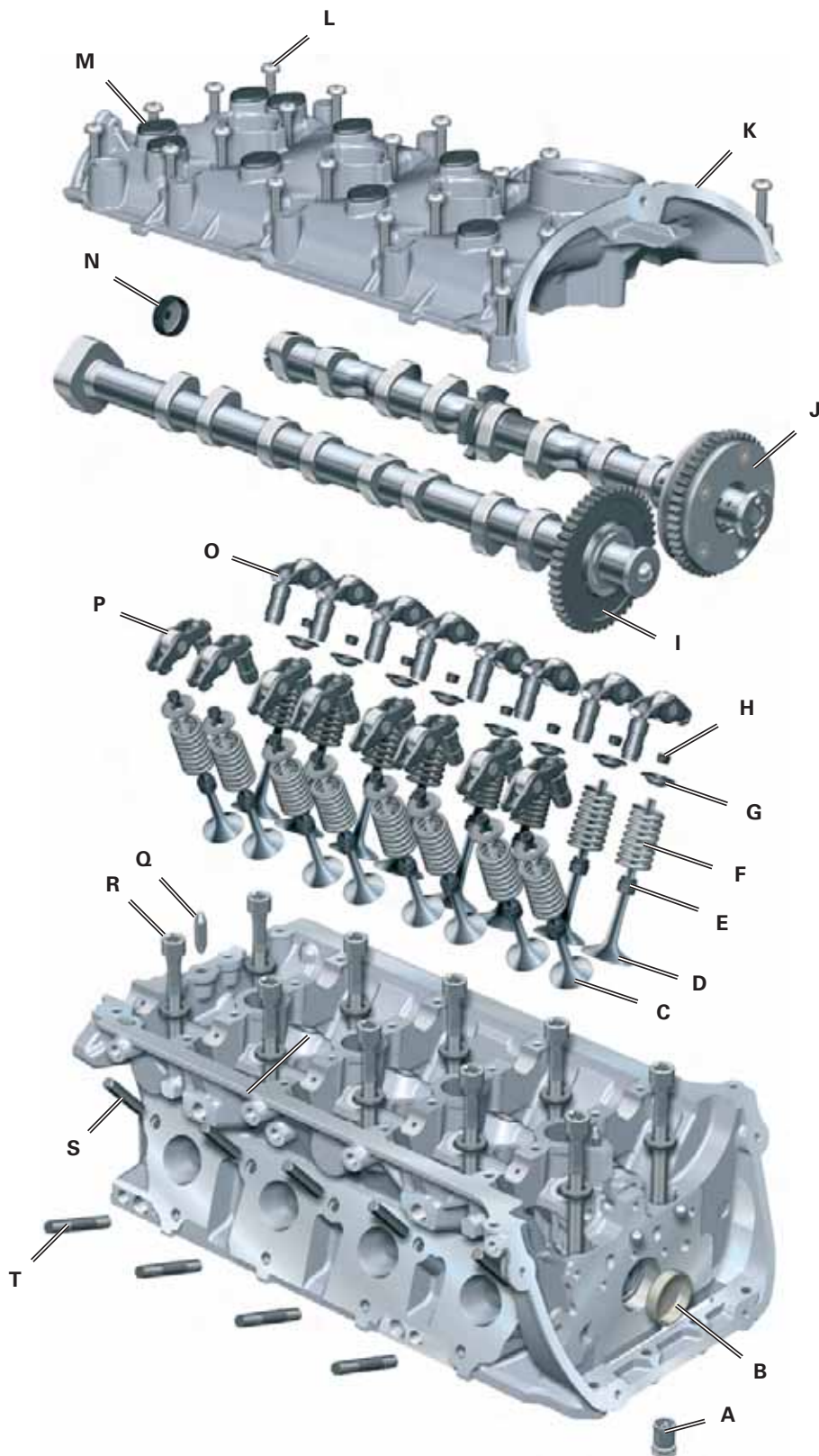
The pistons are specially designed for the TSI engine with a cast-in ring land for the upper piston ring. Coated skirts are used to help reduce frictional losses. The upper piston ring is rectangular, the second piston ring is a taper-faced ring, and the oil scraper ring is a beveled ring with expander.

The 31CrMoV wrist pins are held in place by snap rings. The bottom side of the pistons are cooled by engine oil from spray jets mounted on the cylinder block.



# Engine Mechanicals

## Cylinder Head



# Engine Mechanicals

The 4-valve cylinder head is cast from aluminum alloy. Intake and exhaust valves are actuated by roller cam followers supported by hydraulic valve lifters.

The intake and exhaust camshafts are chain-driven.

The variable timing of the intake camshaft is accomplished through the INA camshaft adjustment system (page 11).

The cylinder head cover adds support by acting as a ladder frame and does not have to be disassembled to remove the cylinder head.

The diagonal opening and sealing face simplifies drive chain installation.

## Features

- Crossflow cylinder head made of AlSi10Mg
- Three-layer metal head gasket.
- Intake ports divided by baffle plate
- Cylinder head cover made of AlSi9Cu3 with integrated ladder frame, bolted to cylinder head and sealed with liquid sealant
- Intake valve: solid-stem valve, chrome-plated with reinforced seat
- Exhaust valve: sodium filled hollow-stem valve, chrome-plated and tempered with reinforced seat
- Single valve spring made of steel
- Roller cam followers running in needle bearings, hydraulic valve clearance adjustment
- Hydro-formed, assembled intake camshaft with variable valve timing, dwell angle 190°, valve lift 10.7 mm
- Hydro-formed, assembled exhaust camshaft with press-fit drive gear, dwell angle 180°, valve lift 8 mm
- INA Camshaft Adjuster, timing range 60° crank angle, basic position is locked in “retard” (*engine not running*)

## Legend

<b>A</b>	Check valve	<b>K</b>	Cylinder head cover
<b>B</b>	Sealing end cap	<b>L</b>	Cylinder head cover screw
<b>C</b>	Exhaust valve	<b>M</b>	Screw plug
<b>D</b>	Intake valve	<b>N</b>	Sealing end cap
<b>E</b>	Valve stem seal	<b>O</b>	Hydraulic valve clearance adjuster
<b>F</b>	Valve spring	<b>P</b>	Roller cam follower
<b>G</b>	Valve spring retainer	<b>Q</b>	Dowel pin
<b>H</b>	Valve keeper	<b>R</b>	Cylinder head bolt with washer
<b>I</b>	Exhaust camshaft	<b>S</b>	Exhaust manifold locating pin
<b>J</b>	Intake camshaft with INA adjuster	<b>T</b>	Exhaust manifold stud



# Engine Mechanicals

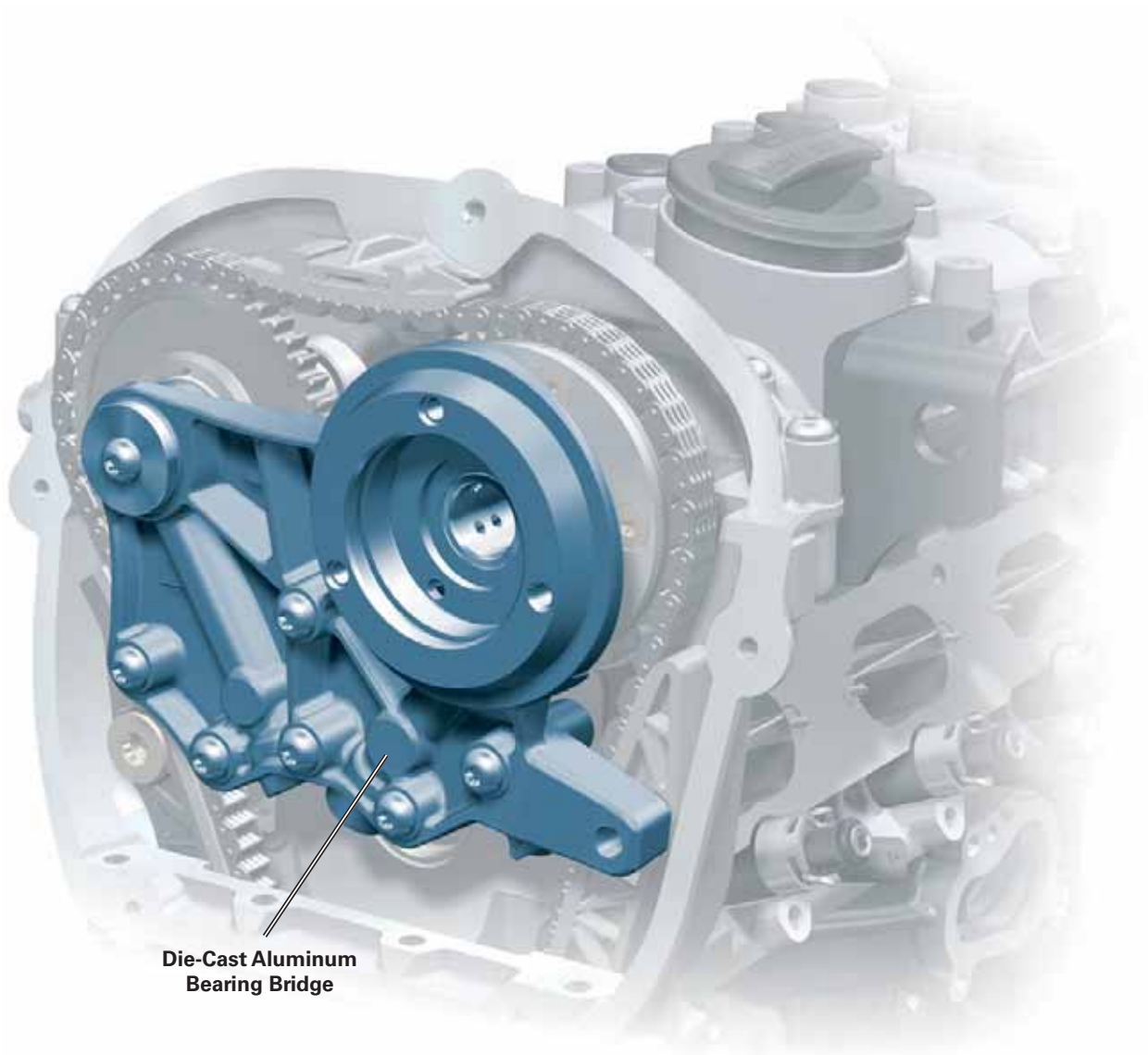
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## Bearing Bridge

A die-cast aluminum bearing bridge mounted at the front of the cylinder head has the following tasks:

- Supporting the camshafts
- Supplying pressurized oil to camshaft bearings
- Supplying pressurized oil to the camshaft adjuster
- Controlling axial movement of camshafts
- Mounting point for Camshaft Adjustment Valve 1 N205

The bearing bridge also serves to connect the two oil galleries of the cylinder head. A check valve and filter screen are integrated in the pressurized oil duct to the INA camshaft adjuster.



# Engine Mechanicals

## INA Camshaft Adjustment System

The 2.0L TSI engine uses a hydraulic vane cell adjuster on the intake camshaft to affect valve timing. Only the intake camshaft has variably adjusted timing on this engine. Oil pressure for this task is provided by the engine oil pump.

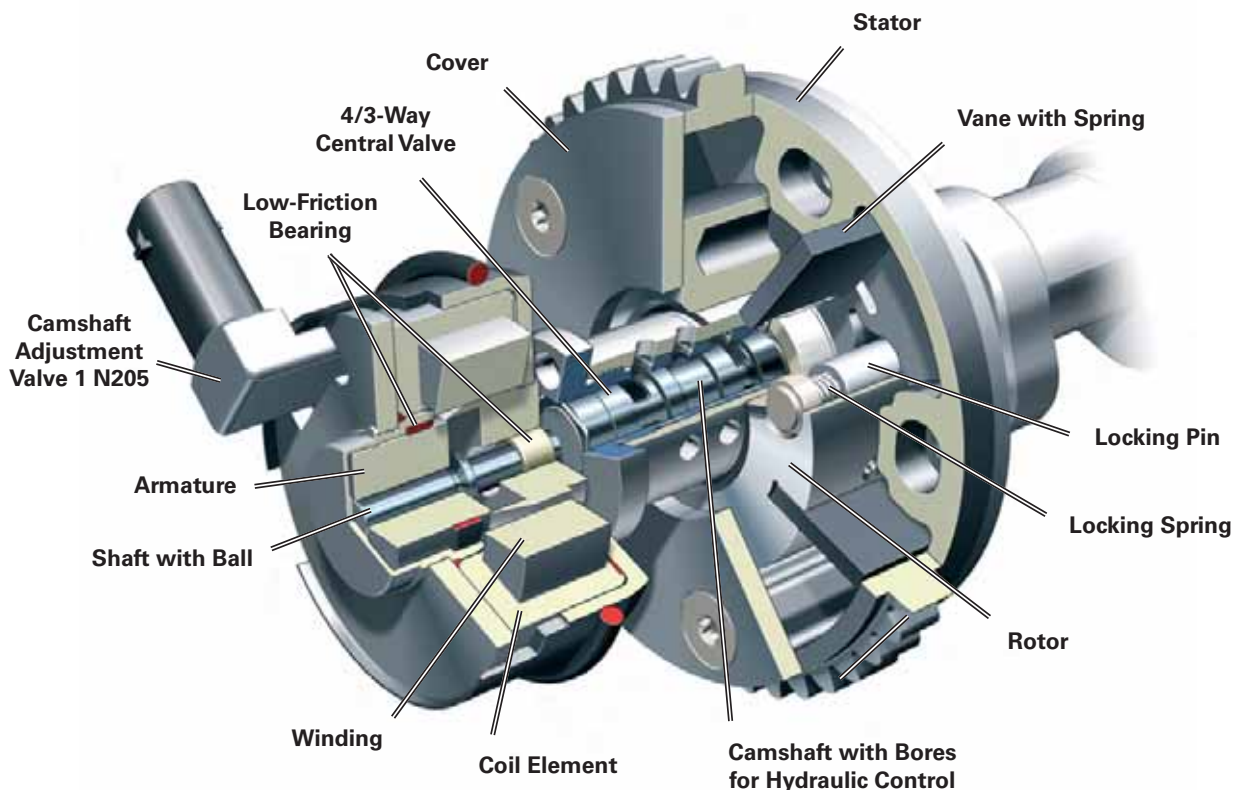
The variable camshaft adjuster provides an adjustment range of 60° crank angle. The camshaft is locked in the retard position at engine shut-off. This function is performed by a spring-loaded locking pin. The camshaft is released when the engine oil pressure exceeds 7.25 psi (0.5 bar).

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

Intake camshaft timing is map-controlled by the engine control module. The goals are to improve engine power, enhance running smoothness, and reduce emissions (*through internal exhaust gas recirculation*).

### Function

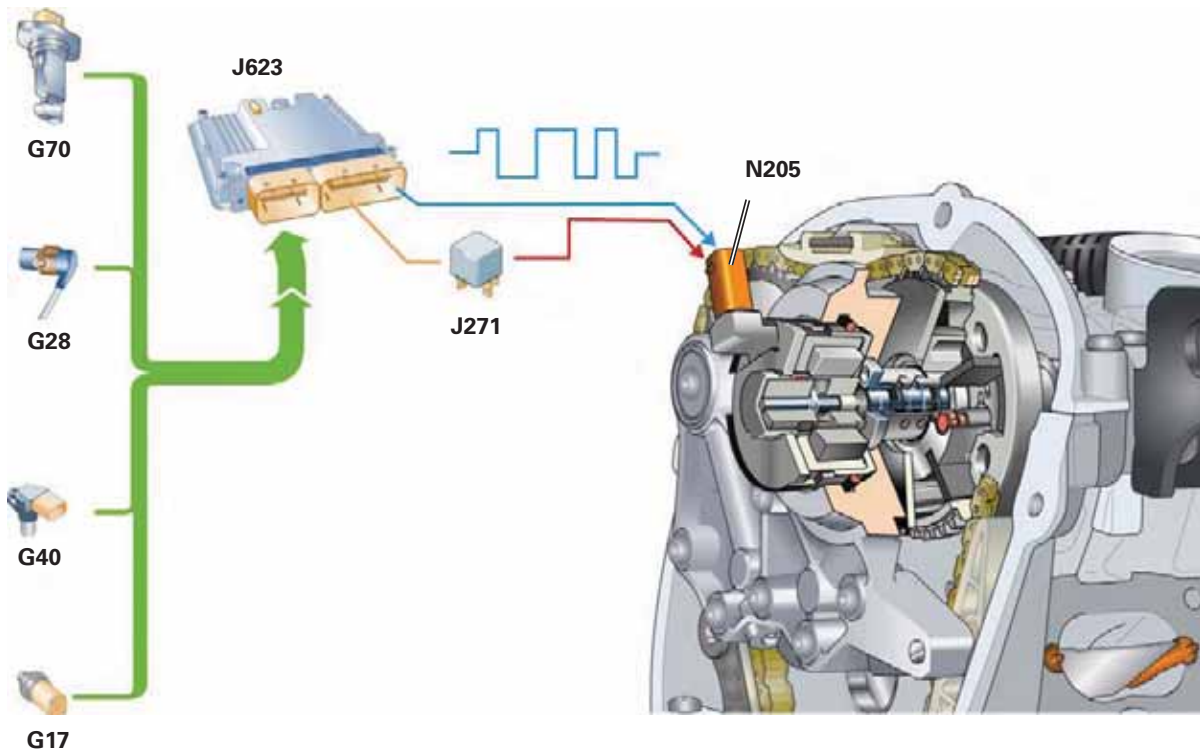
Pressurized oil flows to the central valve via the camshaft bearing through bores in the camshaft. From here, depending on adjustment requirements, the oil flows through additional bores in the camshaft to one of the chambers in the adjuster.





# Engine Mechanicals

## Valve Timing



### Legend

- G17** Engine Coolant Temperature Sensor
- G40** Camshaft Position Sensor
- G28** Engine Speed Sensor
- G70** Mass Air Flow Sensor

- J271** Motronic ECM Power Supply Relay
- J623** Motronic Engine Control Module
- N205** Camshaft Adjustment Valve 1

The valve is activated electrically via Camshaft Adjustment Valve 1 N205.

When activated by a PWM signal, the solenoid produces a variable magnetic field. Depending on the strength of the magnetic field, the shaft with ball is shifted towards the camshaft axis of rotation. This, in turn, displaces the 4/3-way central valve and allows the oil to flow to the corresponding chamber.

The new design has many advantages. It provides a very high adjustment rate capability even in unfavorable conditions such as cold starts or high oil temperatures during engine idling.

# Engine Mechanicals

## Chain Drive

All three chains of the 2.0L engine are driven directly by the chain sprocket mounted to the crankshaft.

