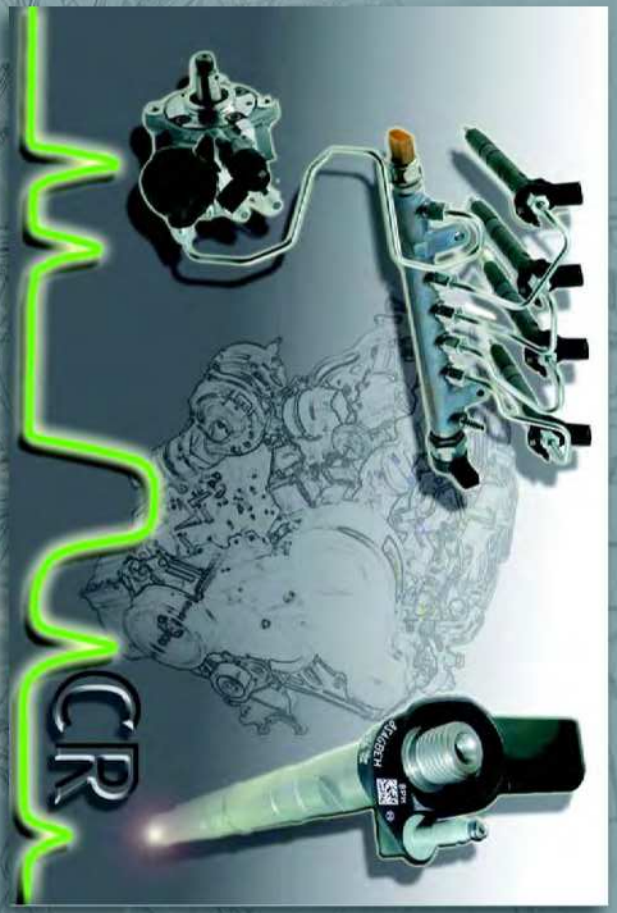


autoemoción

SEAT

With the 2.0l TDi and 105 kW engine SEAT introduces the "Common Rail" technology for the first time into its range of vehicles.

The "Common Rail" (CR) injection system is based on the generation of injection pressure by means of **a single high pressure pump**. Pressure is accumulated in a passage common to all injectors. This injection system has been named after this common injection passage: “Common Rail”.

The Bosch EDC 17 -adapted to the “Common Rail” injection system particulars- controls all the engine functions in order to obtain the optimal performance in all operation ranges, and always with the lowest possible polluting emissions rate.

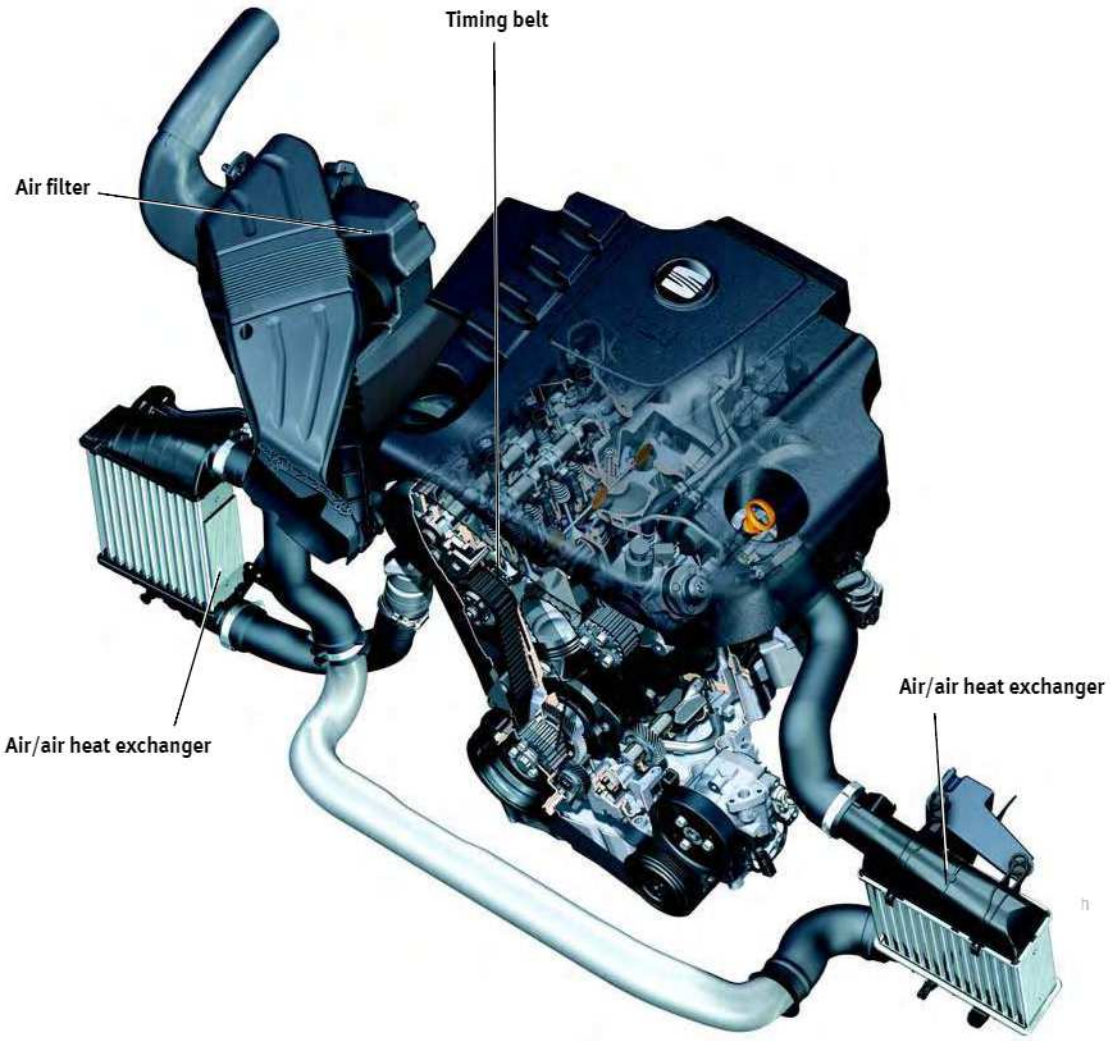
It must be pointed out that thanks to the "Common Rail" technology, the 2.0l TDi CR and 105 kW engine complies with the EU5 polluting gases emissions standard, therefore becoming the first diesel engine fitted in SEAT that complies with this emissions standard.

This self study programme analyses all the mechanical and electronic features of the 2.0l TDi CR and 105 kW engine fitted in the **SEAT Exeo**.

D123-01

***Note**: The exact instructions for checking, adjusting and repairing are included in the ELSA application and in the VAS 505X guided diagnostics.*

SUMMARY OF CONTENTS



D123-02

The new 2.0l TDi engine with "Common Rail" injection system belongs to the EA189 family of engines and inherits many of its features from the pump-injector 2.0l TDi engine, and in particular from the **2.0l TDi 16v and 125 kW** engine.

The "Common Rail" injection system introduces improvements to the 2.0l TDi 16v engines, such as reducing noise, polluting gases emissions, and fuel consumption.

From a mechanical point of view, it has a 16 valve cylinder head although **it lacks internal fuel distribution passages** and, compared to the pump injector engines, it has been adapted to house the "Common Rail" system piezoelectric injectors.

The exhaust camshaft is driven by a toothed belt driven by the crankshaft, whilst the intake camshaft is driven by the same exhaust camshaft via a set of gears.

In the SEAT Exeo, the overboost air cooling system for the 2.0l TDi "Common Rail" engine includes **a double heat exchanger** placed at both sides of the engine compartment.

TECHNICAL DATA

Engine designation letters ..... CAGA

Capacity ..... 1,968 cm^3

Bore x Stroke .....81 x 95.5 mm

Compression ratio .....16.5 : 1

Maximum torque .... 320 Nm at 1750 up to 2500 rpm

Maximum power .....105 kW at 4,200 rpm

Engine management .....Bosch EDC 17

Fuel ..... Diesel, DIN EN 590

Exhaust gases cleaning: .....

Oxidation catalyst, exhaust gases recirculation and particles filter.

Emissions standard EU5

D123-03

TECHNICAL FEATURES

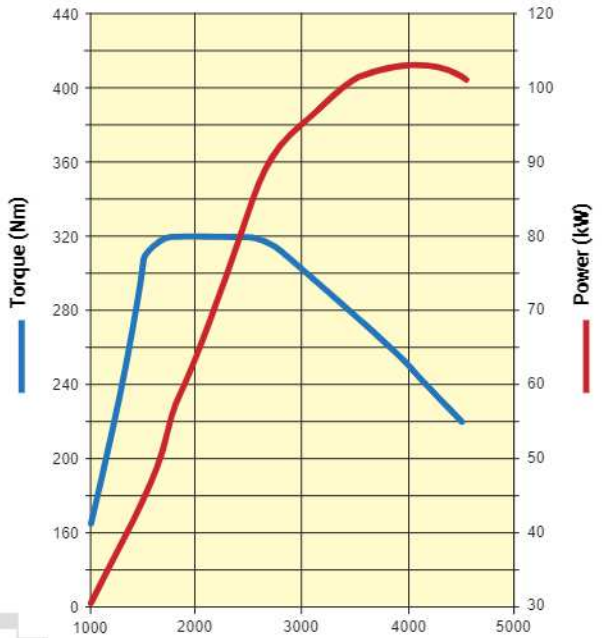
The main features of the 2.0l TDi CR engine are:

- A "Common Rail" injection system with piezoelectric injectors.
- Particles filter with oxidation catalyst at the front.
- Inlet manifold with electrical activation flaps for generating spiral swirl in the cylinder.
- Solenoid valve for the exhaust gases recirculation system.
- Exhaust manifold with one variable vane turbocharger and vanes position feedback to the engine control unit .
- Cooling system for exhaust gases recirculation at low temperature.

TORQUE AND POWER CURVES

Thanks to the cylinder fill-up optimisation, the maximum torque delivery of 320 Nm is practically reached from 1,750 rpm and ranges up to 2,500 rpm.

Maximum 105 kW power output is reached at 4,200 rpm.



D123-04

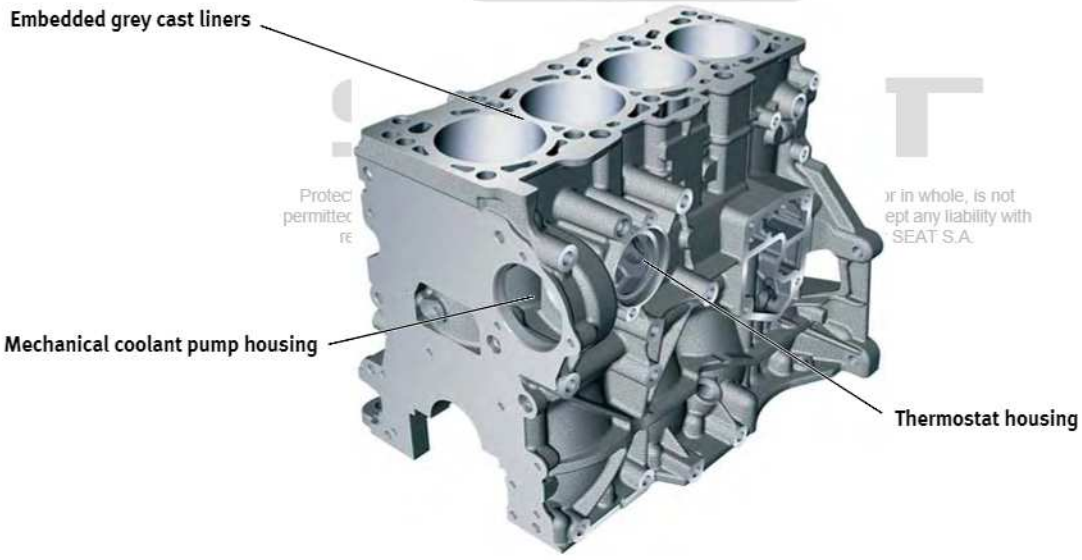
BLOCK

It is built of grey cast with layered graphite.

The cooling pump and the main thermostat are placed in the same place as in the EA188 family of engines known so far.

Inside the block there are oil injectors screwed on for cooling the pistons.

The block has five crankshaft case bearings and a distance between cylinders of only 88 mm so as to achieve a **compact engine** and therefore a short and lighter crankshaft.



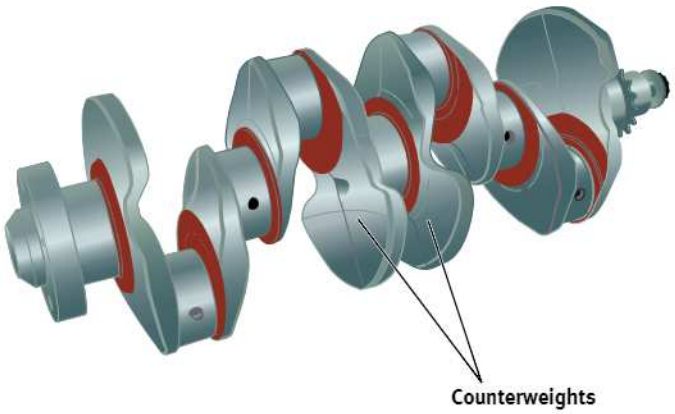
D123-05

CRANKSHAFT

It is made of **forged steel** and includes four counterweights instead of the eight usual counterweights fitted in the four cylinder diesel engines.

Reducing the number of counterweights means less effort on the crankcase bearings, which as a result reduces losses from engine friction.

These changes have contributed to optimising the engine performance, as generally when reducing the masses in motion vibrations and fuel consumption are also reduced.



D123-06

PISTONS

In the 2.0l TDi CR engine pistons, the usual piston crown **valve recesses** have been eliminated. This change, which had already been incorporated to the Altea FR range 2.0l TDi PD and 125 kW engine, eliminates cold zones during diesel combustion therefore preventing build up of soot.

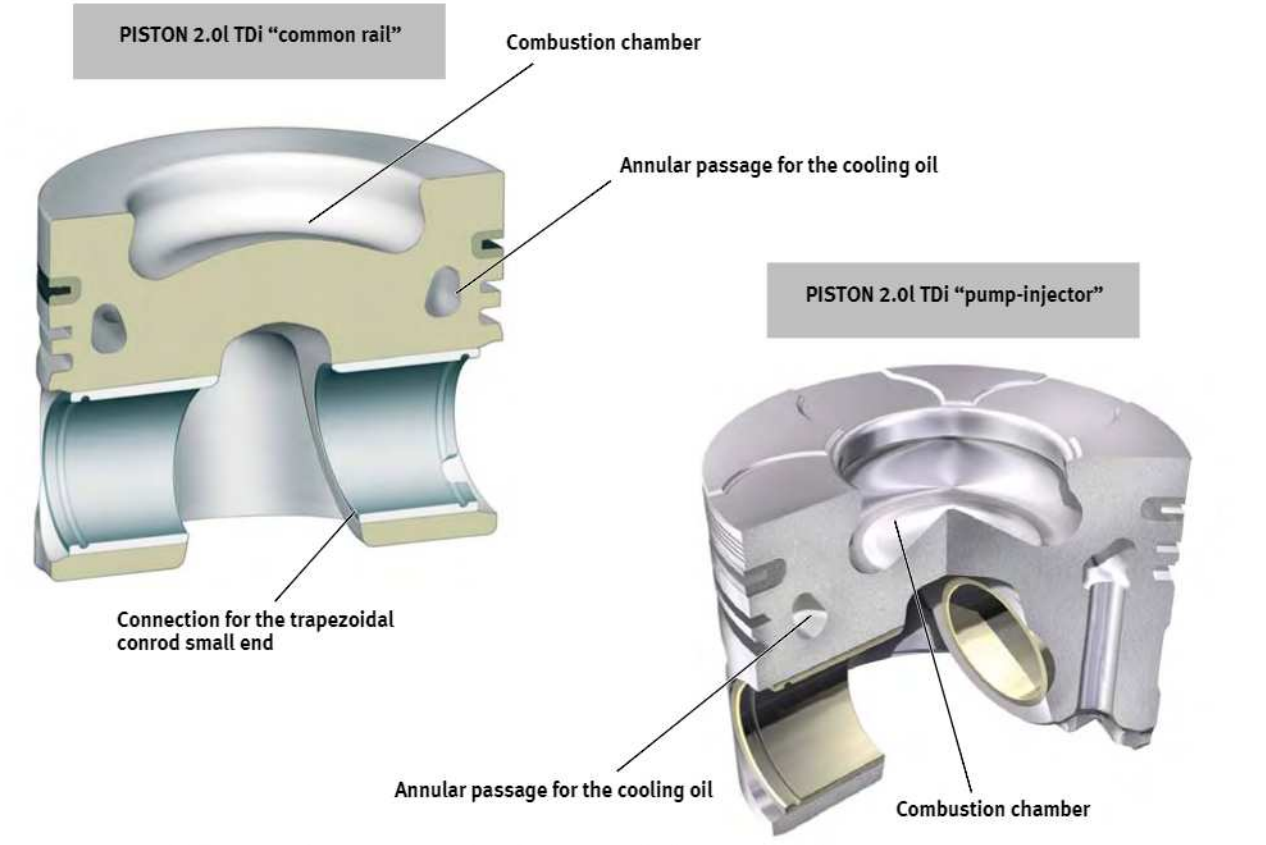
By eliminating the valve recesses, the air input swirl in the cylinder is also improved and as a result there is a better mix and less polluting emissions.

Also, the pistons incorporate the **annular passage** which is used for cooling the rings zone by injecting oil through the injectors screwed onto the engine block.

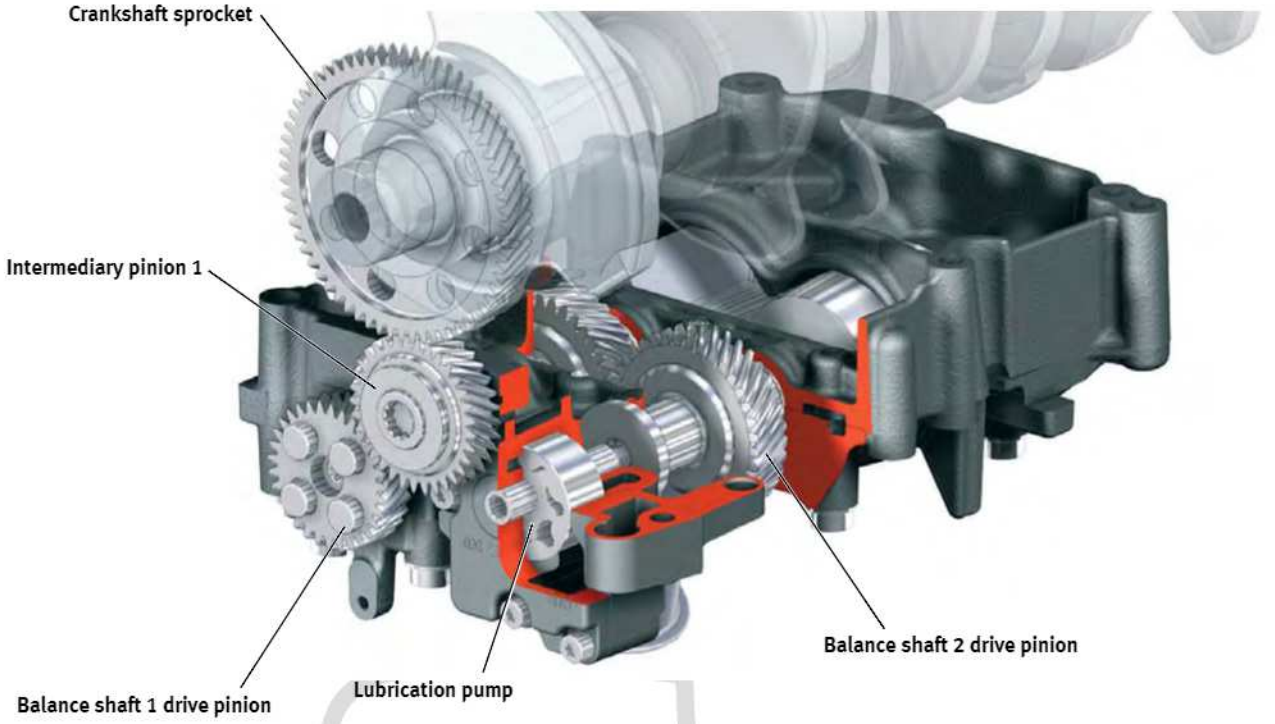
As for the link with the conrod, the **trapezoidal geometry** still remains, which increases the contact surface and therefore the sharing of the forces among the elements involved in the link.

The main difference with the 2.0l TDi engine with Pump Injector pistons is the **shape of the combustion chamber** on the piston head, which has been modified to suit the injectors' nozzle projection.

The injectors' nozzles of the "Common Rail" engine have a wider and flatter output shape than the pump injectors, which contributes to a more homogeneous mix and to reducing soot generation.



D123-07



D123-08

BALANCE ASSEMBLY

The 2.0l TDi CR is equipped with a "Lanchester" type of balance assembly in the lower crankcase. Its function is **to balance the second magnitude vibrations** generated by the engine masses in motion.

LAYOUT

The balance assembly includes a grey cast housing, two counter-rotating balance shafts, the helicoidal teeth drive pinions and the engine lubrication pump.

The crankshaft sprocket transfers motion to the intermediary pinion, which drives balance shaft 1. This shaft resends the motion to balance shaft 2 by means of a couple of drive pinions.

The lubrication pump is directly connected to balance shaft 2.

The intermediary pinion has a **plastic outer layer** on its teeth faces for adjusting play between the pinions' teeth.

During the very first engine rotations the outer layer wears out and creates a perfect adjusting between the teeth faces. The result of this is that when the balance assembly needs to be taken out the intermediary pinion needs to be replaced.

OPERATION PRINCIPLE

Reduction of vibrations is achieved by rotating the two shafts with offset masses in a synchronised way, in opposite directions and at double the number of revs than the crankshaft.

Note: *For further information about the second magnitude vibrations of engines consult Self Study Programme No. 102 "2.0 l FSI mechanicals".*

CYLINDER HEAD

In the 2.0l TDi CR engine the cylinder head is an **aluminium alloy**, with a cross-flow input and output of gases.

There are two camshafts fitted on the cylinder head. The camshafts move two intake valves and two output valves respectively per cylinder.

The **piezoelectric injectors** are fitted vertically and centred on each of the combustion chambers.

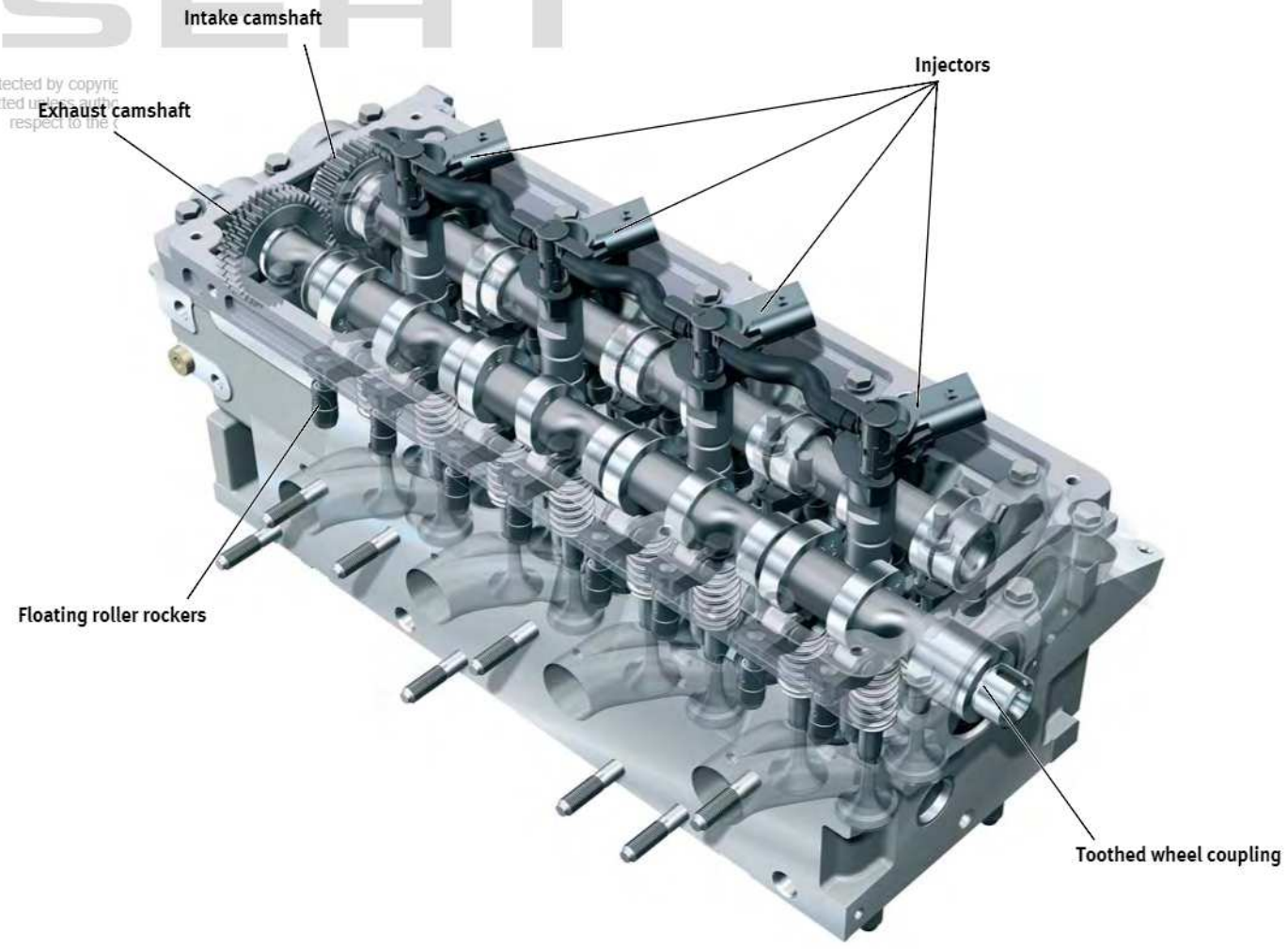
The injectors are fixed to the cylinder head by means of an individual clamp for each of them. To access each of the injectors a small housing with rubber seal on the cylinder head needs to be removed. This allows taking out the injectors without having to remove the cylinder head completely.

CAMSHAFTS DRIVE

The intake camshaft is driven by the exhaust camshaft by means of a cylindrical-teethed gear.

The gears set is placed in the cylinder head end **opposite to the timing belt**.

The exhaust camshaft pinion has a **system that eliminates the play between the faces of the teeth**, thus reducing drive noise.



D123-09

4-VALVES TECHNOLOGY

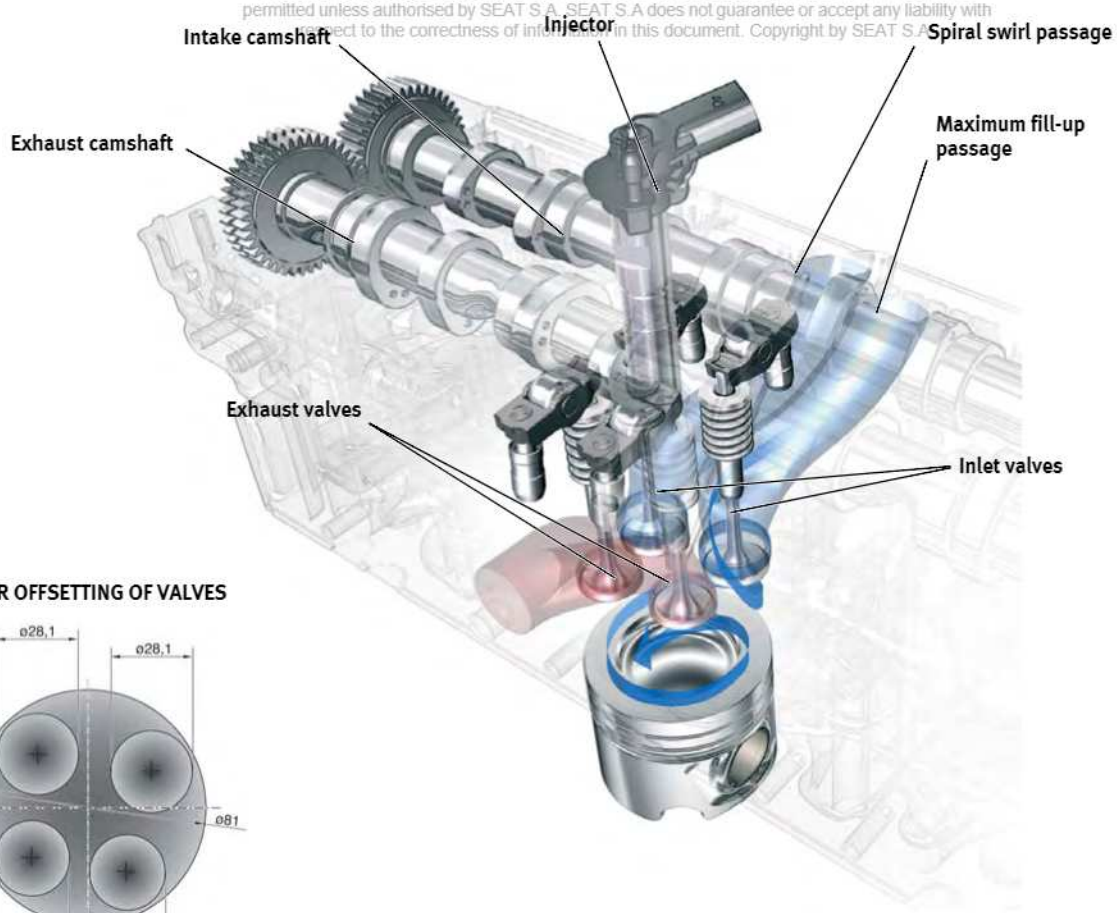
Like with the well known 2.0l 16v TDi pump-injector engines, each cylinder has 2 intake valves and 2 exhaust valves vertically placed on the cylinder head.

The size, shape and path of the intake and exhaust passages have been designed to obtain **optimal fill-up and emptying of the cylinders** at any given revs.

The two intake passages for each cylinder are differentiated from each other by their shape and by the angle they make when reaching the cylinder. For such a reason, one of the passages is called "maximum fill-up" passage, and the other one "spiral swirl" passage.

The **maximum fill-up passage** contributes to good cylinder fill-up -mainly at high revs- where the cylinder fill-up time is shorter. The **spiral swirl passage** makes the incoming air turn and generate the necessary swirl at the entry of the combustion chamber in order to achieve a good mix inside the cylinder.

Another change carried out to create optimal input and exit of gases to and from the combustion chamber is the **offsetting of the valves' star** with regard to the longitudinal geometrical axis of the engine. This offsetting is **8.8°** with regard to the engine's longitudinal axis.



ANGULAR OFFSETTING OF VALVES

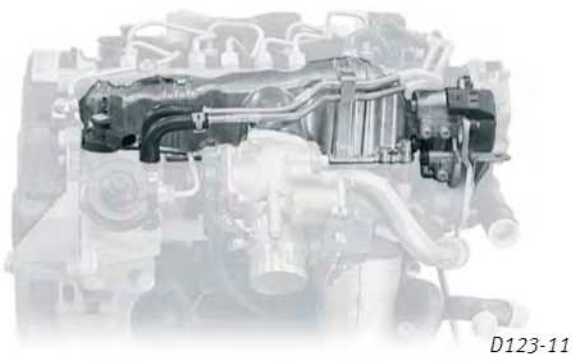
D123-10

INLET MANIFOLD

The inlet manifold is made of plastic and incorporates a **shaft with flaps** that open or close the air flow through the maximum fill-up passage of each cylinder.

Depending on the engine revs and load, the flaps adopt a specific position so that the ideal swirl is generated inside the cylinder to contribute to the air and diesel mix.

When the engine is cold the flaps open partially, even when idling.

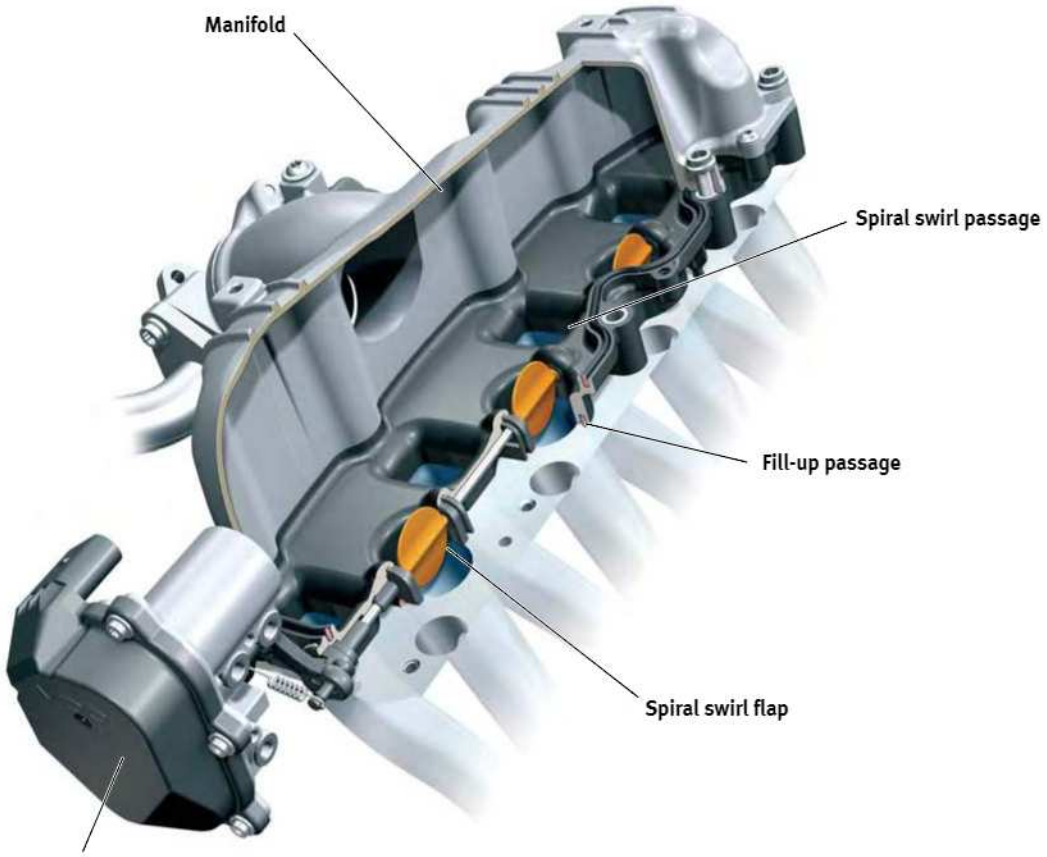


D123-11

SPIRAL SWIRL FLAPS

The spiral swirl flaps are fitted on a shaft which rotates in both directions driven by the **inlet flaps motor V157** by means of a push rod. This motor is controlled by the engine control unit.

The inlet flaps motor V157 has an integrated **potentiometer G336**, through which the engine control unit receives the confirmation signal about the current position of the flaps.



D123-12

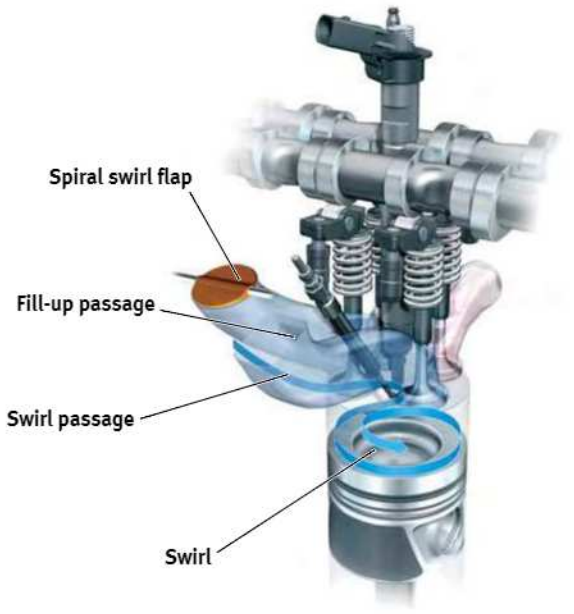
OPERATION AT LOW REVS

When idling and at low revs the air input speed to the cylinder is low because the pistons are moving slowly and the overboost pressure is low.

Under such conditions **the spiral swirl flaps are closed**, which is why all the air sucked in travels through the spiral swirl passage.

This allows for increasing the speed of the air entering the cylinder because all the flow passes into the cylinder through one passage instead of two.

Also, because of the shape of the cylinder an intense swirl effect is generated, which favours homogenising of the mix.



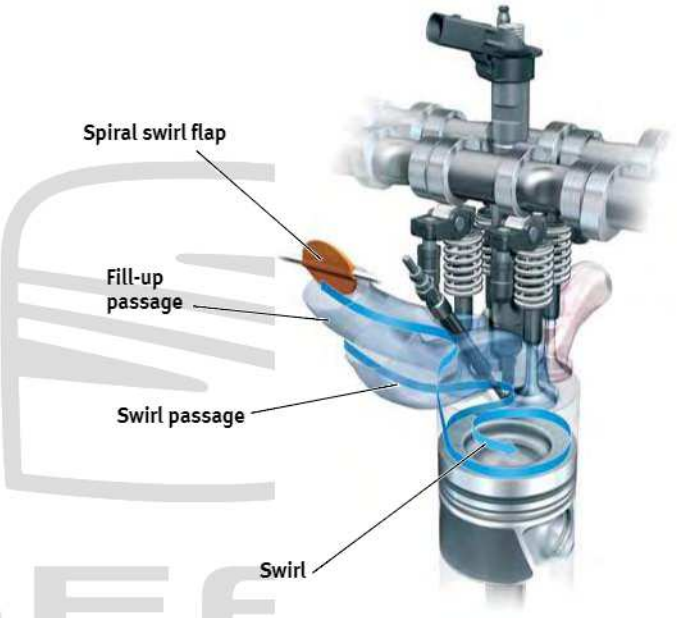
D123-13

RUNNING AT MID AND LOW REVS

At mid and low engine revs the time available for cylinder fill-up is shorter, meaning that the air input section needs to be as large as possible. This is the reason why the **the flaps open** and allow for air to flow through the fill-up passage.

Thanks to the **V157 motor** the flaps can be set at various degrees of opening depending on the load and engine revs.

From 3,000 rpm the flaps are completely open.



D123-14

CAMSHAFTS ACTIVATION

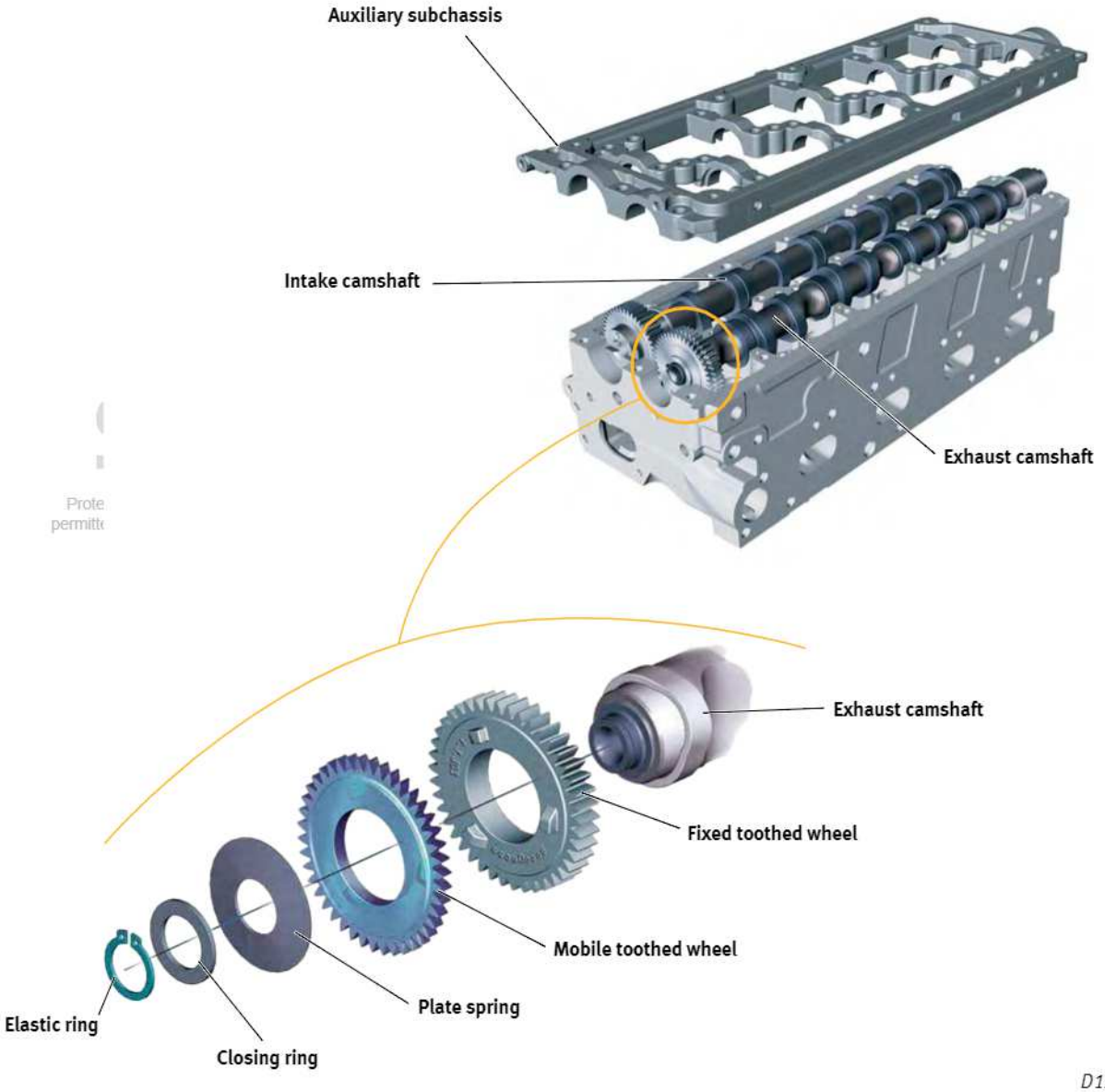
The main new feature about the camshafts drive is that the timing belt moves the exhaust camshaft, whilst in the 2.0l TDi PD engines it drives both camshafts.

The intake camshaft is driven by the exhaust camshaft through a cylindrical pinions gearset placed at the opposite side to the timing belt.

Both pinions have the same number of teeth, because both shafts must rotate at the same number of revs.

To eliminate the existing play between both exhaust camshaft pinions, the exhaust camshaft integrates a system for **compensating play between the faces** of the teeth that allows for a silent driving of the camshafts.

Because of this system, it is necessary to mesh both camshafts before proceeding to fit them into the engine.



D123-15

COMPENSATING FOR THE PLAY BETWEEN FACES

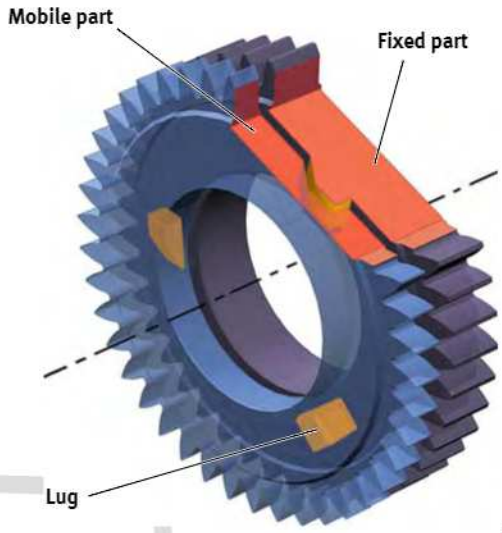
The intake camshaft drive pinions have straight teeth, and also both pinions have the same number of teeth.

To compensate for any possible play between every couple of teeth, a system for eliminating play between the edges is fitted.

LAYOUT

The exhaust camshaft cylindrical pinion **is made up of a mobile part and a fixed part**, which is a single assembly with the exhaust camshaft.

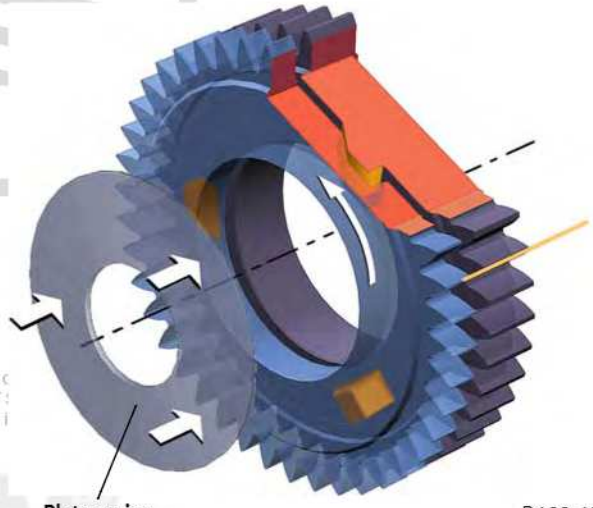
Both parts are connected by means of three **lugs** that allow for a relative movement between them, both radial and axially.



D123-16

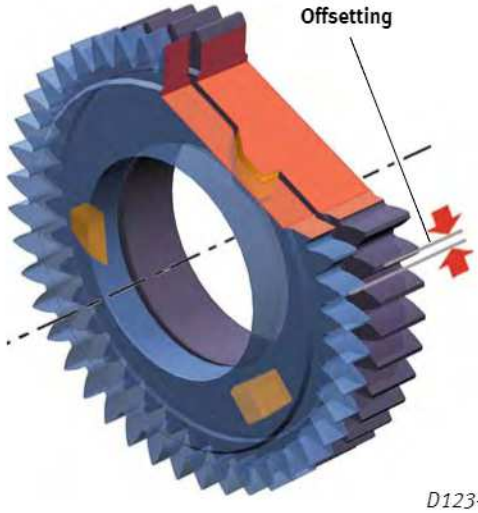
OPERATION

When at rest, both parts are axially linked due to the force made by a **plate spring**. Because of the ramp shape of the lugs, there is a radial displacement which becomes an offsetting between the teeth of both parts.



D123-17

The offsetting between the teeth of both parts allows for the exhaust camshaft cylindrical pinion to be in contact with the intake camshaft cylindrical pinion, therefore compensating for the play between them and thus reducing operation noise.



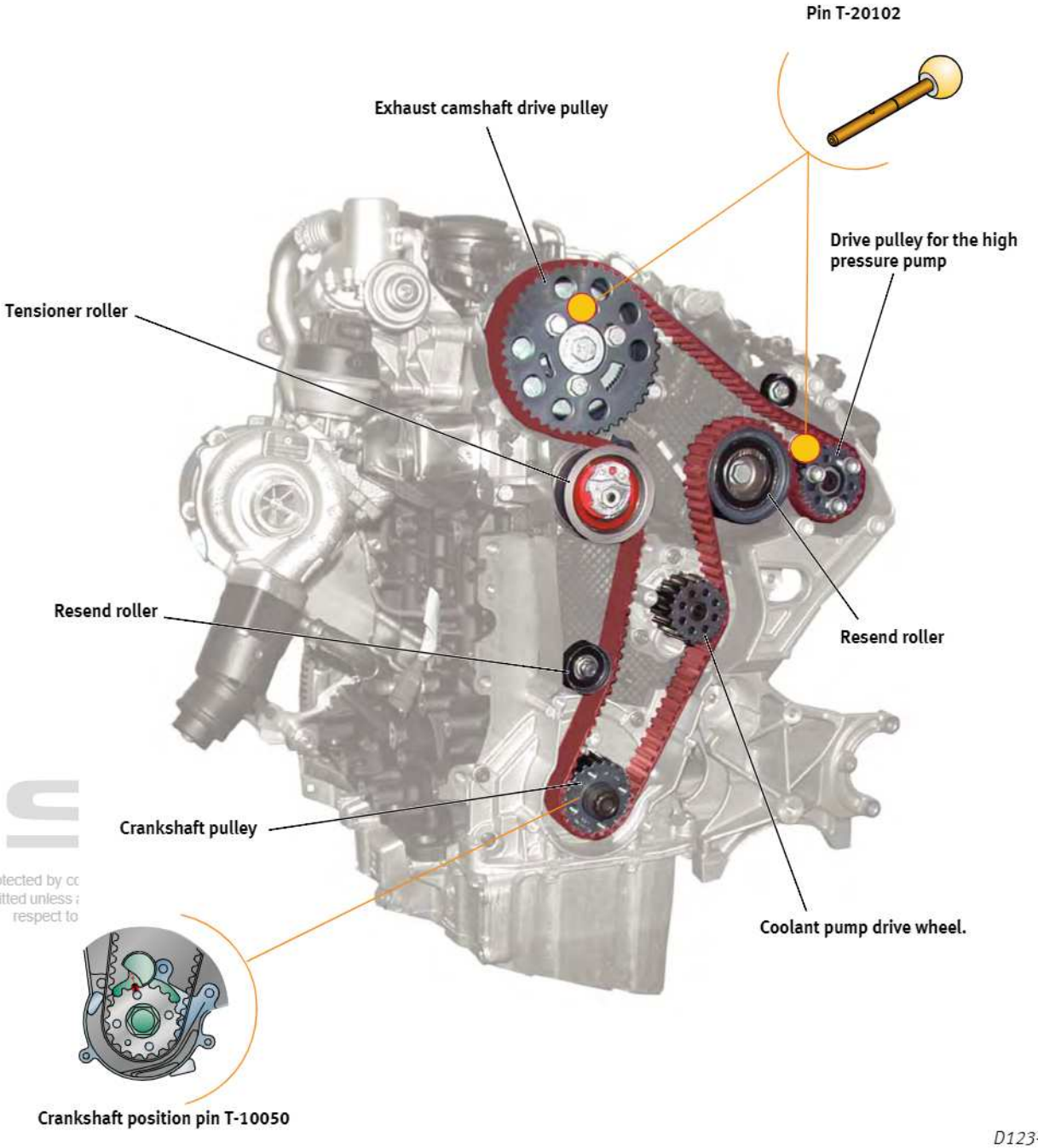
D123-18

TOOTHED BELT ACTIVATION

The toothed belt drives the **exhaust camshaft**, the **fuel high pressure pump** and the **coolant pump**.

The crankshaft pulley is a conventional cylindrical pulley, that is, it is not an oval CTC pulley. This is why the locking tool for the crankshaft pulley is **T-10050**.

Also, to fit the toothed belt it is necessary to block the exhaust camshaft hub and the fuel high pressure pump pulley, because the latter also needs to be synchronised with the timing.



D123-19

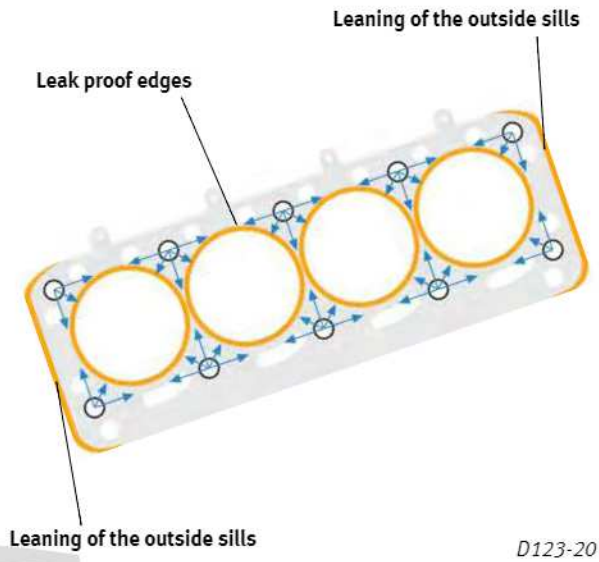
CYLINDER HEAD GASKET

It is one of the components subject to the highest wear in diesel engines.

The 2.0l TDi CR cylinder head gasket is metallic and is made up of a four layer structure.

To improve the sealing of the combustion chambers, the cylinder head gasket incorporates two technical solutions, such as:

- The height **profile of the leak-proof edges of the combustion chamber**.
- The **leaning of the outside sills**.

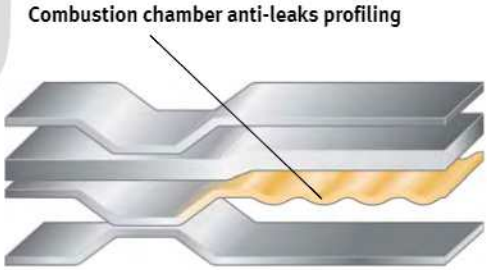


D123-20

HEIGHT PROFILING OF THE LEAK-PROOF EDGES OF THE COMBUSTION CHAMBER

On the peripheral zones of the combustion chamber of each of the cylinders, the cylinder head gasket layers have been moulded so that they have a profile with several heights.

With this moulding, a uniform spreading of the torque forces is achieved in the combustion chamber, and cylinder deformations and vibrations in this zone are reduced.



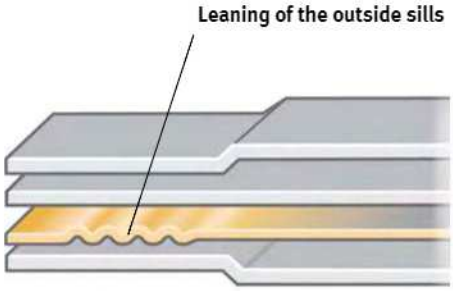
D123-21

LEANING OF THE OUTSIDE SILLS

Leaning on the outside sills is the name given to the cylinder head gasket profile on the outside edges.

The outside edges of the cylinder head gasket have been shaped into an undulated profile.

It is thanks to this profile that a more homogeneous spreading of the torque forces is achieved as well as reducing the cylinder head curvature and the deformation of cylinders at their ends.



D123-22

DIESEL PARTICLES FILTER AND OXIDATION CATALYST

The 2.0l TDi CR engine incorporates an **oxidation catalyst and a diesel particles filter** in the exhaust system to reduce emissions.