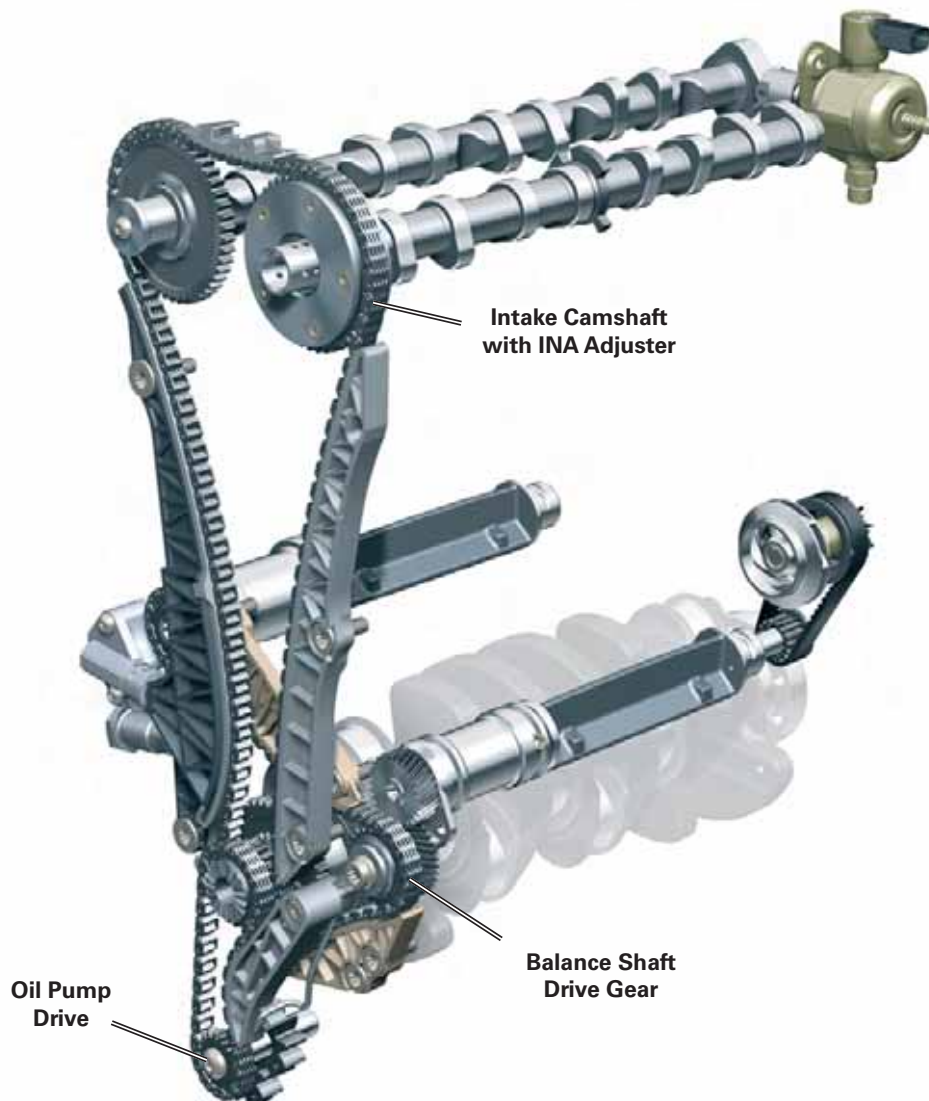
The chains are arranged in three planes (*levels*).

- 1st Plane - Balance Shaft Drive
- 2nd Plane - Camshaft Drive
- 3rd Plane - Oil Pump Drive

Gear chains (*as opposed to roller chains*) are used in all three planes. They are 1/4 inch gear chains whose tension is controlled by four tension plates and five guide plates.

Gear chains are more wear resistant and produce less noise than roller chains. The amount of space required for a given power transmission capacity is less than that of a timing belt or roller chain.

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



# Engine Mechanicals

## 1st Plane — Balance Shaft Drive

Two cylinder block housed balance shafts are used to counteract unwanted vibration at engine speeds above 4000 rpm from being transmitted to the car body.

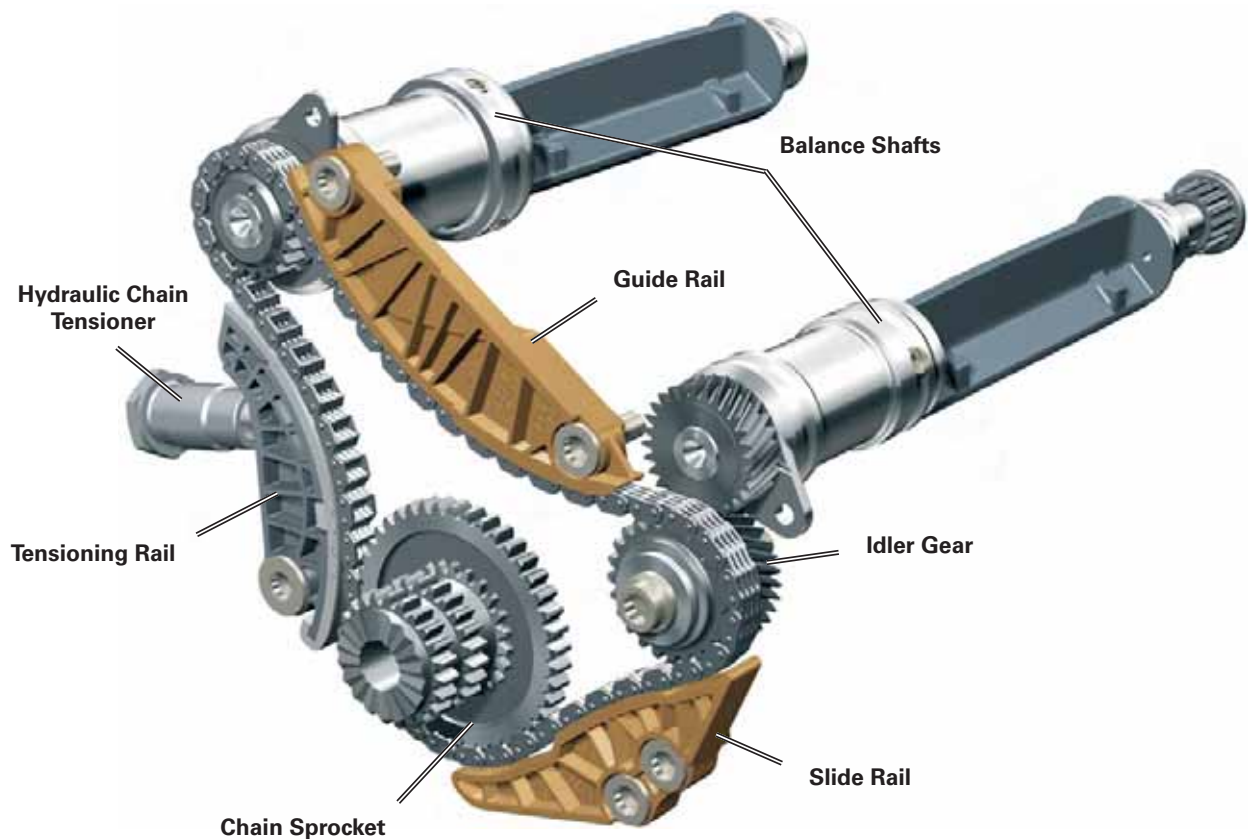
The balance shafts run at twice the engine speed in opposite direction from one another. The direction of the second shaft is reversed by an idler gear. The horizontally staggered arrangement of the balance shafts also helps reduce vibration.

The balance shafts are made from spheroidal graphite cast iron and run in three bearings.

Chain lubrication is provided by oil returning from the cylinder head. Oil is collected and distributed to the chain by a separate lubrication channel.

Mounting the balance shafts in the cylinder block has the following advantages:

- The cylinder block provides higher rigidity
- Oil foaming is eliminated by moving the rotating parts away from the oil sump

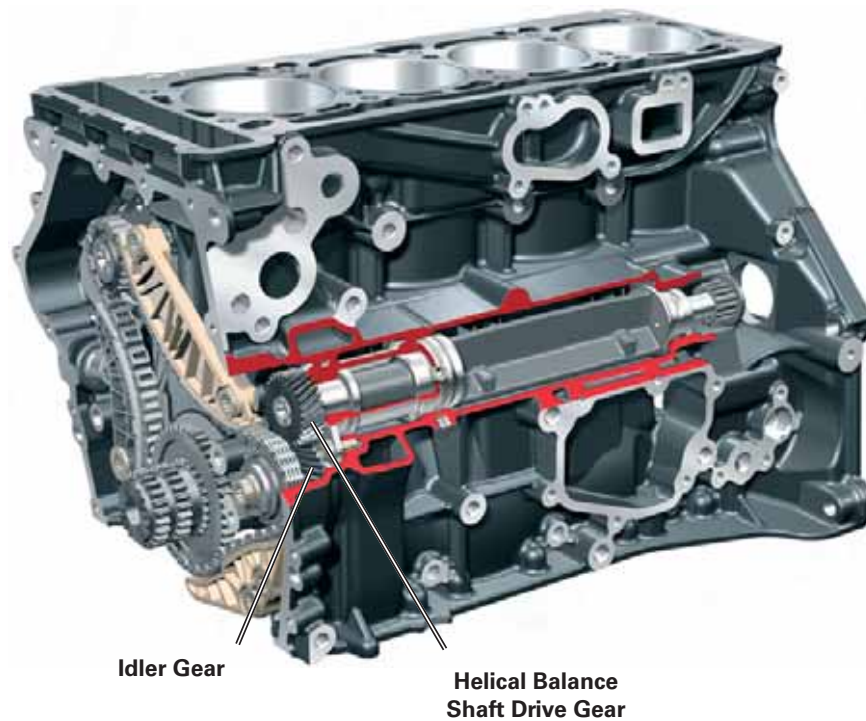
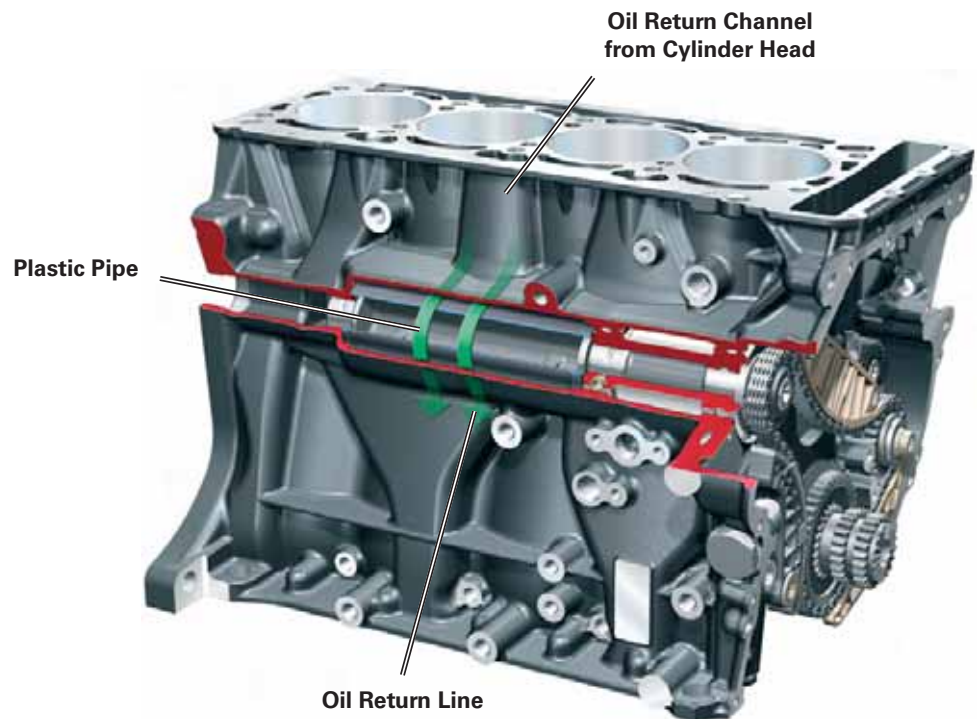


# Engine Mechanicals

## Balance Shaft Layout

The oil return channel from the cylinder head is located on the exhaust side of the cylinder block. Return oil flows through the balance shaft housing.

The balance shaft is mounted in a plastic pipe. This prevents oil returning from the cylinder head from churning and foaming from direct contact with the balance shaft.

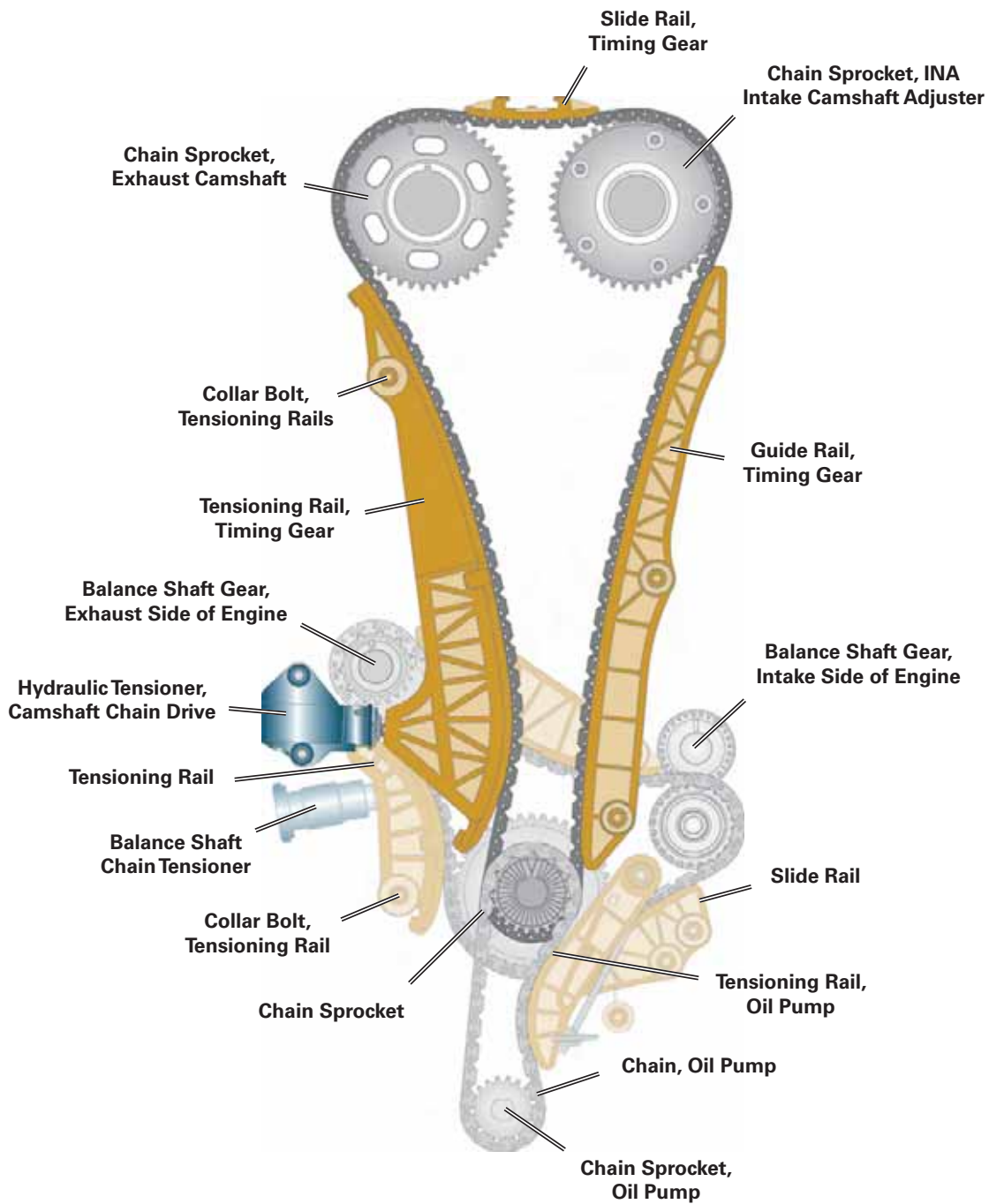
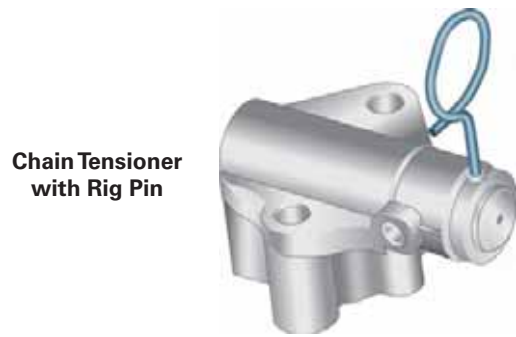




# Engine Mechanicals

## 2nd Plane — Camshaft Drive

The camshafts are driven by a chain positioned on the second level. Tensioning is accomplished by a hydraulic tensioner. The tensioner can be accessed through a service opening. This allows the timing chain to be detached after removing the cylinder head without having to remove the engine timing cover.

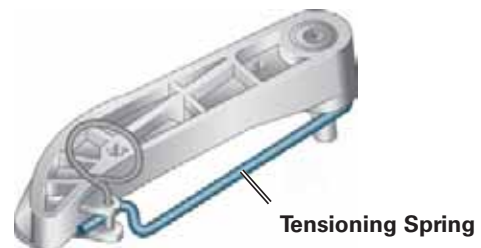
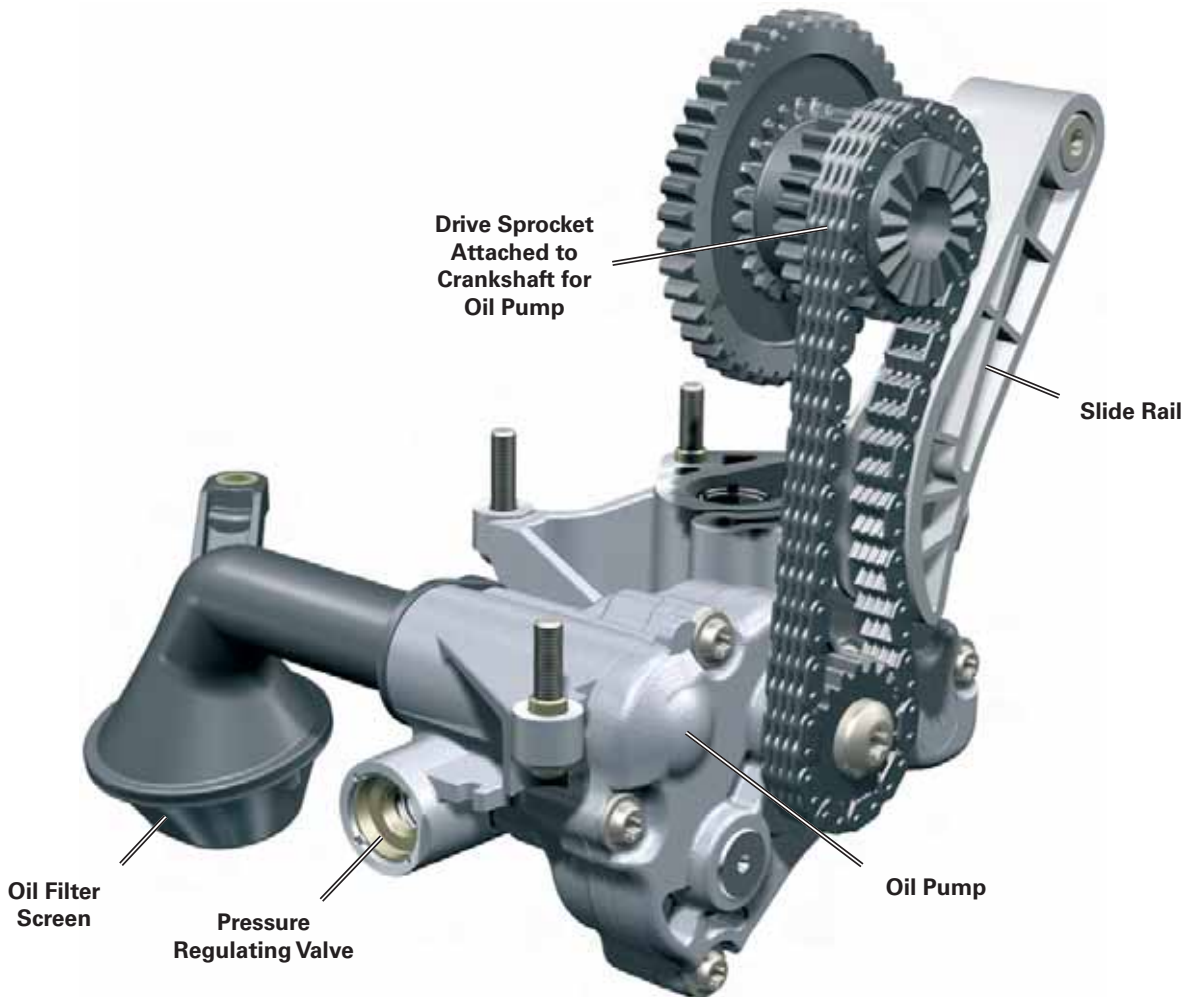


# Engine Mechanicals

## 3rd Plane — Oil Pump Drive

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

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

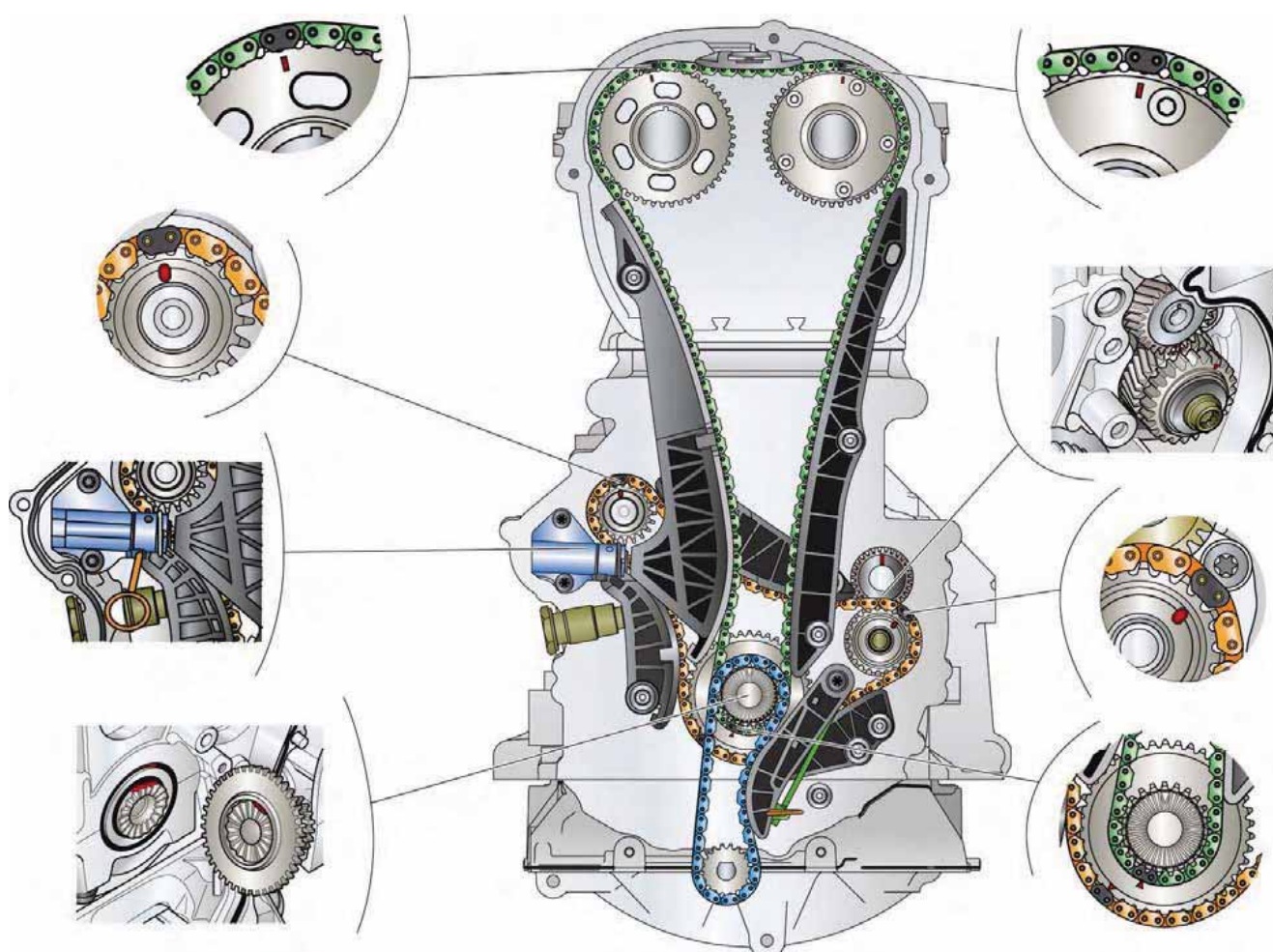


# Engine Mechanicals

Each drive chain has a special dark link. The dark links are only on one side of the drive chain facing out from the engine block. For the adjustment of the camshaft drive, the markings on the chain sprockets must align with the dark links of the chain.

However, to bring the camshaft drive gears into alignment with TDC by rotating the crankshaft requires approximately 166 revolutions of the crankshaft. Therefore, during repairs when the drive chains must be removed, it is acceptable that the technician use the dark links as a guide and make his own markings on the sprockets.

Please refer to the appropriate repair information for complete details.





# Engine Mechanicals

## Alternator/AC Compressor Drive

A subframe supports both the alternator and air conditioning compressor. They are driven by a poly-vee belt which is tensioned by a spring-loaded tensioner.

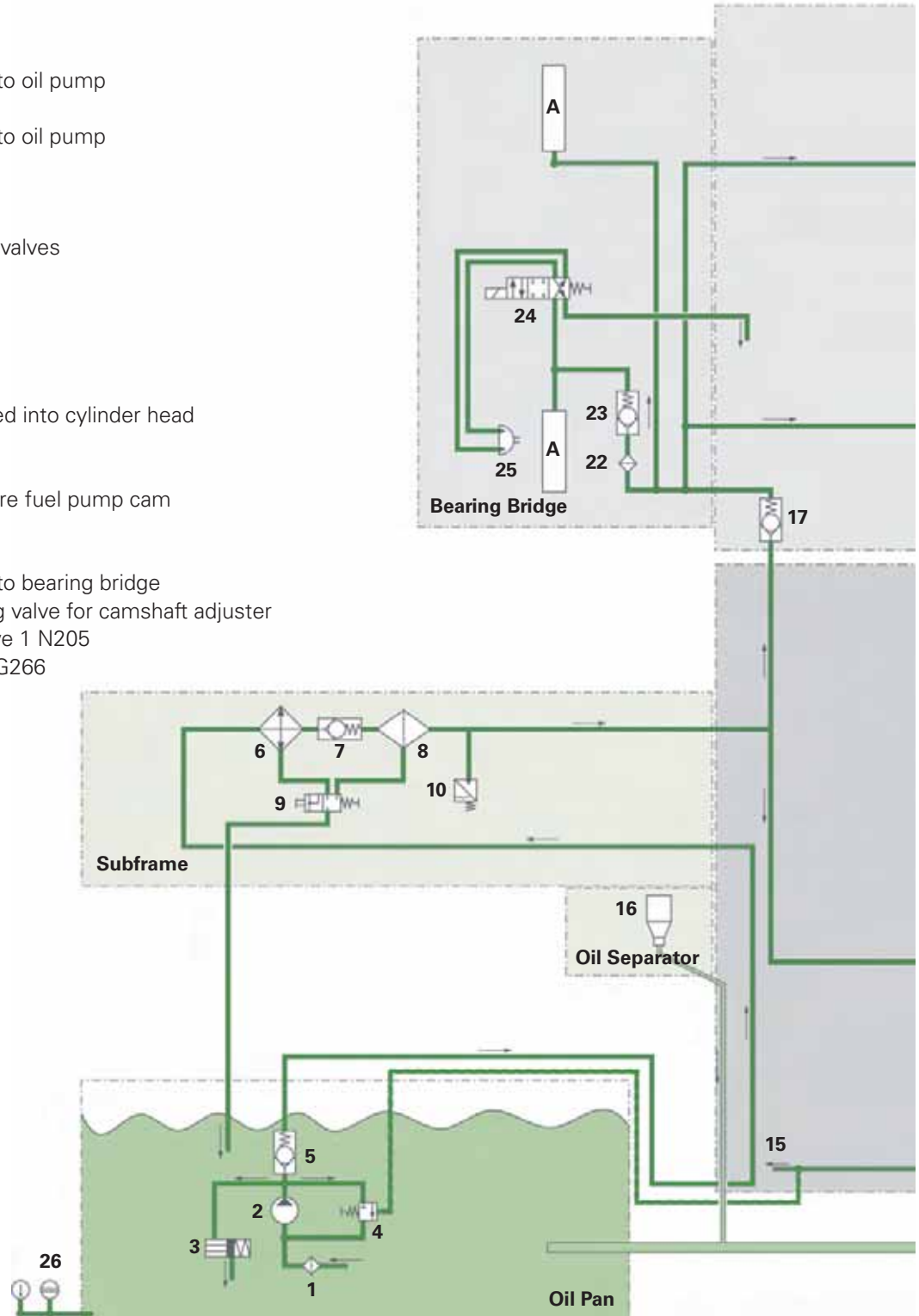


# Lubrication System

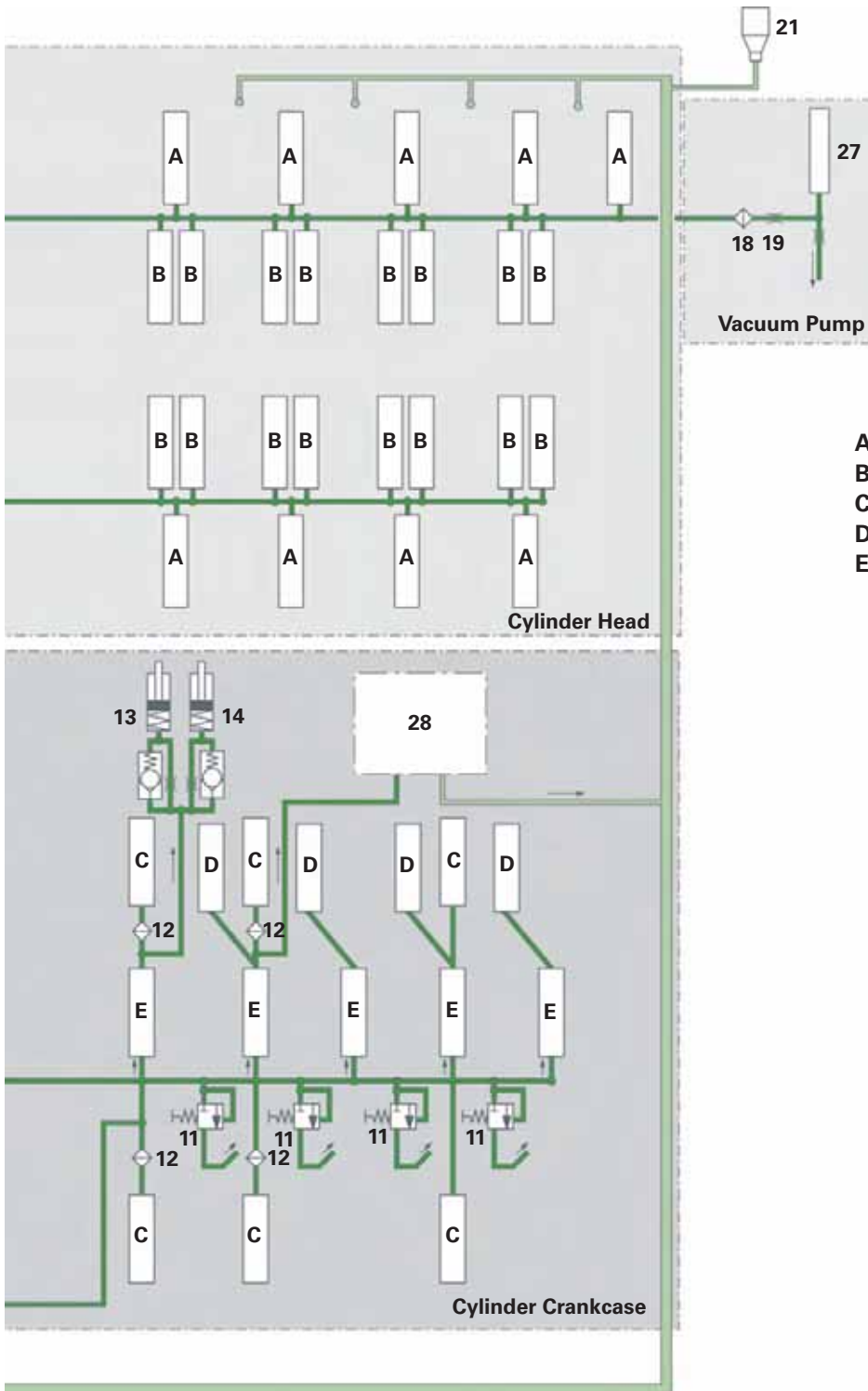
## Lubrication System Schematic

### Legend

- 1 Screen
- 2 Oil pump, chain-driven
- 3 Cold start valve
- 4 Pressure regulating valve
- 5 Check valve, integrated into oil pump
- 6 Water-oil heat exchanger
- 7 Check valve, integrated into oil pump
- 8 Oil cleaner
- 9 Oil drain valve
- 10 Oil Pressure Switch F1
- 11 Spray jets with integrated valves
- 12 Oil screen
- 13 Chain tensioner
- 14 Chain tensioner
- 15 Gear lubrication
- 16 Coarse oil mist separator
- 17 Non-return valve, integrated into cylinder head
- 18 Oil screen
- 19 Flow restrictor
- 20 Lubrication of high-pressure fuel pump cam
- 21 Fine oil mist separator
- 22 Oil screen
- 23 Check valve, integrated into bearing bridge
- 24 Multi-directional regulating valve for camshaft adjuster
- 25 Camshaft Adjustment Valve 1 N205
- 26 Oil Level Thermal Sensor G266
- 27 Vacuum pump
- 28 Turbocharger



# Lubrication System



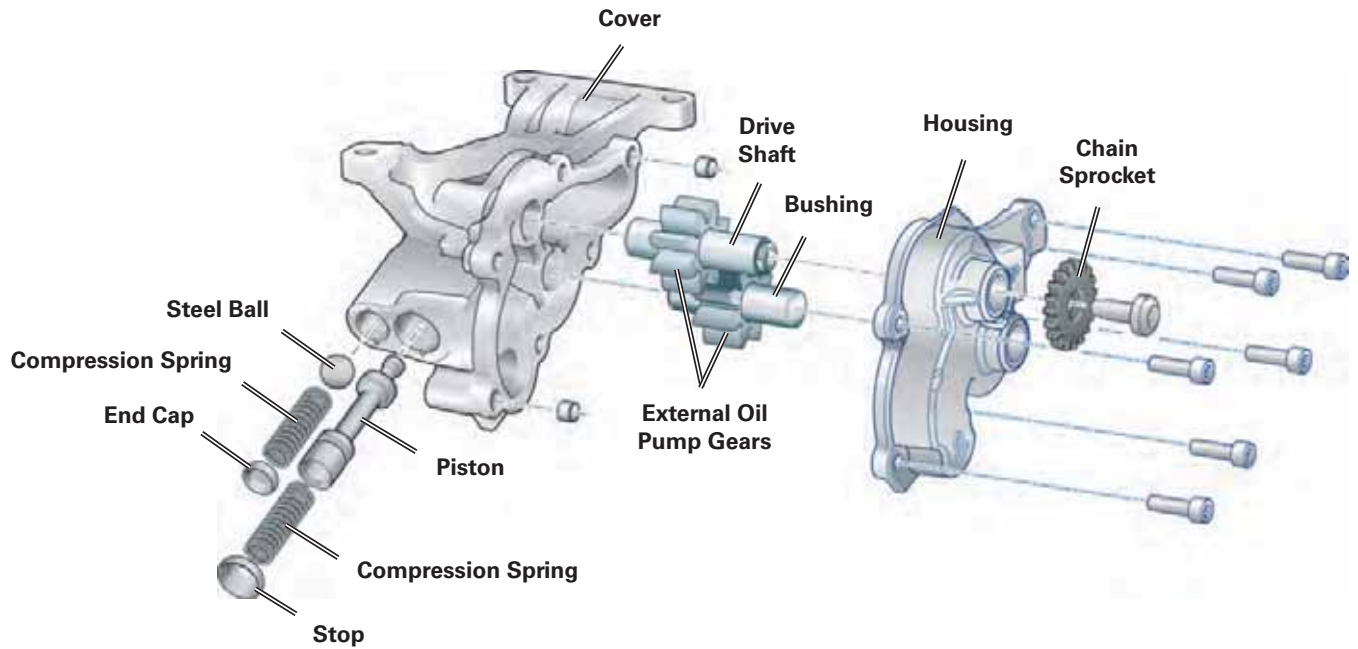
# Lubrication System

## Oil Pump

The external gear oil pump is housed in the oil pan top section and is chain-driven by the crankshaft.

The oil pressure is controlled inside the pump by a control spring and piston. The system is also protected against overpressure by a spring loaded valve ball (*cold start valve*).

Excessively high oil pressures can occur at high oil viscosity levels during cold starting.