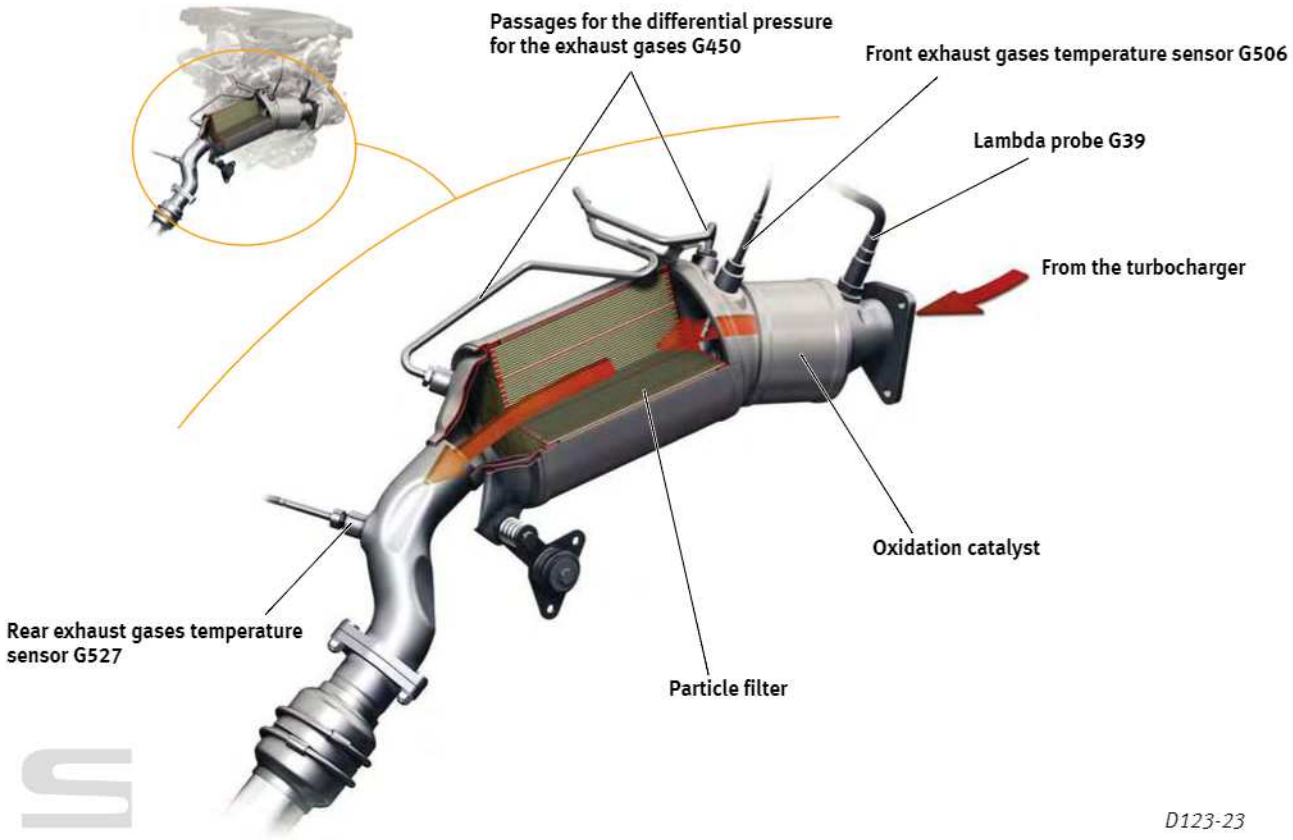
The oxidation catalyst is placed **in front of the particles filter**, both housed in the same housing and placed very close to the turbocharger gases exit.

The oxidation catalyst configuration before the particles filter in combination with the "Common Rail" injection system contributes as follows:

- **It increases the exhaust gases temperature** at the particles filter intake, contributing to the filter rapidly reaching its operation temperature and contributing to filter regeneration.
- **It prevents the air sucked in by the engine cooling the particles filter** during decelerations, because the catalyst behaves like a heat accumulator that heats up the air that flows through the cylinders when fuel is not being injected.
- **It helps calculate the amount of fuel needed** to carry out the fuel post-injections during the filter regeneration cycles, due to the installing of a temperature sensor at the particles filter intake.

As happens with the Ibiza and Altea range, this type of particles filter **does not require an additive system** to help with the regeneration process.

Note: *For further information about the diesel particles filter consult Self Study Programme No. 111 "Altea FR".*



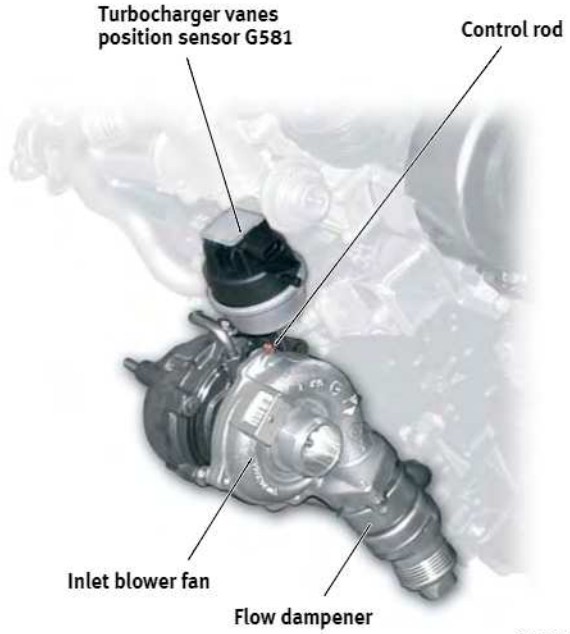
D123-23

TURBOCHARGER

The 2.0l TDi CR engine generates the overboost pressure by means of a **variable vane** turbocharger.

Overboost pressure regulation is carried out with vacuum through a pneumatic regulator valve and a rods system.

The pneumatic regulation valve incorporates **a position sensor** which informs the engine control unit about the actual position of the blower fan vanes.



D123-24

***Note**: For further information about the variable vane compressor consult Self Study Programme No. 55 "1.9l TDi and 81 kW engine".*

FLOW DAMPENER

At the turbocharger output to the engine inlet passage a flow dampener has been installed to **reduce overboost air noise**.

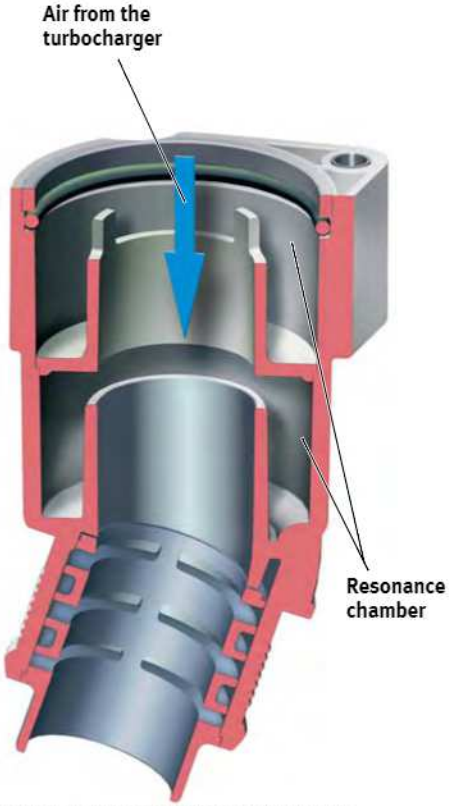
This silencer, or muffler, element is made of stainless steel and has two resonance chambers inside.

OPERATION

Sudden changes of the compressor vanes speed of rotation create overboost air flow cuts. These flow cuts generate waves that make a lost of noise.

The flow dampener resonance chambers make the overboost air vibrate inside them at approximately the same frequency as it does outside.

Overlapping of the sound waves inside and outside the chambers minimises overall noise.



D123-25

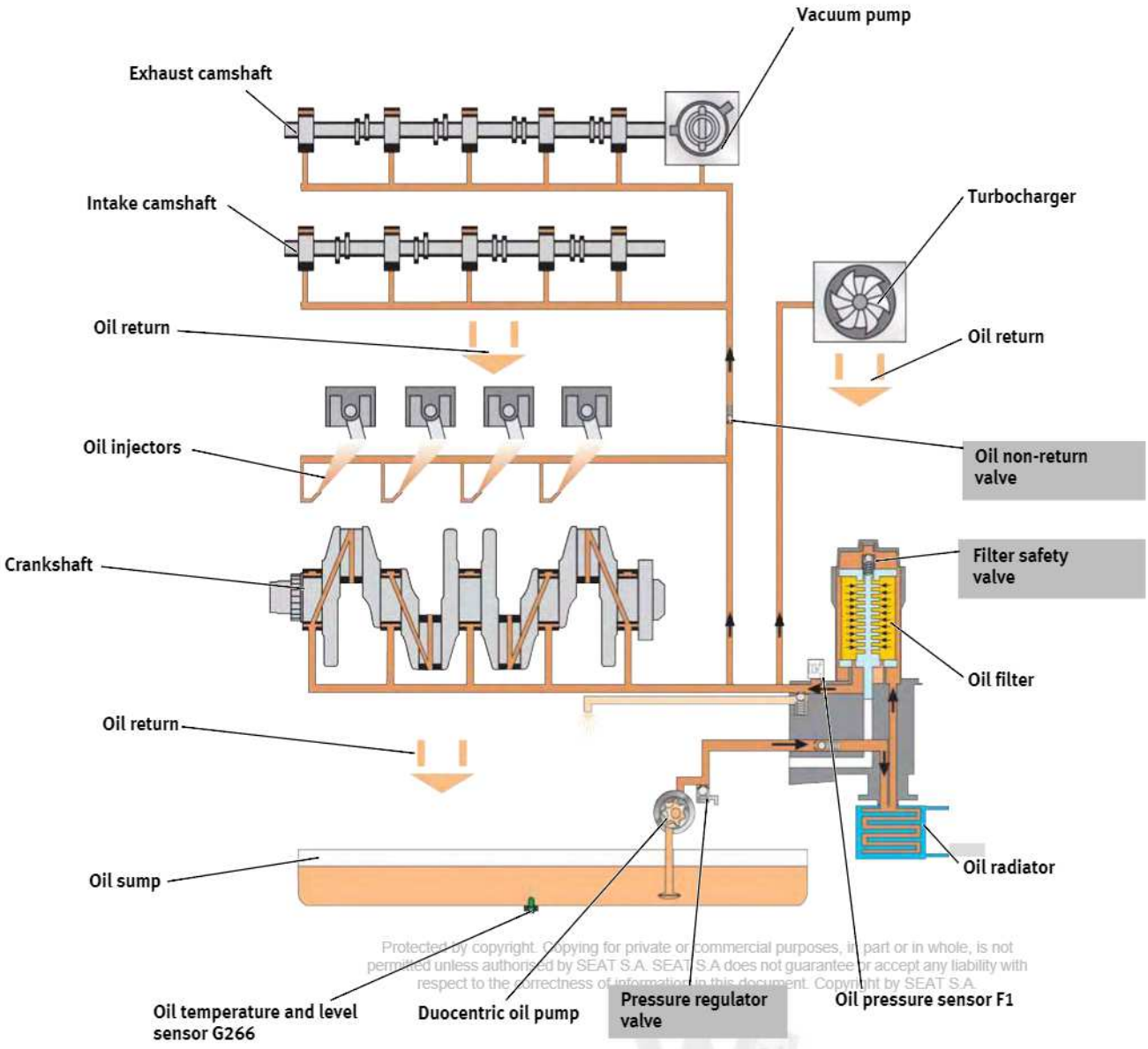
LUBRICATION CIRCUIT

Pressure in the lubrication circuit is generated by a Duocentric type of pump integrated in the balance shaft and **driven by balance shaft 2**.

In the circuit there are two valves that guarantee safety of operation and engine protection, such as:

- The **pressure regulation valve**, which discharges directly to the sump when there is overpressure in the circuit, for instance at low ambience temperatures and high revs.

- **The filter safety valve**, that commutes the oil passage in the filter when it becomes obstructed, making sure that the engine is lubricated under any circumstance.



D123-26

LUBRICATION CIRCUIT

ENGINE BLOCK BREATHING

It is a closed system which introduces residual gases generated in the block and in the sump into the cylinders so that they combust and therefore prevent them from getting outside.

The 2.0l TDi CR engine incorporates in the cylinder head a **step-by-step oil particles separator** for the engine block ventilation circuit.

By means of the stepped separation of the oil particles, a great deal of the vapours oil content is recovered.

This system reduces the hydrocarbons contents present in the exhaust emissions as well as reducing soot in the engine.

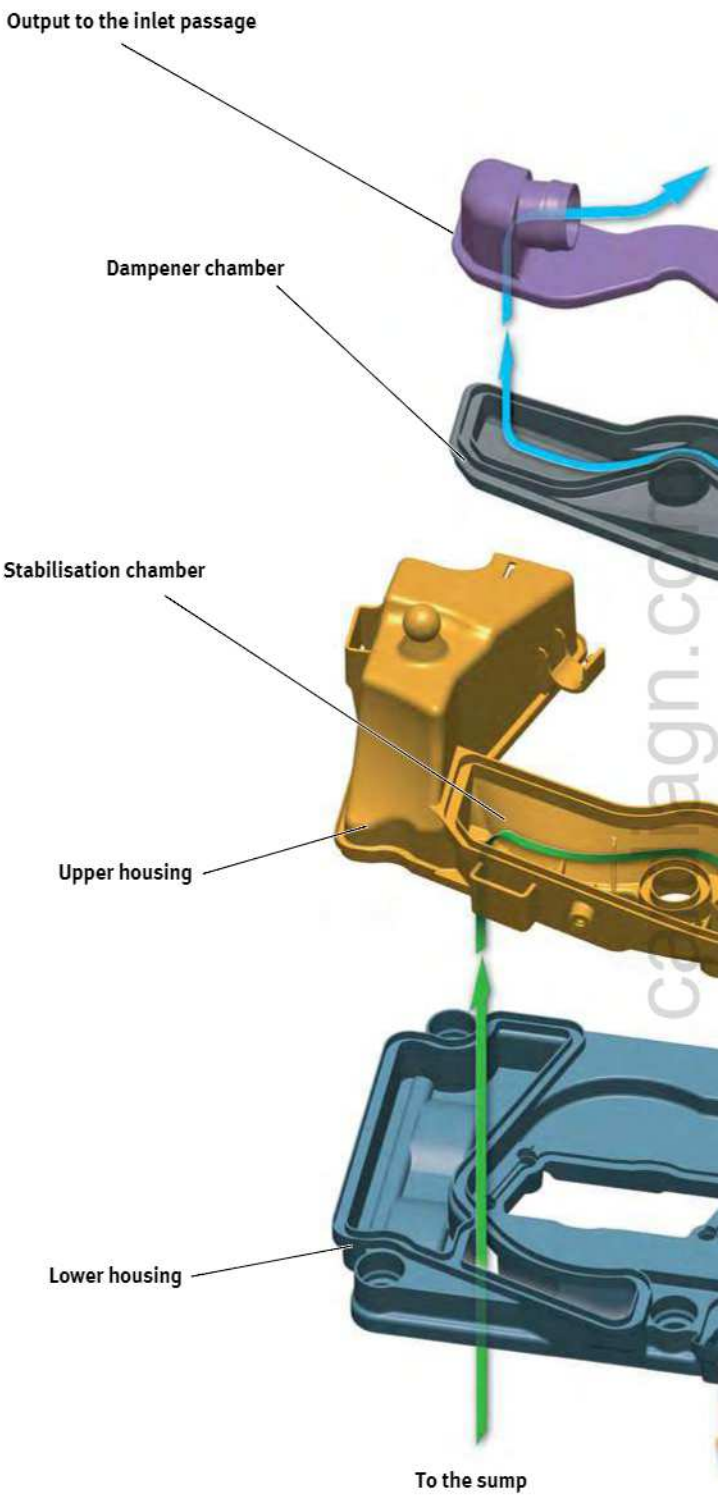
Also, elimination of oil particles from the blow-by vapours is **basic for guaranteeing durability of the particles filter**, because it is the main source of ashes in the particles filter that cannot be eliminated.

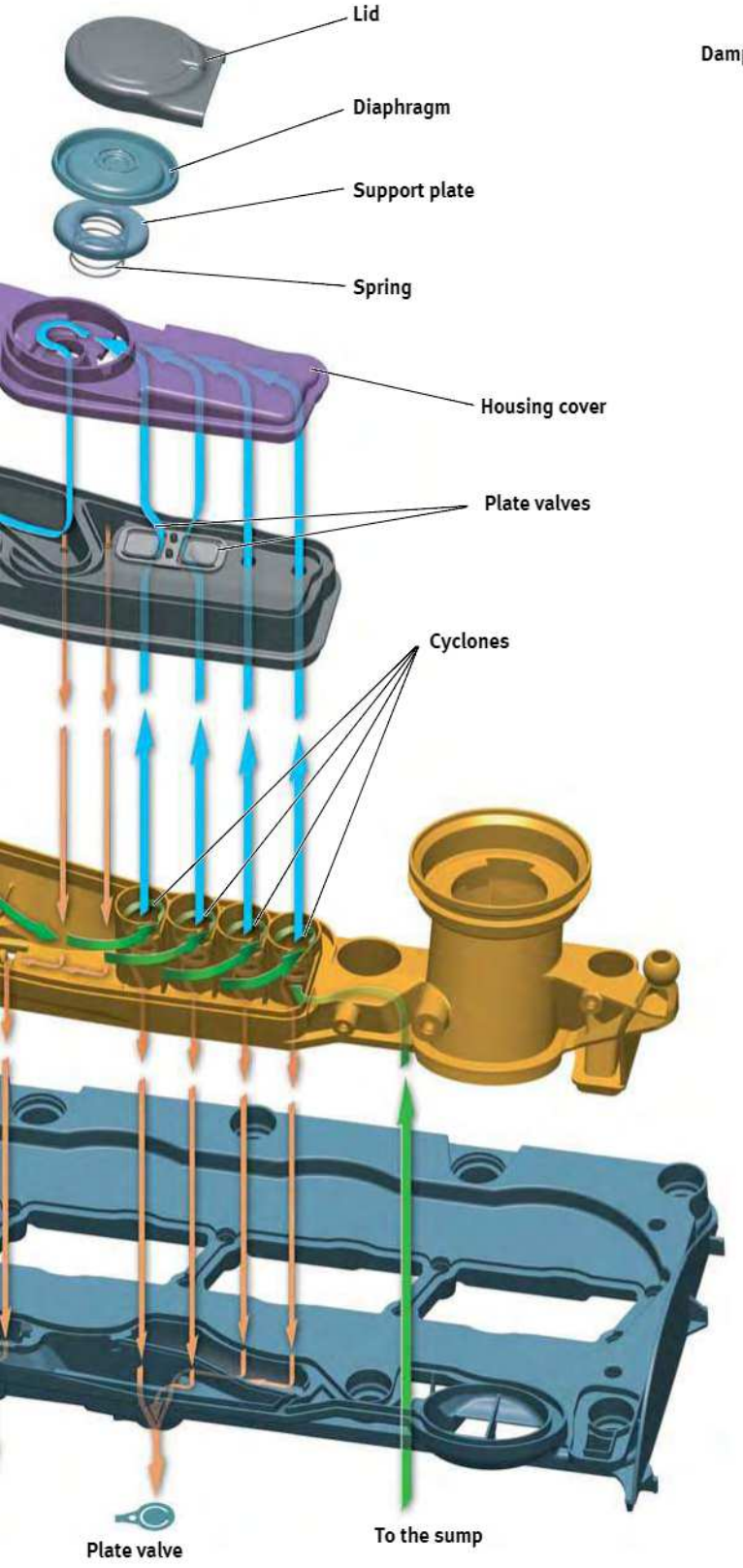
Oil separation takes place in three phases:

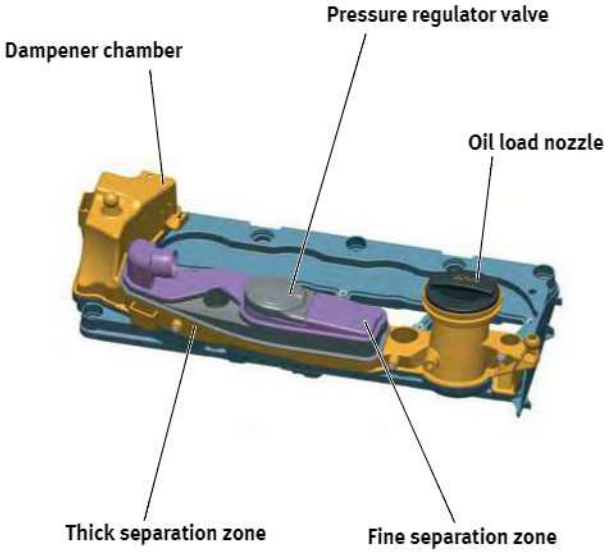
- Thick separation.
- Fine separation.
- Dampener chamber.

THICK SEPARATION

It is carried out in the stabilisation chamber, which is integrated in the cylinder head cover. Vapours from the sump flow through it, and the larger size drops are precipitated on its walls. These drops are collected at the bottom of the cover and run down through several drillings to the cylinder head.







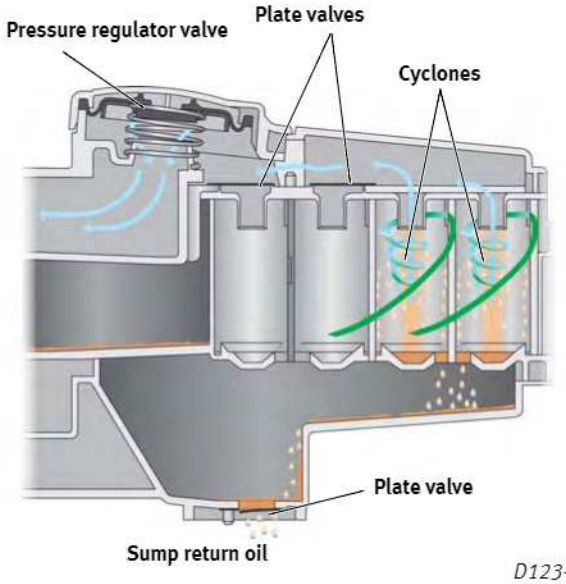
D123-27

FINE SEPARATION

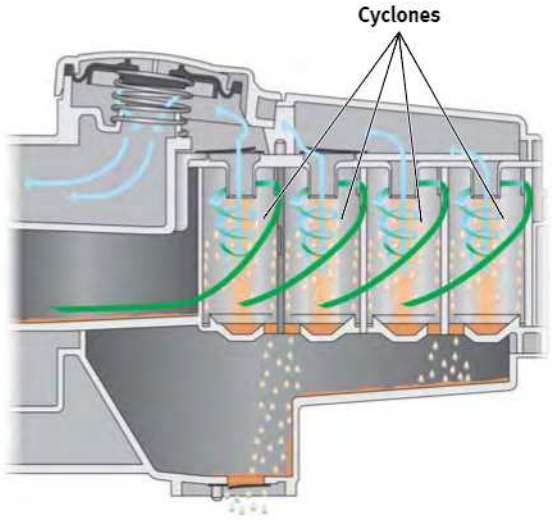
Fine separation is carried out in a cyclone separator placed in the **cylinder head** stabilisation chamber .

Depending on the pressure difference between the inlet manifold and the crankshaft sump, two or four cyclones are involved. Both the right hand side cyclones are always working, while the two on the left only work when there is a very big pressure difference, thanks to the opening of the single direction plate valves.

Specific geometry of the cyclones makes the vapours describe a rotary movement. Centrifugal force generated in the vapours flow due to the rotation movement makes the oil droplets contained stick to the walls and fall into a collector chamber from their own weight.



D123-28



D123-29

SEPARATION WITH LOW PRESSURE DIFFERENCE

The upper plate valves are closed, because there is not enough pressure difference for them to open.

Under such circumstances, only two cyclones are needed to carry out the oil separation properly.

If, when there is a low pressure difference the passage to the four cyclones were to be open, they would loose efficiency because the speed of the vapours would be insufficient.

SEPARATION WITH HIGH PRESSURE DIFFERENCE

When the pressure difference is very high the upper plate valves open.

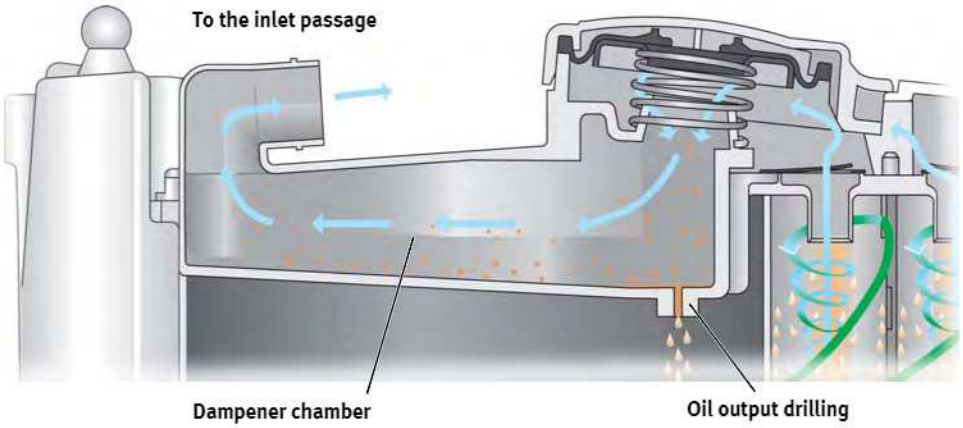
Otherwise, excess speed of the vapours would mean the two cyclones would not be enough for correct separation of the oil drops.

DAMPENER CHAMBER

After the cyclone separator, the vapours enter a dampener chamber where **the kynetics energy they have taken in** after passing the cyclones is reduced.

It is necessary to reduce the kynetics energy in order to prevent possible swirls in the flow of vapours when they enter the inlet manifold.

There is a drilling at the lower part of this chamber for releasing the oil recovered in this zone.



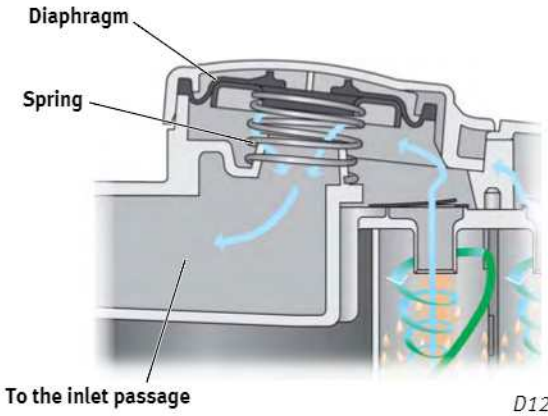
D123-30

MEMBRANE VALVE

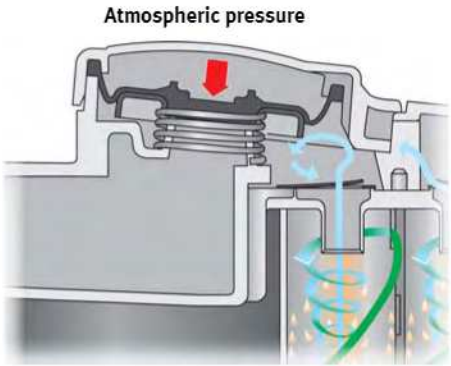
This valve maintains constant pressure and good block ventilation by **regulating the vapours flow** to the inlet manifold. The flow of vapours from the sump is carried out **depending on the existing vacuum in the inlet manifold**.

The higher the vacuum in the inlet manifold, the lower the vapours pass section.

This valve also contributes to preventing the oil seals being damaged by the intense sump vacuum effect.