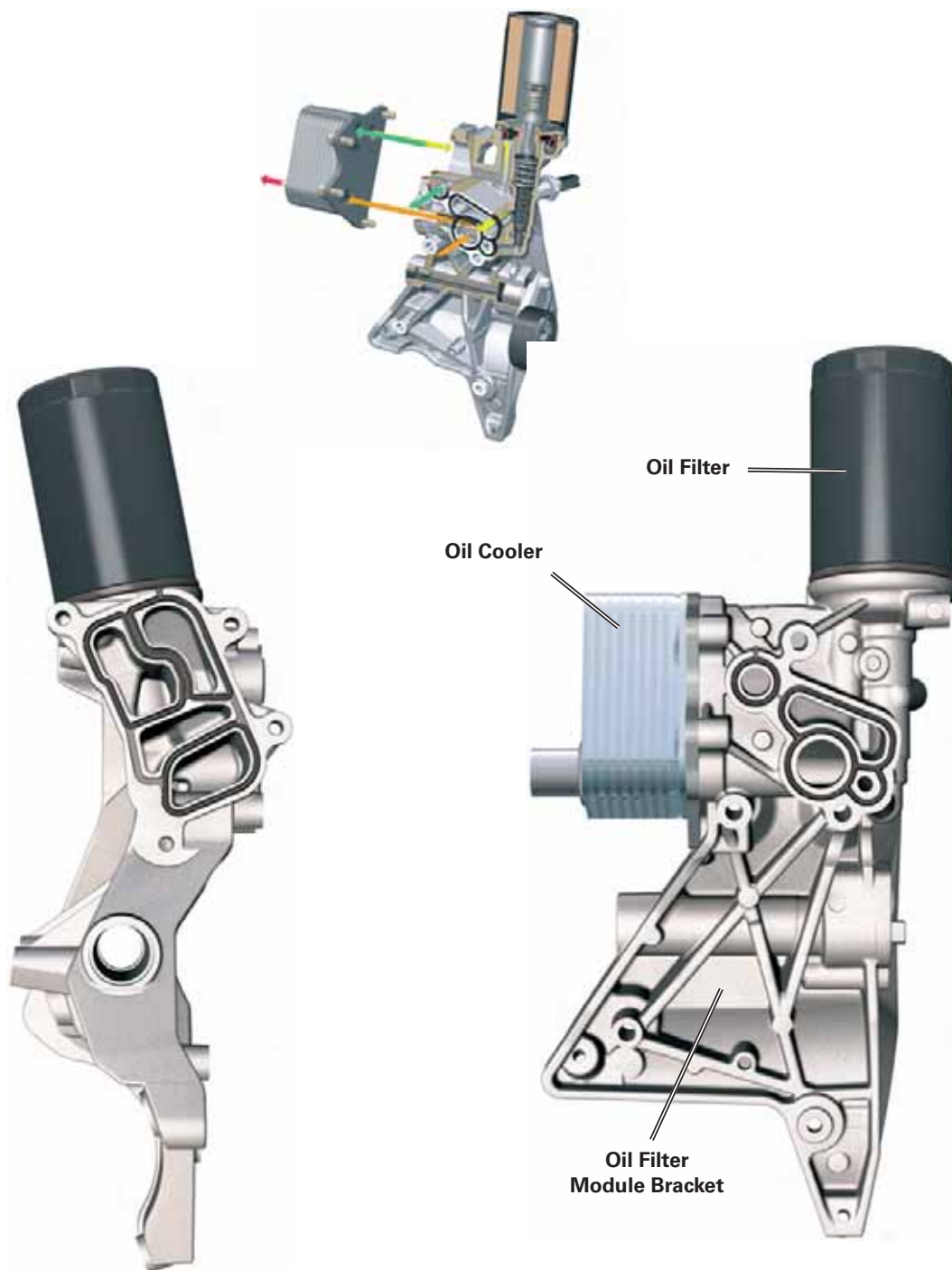


# Lubrication System

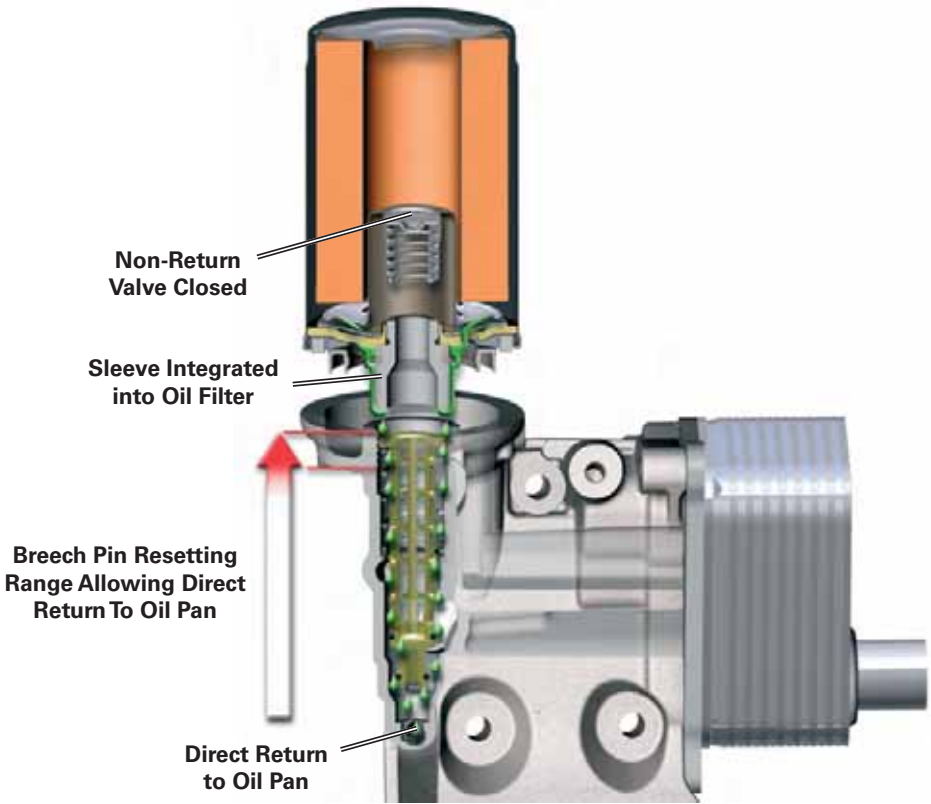
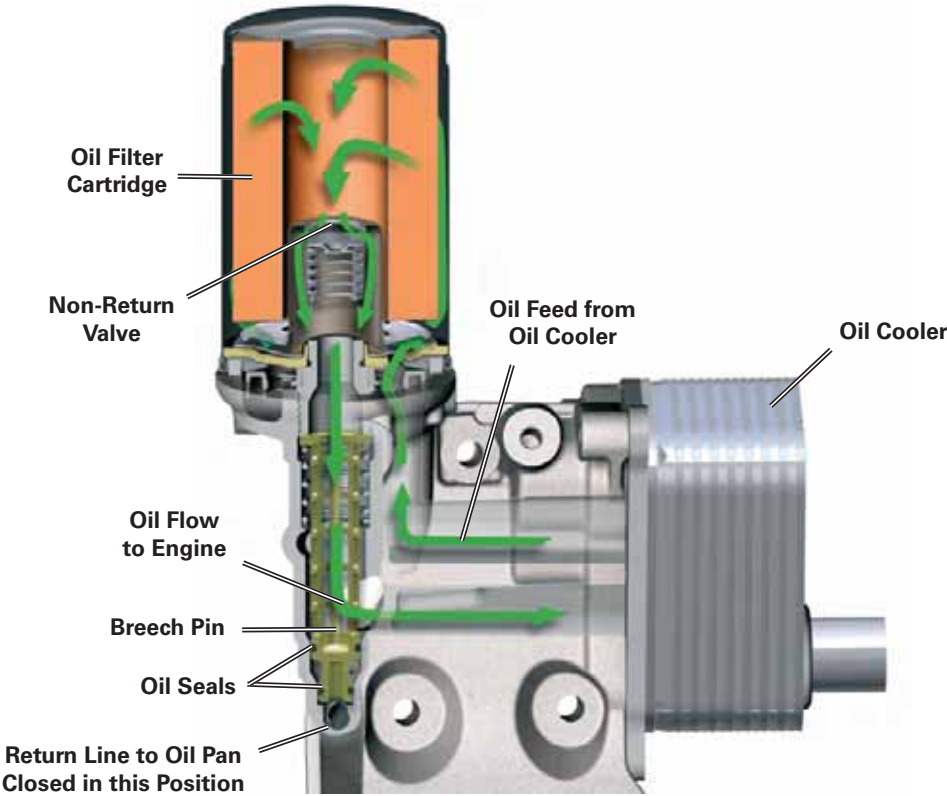
## Oil Filter and Cooler

The oil filter and oil cooler bracket are integrated in a subframe. It also houses the oil pressure switch and the tensioner for the belt drive.

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



# Lubrication System





# Crankcase Ventilation System

## System Overview

A primary oil separator is installed on the cylinder block just below the engine coolant pump. A baffle plate in the oil pan upper section prevents engine oil from being drawn out of the sump at the gas extraction point. In the primary oil separator, the blow-by gases flow through a labyrinth to separate coarse particles from the oil. The primary oil separator has two separation stages which work on the baffle-plate principle.

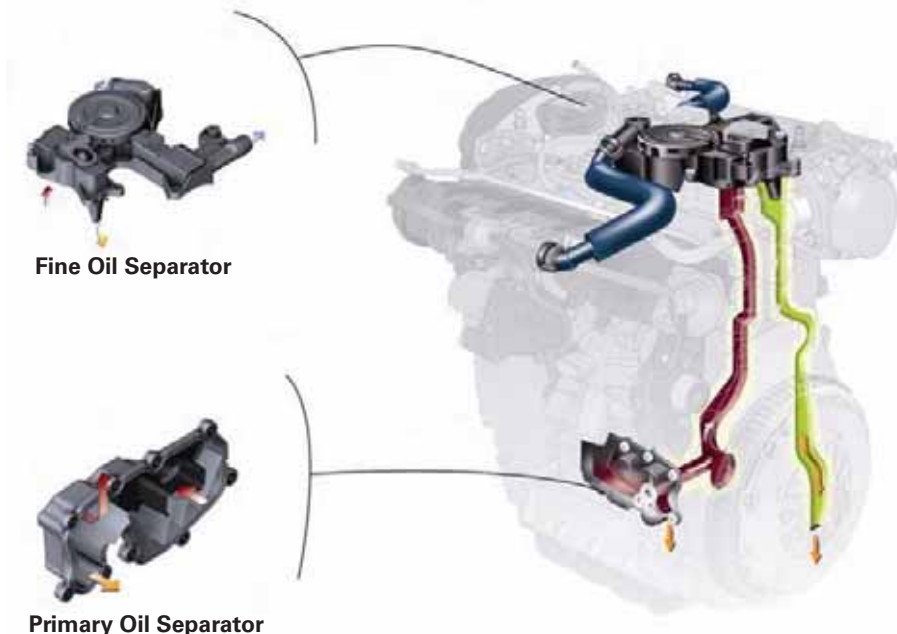
The separated oil flows back along oil return lines into the oil pan. The blow-by gases continue to flow from the primary oil separator through a channel in the cylinder block to the cylinder head. The large cross-section channels results in a low crankcase breather gas flow rate which prevents oil droplets from travelling along the sides.

A fine oil separator is integrated with the cylinder head cover. A single-stage cyclone separator with a parallel bypass valve filters out any residual ultra-fine oil particles.

The separated oil flows into the cylinder head through a port in the cylinder head cover; from there, the oil is returned to the oil pan. To prevent intake of the engine oil under excessively high vacuum, a check valve is installed at the end of the oil return duct. This check valve is installed in the honeycomb insert in the oil pan.

The blow-by gases flow along a duct integrated in the cylinder head cover to a two-stage pressure regulating valve. The pressure regulating valve prevents excessively high vacuum from developing within the cylinder block.

The pressure regulating valve is installed in a housing together with two check valves. The check valves regulate blow-by gas flow depending on pressure conditions in the intake manifold. If a vacuum is present in the intake manifold (*for example, at low engine speed*) when the exhaust gas turbocharger is not producing boost pressure, the blow-by gases are drawn directly into the intake manifold. If boost pressure is present, the blow-by gas is inducted on the intake side of the turbocharger.





# Crankcase Ventilation System

## Positive Crankcase Ventilation

This system supplies the crankcase with fresh air to mix with blow-by gases. Fuel and water vapors in the blow-by gases are absorbed by the fresh air and then discharged through the crankcase ventilation system.

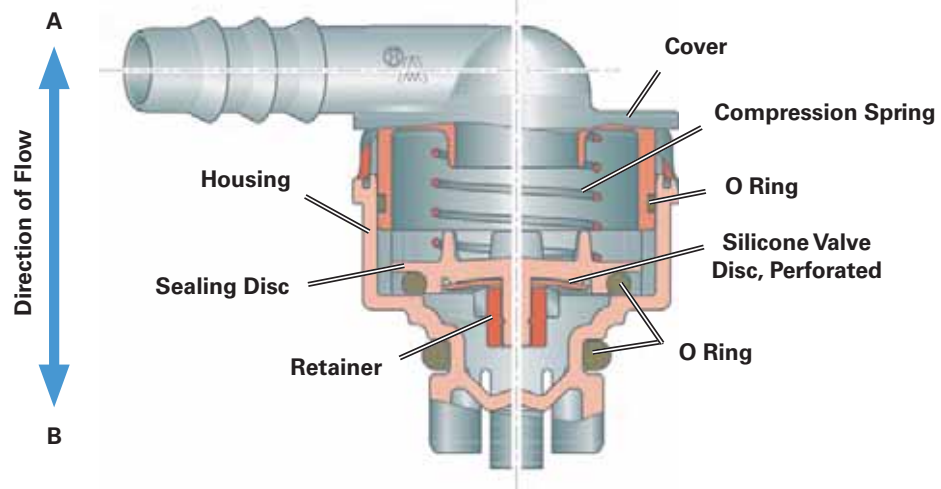
Fresh air is drawn in from the intake air system downstream of the air filter and Mass Air Flow Sensor. A breather pipe is connected to the cylinder head cover via a check valve (PCV valve).

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

The PCV valve is also designed to open under high pressure inside the crankcase. This precaution prevents damage to seals due to over-pressure.



Cutaway View of Crankcase Breather Valve



	Direction of Flow A-B	Direction of Flow B-A
Opening Pressure	Pressure Greater Than - 0.10 psi (-7 hPa)	1.4 ± 0.21 psi (100 ± 15 hPa)

# Cooling System

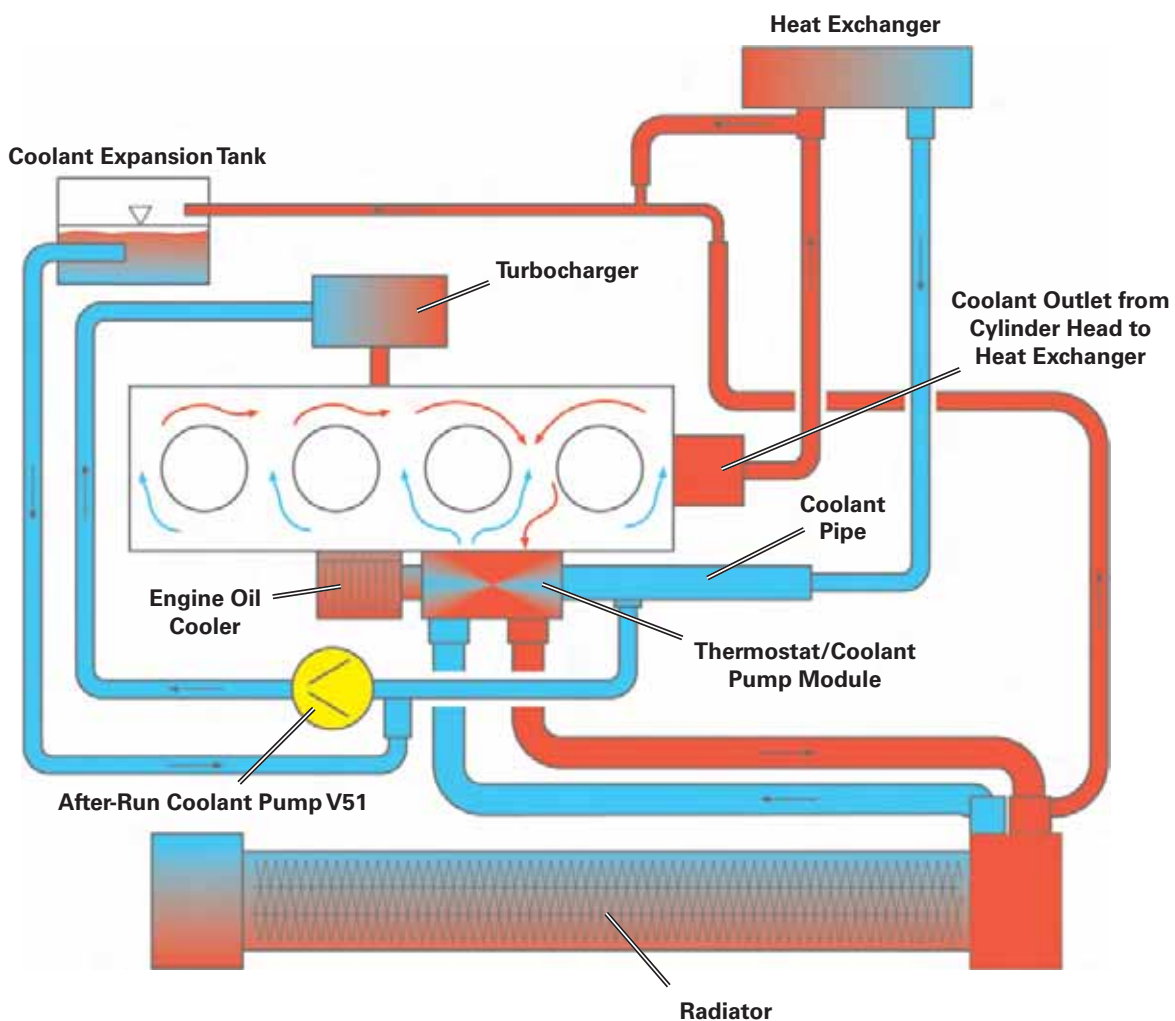
## Engine Cooling System

The engine uses a cross-flow cooling system. Engine coolant first flows to the front of the engine from the coolant pump. The coolant is then distributed along ducts and circulates around the cylinders. After circulating through the cylinder head, the coolant is routed back to the radiator via the thermostat housing or recirculated through the coolant pump if the thermostat is closed.

The heat exchanger and turbocharger are part of the engine cooling circuit. The engine oil cooler is connected directly to the cylinder block through its mounting subframe.

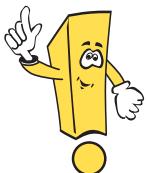
After-Run Coolant Pump V51 protects the turbocharger bearings from overheating after engine shut-off.

The pump is activated by the engine control module based on programmed characteristic maps.

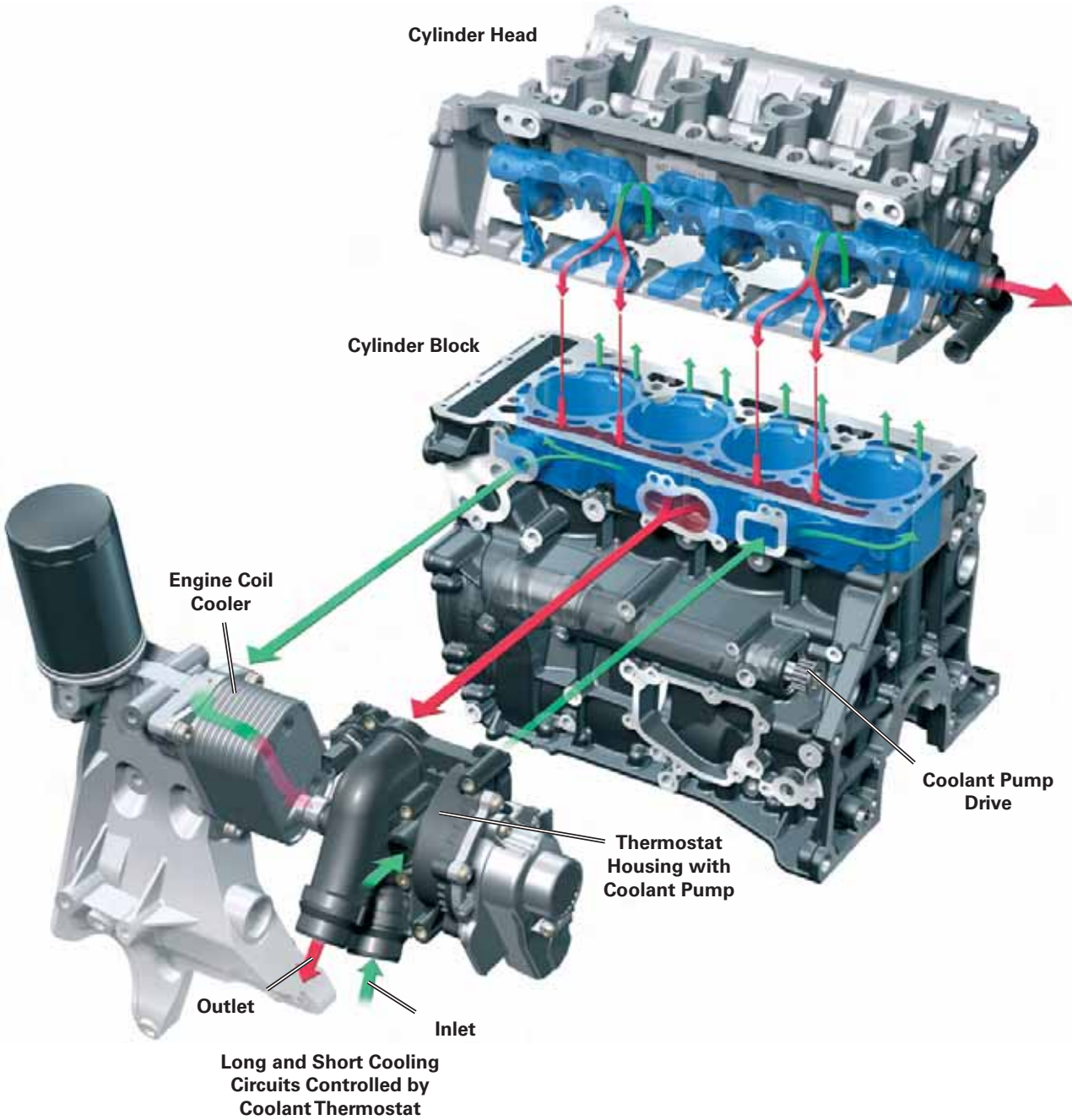


### Note

Vehicle coolant systems are dependent on model equipment installed. For vehicle specific information, please consult the relevant Repair Manual.



# Cooling System



# Cooling System

## Coolant Pump

The coolant pump, temperature sensor, and coolant thermostat are integrated in a common housing made of duroplastic.

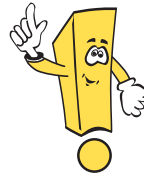
This housing is attached to the cylinder block below the intake manifold.

A drive gear at the end of the balance shaft drives the coolant pump via a toothed belt. The larger drive gear on the pump acts as a speed reducer. A fan wheel is attached to the coolant pump drive gear to cool the toothed belt.

The coolant pump impeller is made of plastic and has a special vane contour which permits high engine speeds with low risk of pump cavitation.

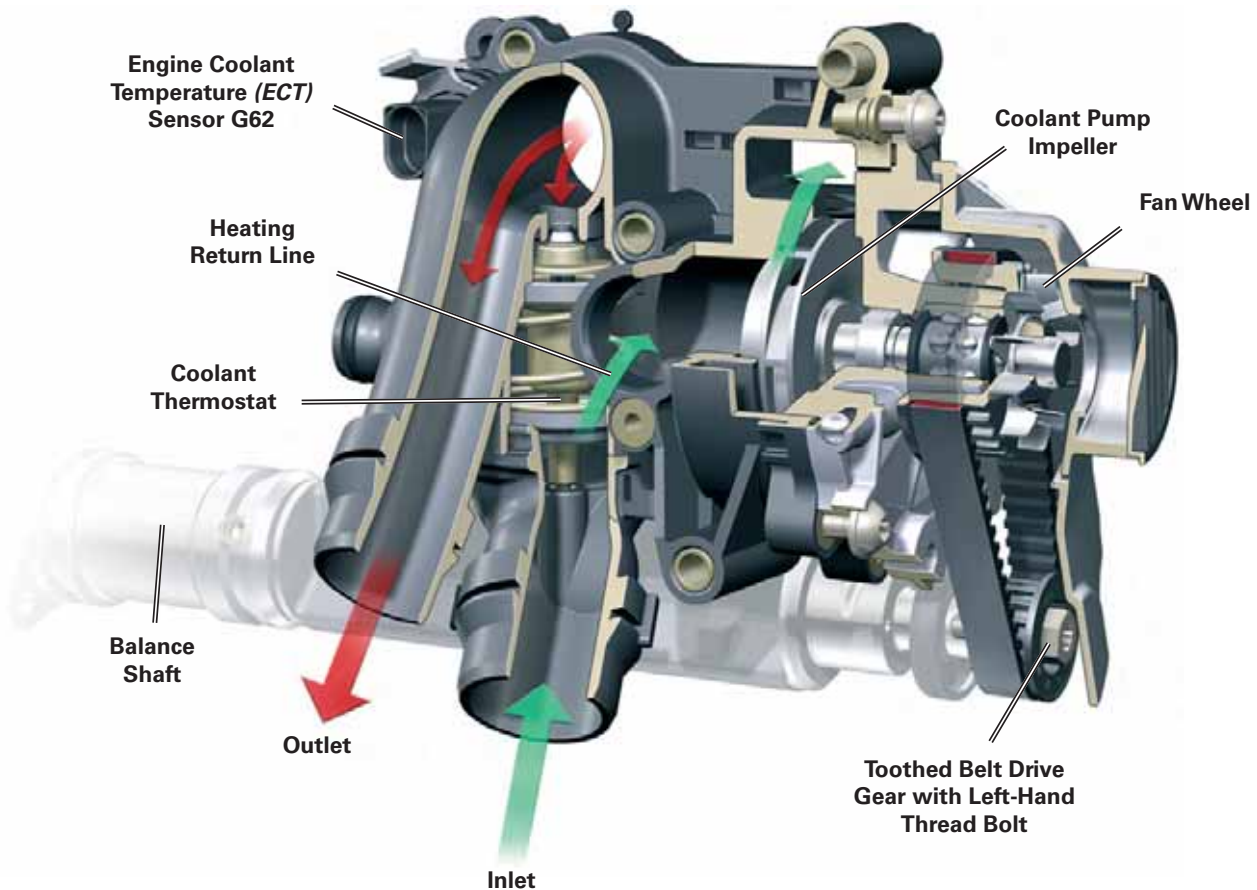
The thermostat begins to open at 203°F (95°C) and is fully open at 221°F (105°C).

### Note



The tension of the coolant pump drive belt is defined by the installation position of the coolant pump and cannot be adjusted. In the event of coolant pump failure, the housing must also be replaced.

The toothed belt drive gear of the coolant pump has a left-hand thread.



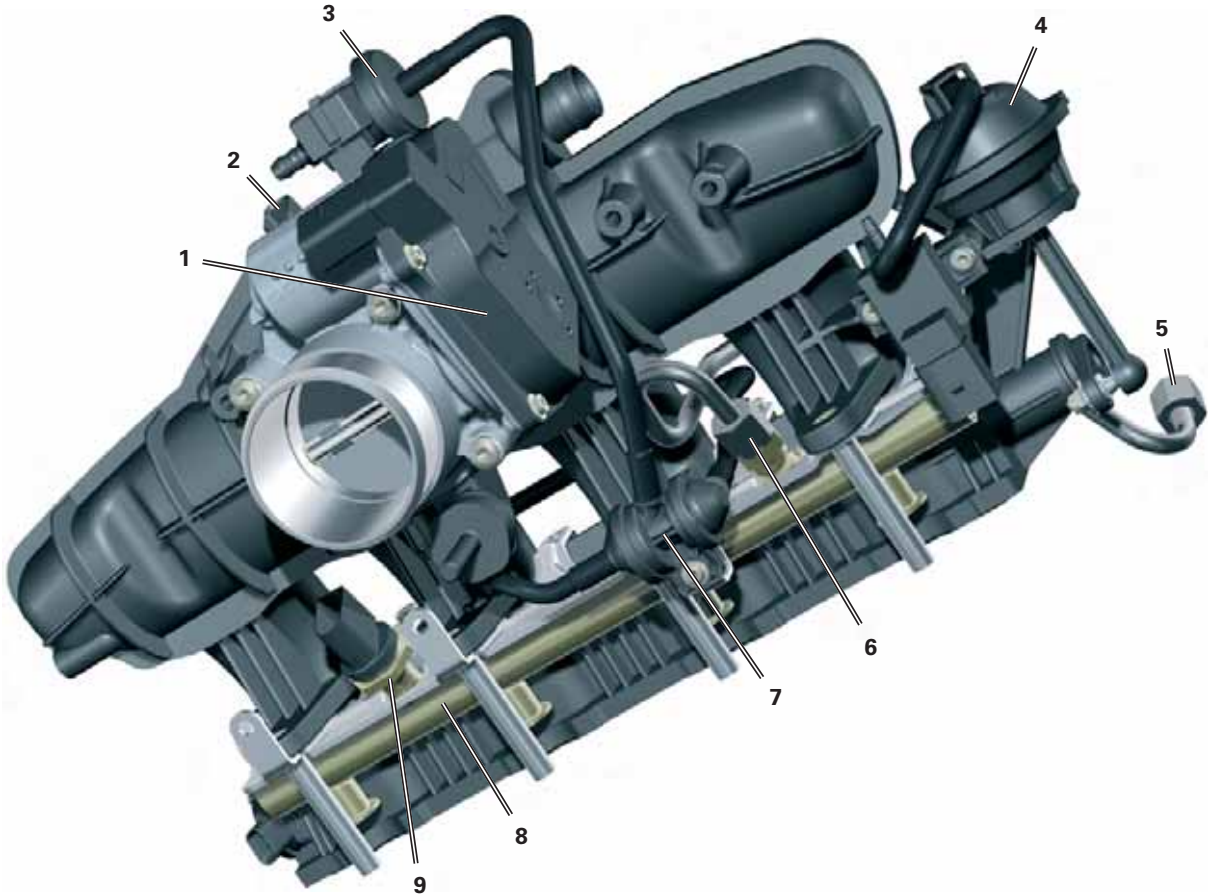


# Air Intake System

## Intake Manifold Module

### Legend

- 1 Throttle valve control module
- 2 Intake Air Temperature (IAT) Sensor G42
- 3 Evaporative (EVAP) Emission Canister Purge Regulator Valve N80
- 4 Vacuum motor for intake manifold flap changeover
- 5 Fuel port, high-pressure pump
- 6 Fuel port, high-pressure fuel rail
- 7 Double check valve for EVAP system
- 8 High-pressure fuel rail
- 9 Fuel Pressure Sensor G247
- 10 Intake manifold flaps
- 11 Intake Manifold Runner Position Sensor G336



# Air Intake System

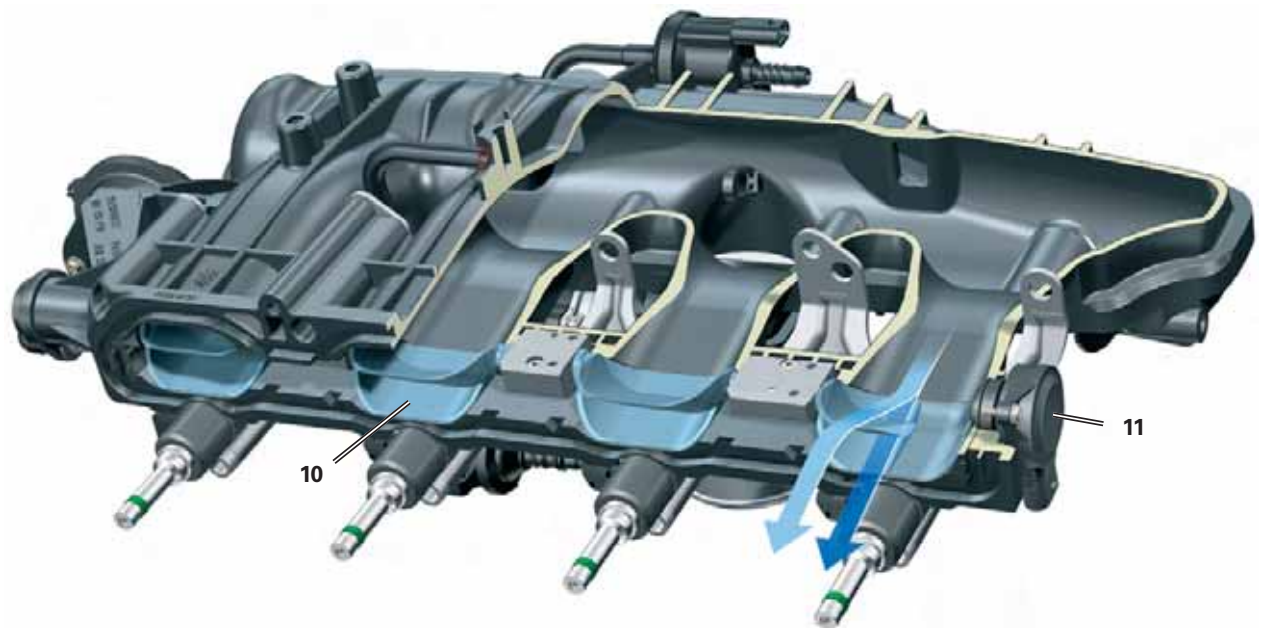
The body of the intake manifold module is made of polyamide and consists of two shells which are plastic-welded together.

The intake manifold flaps are trough shaped. Through this shape and their arrangement in the intake port, the intake airflow is improved when the flaps are open. An improvement in tumble capacity is also achieved when closing the flaps.

The intake manifold flaps are adjusted by a vacuum motor. The motor uses a two stage process.

Feedback about the flap position is provided by Intake Manifold Runner Position Sensor G336. When the engine is not running, the intake manifold flaps are closed.

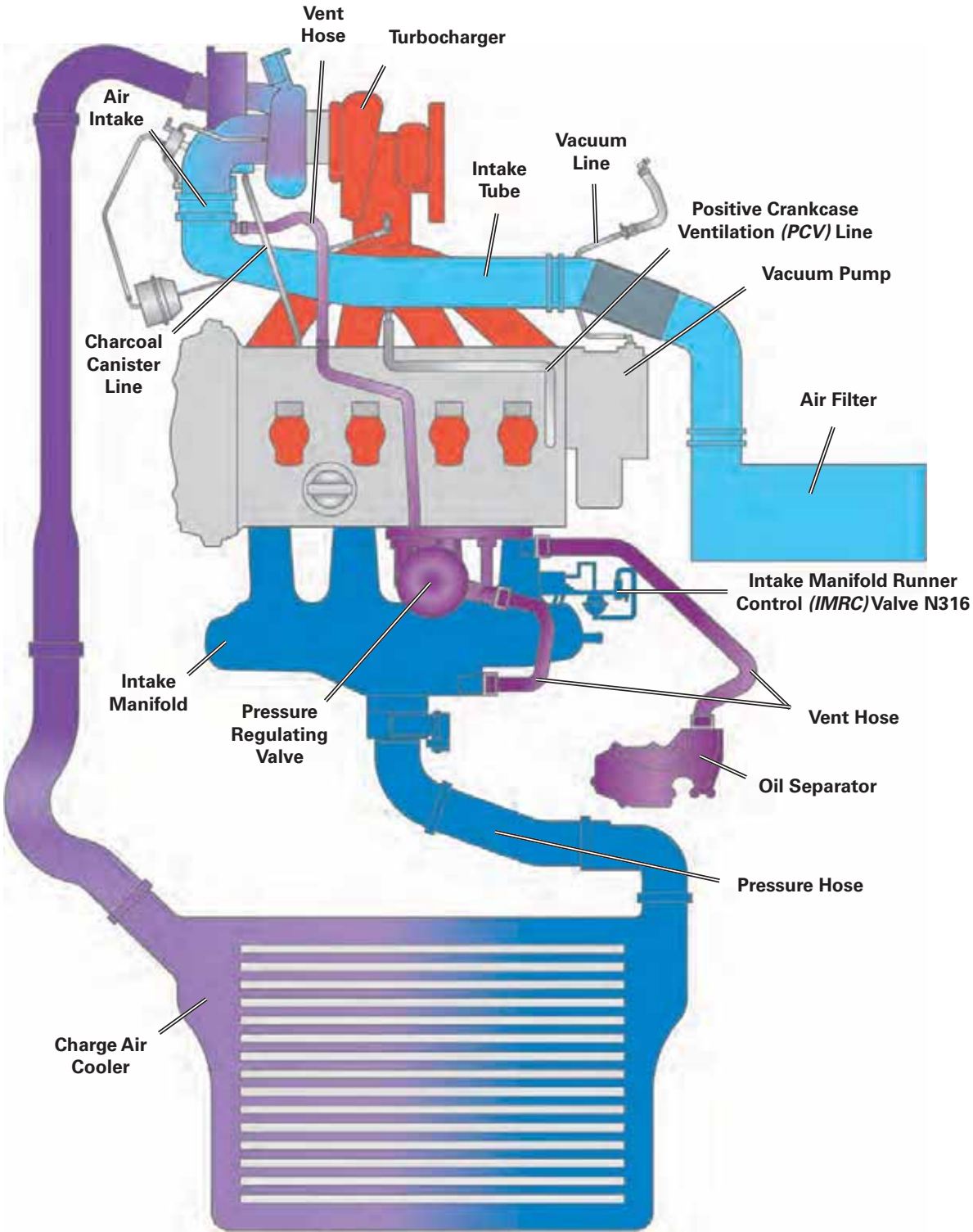
Blow-by gases and vapor from the charcoal canister vent directly into the airflow downstream of the throttle valve assembly.





# Air Intake System

## Air Supply

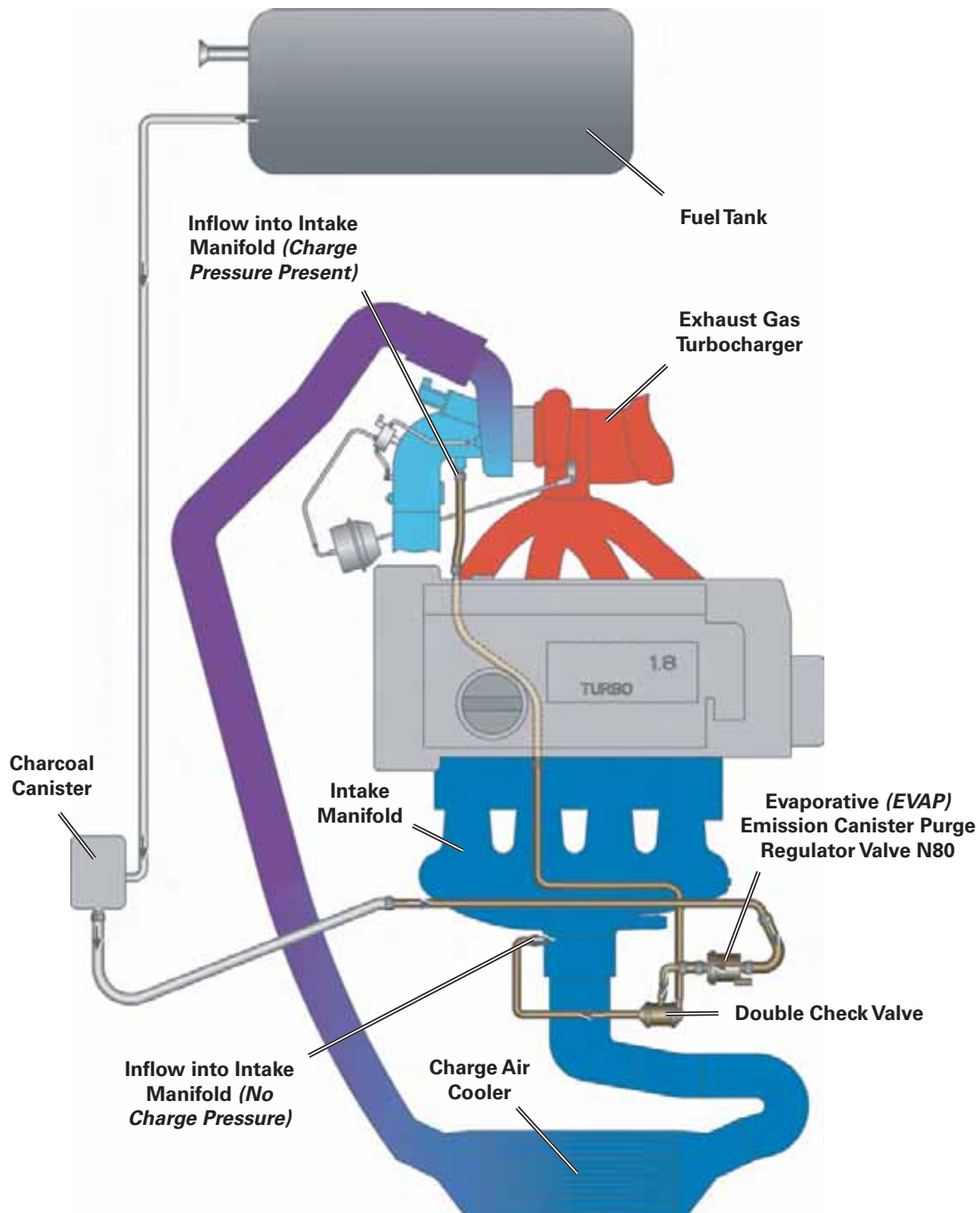


# Air Intake System

## Evaporative Emission System

Venting of fuel vapors from the charcoal canister while the engine is running involves using two different paths. When boost pressure from the turbocharger is present, fuel vapors cannot directly flow into the intake manifold. In this case, the vapors are directed to the intake side of the turbocharger.