D123-31

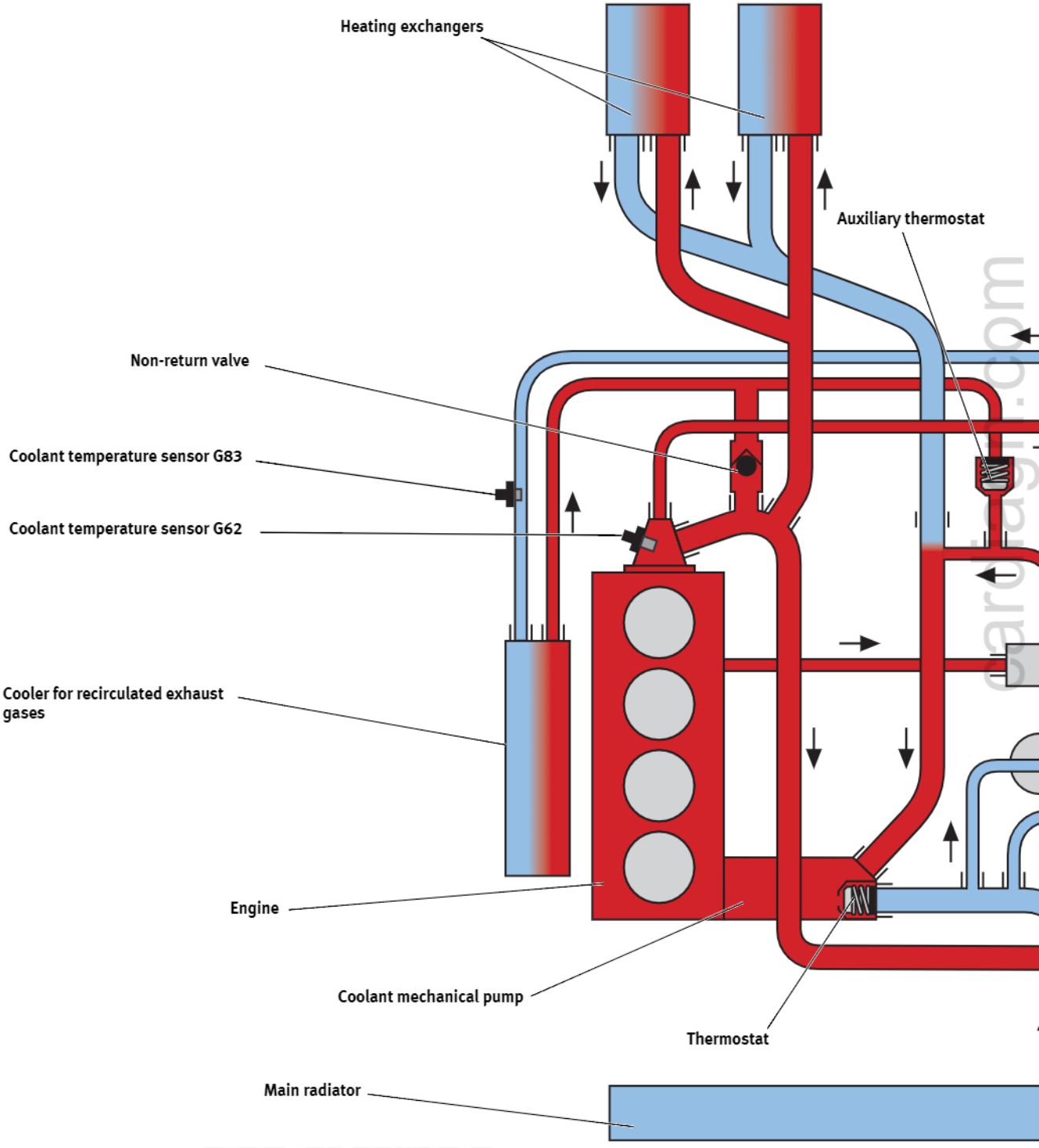


D123-32

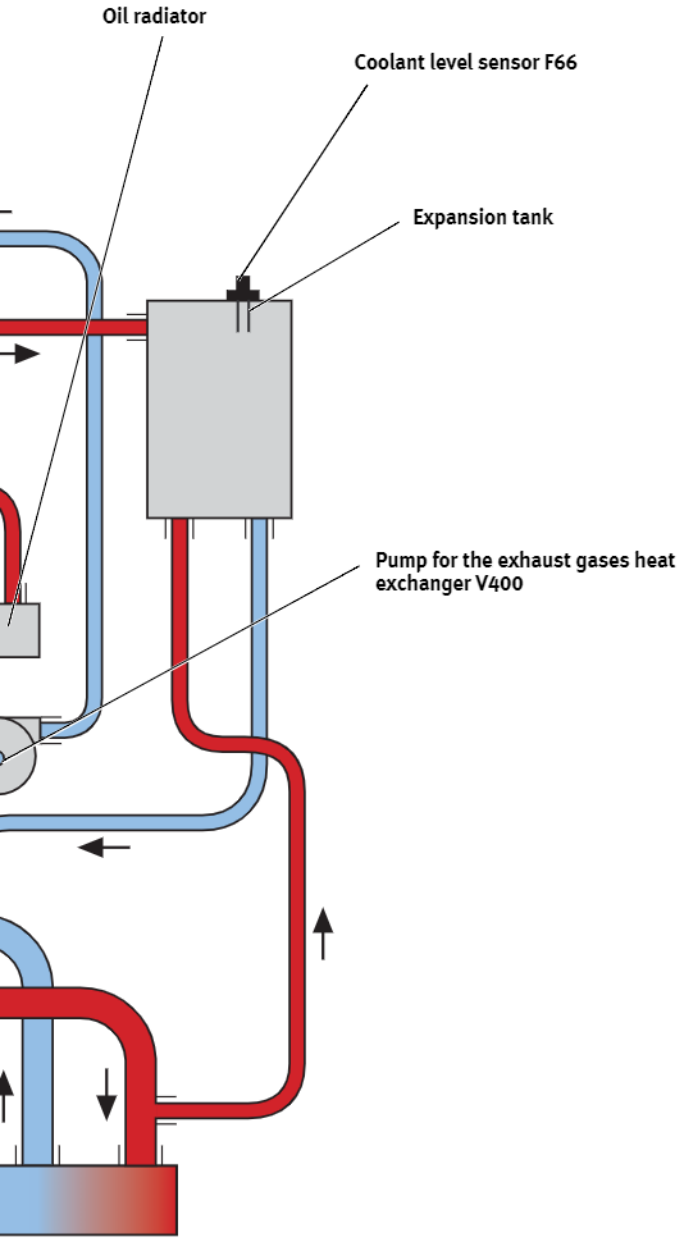
COOLING CIRCUIT

The 2.0l TDi CR engine cooling circuit is very similar to the cooling circuit of a pump injector technology 2.0l TDi engine.

The coolant is driven by the mechanical pump placed in the engine block, which is driven by the timing toothed belt.



The main components of the cooling circuit are the heat exchangers for the passenger compartment, the oil filter radiator, the recirculated exhaust gases radiator, the expansion tank and the main thermostat.



D123-33

There are two passenger compartment exchangers, one for the left side and one for the right side, and they are placed at either sides of the climate assembly.

The expansion tank includes the coolant level sensor F66, which sends its signal directly to the instrument panel via a conventional wire to indicate when the level of the coolant is too low.

Also, the **coolant temperature sensor G62** is placed on the distributor rail at the cylinder head output, on the flywheel side.

The thermostat opens the coolant's passage from the main radiator to the engine when the temperature reaches 82°C.

The main new feature of the cooling circuit is that there is a **sub-circuit for cooling the recirculated exhaust gases at low temperature**.

This sub-circuit guarantees cooling of the exhaust gases with cold fluid from the main engine radiator.

Thanks to the subcircuit for cooling the recirculated exhaust gases it is possible to recirculate a larger amount of gases without any danger of increasing the NOx from excess temperature in the combustion chamber.

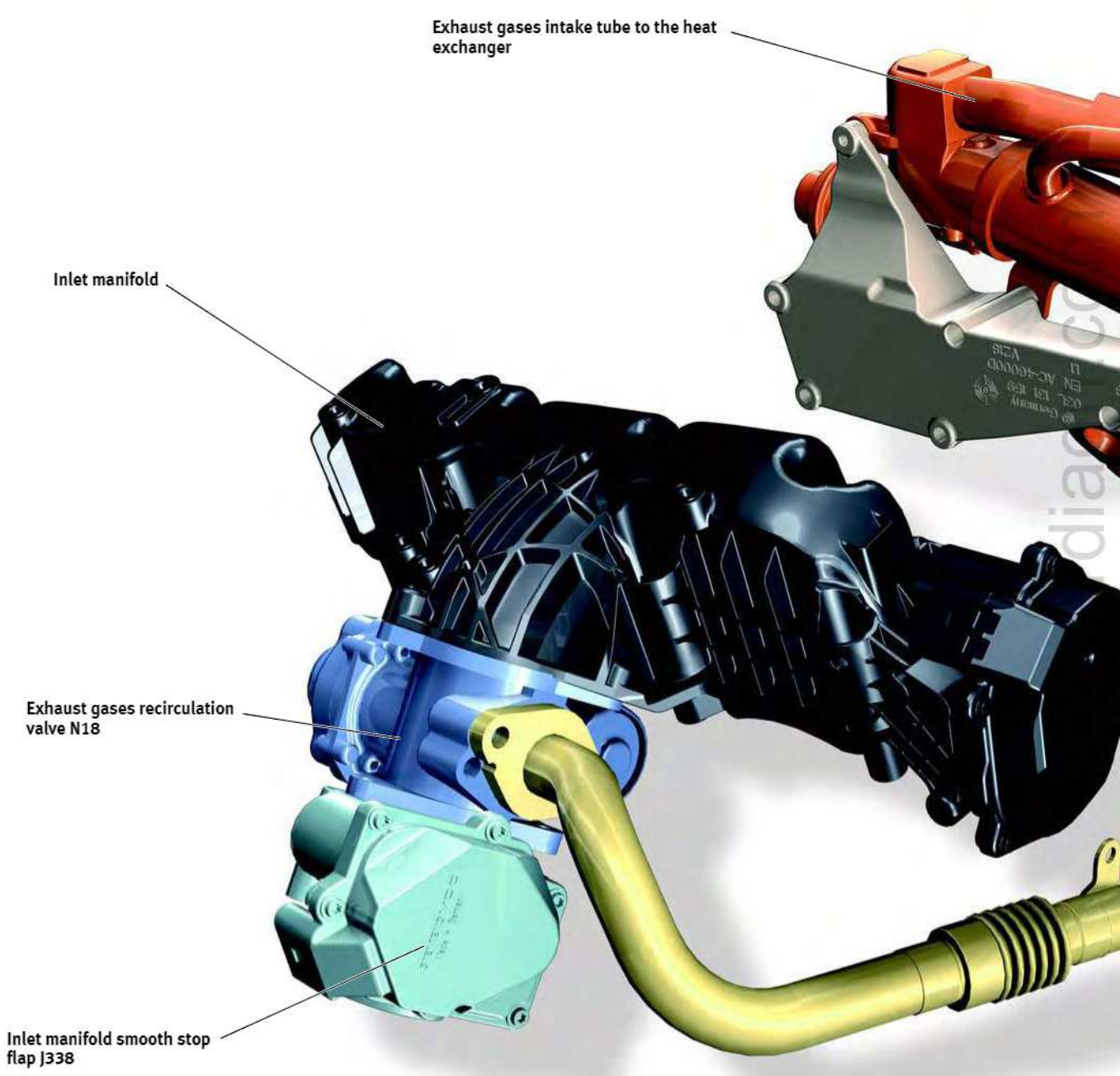
The coolant temperature sensor G83, at the output of the engine radiator, is actually placed at the entrance to the recirculated exhaust gases so that the engine control unit can know the exact temperature the recirculated gases are being cooled at.

In the following pages the operation of recirculated exhaust gases cooling circuit is explained.

EXHAUST GASES RECIRCULATION

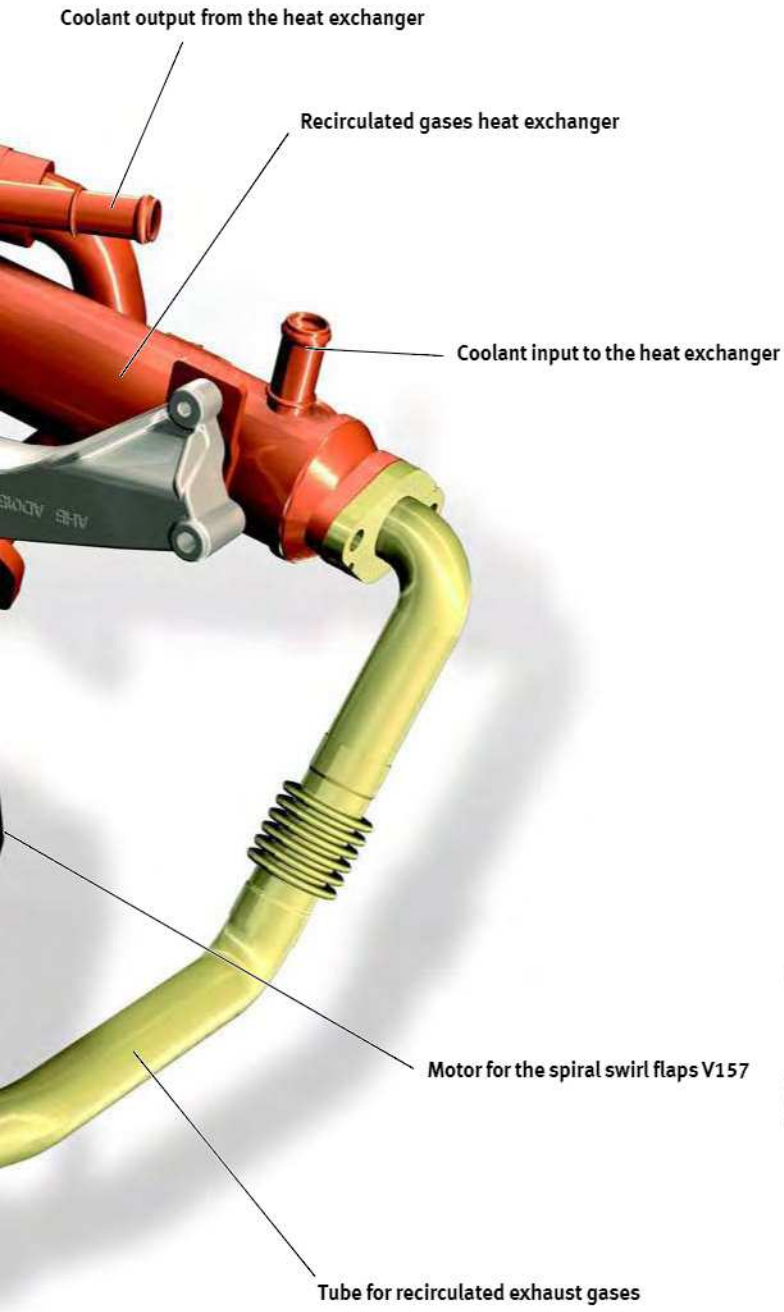
The 2.0l TDi CR engine includes an exhaust gases recirculation system for reducing the emissions of unburnt hydrocarbons and of carbon monoxide.

So as not to increase the NOx emissions due to a possible increase of the combustion temperature, the recirculated exhaust gases are cooled in a **heat exchanger** placed above the turbocharger, similar to the one fitted in the 2.0l TDi pump injector engines.



SYSTEM COMPONENTS

The main components are the recirculated exhaust gases heat exchanger, the recirculated exhaust gases cooling solenoid valve N345, and the exhaust gases recirculation valve N18.



D123-34

The heat exchanger does not have external cooling vanes because of the closeness of the particles filter, because it would have the opposite effect, that is, it would heat instead of cooling.

The exhaust gases control solenoid valve N345 opens or closes the passage to the exhaust gases through the heat exchanger.

Once they have gone through the heat exchanger, the exhaust gases reach the **exhaust gases recirculation valve N18** through a metal tube that surrounds the engine from the flywheel side.

The N18 valve is placed immediately after the **inlet manifold smooth stop flap**. When the N18 valve is open, the engine control unit closes the flap slightly to create a Venturi effect just at the output of the recirculated exhaust gases. This contributes to driving the recirculated gases to the inlet manifold.

OPERATION

By controlling the degree of opening of the N18 valve, the engine control unit allows for a greater or smaller amount of recirculated exhaust gases according to a **characteristics curves map**, and to the signals from the engine revs, intake air temperature, injection flow, sucked in air mass and atmospheric pressure.

The N345 solenoid valve is electrically controlled by the engine control unit so that it opens or closes the vacuum passage to a pneumatic actuator attached to the heat exchanger. The flow of exhaust gases through the heat exchanger is switched from the cooling zone to the no-cooling zone by the pneumatic actuator switches.

When the **coolant temperature is higher than 24°C**, the solenoid valve N345 sends the recirculated exhaust gases through the heat exchanger cooling zone.

EXHAUST GASES COOLING

OPERATION

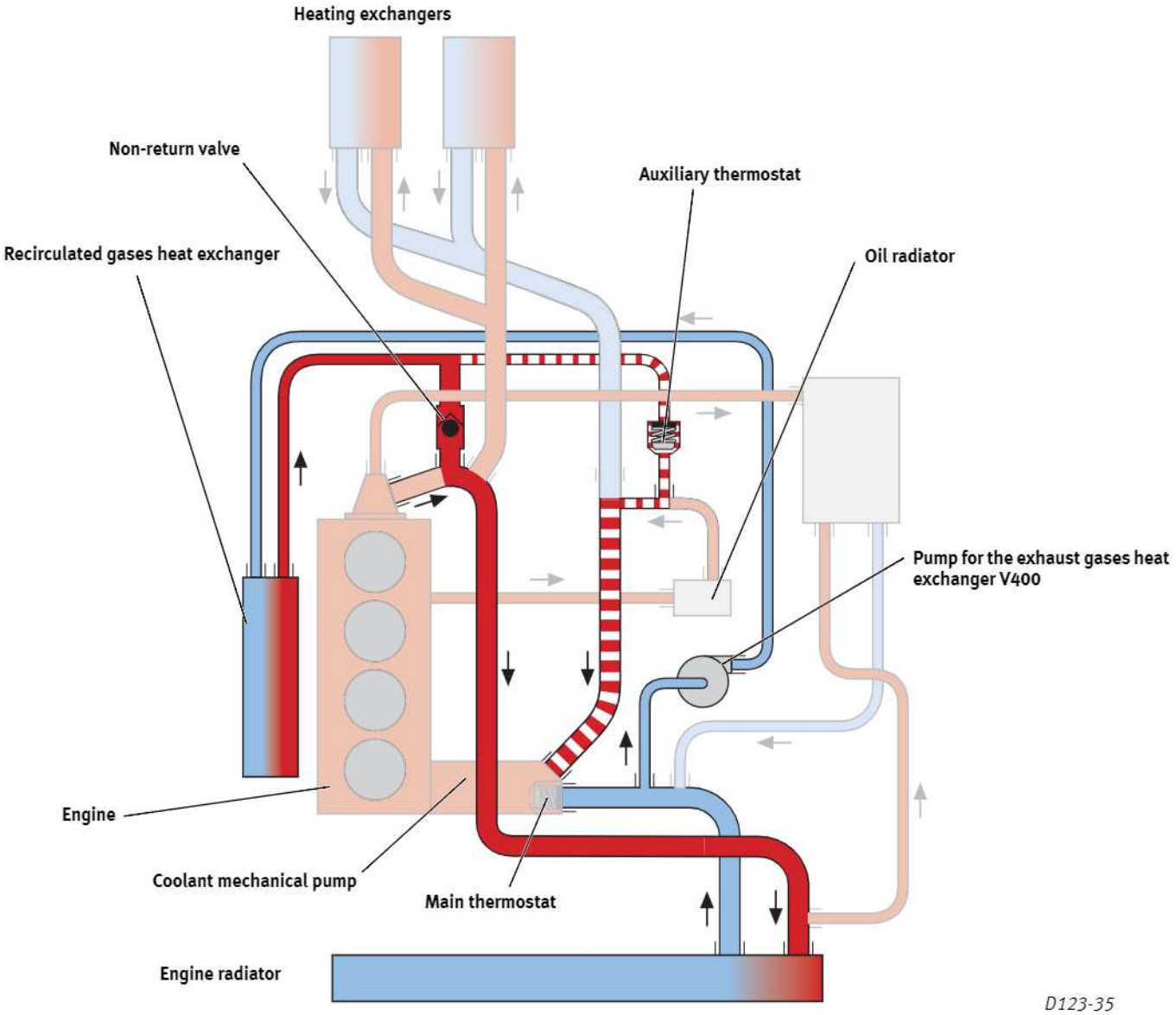
After starting the engine, **the V400 pump** drives the coolant from the radiator outlet to the heat exchanger to cool the recirculated exhaust gases.

No cold coolant from the radiator flows through the rest of the circuit elements, because the main thermostat is closed.

The **secondary thermostat**, placed in a flexible tube, is initailly closed and prevents the coolant from the subcircuit mixing with the higher temperature coolant flowing through the rest of the circuit.

This system allows cooling the recirculated exhaust gases withoiut the engine taking more time to reach the service temperature.

From a temperature value of 70°C in the subcircuit, the secondary thermostat begins to open and the non-return valve closes to prevent the formation of an reverse flow that could generate heat accumulation in the recirculated exhaust gases heat exchanger.



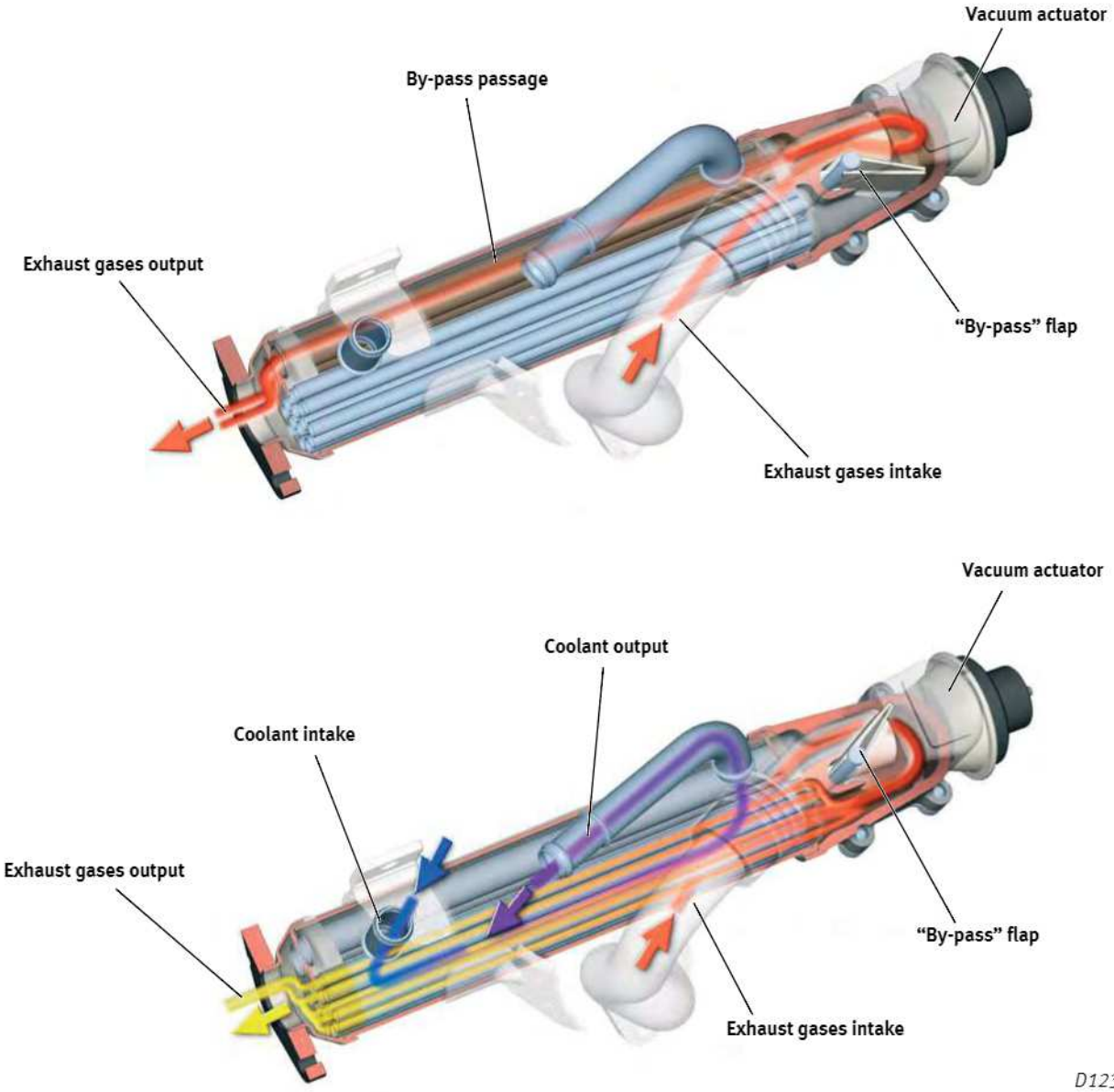
The vacuum actuator controlled by the recirculated exhaust gases cooling control solenoid valve N345 has a flap inside for switching over the flow of exhaust gases along the cooling tubes.

COLD ENGINE

When the engine is very cold it is not necessary to cool the exhaust gases being recirculated. The "by-pass" flap opens so that the exhuast gases flow through the heat exchanger via the by-pass, therefore without being cooled. This contributes to rapidly reaching the engine and the catalyst operation temperature.

ENGINE IN HEAT PHASE

When the engine temperature reaches 24°C, the flaps change position, making the recirculated exhaust gases flow through the heat exchanger cooling tubes.