When boost pressure is not present, the vapors are drawn in through the intake manifold downstream of the throttle body. A double check valve in the evaporative system accomplishes this task.



# Air Intake System

## Vacuum Supply

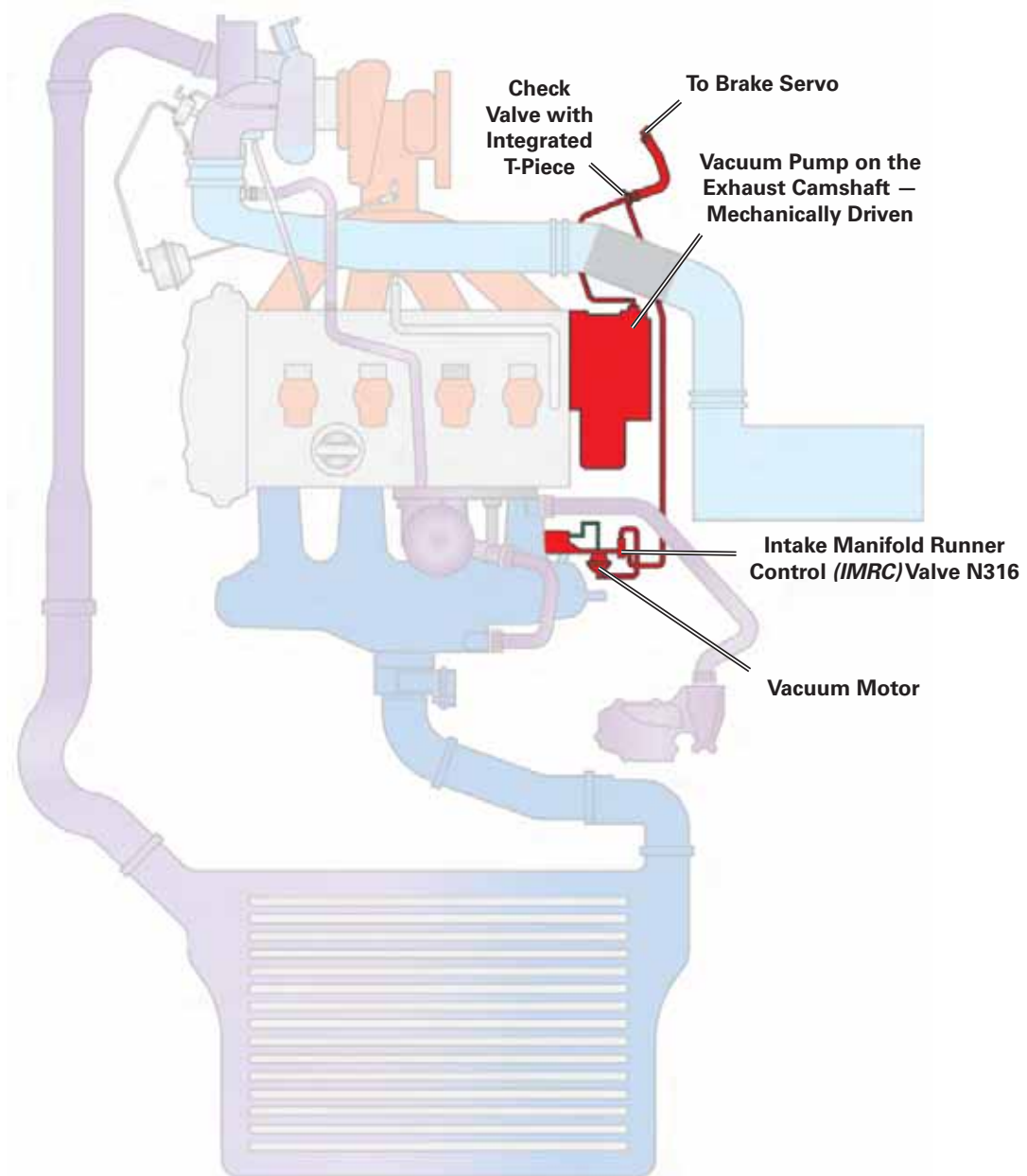
The required vacuum for the brake booster and other vacuum driven components of the engine is produced by a mechanically driven vacuum pump.

The pump is a swivel vane pump driven by the exhaust camshaft and is installed behind the high-pressure fuel pump.

The vacuum pump is capable of providing a sufficient vacuum for all vacuum components under any operating condition.

For this reason, it is not necessary to use an additional vacuum reservoir. The pump is rated to deliver a continuous absolute pressure of 0.73 psi (50 mbar).

Oil for lubricating the pump and to enhance the sealing of the pump vanes is provided through a special port in the cylinder head.



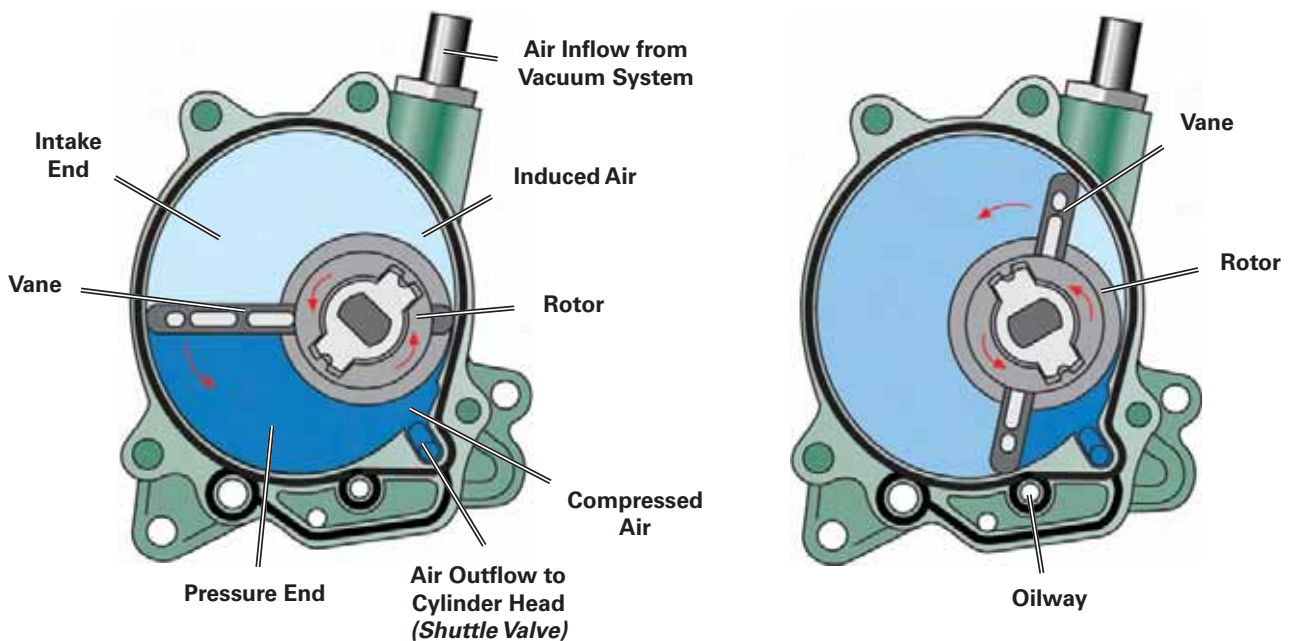
# Air Intake System

## Vacuum Pump



The vacuum pump consists of a rotor running in bearings and a moving vane made of plastic which divides the vacuum pump into two sections.

The position of the vane is constantly changing due to the rotational movement of the rotor. As a result, the volume of one section increases while the volume of the other section decreases.



# Fuel System

## Fuel System

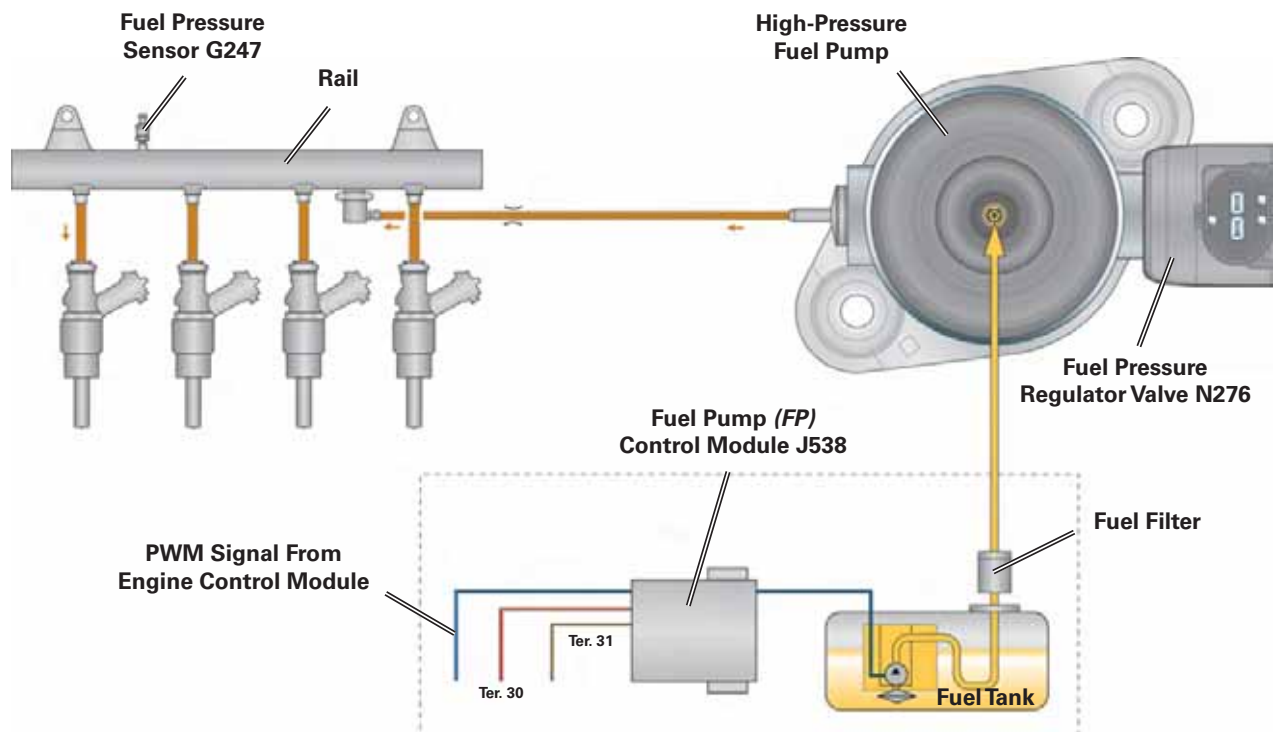
The fuel system is an advanced version of the system used on earlier TSI engines.

All parts which are in direct contact with fuel are designed in such a way that the engine can run on any available fuel grade.

Special materials are used to ensure the fuel system meets all requirements relating to corrosion protection.

The high-pressure system is supplied with fuel by a returnless, demand controlled pre-supply system. Fuel is delivered at a variable pressure between 50.7 psi (3.5 bar) and 87.1 psi (6.0 bar).

No low pressure sensor is used in this system. The correct fuel pressure is determined by mapped settings of the engine control module and subsequently set by Fuel Pressure Regulator Valve N276.





# Fuel System

## Fuel Rail

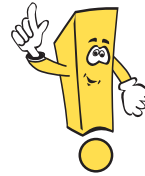
The fuel delivery rate of the high-pressure pump has been reduced through the use of a four-lobe cam.

A quicker pressure build-up is thus possible. This build-up benefits both cold start and hot start situations.

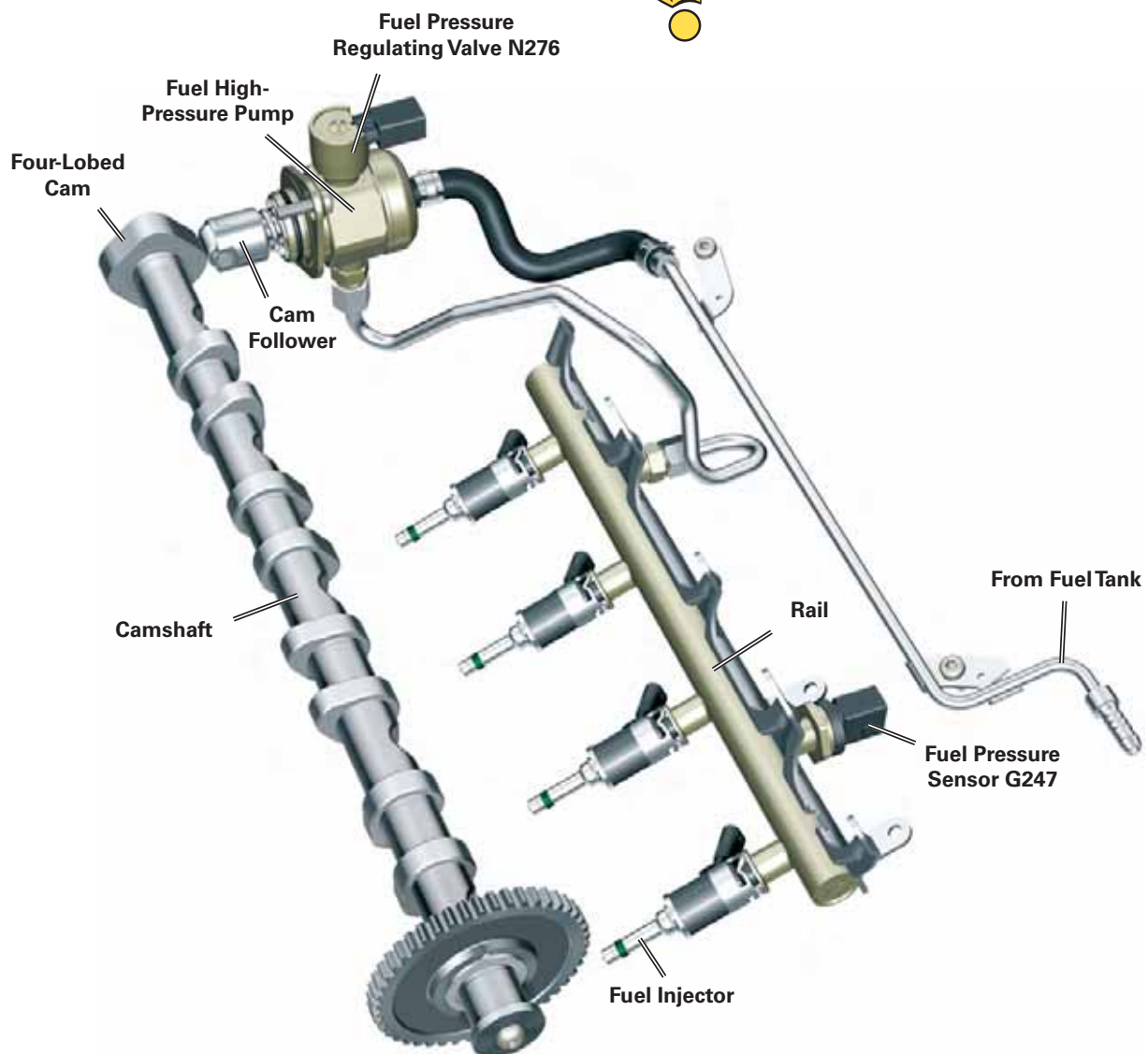
## Fuel Pressure Sensor G247

The fuel pressure sensor is mounted in the fuel rail and is designed for measuring pressures up to 2900 psi (200 bar).

### Note



Always carefully follow the repair manual instructions when replacing the high-pressure fuel pump. The pump can be destroyed if the actuating cam follower is not properly installed.



# Fuel System

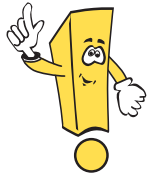
## High-Pressure Pump

The demand controlled high-pressure pump by Bosch is driven by a four lobed cam on the end of the intake camshaft.

The pump piston is driven by the camshaft and a cam follower. This reduces friction as well as the chain forces. The results are smoother engine operation and higher fuel economy.

The use of the four lobe cam has allowed a reduced piston stroke compared to earlier versions of the 2.0L TSI engine. Due to the shorter stroke, the individual delivery rates are lower. This, in turn, results in reduced pressure fluctuations. The metering precision of the injectors is also improved, as there is now one feed stroke per injection. The advantage of this is improved oxygen sensor control and fuel efficiency.

### Note



Always follow the repair manual cautions and warnings when opening the high-pressure fuel system lines. Serious injury can result if proper procedures are not observed.

The high-pressure pump produces a maximum pressure of 2175.5 psi (150 bar). The fuel pressure requested by the engine control module is adjusted by Fuel Pressure Regulator Valve N276. The pressure is regulated between 725.1 psi (50 bar) and 2175.5 psi (150 bar) depending on engine requirements.

The high-pressure pump now has its own pressure limiting valve. This valve opens at approximately 2900 psi (200 bar) and admits pressure into the pump chamber. Previously, pressure was discharged into the low-pressure circuit. Excessively high-pressures can build up in overrun or when the engine heat soaks after shut-off.

The pressure pulsations in the low-pressure circuit are reduced by a damping element integrated in the pump.



## High-Pressure Regulation

Fuel pressure and fuel quantity are regulated by Fuel Pressure Regulator Valve N276. The signal from Fuel Pressure Sensor G247 is used by the engine control module as a parameter. This sensor is located in the fuel rail.

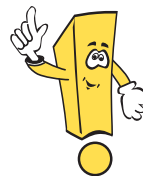
Power demand has been reduced significantly through a newly designed fuel pressure regulating valve and associated control concept.

At the start of delivery, Fuel Pressure Regulating Valve N276 is activated only very briefly. The intake valve closes, fuel pressure builds up, and fuel delivery immediately begins.

After the intake valve closes, electrical power to the solenoid valve is shut off.