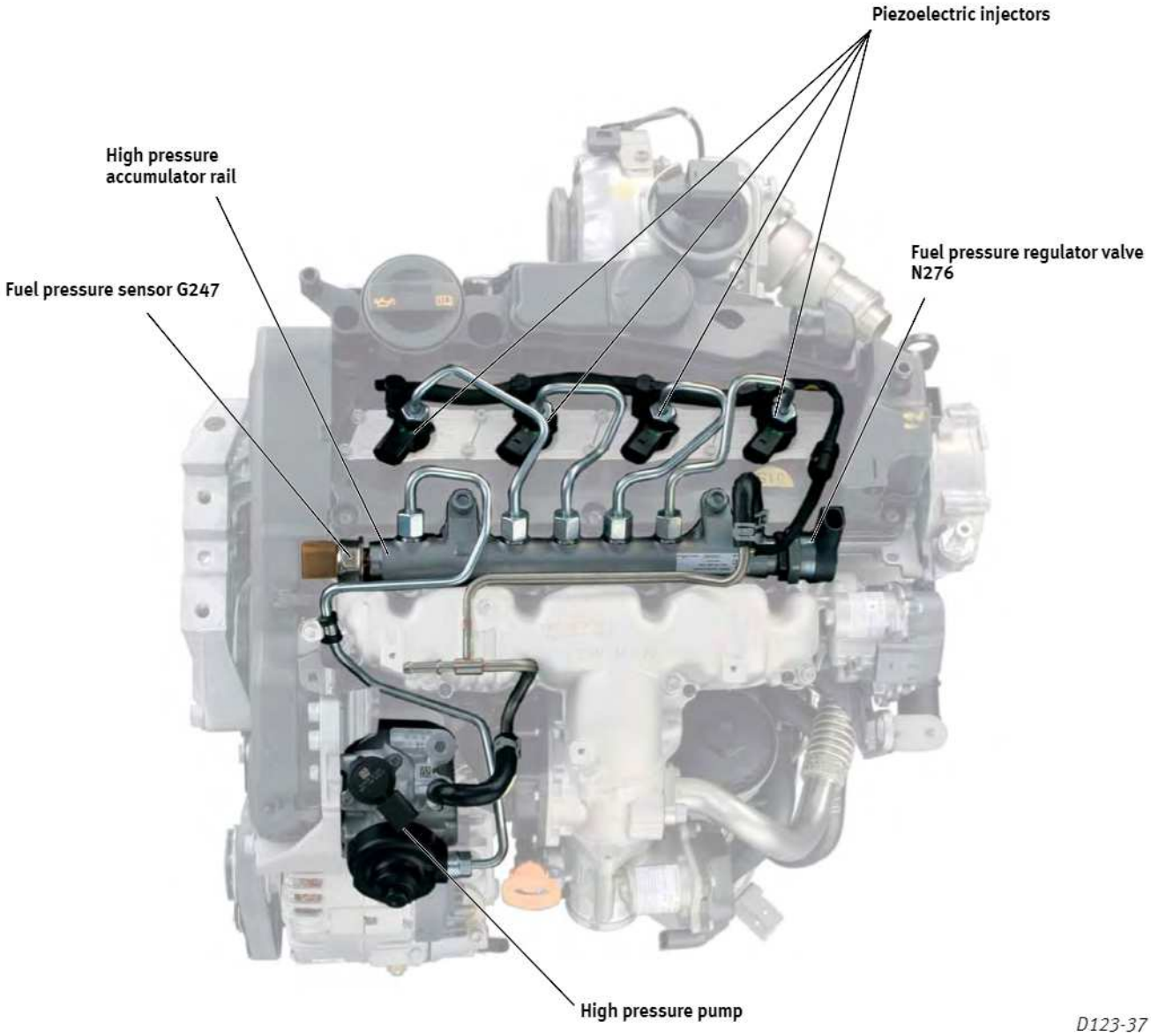
D123-36

"COMMON RAIL" SYSTEM

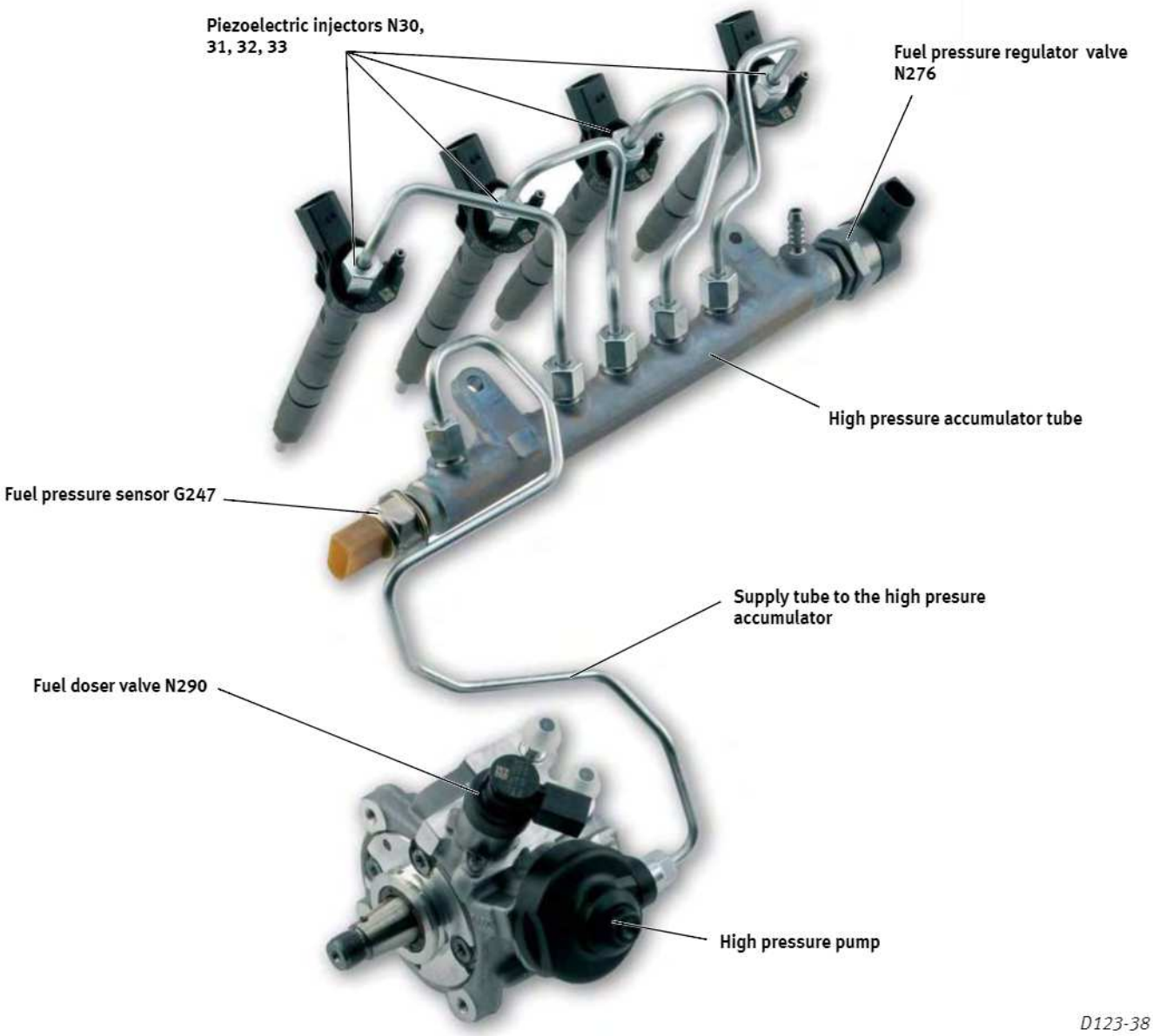
The "Common Rail" injection system offers several advantages compared to the pump injector system:

- The pressure of injection can be adapted to any state of engine operation.
- The pressure of injection of the "Common Rail" system implemented in SEAT can reach up to **1.800 bar**, a high enough pressure to achieve an optimum air and fuel mix.
- Because of using **piezoelectric injectors**, it is possible to carry out multiple preinjections and postinjections depending on the engine needs.

All these characteristics allow reducing the emissions, reducing fuel consumption and improving driving comfort by also reducing the engine noise and vibrations.



D123-37



D123-38

The main components of the "Common Rail" injection system are:

- The **fuel high pressure pump**. It is driven by the timing toothed belt and generates the necessary fuel pressure for the injection.
- The **fuel high pressure accumulator or common passage**. The tubes that bring the high pressure fuel to the injectors are connected to it.
- The **piezolectric injectors**. Are the ones in charge of introducing the diesel into the cylinder. The various phases of injection are controlled by a valve with a piezoelectric actuator.

It can be said that the "Common Rail" system injectors only work as valves that control the phases of injection. They do not generate the pressure of injection, as happens with the pump injectors; it is the high pressure pump that provides the pressure.

FUEL CIRCUIT

The fuel pre-priming electrical pump placed inside the tank drives the fuel at a pressure between 0.3 and 0.5 bar, from the fuel tank to the **pre-heat valve**.

The preheat valve prevents the parafine contained in the fuel from precipitating and creatig crystals that can end up obstructing the filter.

The pre-heat valve drives the return fuel to the auxiliary electrical pump or to the fuel tank, depending on whether the fuel is cold or hot.

Fuel arrives at the **auxiliary electrical fuel pump V393**, which is placed in the vehicle underfloor and carries out a very similar function to that of the mechanical tandem pump in the pump injector engines. It drives fuel at 5 bar to the high pressure pump.

Between the auxiliary pump and the high pressure pump there is the **filter and temperature sensor G81**, with which the engine control unit determines the fuel temperature before it is compressed in the high pressure pump.

The **fuel high pressure pump** generates the necessary fuel pressure for injection.

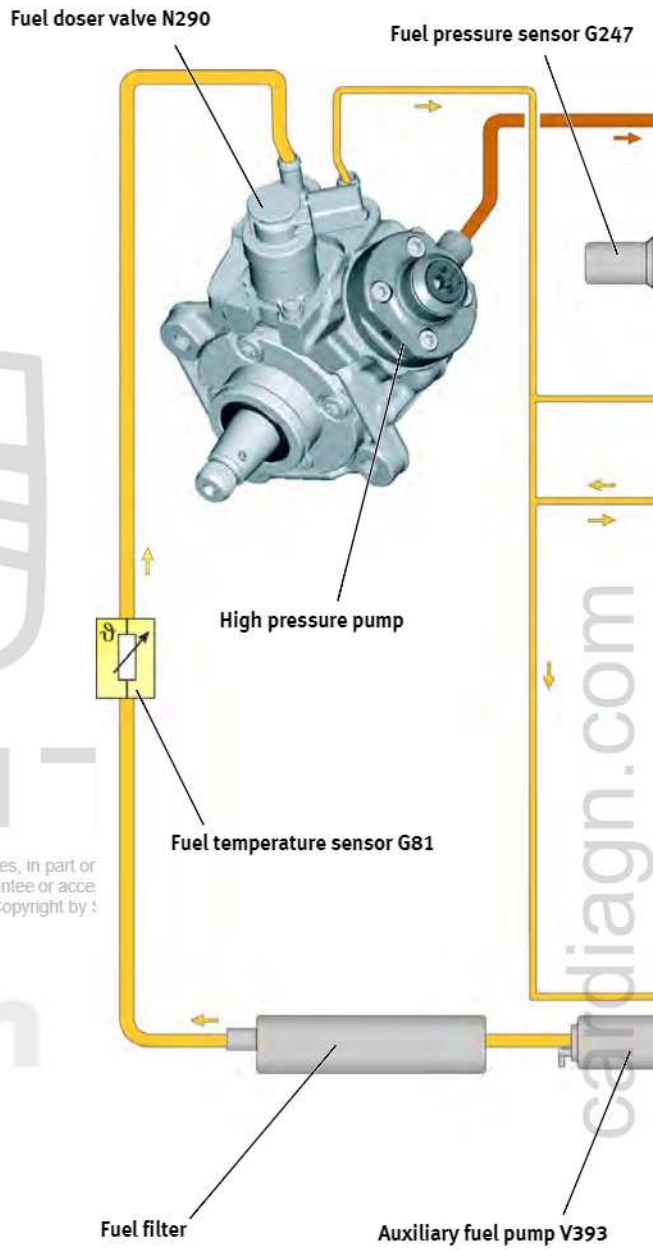
The **fuel doser N290** valve is placed at the entry to the high pressure pump; it regulates -depending on the engine needs- the amount of fuel to be compressed, therefore optimising the pressure generation process.

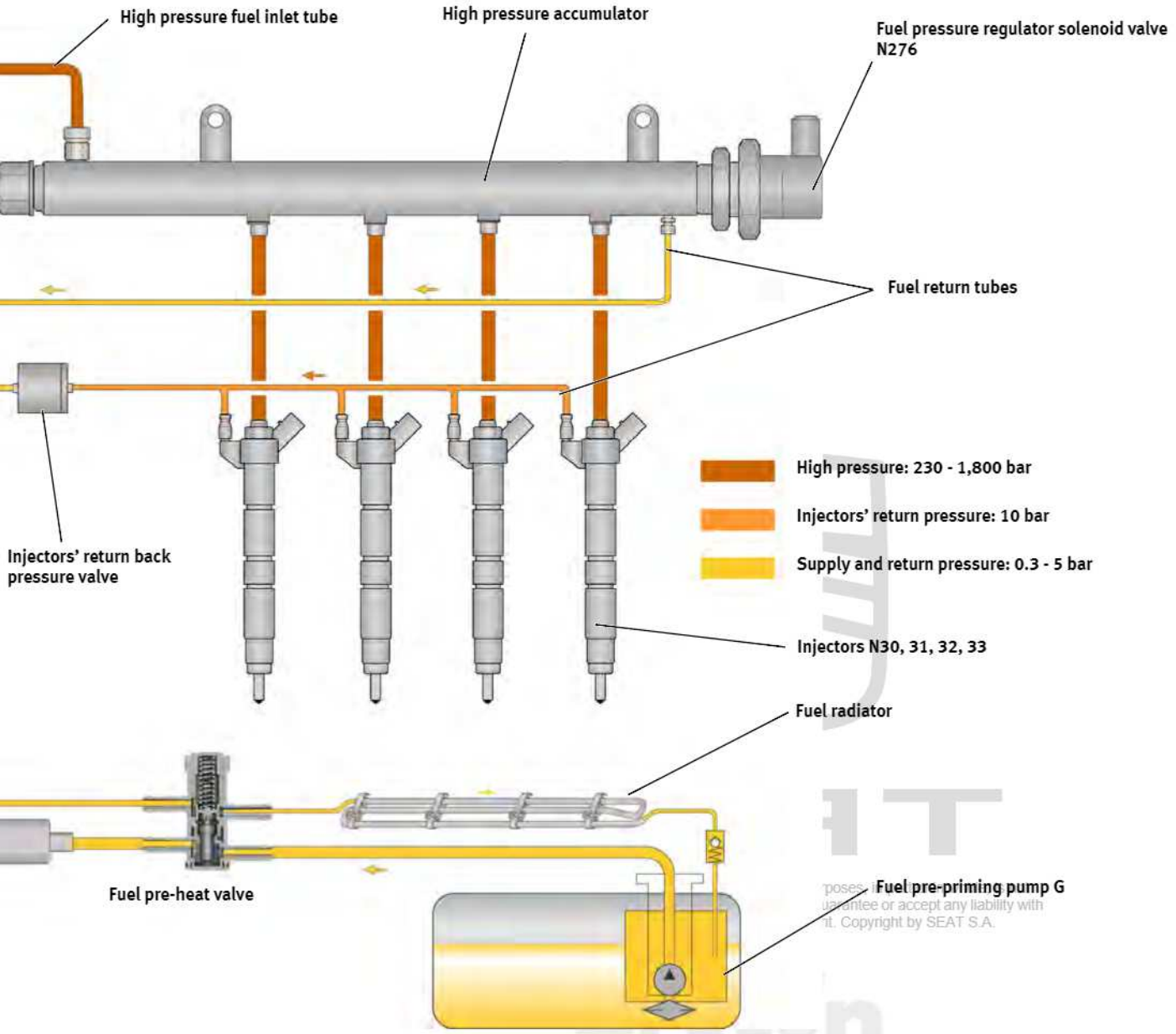
The high pressure fuel gets to the **high pressure accumulator** where each of the injectors is connected by short tubes, so that the pressure downgrades as little as possible.

The **fuel pressure regulator valve N276**, placed at one end of the high pressure accumulator, regulates the necessary fuel pressure for the injection depending on the engine operation needs.

Placed at the other end of the accumulator is the **high pressure sensor G247**, which informs the engine control unit about the fuel pressure in the accumulator.

The **pressure choke valve** is placed in the injectors' return tube. It is a mechanical rheostat that mintains the return pressure at 10 bar. This constant pressure in the retrun tube is necessary for correct operation of the piezoelectric injectors.





D123-39

The **fuel radiator** is placed in the Exeo underfloor. Its function is to reduce the fuel's residual heat so that the temperature does not rise inside the tank.

In any case, it has to be taken into account that the fuel heats up less in the "Common Rail" injection system than in the pump injector system, because the fuel does not flow inside the cylinder head as happens with the pump injector engines.

For such reason, the dimensions of the fuel radiator fitted in the Exeo with 2.0l TDi CR engine, are smaller than the fuel radiators fitted in the rest of the range with the pump injector engines.

FUEL PRE-HEAT VALVE

It is interspaced **in the low pressure zone of the fuel circuit**, just before the auxiliary fuel pump.

If the fuel is cold the preheat valve drives the return fuel back again to the engine; however, if it is hot it sends it to the tank.

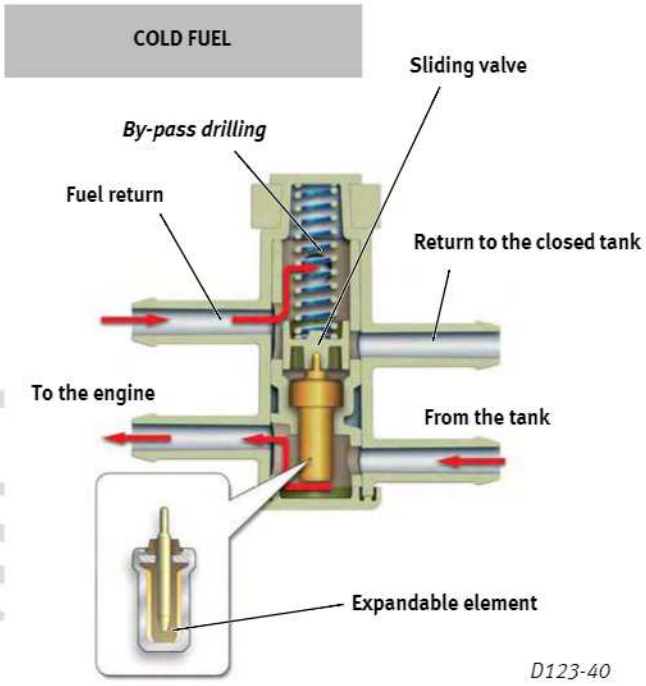
LAYOUT

The valve contains a metal capsule inside filled up with an **expandable substance and a central rod**.

The effect of temperature on the expandable substance makes it contract or expand and move the rod to one or the other side.

One end of the rod is immersed in an expandable substance, and the other end is attached to a **slide valve** pressed by a **spring**.

Depending on the return fuel temperature, it is sent back to the engine again, or sent to the fuel tank.



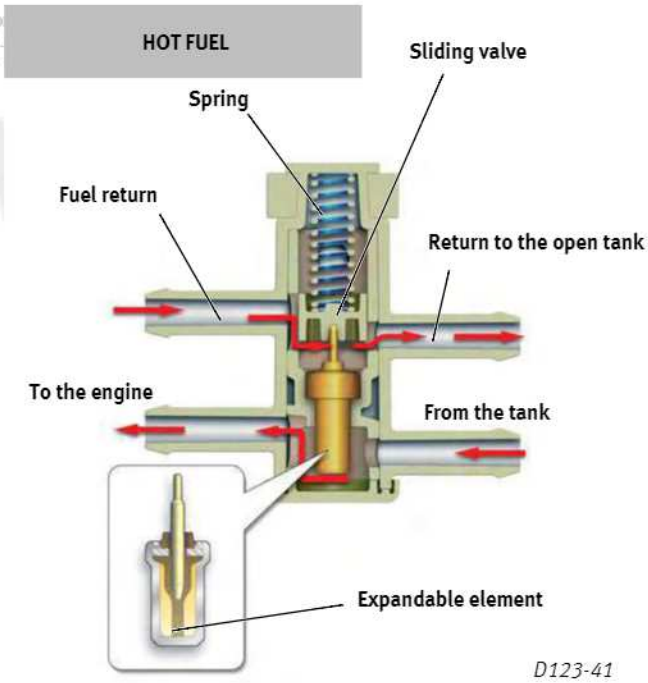
D123-40

OPERATION

When the return fuel has a temperature below 15°C, the force from the spring holds the **slide valve in the lower position**, closing the fuel return drilling to the tank and opening the passage to the by-pass drilling zone so that the fuel can return to the engine

From 15°C fuel temperature, the central rod is moved by the expandable substance until it completes a 2mm stroke. **The rod moves the slide upwards** and closes the passage of fuel to the by-pass drilling and opens the return passage to the tank.

If replaced, it is necessary to confirm that the preheat valve has been fitted in the correct position.



D123-41

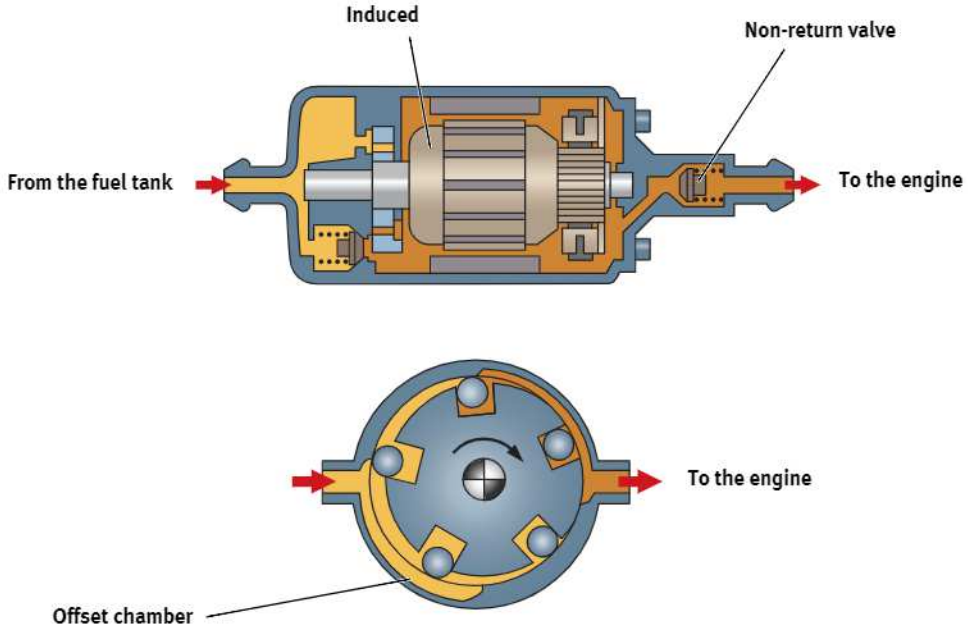
AUXILIARY FUEL PUMP V393

It is the component in charge of **increasing the fuel pressure up to aproximately 5 bar** in the circuit section that drives the fuel to the high pressure mechanical pump.

The auxiliary pump is energised by the engine control unit through a relay placed in the engine compartment relay holder.

REPLACEMENT FUNCTION

If the auxiliary fuel pump fails, the pressure generated by the tank pre-priming pump is not enough for correct engine operation.



D123-42

VACUUM GENERATOR PUMP

It is the component that generates enough vacuum for the engine and all other vehicle components that require it.

The vacuum generator pump **is driven by the intake camshaft**, like the tandem pump of the TDi pump-injector engines.

The difference is that in the 2.0l TDi CR engine, the fuel pump is not coupled next to the vacuum pump, because it has been replaced by the auxiliary electrical fuel pump V393.

This is because in the 2.0l TDi CR engine, fuel is not driven along the inside of the cylinder head, as happened with the tandem pump.

D123-43

HIGH PRESSURE PUMP

It is in charge of generating the fuel pressure of **up to 1,800 bar** necessary for injection.

It is a single piston pump driven by the crankshaft through the timing belt at a **downgearing ratio of 1 to 1**.

The piston that drives the high pressure fuel is moved by two camshafts offset 180o to each other and placed on the drive shaft.

These characteristics offer the following advantages:

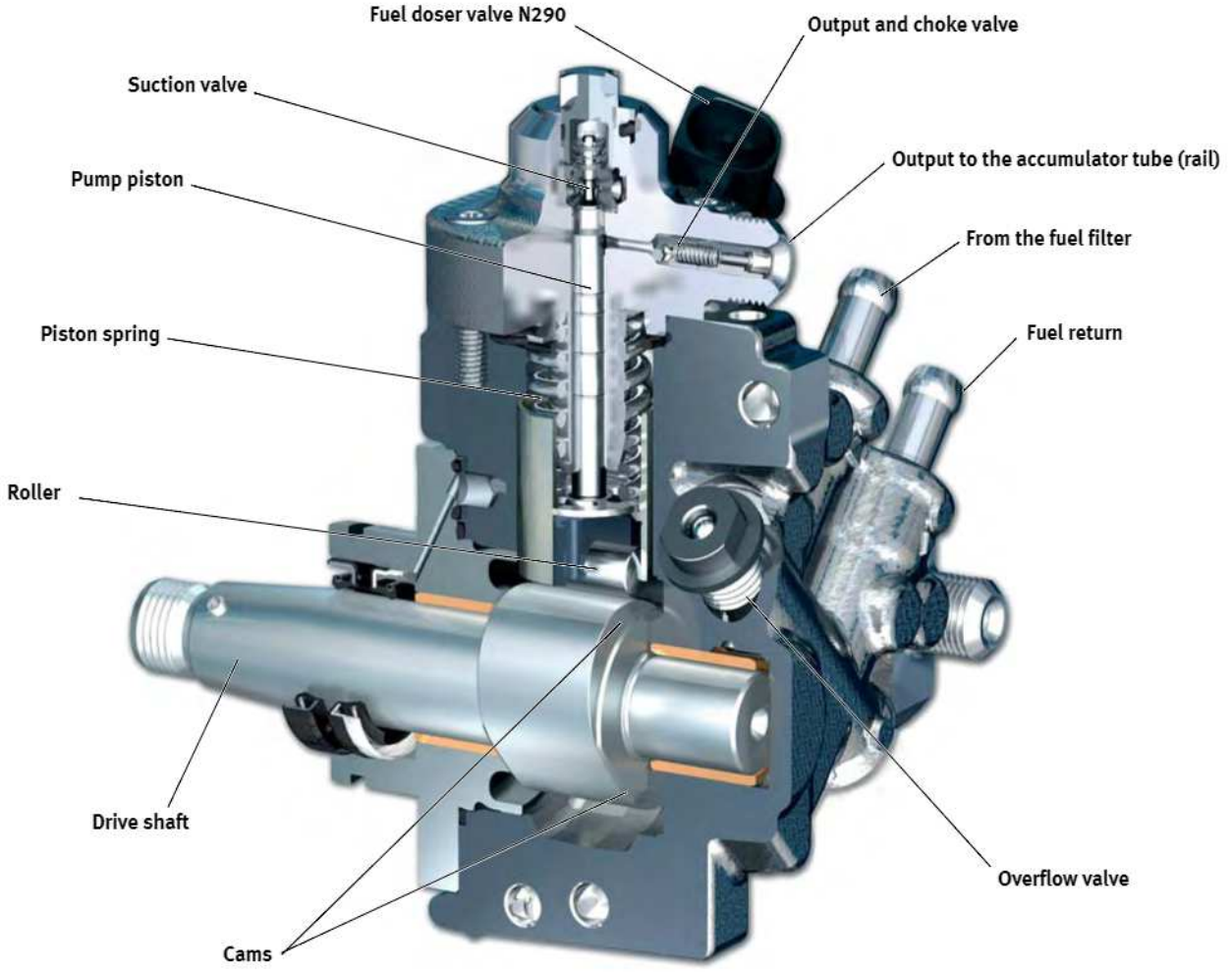
- Carrying out each injection in the fuel high pressure acumulator tube at the same time as carrying out the compression stroke in each of the cylinders.

- Maintaining a uniform load for activating the pump and therefore reduce pressure fluctuations in the high pressure zone.

For this reason, when replacing the timing belt **the high pressure pump needs to be synchronised with the crankshaft**.

Also, between the drive shaft and the pump rod there is a roller interspaced that contributes to transmitting the forces between both with minimum internal friction.

Another important feature is that the pump body is practically made of one single part, minimising the risk of loss of sealing.



D123-44

LAYOUT

The high pressure pump has three drillings through which the fuel flows:

- The intake drilling, from the fuel filter. It is a low pressure connection.
- The output drilling to the high pressure accumulator. It is a high pressure connector with a **choke valve**.
- The fuel return drilling. Through it, the left overfuel is returned to the tank.

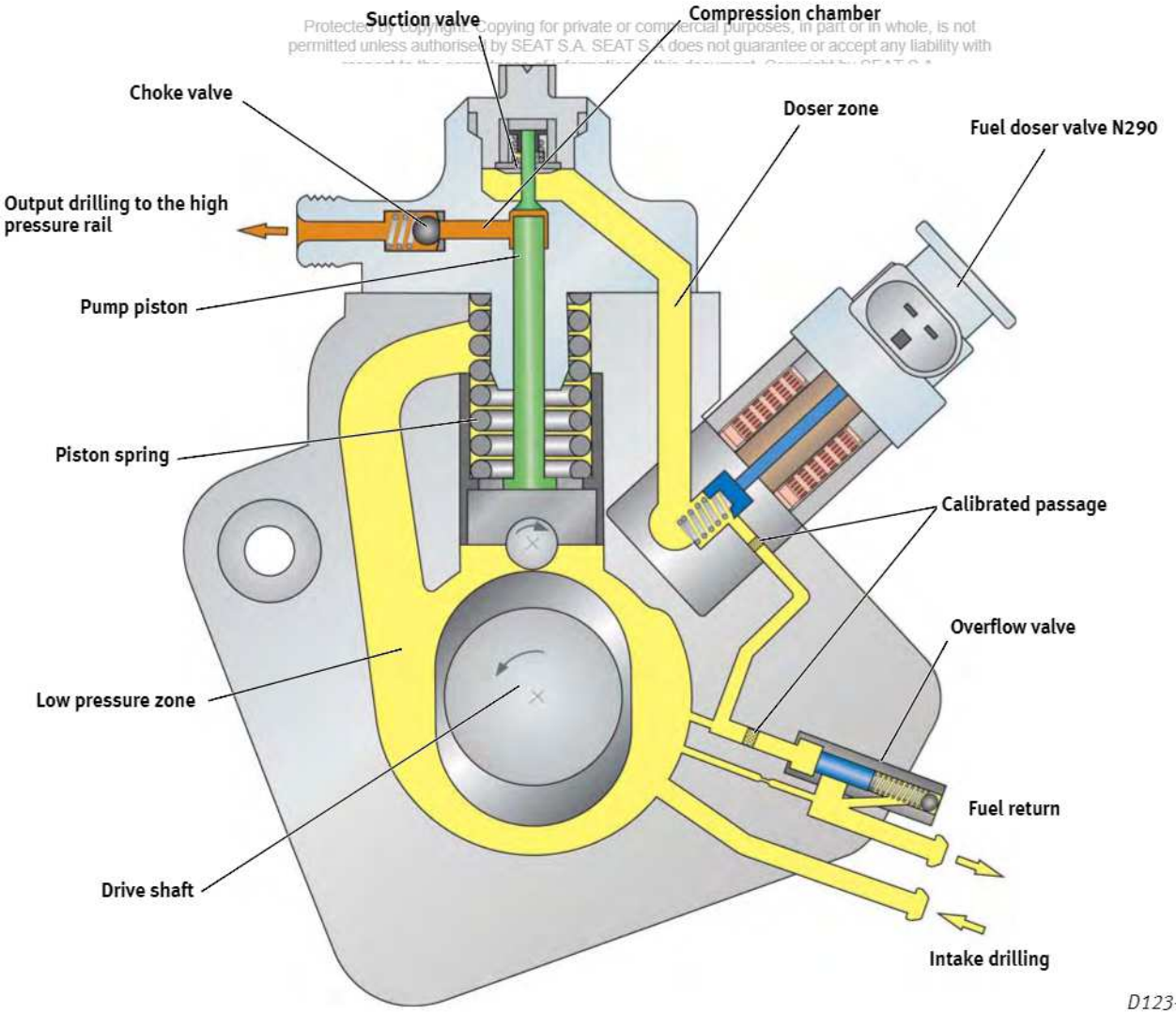
Two zones can be differentiated in the pump:

One of them is the **low pressure zone**. It takes up most of the pump's volume and one of its functions is to lubricate and cool the drive shaft and the piston with the same fuel that flows through the pump.

For this reason the pump **can never work in vacuum**. When replacing the pump, it must be filled-up with fuel by using the diagnoisis tester basic settings function.

The other zone is the doser zone, which starts at the fuel doser valve zone and ends at the compression chamber.

The high pressure generation cycle is explained in the appropriate section of this Self Study Programme.



D123-45

INJECTORS

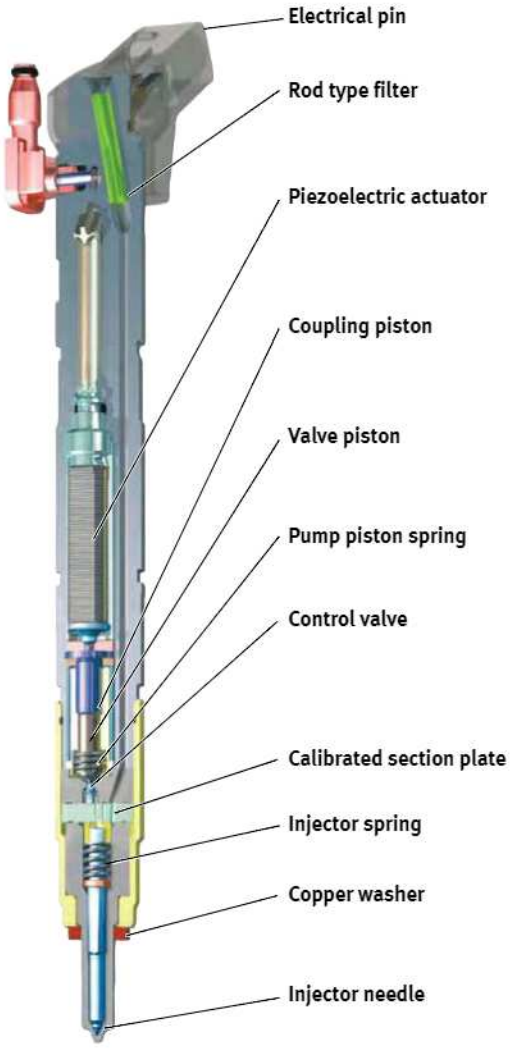
The 2.0l TDi engine "Common Rail" system incorporates injectors with valves driven by **piezoelectric actuators**.

The main advantage of piezoelectric actuators is the **high speed of switching**, which is approximately four times that of the electro-magnetic solenoid valves.

Also, the piezoelectric technology applied to the injectors implies a 75% reduction of masses in motion compared to an injector managed by an electromagnetic valve actuator.

These system characteristics offer the follwing advantages:

- Very short response times.
- Possibility of carrying out several injections per injction cycle.
- Injection amounts dosified with great accuracy.

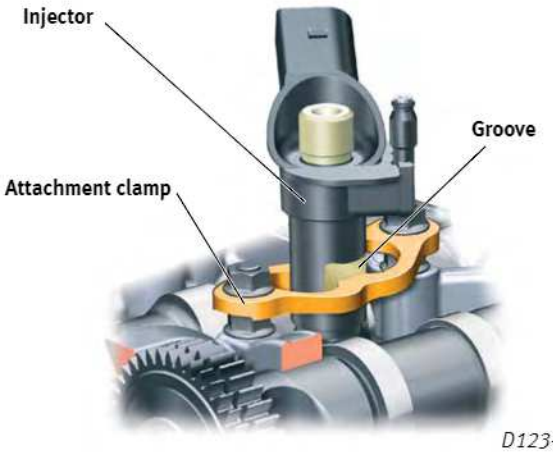


D123-46

INJECTORS ATTACHMENT

The injectors can be easily accessed through windows on the cylinder head cover.

They are attached in place by a clamp that holds the injector by its groove and two screws that hold the clamp to the cylinder head.



D123-47

CHOKE VALVE

It is placed on the cylinder head, on the return passage from the injectors.

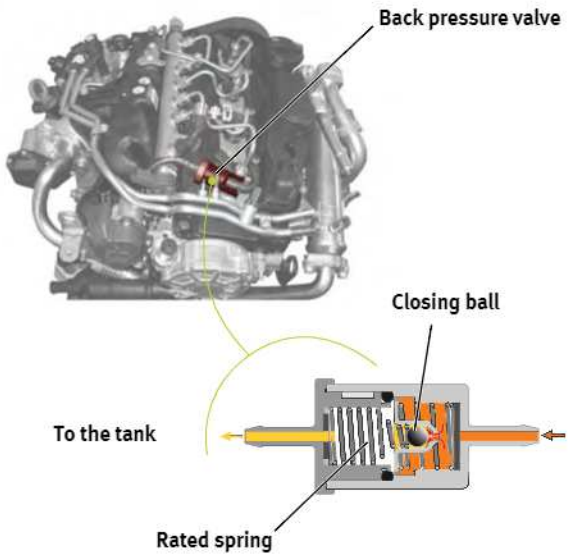
It is a reosthat that holds the pressure in the injectors return tube at 10 bar.

OPERATION

When the return pressure overcomes 10 bar, the rated spring releases and the ball opens the fuel passage to the tank.

When the pressure reaches 10 bar, the rated spring overcomes the pressure action and pushes the ball to close the fuel output.

This is how a 10 bar return pressure is guaranteed, which is **necessary for the injectors to work correctly**.



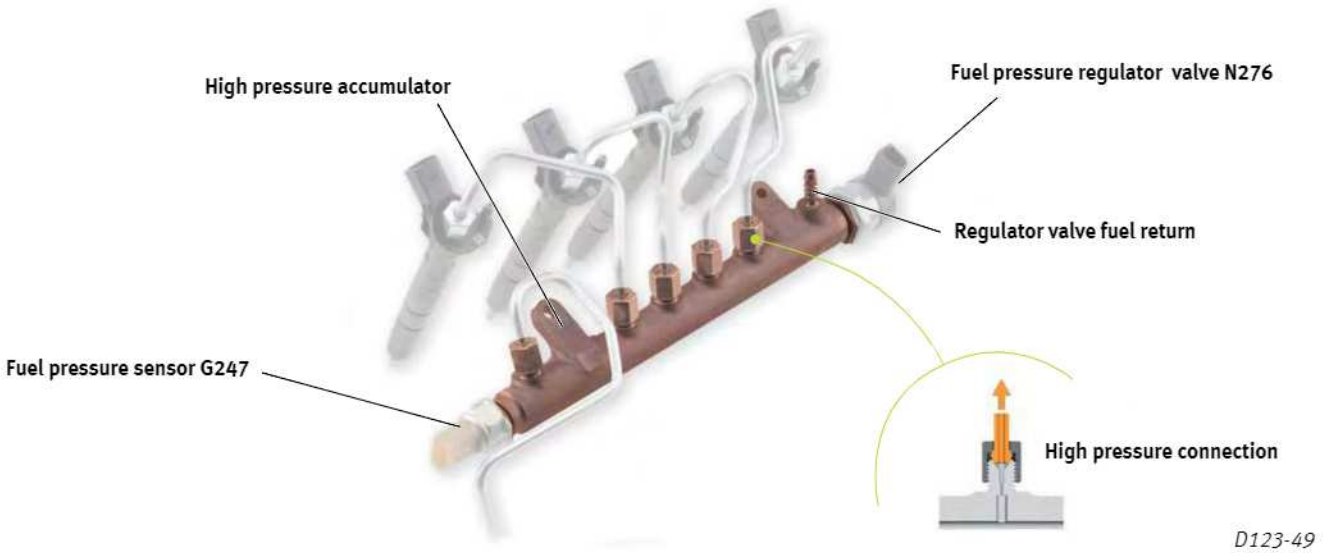
D123-48

HIGH PRESSURE ACCUMULATOR (RAIL)

It is a steel forged tube the function of which is to accumulate the high pressure fuel for supplying the injectors.

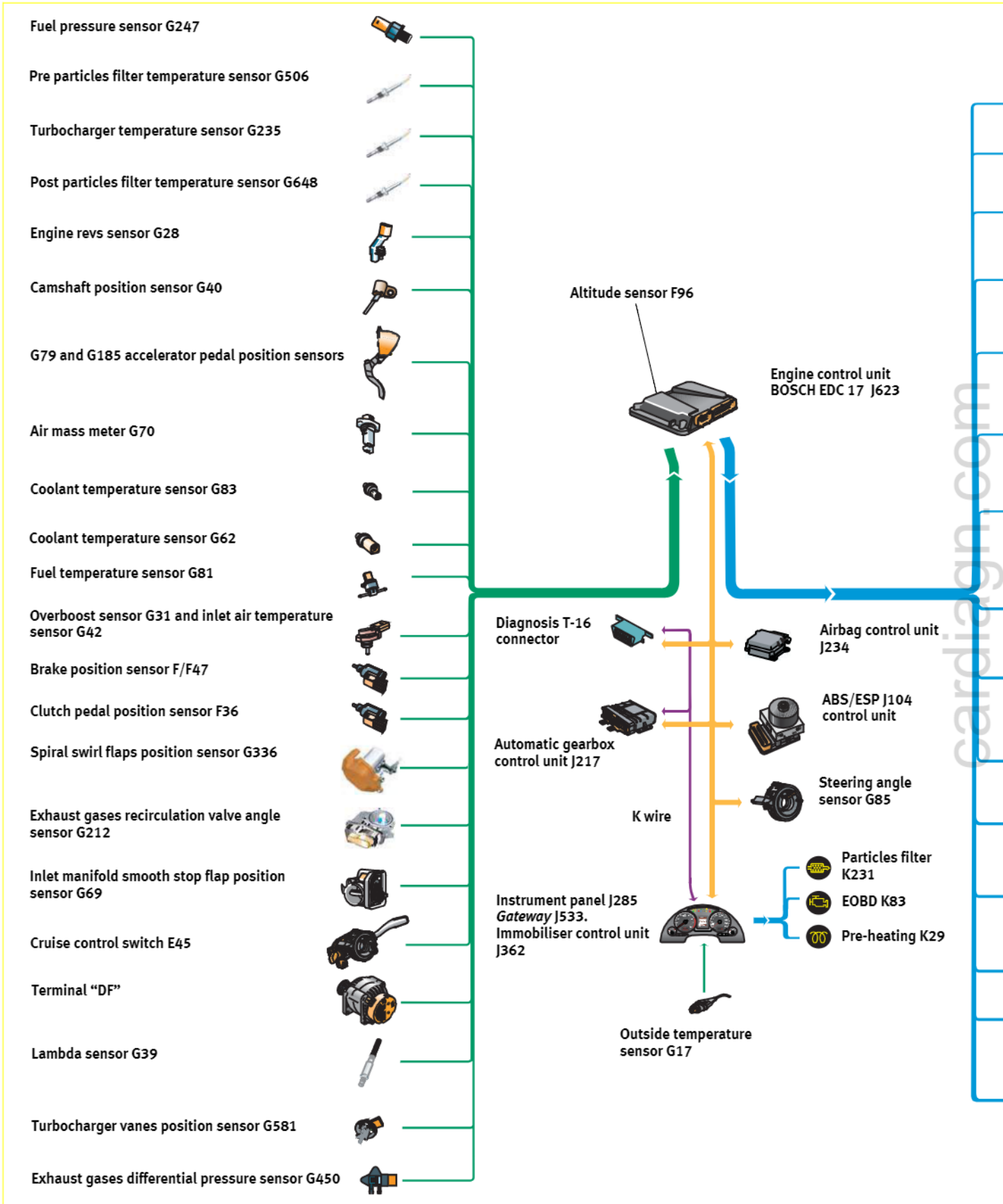
Another very important function it has is to compensate for pressure variations due to the constant flowing in and flowing out it is submitted to. This is why it is so important for it to have a relatively high volume.

As well as the high pressure connections, the high pressure accumulator houses the **fuel pressure regulator valve N276**, the left over fuel return valve exit and the **fuel pressure sensor G247**.



D123-49

SYNOPTIC CHART



D123-50

ASSUMED FUNCTIONS

FUEL INJECTION

- Fuel pressure regulation.
- Calculation of the injection cycles and flow to be injected.
- Maximum revs limitation.
- Ajusting of the idling stability

PRE-HEAT SYSTEM

- Pre-heat time control.
- Post-heat time control.

EXHAUST GASES RECIRCULATION

- Exhaust gases recirculation electrical regulation.
- Control for recirculated exhaust gases cooler.

PRESSURE REGULATION OF OVERBOOST

- Limitation of the overboost pressure and correction depending on the working conditions.

ELECTRONIC MANAGEMENT OF THE FANS

- Activation and regulation of the radiator fans speed.

EOBD

- Systems and components surveillance.

START AND STOP

- Immobiliser system intervention.
- Inlet manifold smooth stop flap control.

INTAKE AIR FLOW

- Inlet manifold spiral swirl flaps movement control

PARTICLES-FILTER

- Filter saturation control.
- Particles filter active regeneration.

SELF-DIAGNOSIS

- Monitoring and diagnosing possible faults.
- Emergency functions.

ENGINE REVS SENSOR G28

The 2.0 l TDi CR uses a Hall type revs sensor, with a generator crown that incorporates consecutive magnetised zones with alternating magnetic fields. This generator crown is integrated in the crankshaft seal cover of the flywheel side, like the ones of the 2.0 l 16v TDi pump injector engines.

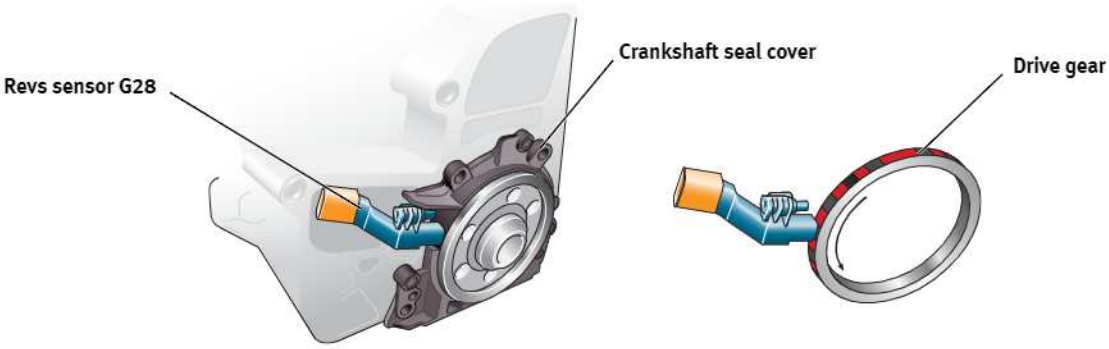
SIGNAL APPLICATION

The sensor signal is used by the engine control unit to know the crankshaft speed of rotation and the exact position of the crankshaft.

REPLACEMENT FUNCTION

If this signal is missing, the engine control unit recognises the crankshaft position with a signal from the camshaft sensor G40. The engine reves are limited to a maximum of between 3,200 and 3,500 rpm.

***Note**: For further information about the G28 sensor replacement function consult Self Study Programme No. 99 "2.0 l 16v TDi engine".*



D123-51

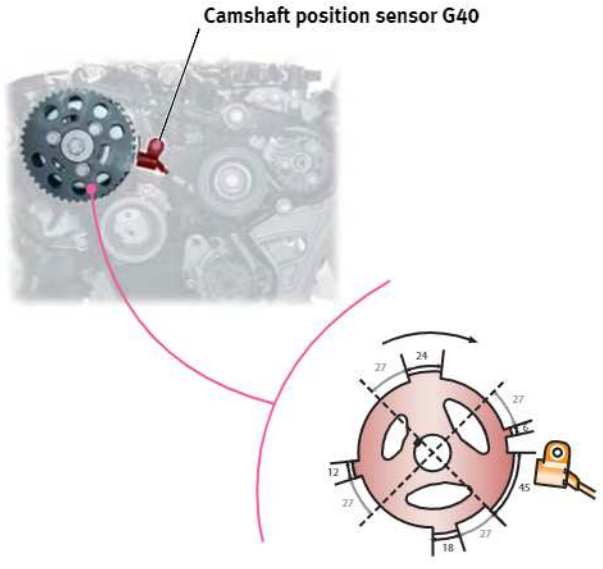
CAMSHAFT POSITION SENSOR G40

The camshaft sensor is a Hall sensor with integrated magnet, placed before the timing cover. It is facing the metal segments generator wheel that rotates as a single assembly with the exhaust camshaft hub.

SIGNAL APPLICATION

With this signal and the signal from the revs sensor G28, the engine control unit is able to know the moment when cylinder 1 is in the compression phase.

Once the engine control unit knows the position of cylinder 1 it is possible to synchronise the fuel injection at the right moment, when starting the engine.



D123-52

REPLACEMENT FUNCTION

If the signal is lacking, the engine takes longer to start because the engine control unit has to determine the position of cylinder 1 with the engine revs sensor signal G28.

INLET AIR TEMPERATURE SENSOR G42

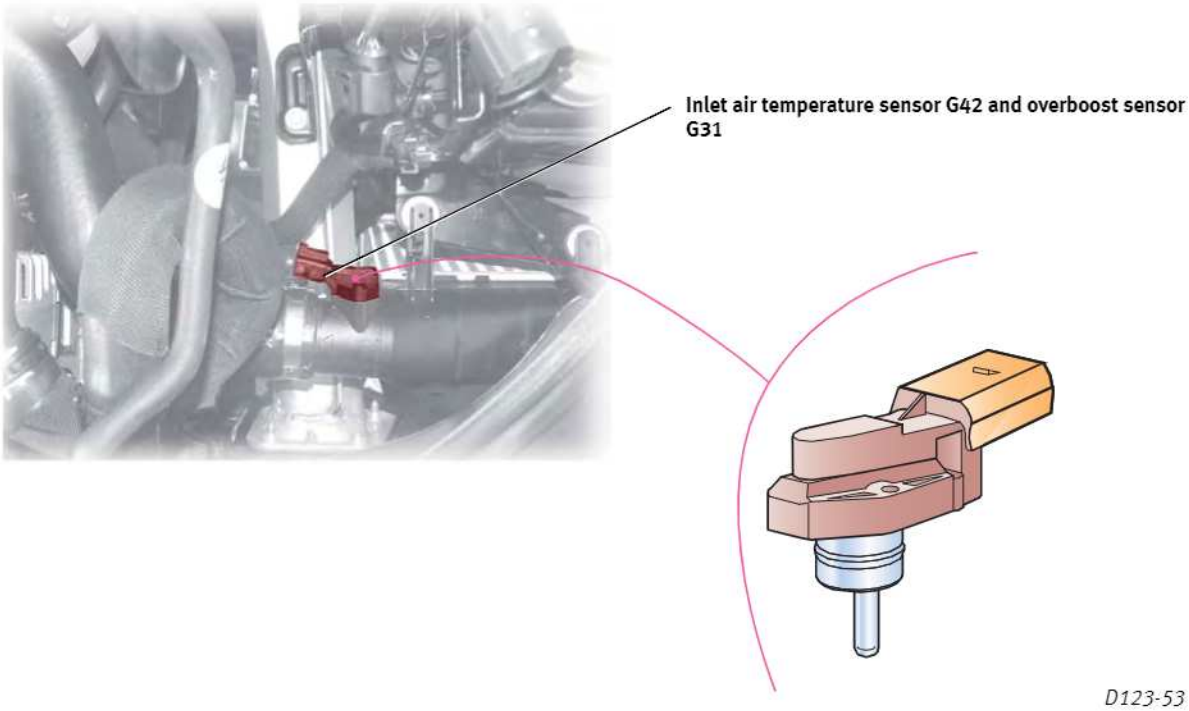
It is an **NTC resistance** placed in the intake passage, behind the intake air heat exchangers.

SIGNAL APPLICATION

With this signal the engine control unit corrects the overboost pressure according to the density of the air sucked in.

REPLACEMENT FUNCTION

If the signal is lacking, the engine control unit varies the overboost pressure based on a fixed temperature value, which can affect the engine performance.



OVERBOOST PRESSURE SENSOR G31

It is placed in the inlet passage, and it is a sensor that varies its signal **depending on the deflection to which a measuring plate is submitted to** by effect of the overboost air pressure.

SIGNAL APPLICATION

With this signal the engine control unit compares the theoretical calculation of the overboost pressure -based on the characteristic curves maps- with the real one measured by the G31 sensor.

REPLACEMENT FUNCTION

If the signal is lacking, the engine control unit reduces the overboost pressure and therefore the engine power is also reduced, as there is no guarantee of the overboost pressure being correctly adjusted.

ACCELERATOR PEDAL POSITION SENSORS G79/G185

In the Exeo it includes **two independent potentiometers** that offer a redundant signal to the engine control unit.

When there is no engine load the revs are limited to 2500 rpm.

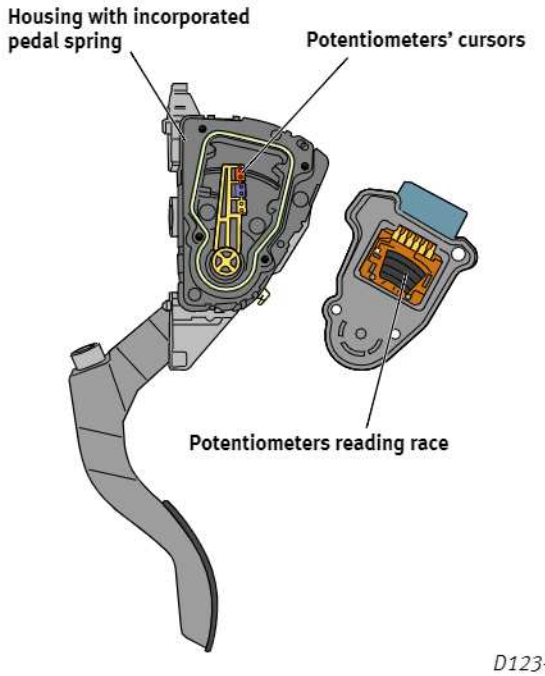
SIGNAL APPLICATION

The sensors inform the engine control unit about the accelerator position along its scale of regulation. This is a basic signal for the engine control unit to calculate the amount of fuel to be injected.

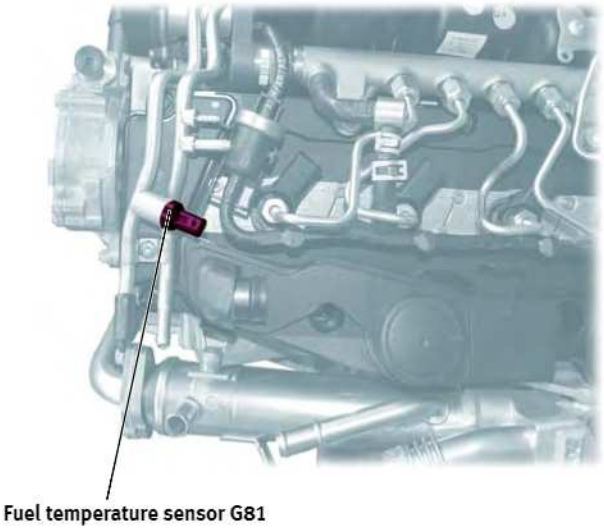
REPLACEMENT FUNCTION

If the signal of one of the two sensors is missing, the engine accelerates slowly after stepping on the accelerator pedal at full load. Revs are limited to 3000 rpm.

If the signal from both sensors is lacking, the engine **remains idling** and does not react to accelerator pedal activation.



D123-54



D123-55

FUEL TEMPERATURE SENSOR G81

If it is an NTC accelerator resistance placed on the engine, **interspaced in the fuel tube going from the filter to the high pressure pump**.

SIGNAL APPLICATION

It informs the engine control unit about the fuel temperature. The engine control unit uses this data to correct the injection flow.

REPLACEMENT FUNCTION

If the fuel temperature signal is missing, the engine control unit takes a **replacement value -by considering the coolant temperature**- from the G62 sensor information.

COOLANT TEMPERATURE SENSOR G62

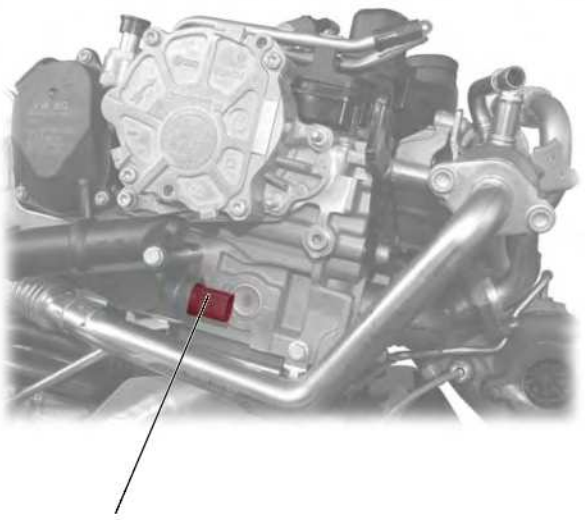
It is an NTC resistance placed in the coolant output plastic tube of the cylinder head.