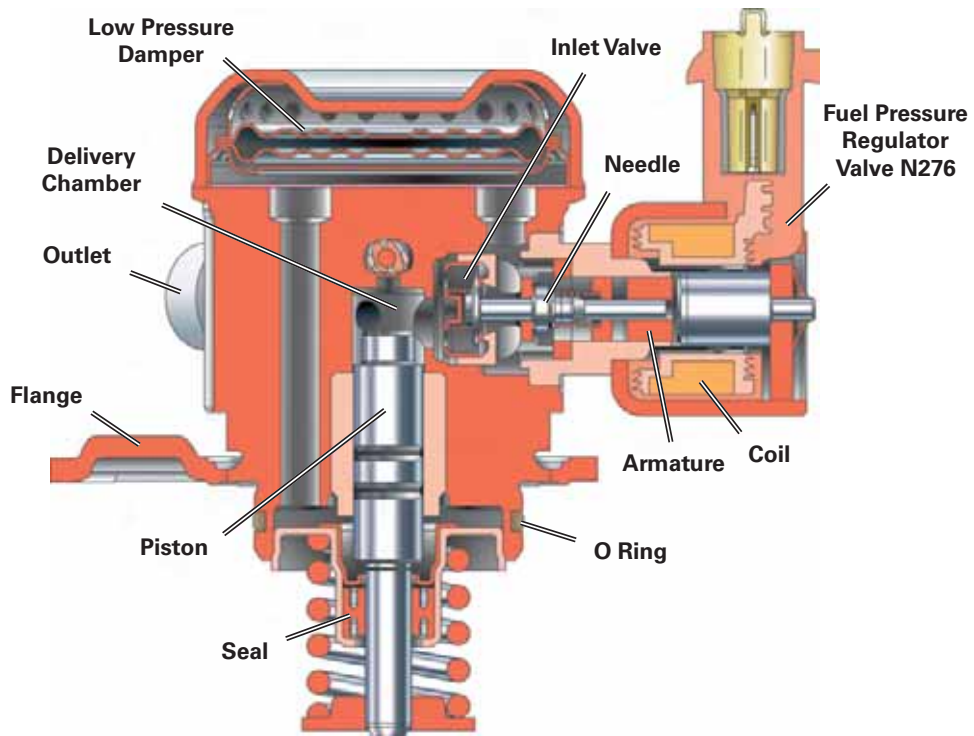
The intake valve kept closed by the pressure in the pump until the pump piston feed stroke is complete and the intake stroke begins.

### Note

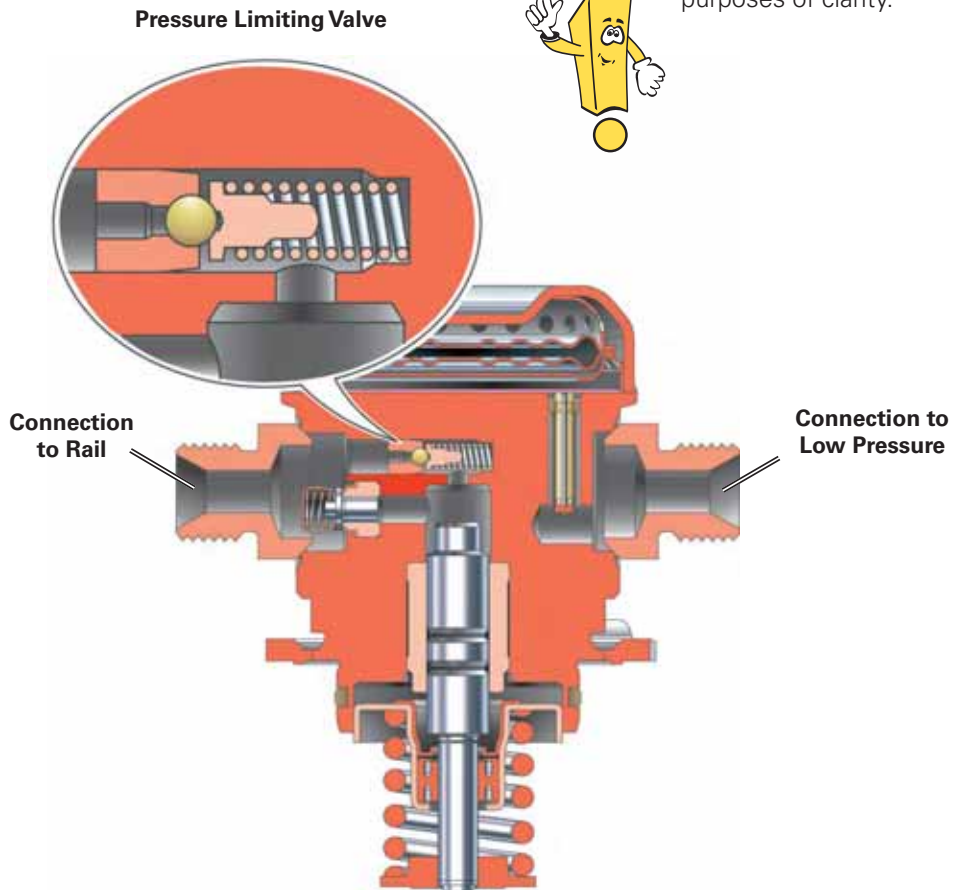
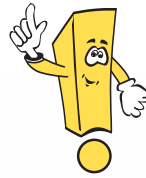


Applying continuous voltage to Fuel Pressure Regulator Valve N276 for longer than one second will cause damage to N276.

# Fuel System



**Note** These illustrations have been modified slightly from the actual pump for purposes of clarity.

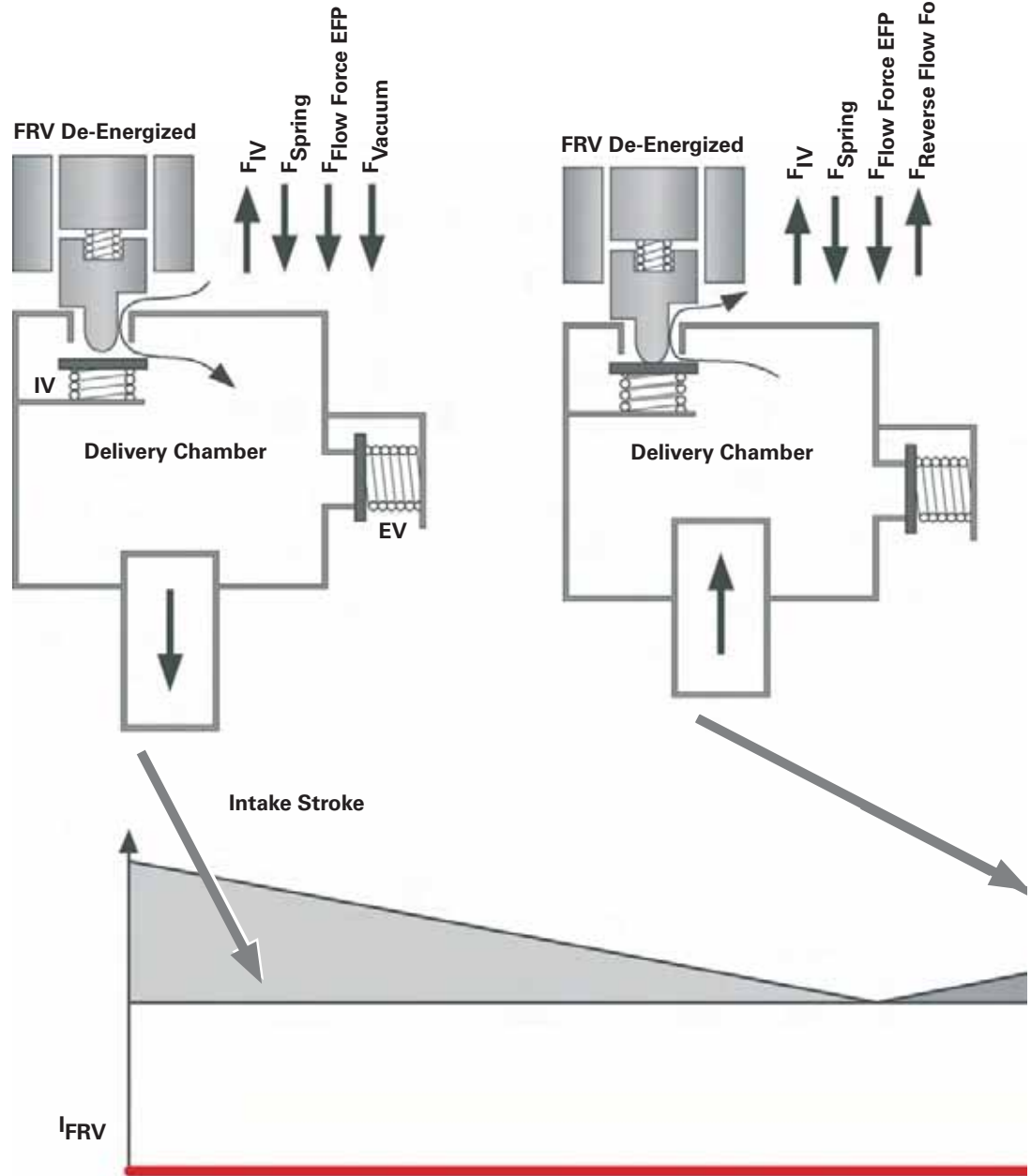


# Fuel System

## Control Concept

The diagram shows the high-pressure regulation function of the high-pressure pump. The complete delivery cycle for a cam is shown here.

This cycle takes place four times during a single revolution of the camshaft. The bottom diagram shows the movement of the pump piston and the activation of Fuel Pressure Regulator N276.



**Fig. 1**

- Pump piston intake stroke, fuel flows into pump chamber
- N276 de-energizes
- Intake Valve (IV) opens because spring force is less than flow force of transfer fuel pump — vacuum is present inside pump
- Exhaust Valve (EV) closes

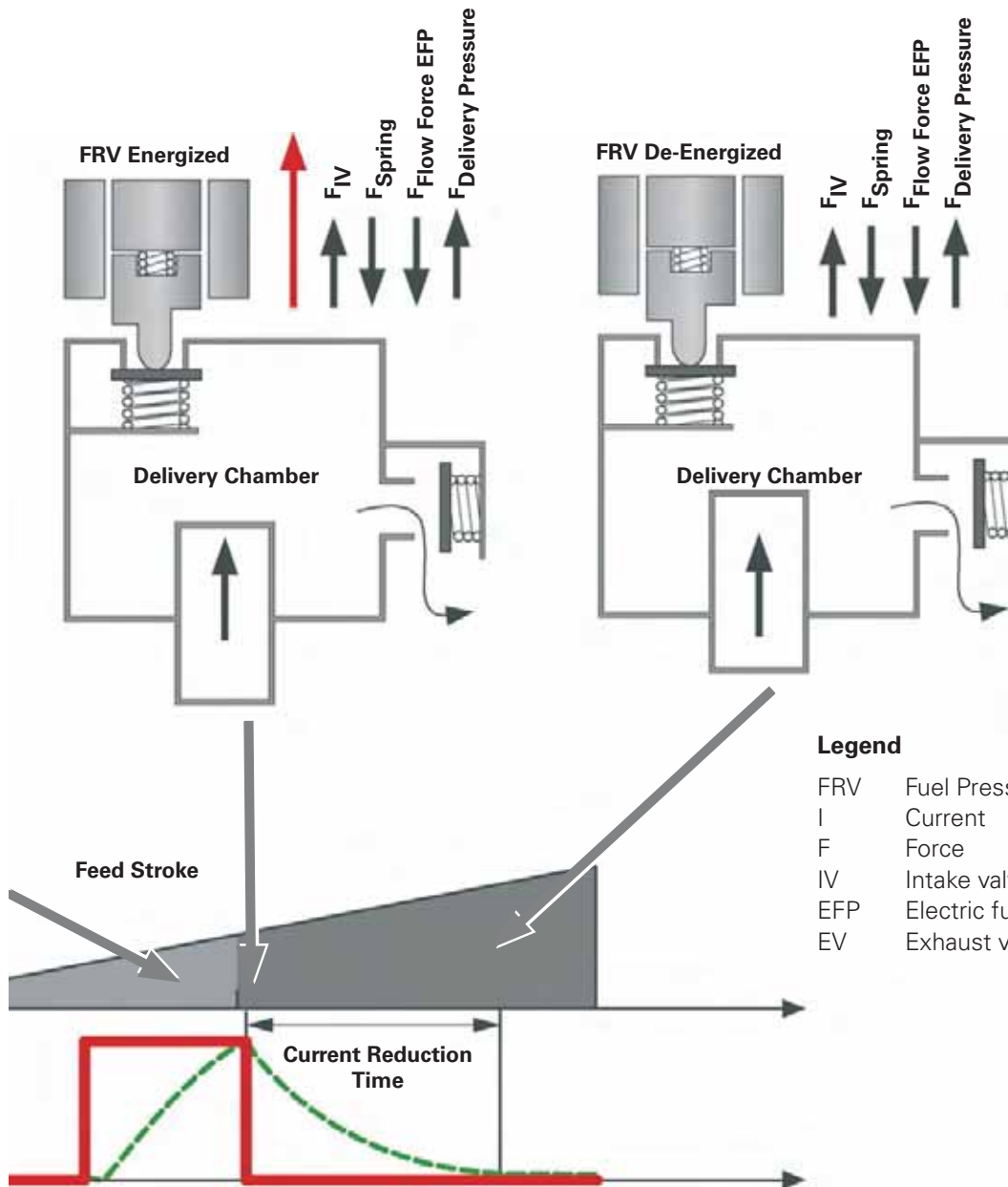
**Fig. 2**

- Pump piston feed stroke, fuel flows back to inlet
- N276 de-energizes
- IV opens due to upward motion of pump piston, fuel moves from pump chamber into inlet
- EV closes

# Fuel System

The operating point of the N276 changes depending on when it is activated by the engine control module. The ON time remains the same.

The earlier N276 is activated, the more actively the delivery stroke can be used and hence the more fuel can be delivered.



**Fig. 3**

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

**Fig. 4**

- Pump piston feed stroke, fuel flows to rail until intake stroke begins
- N276 de-energizes
- IV closes
- EV opens



# Fuel System

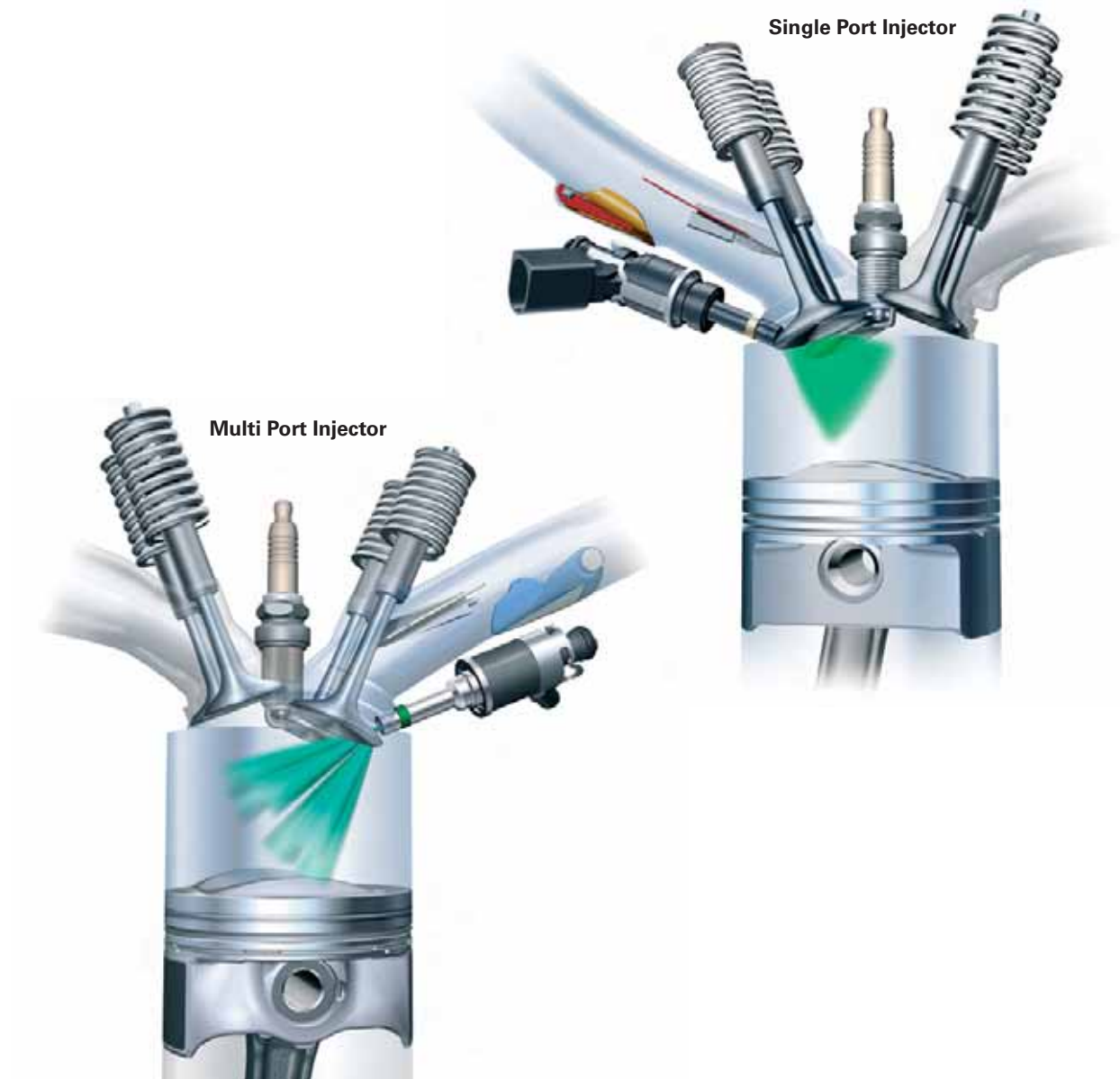
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## Injector

Each fuel injector has six individual fuel openings, providing better mixture preparation.

This also helps prevent “wetting” the intake valves and the combustion chamber surfaces during injection cycles.

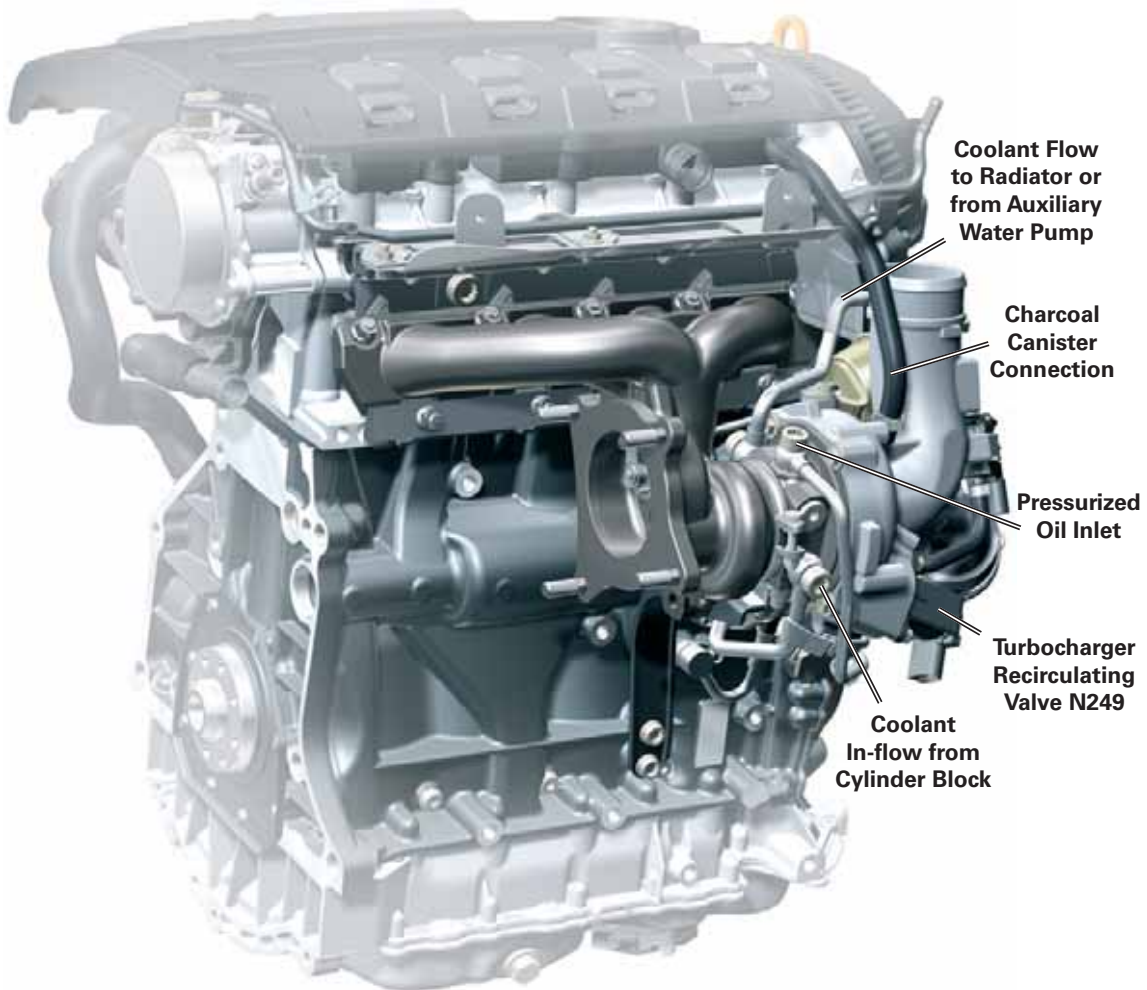
The angle of cone of the jet is 50°. These modifications have resulted in reduced HC emissions, particulate matter formation, and oil thinning.