SIGNAL APPLICATION

The coolant temperature is a **basic signal for the engine control unit**, as the correct calculation of the injection flow, the injection advance, the recirculated exhaust gases flow or the overboost air pressure depend on it

REPLACEMENT FUNCTION

If the signal is missing, the engine control unit uses as a replacement value a characteristic curves map with the intake air temperature sensor G42 and the fuel temperature sensor G81 functions.



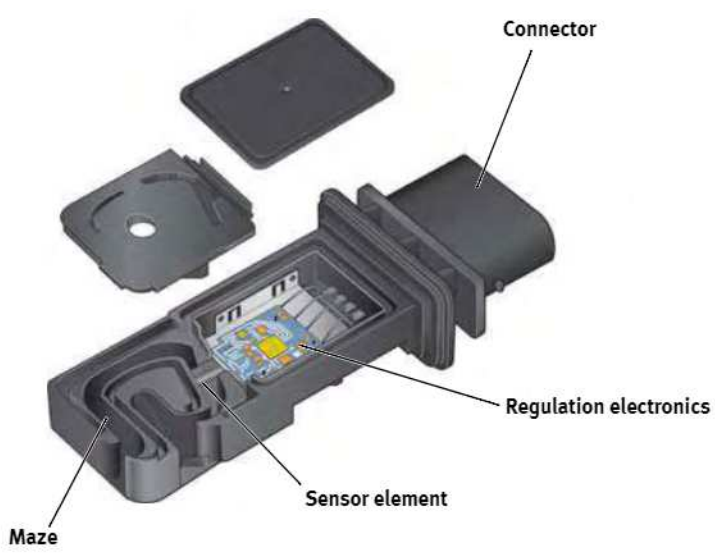
D123-56

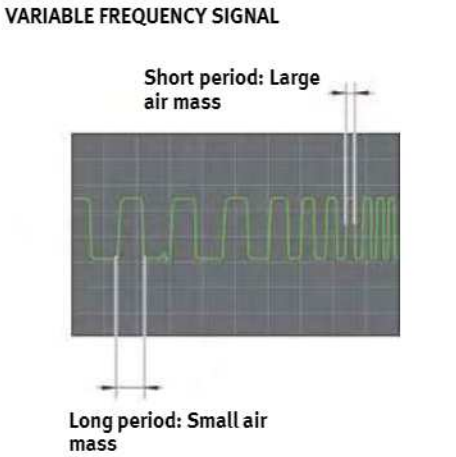
AIR MASS METER G70

It is the latest generation **hot film** air mass meter. It incorporaes a maze for the air intake that prevents dirt from building up on the sensor, which as a result extends the air mass meter's durability.

The signal generated by the regulation electronics is a variable frequency square signal, which can be easily decoded by the engine control unit.

The higher the frequency, the higher the amount of air sucked in.





D123-57

OPERATION

Part of the air flowing through the air mass meter tube enters the passenger compartment and strikes on the sensor.

The sensor is made of **two measuring resistances R1 and R2** and by a **heating resistance** interspaced between both.

The temperature from the measuring resistances R1 and R2 depends from the air flowing around the sensor and which drags heat from the heating resistance. The higher the air flow, the greater the temperature difference between R1 and R2.

Such a layout of the measuring resistances also allows for **quantifying the reflux** opposite to the entry flow as a result of the air bouncing off the intake valves when they are closed.

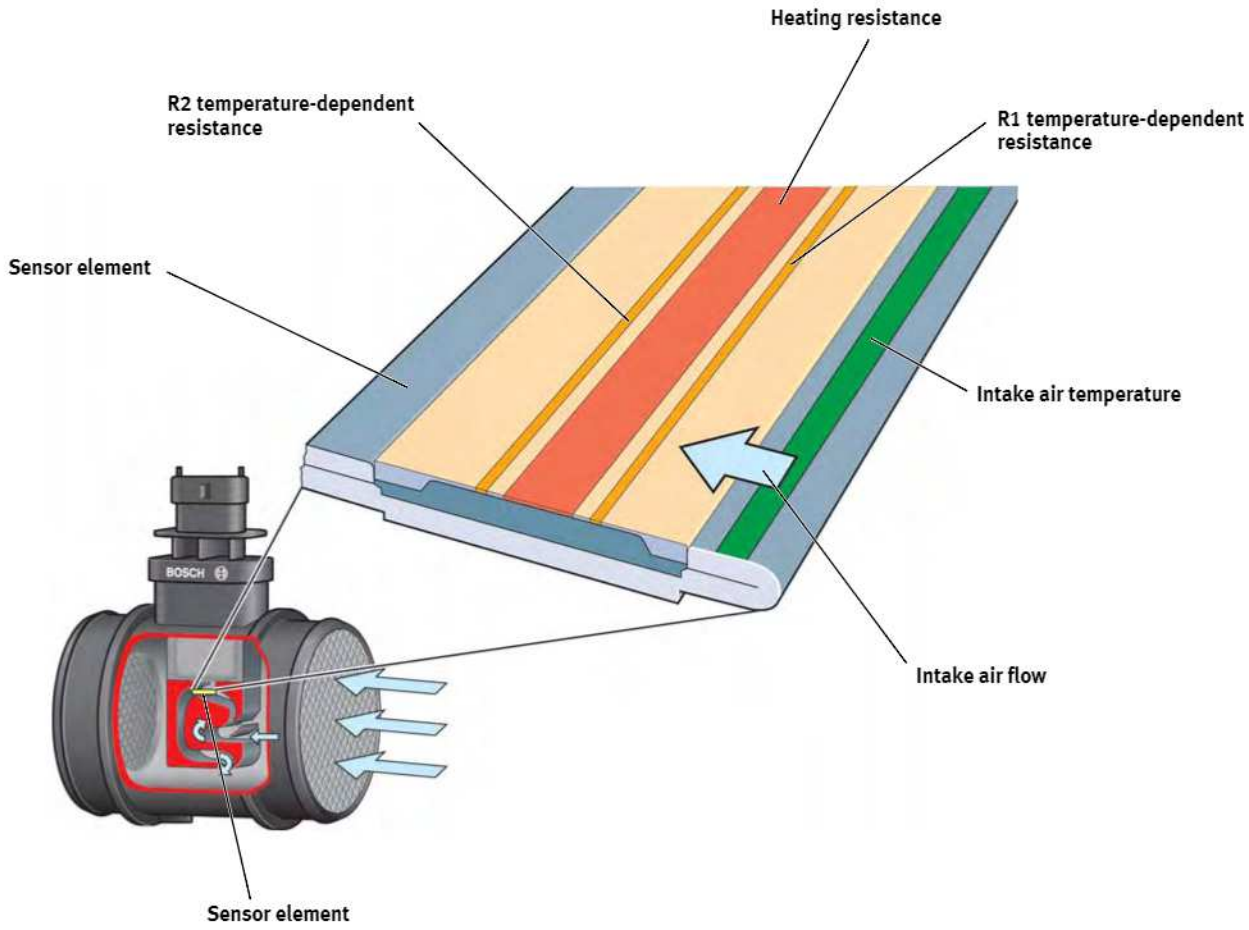
The sensor also incorporates an NTC resistance that measures the intake air temperature just after the filter.

SIGNAL APPLICATION

The engine control unit adjusts the flow to be injected and the amount of exhaust gases recirculated in the engine.

REPLACEMENT FUNCTION

If the signal is missing, the engine control unit uses a replacement value from a characteristic curves map according to the overboost pressure and the engine revs.



D123-58

OPERATION PRINCIPLE OF THE HALL SENSORS AS POSTION READERS

So far, Hall sensors were mainly used as revs sensors.

However they are increasingly being used to determine the lineal displacement or the rotation angle of a shaft.

For this type of readings, Hall sensors replace potentiometers because Hall sensors do not have any physiscal contact with the shaft. Which means that the **probability of faults due to accumulation of dirt, wear or oxidation is reduced**.

LINEAL MOVEMENT HALL SENSOR

A permanent magnet is attached to the shaft the displacement of which needs to be controlled.

A Hall sensor is fitted opposing the shaft

When the shaft moves, the intensity of the magnetic field affecting the sensor varies depending on the proximity of the magnet. The closer the magnetic field from the Hall sensor, the higher the signal voltage.

A regulation electronics integrated in the sensor modulates the signal, so that it is easy to interpret by the control unit.

In the 2.0l TDi CR engine, this type of Hall sensors are used in the **turbocharger vanes position sensor G581**.

STEERING ANGLE SENSOR

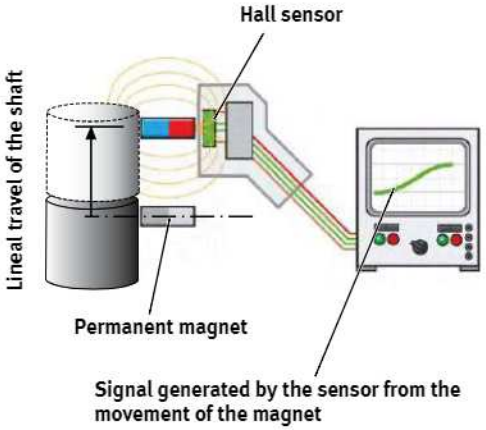
The angle of rotation can be determined by means of a 'permanent magnet attached to the shaft and **two Hall sensors perpendicular to each other** and opposing the magnet's magnetic field.

When the shaft rotates a certain degrees arch, the magnetic field variation generates a Hall voltage in each sensor.

The signals that generate these voltages have an opposing slope to each other, because both sensors are turned 90 degrees with respect to each other.

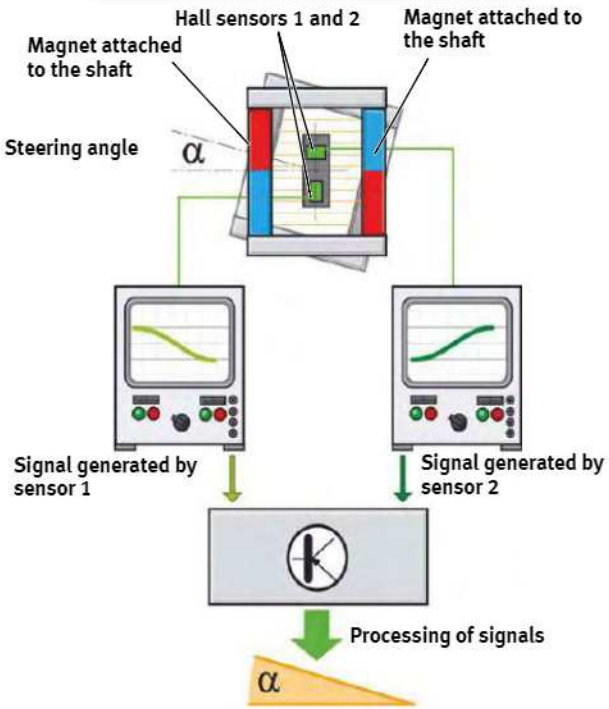
In the 2.0l TDi CR engine, this type of Hall sensors are used in the exhaust gases recirculation valve angle sensor G212.

LINEAL MOVEMENT SENSOR



D123-59

STEERING ANGLE SENSOR



D123-60

EXHAUST GASES RECIRCULATION VALVE ANGLE SENSOR G212

It is a **Hall sensor** integrated in the cover of the exhaust gases recirculation valve N18.

Depending on the opening of the plate valve, the engine control unit allows a greater or smaller amount of recirculated gases flow to the inlet manifold.

OPERATION

The Hall sensor picks up the rotation of the magnet permanently attached to the toothed section shaft that drives the plate valve.

As it is attached to the shaft there is a relation between the position of the permanent magnet and the degree of opening of the valve N18.

Recirculation valve N18 and angle sensor for the exhaust gases recirculation valve G212

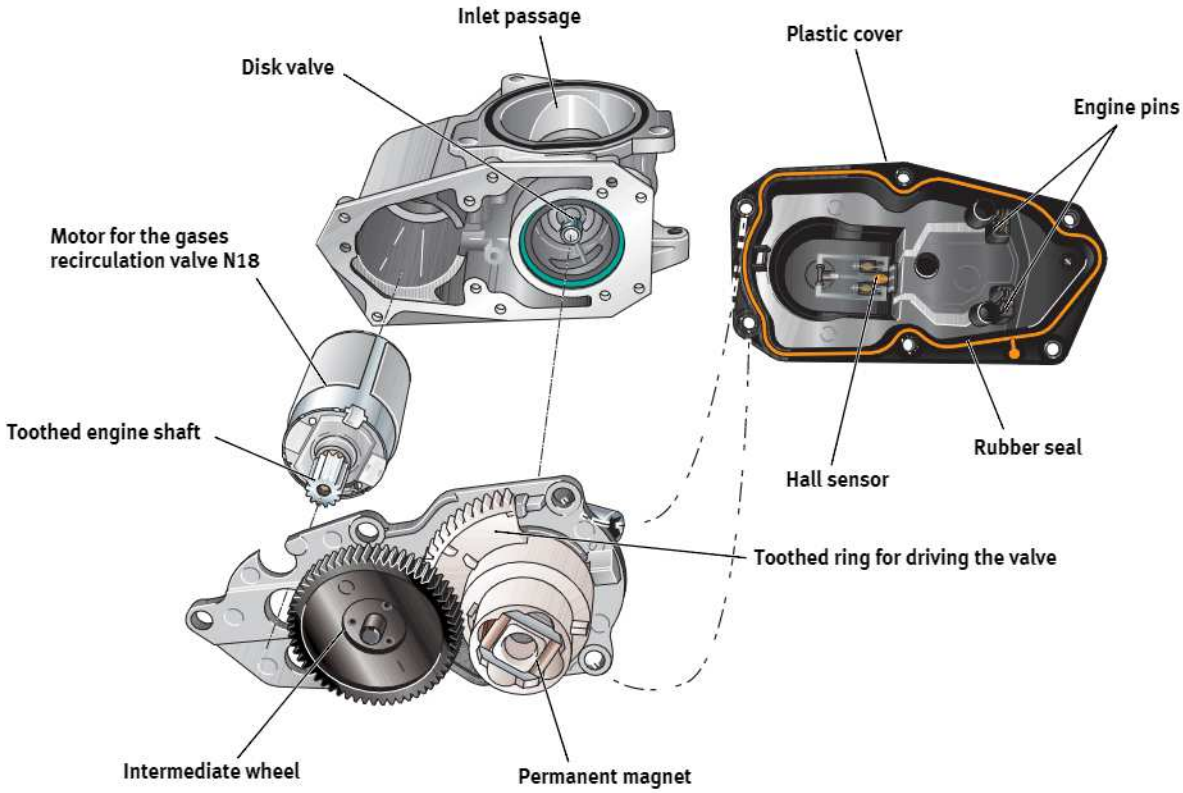
D123-61

SIGNAL APPLICATION

Thanks to this signal the engine control unit can adjust the exhaust gases flow recirculated at any given moment.

REPLACEMENT FUNCTION

If the signal is missing, the exhaust gases recirculation is interrupted so the plate valve remains completely closed.



D123-62

FUEL PRESSURE SENSOR G247

It is screwed **to the end of the pressure accumulator tube**.

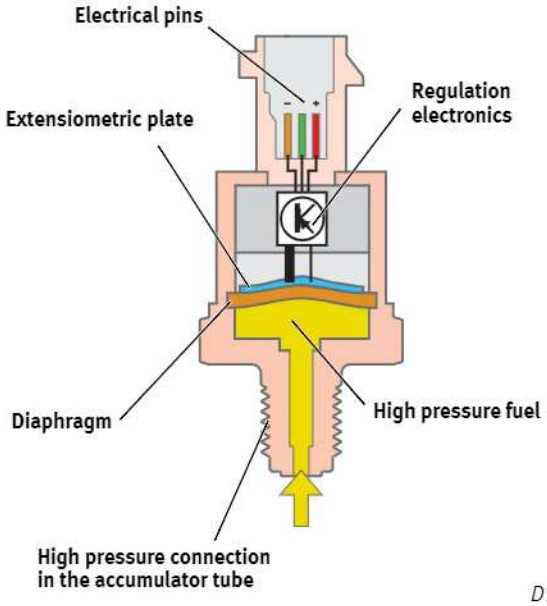
OPERATION

The fuel high pressure sensor is made of a steel diaphragm on which the pressure of the fuel inside the high pressure accumulator strikes.

On the steel diaphragm there is an **extensiometric plate** that modifies is electrical resistance when deforming.

Depending on the value of the pressure striking on the diaphragm, the extensiometric plate will deform to a greater or lesser extent and modify proportionally with its electrical resistance.

The regulation electronics generates an output signal to the engine control unit depending on the existing fuel pressure.



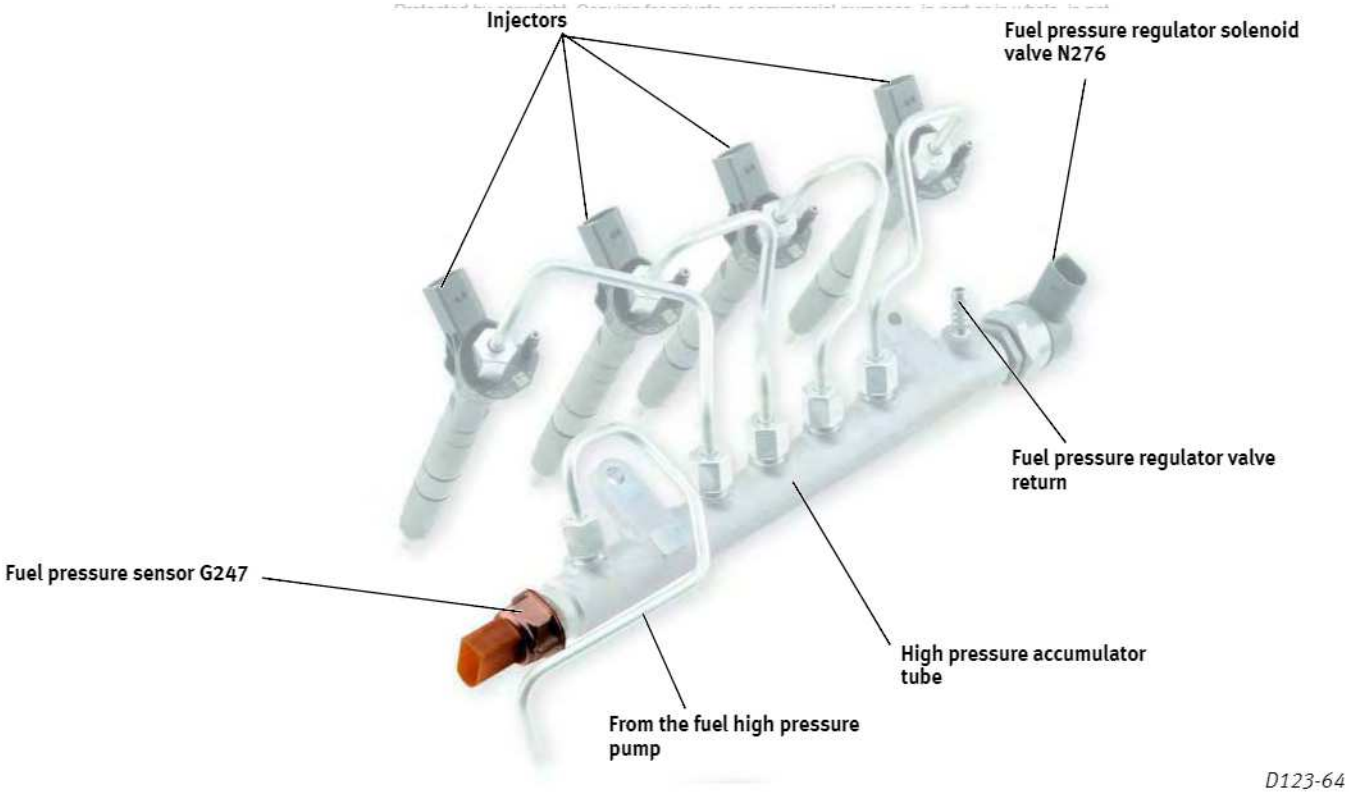
D123-63

SIGNAL APPLICATION

This signal is basic for the engine control unit to adjust the high pressure.

REPLACEMENT FUNCTION

Should this signal be missing, the engine control unit takes a fixed replacement value for the fuel pressure and reduces the engine power.



D123-64

TURBOCHARGER TEMPERATURE SENSOR G235

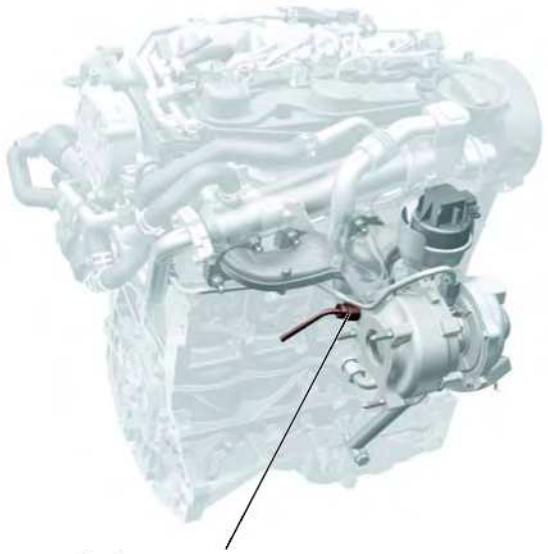
It is a PTC resistance that reads the temperature of the exhaust gases **at the turbocharger entry**.

SIGNAL APPLICATION

With this signal the engine control unit checks that the temperature the exhuast gases reach during the active regeneration of the filter is not excessive;this prevents damage to the turbocharger.

REPLACEMENT FUNCTION

If the signal is missing the engine control unit interrups -for safety reasons- the particles filter regeneration.



Turbocharger temperature sensor G235

D123-65

LAMBDA SENSOR G39

It is a **broad-band probe** that measures the amount of oxygen contained in the exhuast gases with a lambda value of up to 2.5 -a very poor mix- which is a general feature of diesel engines.

OPERATION

It is based on the difference in potential generated at either side of an **electrical charged conductor ceramics plate** from a certain temperature. The ceramics plate is in contact with the exhaust gases on one side, and with the atmosphere on the other side.

Depending on the **oxygen difference** between the inside of the exhaust passage and the atmosphere, the voltage generated between both electrodes will be higher or lower. This is how it is possible to know the existing proportion of oxygen in the exhaust gases.

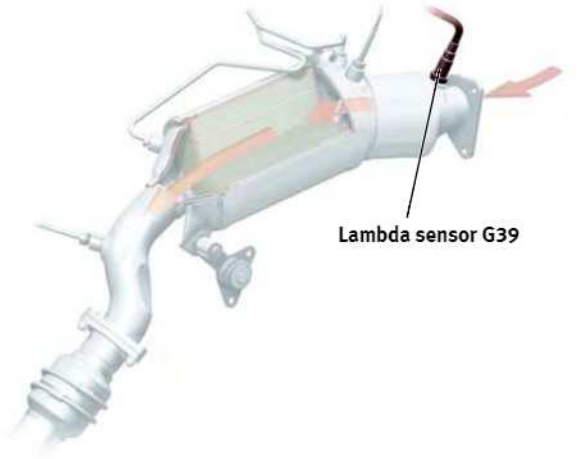
SIGNAL APPLICATION

In diesel engines, the engine control unit uses this signal to correct the amount of recirculated exhaust gases and to confirm that there is enough oxygen in the inlet passage to carry out the active regeneration of the particles filter.

REPLACEMENT FUNCTION

If there is no signal, the engine control unit takes as a reference signal the air mass meter G70 signal to calculate the recirculated exhaust gases amount.

***Note**: For further information about the broad band probe consult Self Study Programme No. 73 "Motronic ME 7.5.10: 1.0 and 1.4l engines".*



Lambda sensor G39

D123-66

PRE-PARTICLES FILTER TEMPERATURE SENSOR G506

It is a PTC resistance that measures the exhuast gases temperature **between the oxidation catalyst and the particles filter**.

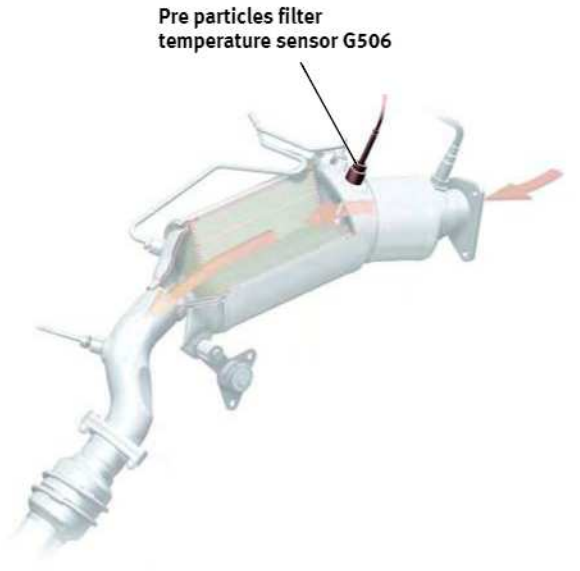
SIGNAL APPLICATION

This signal serves to **protect the catalyst and particles filter** from ecessive temperature and to calculate the optimum amount of fuel during post-injections.

The engine control unit also uses this signal to determine the particles filter degree of saturation.

REPLACEMENT FUNCTION

If the signal is missing, the engine control unit carries out the active regeneration according to the running time or the distance travelled.



D123-67

POST-PARTICLES FILTER TEMPERATURE SENSOR G648

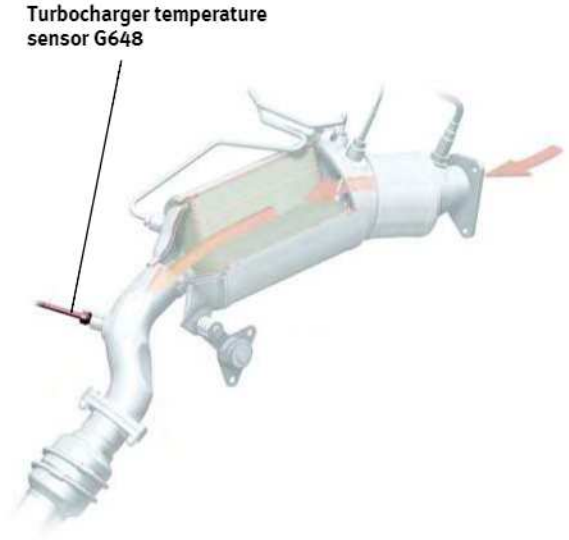
It is a PTC resistance that measures the exhuast gases temperature after travelling through the particles filter.

SIGNAL APPLICATION

With this signal the engine control unit **confirms that the filter regeneration is carried out correctly** and to protect the particles filter from too high a temperature.

REPLACEMENT FUNCTION

If the signal is missing, the engine cointrol unit carries out the active regeneration according to the time the engine has been running or the distance travelled.



D123-68

EXHAUST GASES DIFFERENTIAL PRESSURE SENSOR G450

It is placed in the engine compartment and has **two measuring passages** that reach the exhaust passage.

OPERATION

It is a set of **piezoelectric sensors fitted on a deformable membrane.** The piezoelectric sensors generate a variable voltage according to the deformation they are submitted to.

The pre-particles filter exhaust gases pressure strikes on one side of the membrane, and on the other side the post-particles filter exhuast gases pressure.

Depending on the pressure differenece the membrane will deform to a greater or lesser extent and, therefore, the signal generated by the piezoelectric sensors will be proportional to such pressure difference.