# Exhaust System

## Turbocharger and Manifold Module

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



# Engine Management System

## Overview of Bosch MED 17.5 System

### Sensors

Mass Air Flow (MAF) Sensor G70  
Intake Air Temperature (IAT) Sensor G299

Engine Coolant Temperature (ECT) Sensor (on Radiator) G83

Engine Coolant Temperature (ECT) Sensor G62

Change Air Pressure Sensor G31

Engine Speed (RPM) Sensor G28

Camshaft Position (CMP) Sensor G40

Throttle Valve Control Module J338 with Throttle Drive Angle Sensor 1 G187 and Throttle Drive Angle Sensor 2 G188

Throttle Position (TP) Sensor G79  
Accelerator Pedal Position Sensor 2 G185

Brake Pedal Switch F63  
Clutch Position Sensor G476

Fuel Pressure Sensor G247

Intake Manifold Runner Position Sensor G336

Knock Sensor (KS) 1 G61

Heated Oxygen Sensor (HO2S) G39

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

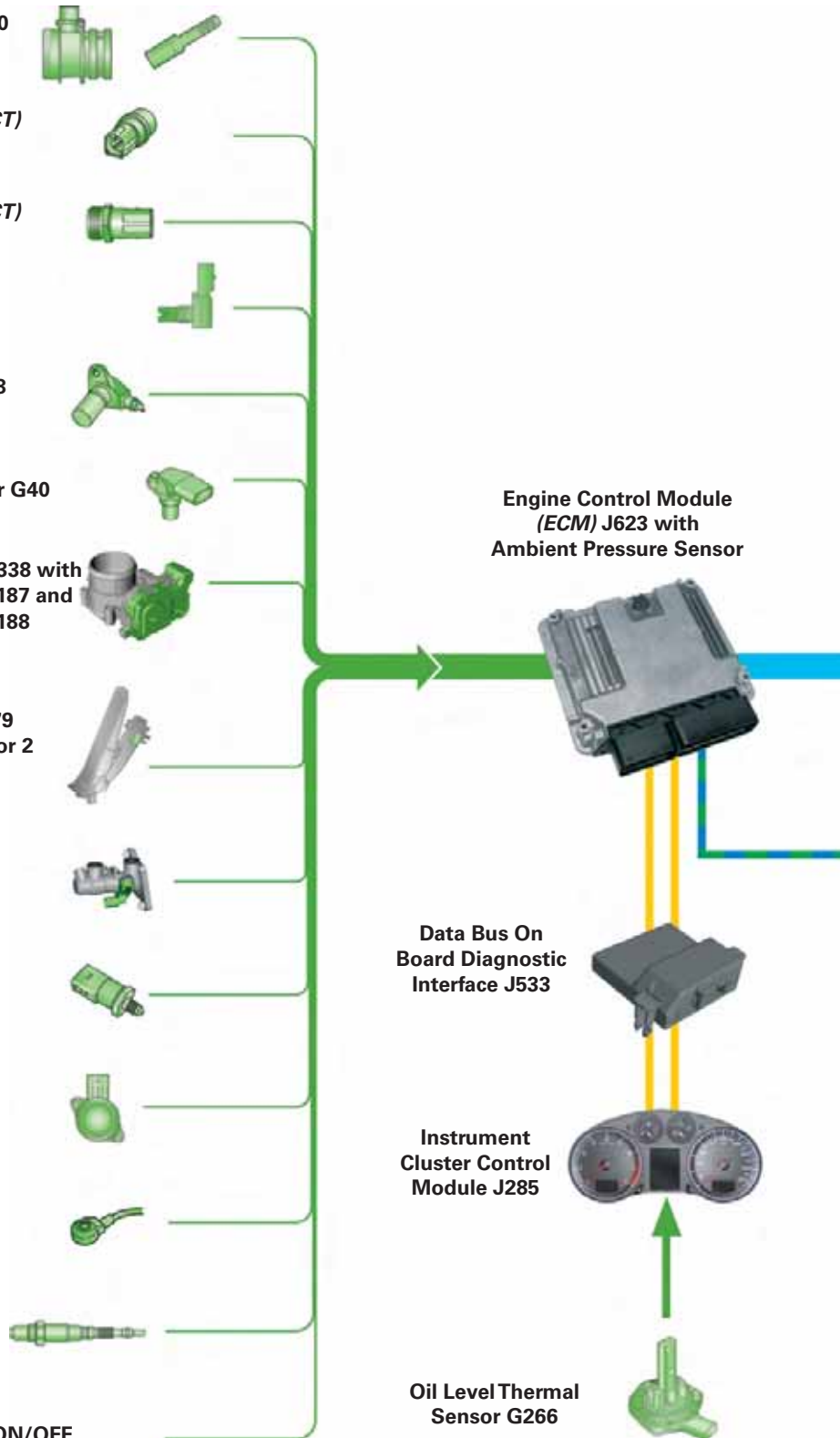
DFM Generator, Cruise Control ON/OFF

Engine Control Module (ECM) J623 with Ambient Pressure Sensor

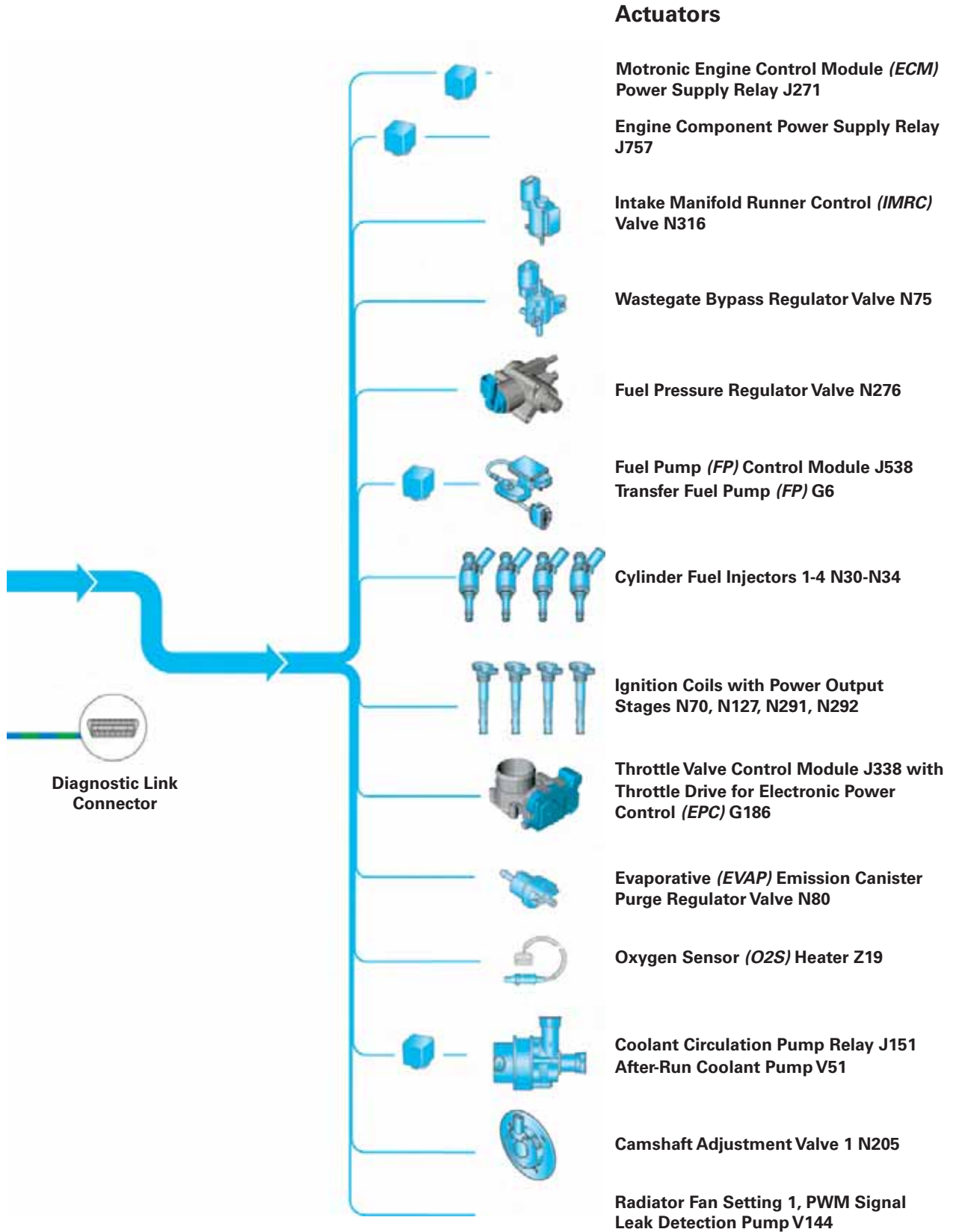
Data Bus On Board Diagnostic Interface J533

Instrument Cluster Control Module J285

Oil Level Thermal Sensor G266



# Engine Management System



## Actuators

- Motronic Engine Control Module (ECM)  
Power Supply Relay J271
- Engine Component Power Supply Relay  
J757
- Intake Manifold Runner Control (IMRC)  
Valve N316
- Wastegate Bypass Regulator Valve N75
- Fuel Pressure Regulator Valve N276
- Fuel Pump (FP) Control Module J538  
Transfer Fuel Pump (FP) G6
- Cylinder Fuel Injectors 1-4 N30-N34
- Ignition Coils with Power Output  
Stages N70, N127, N291, N292
- Throttle Valve Control Module J338 with  
Throttle Drive for Electronic Power  
Control (EPC) G186
- Evaporative (EVAP) Emission Canister  
Purge Regulator Valve N80
- Oxygen Sensor (O2S) Heater Z19
- Coolant Circulation Pump Relay J151  
After-Run Coolant Pump V51
- Camshaft Adjustment Valve 1 N205
- Radiator Fan Setting 1, PWM Signal  
Leak Detection Pump V144

# Engine Management System

## Engine Control Module

The 2.0L TSI engine uses the Bosch MED 17.5 engine control module. The hardware and software components have been developed so they can be used for future projects both for gasoline and diesel engine applications.

This allows maximum use with regards to functions and vehicle interfaces independent of the engine combustion configuration. Examples of this include the Electronic Pedal Control and radiator fan activation strategies.

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

Hardware in the engine control module:

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



## Oxygen Sensor Control

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

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

### Advantages:

- Fewer potential sources of fault
- More cost-effective
- Requirements of ULEV are met without continuous-duty oxygen sensor
- No adjustments needed in customer service or for exhaust emission inspections

## Operating Modes

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

The following operating modes are implemented:

- In **Start** phase: high-pressure — start of fuel-air mixture
- For several seconds after **Start**: HOSP
- Following **Warm-Up** phase: engine map controlled dual injection cycle
- At coolant temperatures of 176°F (80°C) or higher: fuel injection synchronous with intake cycle only

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



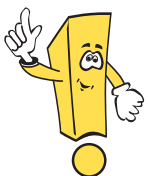
# Engine Management System

## Substitute Functions in Case of Sensor/Actuator Failure

	Symptom in Case of Failure	DTC Entry	MIL	EPC	Substitute Signal	Power Limitation	Emergency Operation
F63	No Cruise Control	Yes	No	No	No	No	No
G39	No Control	Yes	Yes	No	Yes	No	No
G61	No	Yes	No	No	Yes	Yes	No
G62	No	Yes	Yes	No	Yes	No	No
G83	Radiator Fan Runs Permanently in Setting 1	No	No	No	No	No	No
G79/G185	No Throttle Response	Yes	Yes	Yes	No	Yes	Yes
G187/G188	No Throttle Response	Yes	Yes	Yes	No	Yes	Yes
G247	No High-pressure	Yes	Yes	No	No	Yes	Yes
G336	No	Yes	Yes	No	No	No	No
G476	No Cruise Control	Yes	No	No	No	No	No
J271	No Power Supply to ECM — Engine Not Running	No	No	No	No	No	No
J538	No	Yes	Yes	No	No	No	No
J757	No High-pressure	Yes	Yes	Yes	No	Yes	Yes
Ignition Coils	Engine Not Running Smoothly	Yes	Yes	Yes	No	Yes	Yes
N30-N33	Engine Not Running Smoothly	Yes	Yes	Yes	No	Yes	Yes
N75	No	Yes	Yes	Yes	No	Yes	Yes
N205	No	Yes	Yes	No	No	No	No
N276	No High-pressure	Yes	Yes	Yes	No	Yes	Yes
N316	No	Yes	Yes	No	No	No	No

### Note

This table refers to generally occurring faults. It is not a substitute for fault finding with the Workshop Manual and the "Guided Fault Finding" function. The parameters specified in the table are subject to deviation depending on fault type. Specifications are subject to change due to updating of engine control module software.

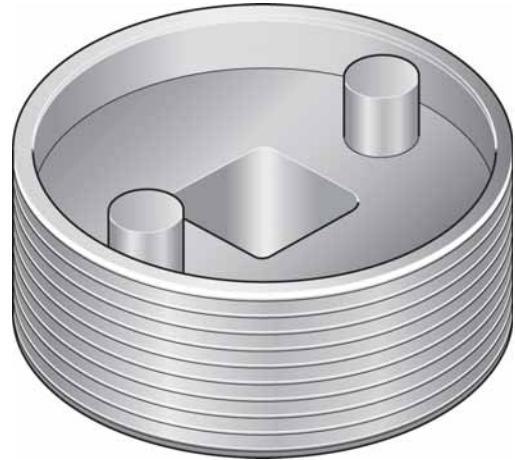


# Service

## Special Tools



Shown Here are the Special Tools for the Chain-Driven 2.0 Liter 4V TSI Engine:



**T10352**

For Removing the 4/3-Way Central Valve of the Camshaft Adjuster



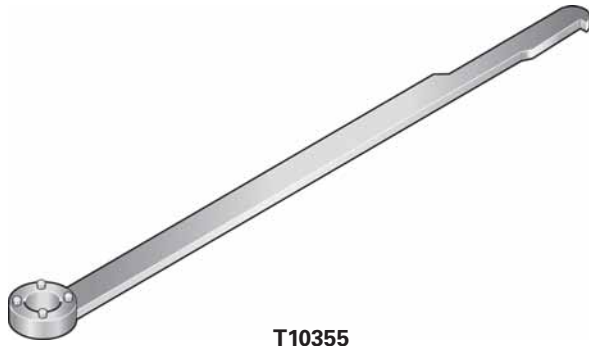
**T10353**

Thrust Piece for Installing the Oil Seal on the Water Pump Shaft

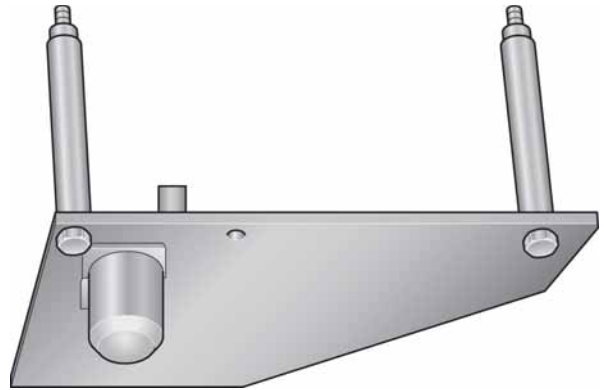


**T10354**

Thrust Piece for Installing the Oil Seal on the Front Crankshaft (*Vibration Damper*)



**T10355**  
**Retainer for Removing the**  
**Crankshaft Center Bolt**



**T10359**  
**Engine Holder for Removing**  
**the Engine with Transmission**



**T10360**  
**Torque Wrench Adapter Used for**  
**Removing/Installing the Belt Drive Pulley**  
**Bolt for the Engine Coolant Pump**



**V.A.G. 1331**

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# Knowledge Assessment

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

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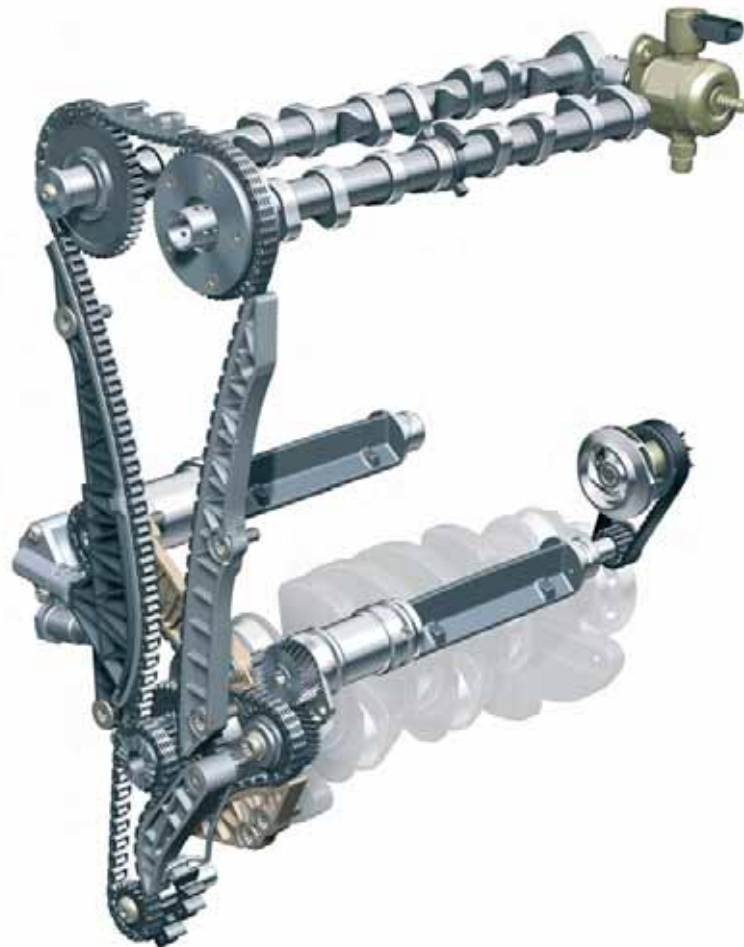
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**[concierge@volkswagenacademy.com](mailto:concierge@volkswagenacademy.com)**





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