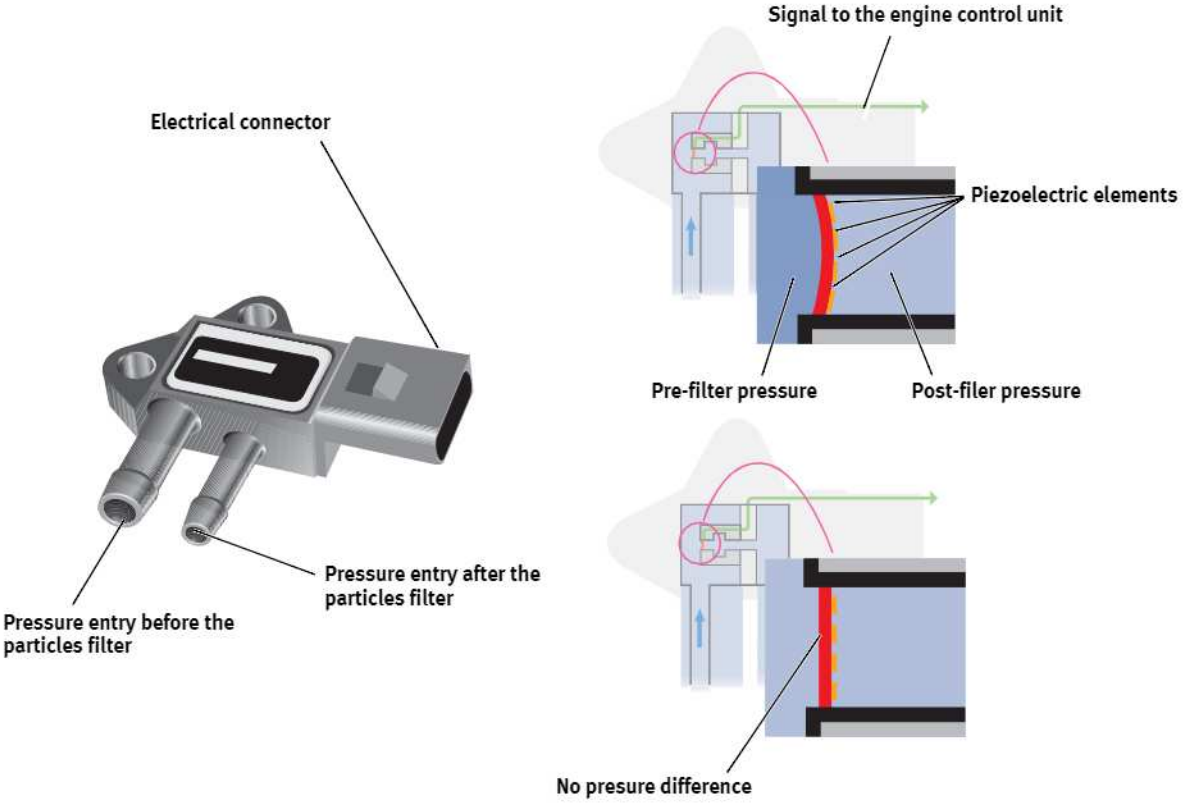
The electronics of the sensor amplifies and modulates the signal sent to the engine control unit.

SIGNAL APPLICATION

The engine control unit calculates the degree of particles filter saturation, together with the pre-particles filter temperature sensor G506, the air mass meter signal G70, and the lambda probe G39.

REPLACEMENT FUNCTION

If the signal is missing, the engine control unit carries out the active regeneration according to the time the engine has been running or the distance travelled.



D123-69

BRAKE PEDAL SWITCHES F/F47

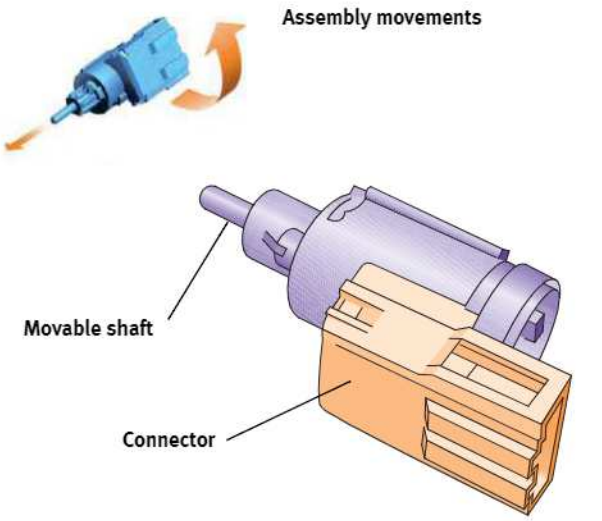
It is a double mechanical switch placed on the brake pedal.

SIGNAL APPLICATION

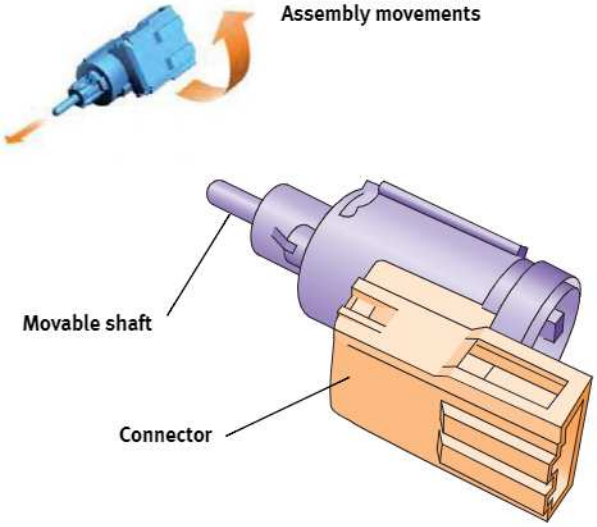
The engine control unit **deactivates the cruise control** when it detects brake pedal activation.

REPLACEMENT FUNCTION

If the signal is missing the cruise control cannot be activated.



D123-70



D123-71

CLUTCH PEDAL POSITION SENSOR F36

It is a mechanical switch placed on the clutch pedal.

SIGNAL APPLICATION

With the activated clutch pedal signal the engine control unit deactivates the cruise control and **reduces the injected amount momentarily** to prevent engine jerking when shifting gears.

REPLACEMENT FUNCTION

If the activated clutch pedal signal is missing, the engine control unit cannot activate the cruise control nor the jerking reduction function.

TURBOCHARGER VANES POSITION SENSOR G581

It is placed on the turbocharger vacuum actuator and detects the displacement of the shaft that moves the turbocharger vanes.

D123-72

OPERATION

It is a Halll sensor that reads the longitudinal movement of the magnet attached to the sensor's movable shaft.

When the engine control unit activates the overboost pressure regulation valve the position of the turbocharger vacuum actuator membrane is modified.

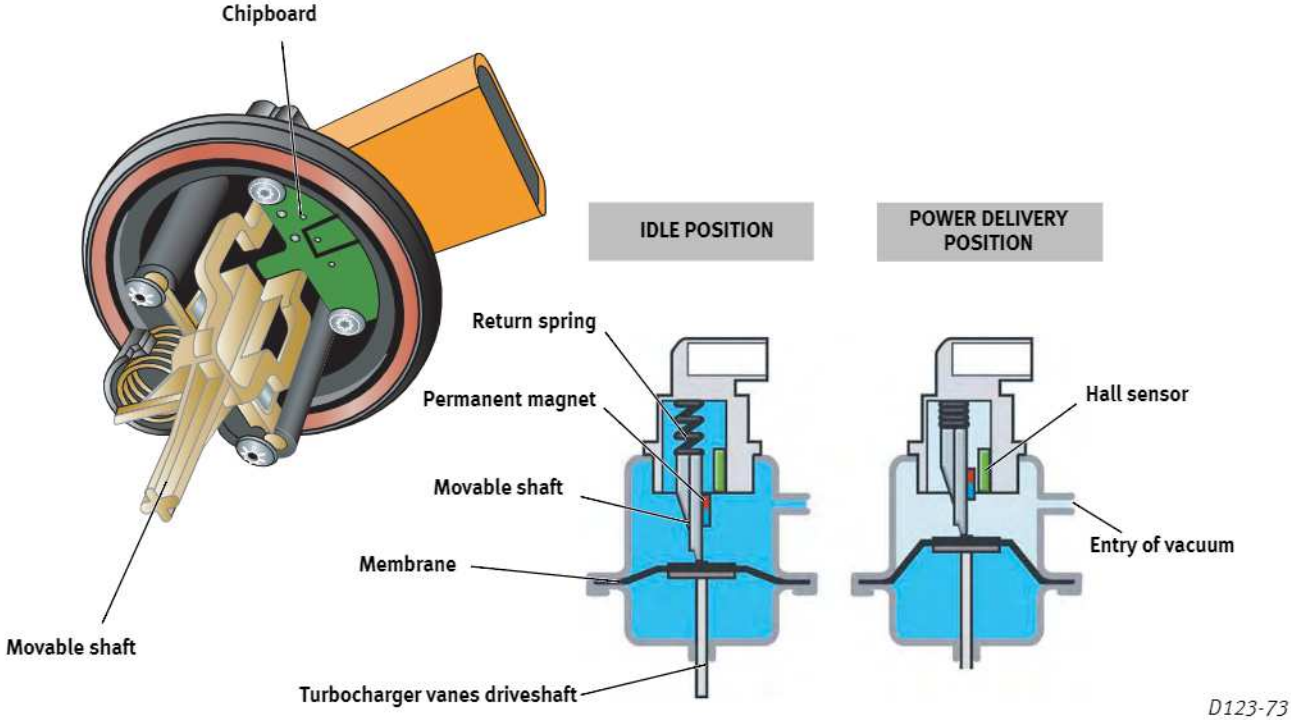
There is a direct relation betwen the position of the membrane and the overboost pressure generated by the turbocharger.

SIGNAL APPLICATION

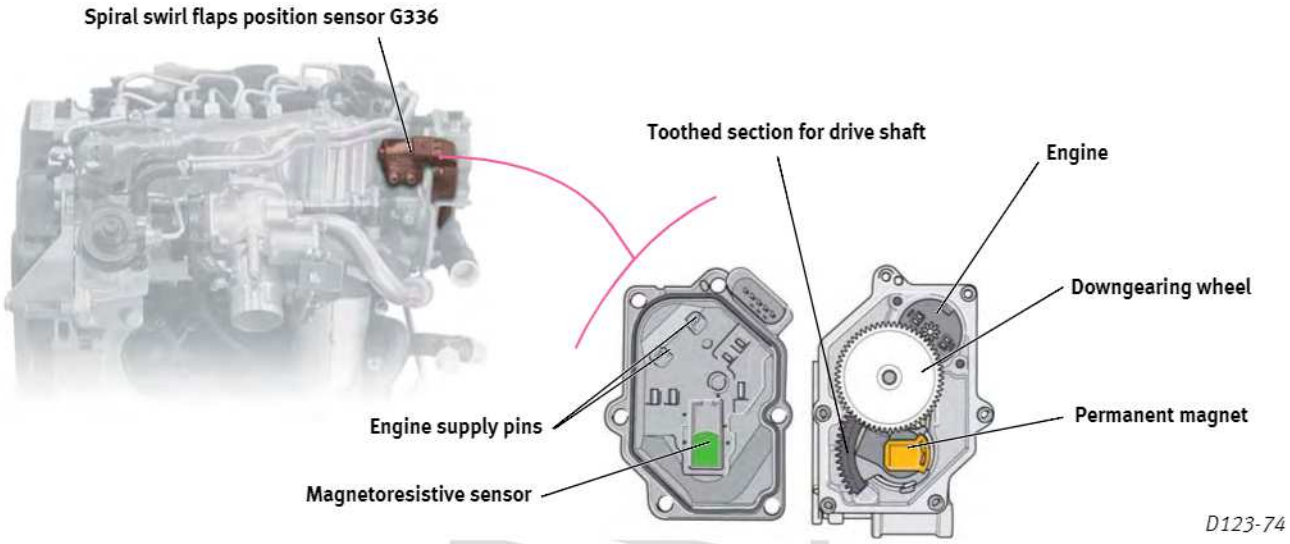
With this signal and the real overboost pressure signal provided by the G31 sensor, the engine control unit is able to establish the turbocharger performance.

REPLACEMENT FUNCTION

If the signal from the sensor G581 is missing, the overboost pressure regulation is cut off. The turbocharger vanes remain in a fixed position and, therefore, the engine power is limited.



D123-73



D123-74

SPIRAL SWIRL FLAPS POSITION SENSOR G336:

It is housed in the engine cover for activating the spiral swirl flaps.

OPERATION

It is a sensor without pins, based on the **electrical resistance variation of a magnetoresistive element**. The sensor is opposing the magnetic field of a magnet attached to the drive shaft for the spiral swirl flaps.

SIGNAL APPLICATION

The engine control unit checks that the position of the spiral swirl flaps is correct.

REPLACEMENT FUNCTION

If the signal from this sensor is missing, the engine control unit holds the swirl flaps in fully open position.

D123-75

INLET MANIFOLD 'SMOOTH STOP 'FLAP POSITION SENSOR G69

It is a magneto-resistive sensor that replaces the traditional potentiometer.

SIGNAL APPLICATION

The engine control unit checks the position of the flap. The opening dregree of the flap affects the **exhaust gases recirculation**, and the **active regeneration of the particles filter**.

REPLACEMENT FUNCTION

If the signal is missing there is neither active regeneration of the particles filter nor exhuast gases recirculation.

FUEL DOSER VALVE N290

It **is placed in the fuel high pressure pump** and includes an electromagnetic coil, a variable section control piston and a spring.

The doser valve regulates -depending on the engine's working conditions- the amont of fuel introduced into the high pressure pump compression chamber.

The doser valve objectives are:

- To reduce the power the high pressure pump is removing from the engine.
- To prevent the fuel from heating up innecessarily.

The energising signal is a variable duty cycle (PWM) signal, which as well as modifying the valve travel also modifies the position of the central piston.

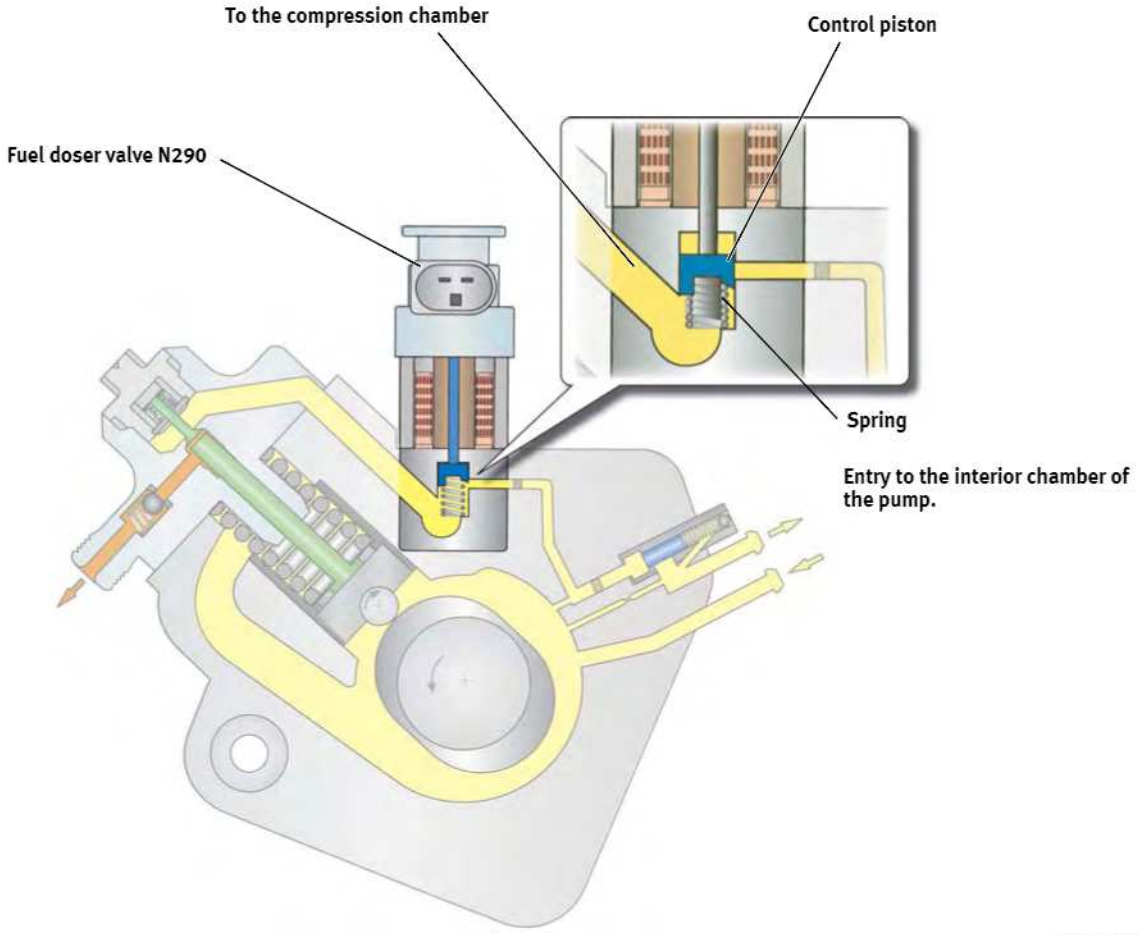
The doser valve remains open as long as it is not energised by the engine control unit.

IN THE EVENT OF A FAULT

If the energising voltage is missing, the doser valve will remain permanently open. If the engine control unit detects this fault it reduces torque delivery.

OPERATION

The engine control unit energises the fuel doser valve N290 to reduce the fuel flow to the compression chamber.



D123-76

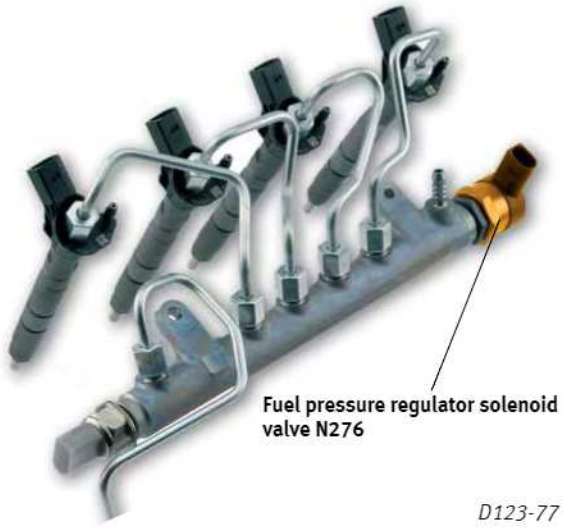
FUEL PRESSURE REGULATOR SOLENOID VALVE N276

It is placed **at one end of the high pressure fuel accumulator**.

It is in charge of modulating the presure inside the common rail.

It is an electromagnetic type of valve and includes:

- An electrical part including the connector and the electromagnetic coil.
- An hydraulic part, with the fuel flow passages to the pressure accumulator or to the fuel return.



D123-77

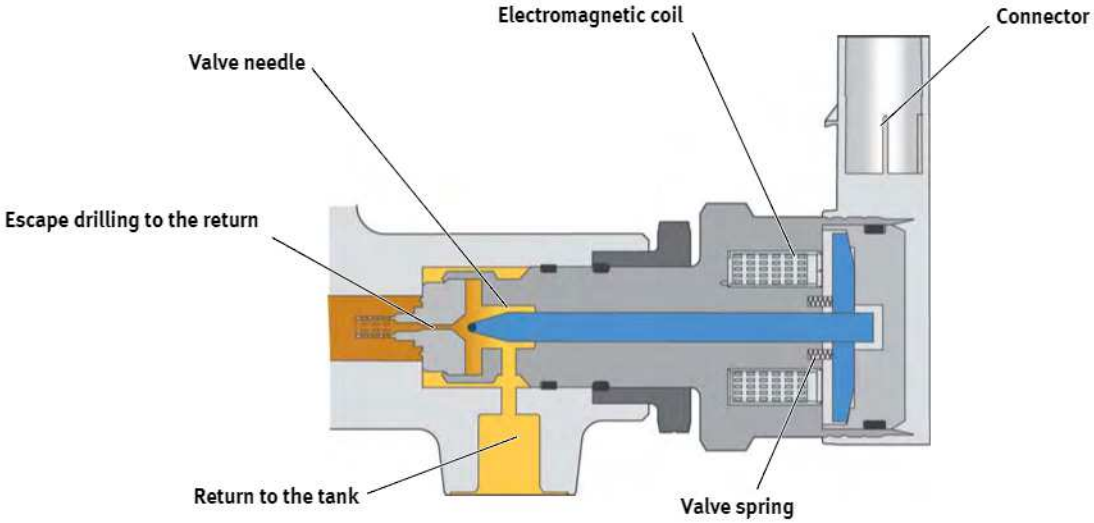
OPERATION

When at rest the valve remains wide open.

To maintain the pressure in the accumulator passage, the engine control unit energises the electromagnetic coil with a **variable duty cycle signal**.

The valve needle closes the fuel release drilling to the return.

The small bore of the release drilling allows the needle overcome the high fuel pressure.



D123-78

INJECTORS

They are in charge of introducing the high pressure fuel into the cylinder and of carrying out each of the injection phases. **They include two parts**: the piezoelectric actuator and the coupling module.

PIEZOELECTRIC ACTUATOR

It is placed on the upper part of the injector housing and is made up of a set of 260 piezoelectric elements.

Its operation is based on the **inverse piezoelectric effect**, that is to say, they are ceramics that expand when electrical voltage is applied to them. This is how the necessary travel, of about 0.03 mm, is achieved for the injector operation.

The piezoelectric actuator is energised by the engine control unit with a voltage of between 110 and 148 V.

This type of actuator is already being fitted in the 2.0l TDi and 125 kW engine pump injectors.

***Note**: For further information about the inverse piezoelectric effect consult Self Study Programme No.107 "Piezoelectric pump injector".*

COUPLING MODULE

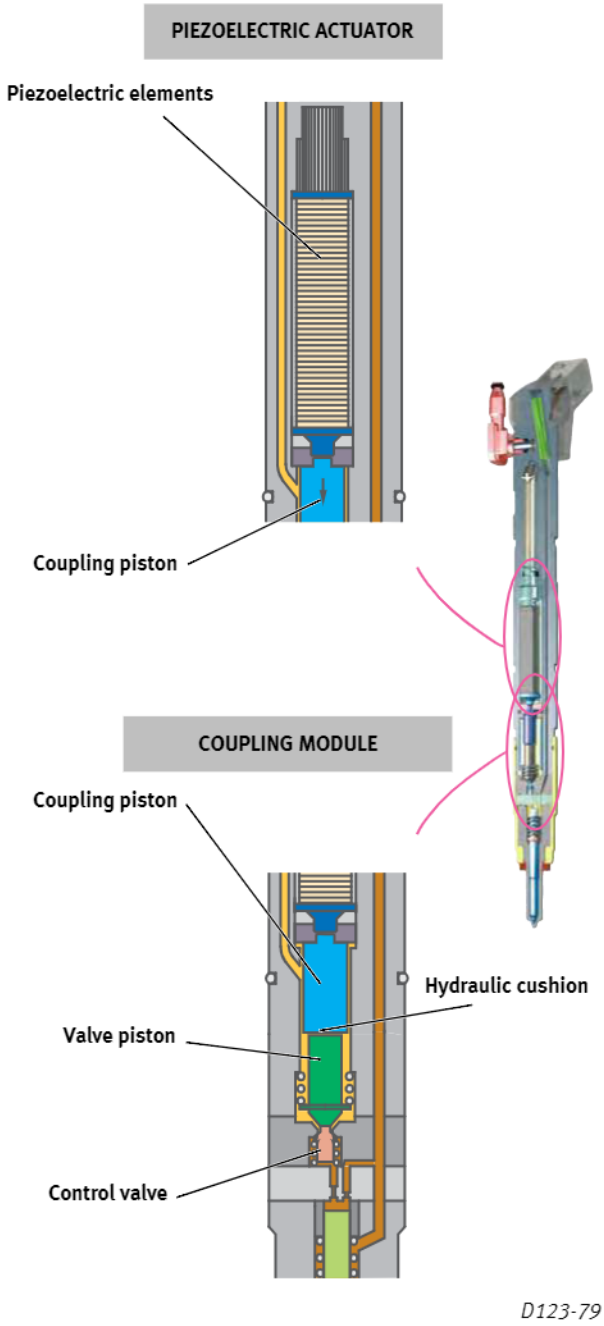
The coupling module is an **hydraulic converter** that transforms the length variation of the piezoelectric actuator into hydraulic pressure and travel.

It is made of a set of different diameter pistons with the purpose of multiplying the force of each of the pistons by pressing against the next one, so that the **control valve** can overcome the existing pressure in the high pressure accumulator.

It is made up by the **coupling piston and the valve piston**, both of different diameters.

Also, as has already been explained in the fuel circuit section, the **pressure retention valve** placed in the return circuit of the injectors maintains a constant 10 bar pressure.

This is the pressure affecting the coupling module. The fuel at 10 bar pressure generates an **hydraulic cushion** between the coupling piston and the valve piston.



The hydraulic cushion is used to transmit the force between both pistons. This system implies the following advantages:

- It reduces the friction forces.
- It acts as a dampener between the mobile elements.
- It compensates for any longitudinal variations of components due to temperature

OPERATION PRINCIPLE

When the engine control unit applies voltage the piezoelectric actuator expands.

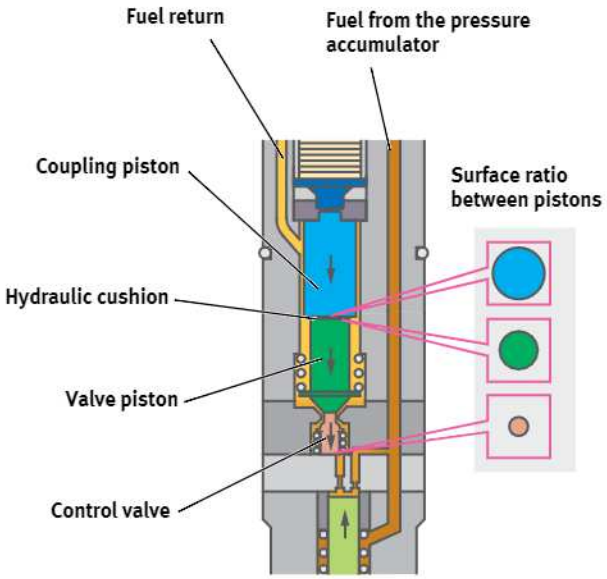
Instant expansion of the actuator strikes on the **coupling piston**.

The coupling piston pushes the **valve piston**, which is of a smaller diameter. There is no mechanical contact between them because of the hydraulic cushion.

The valve piston pushes the **control valve**, which opens the passage for the high pressure fuel to the return.

Because **the pistons have a different diameter** in descending order, the final force made on the control valve is very strong in order to overcome the high pressure of the accumulator tube.

This is the first step generated by the injection of fuel into the cylinder, which is explained in the "injection cycle" section of this current self study programme.



D123-80

OVERBOOST PRESSURE REGULATION VALVE N75

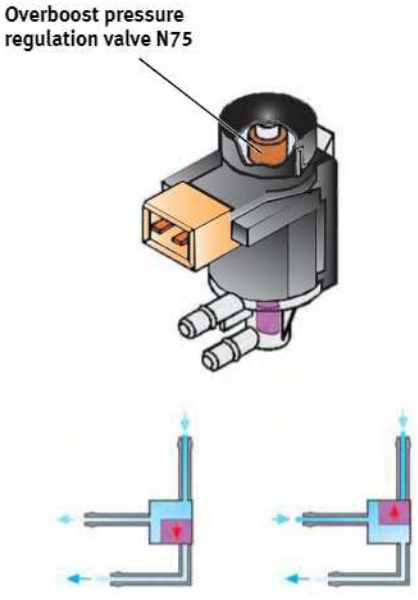
It is a **combined solenoid valve** that regulates the flow of vacuum or atmospheric pressure to the turbocharger pneumatic actuator.

ENERGISING

The engine control unit regulates the overboost pressure by energising the solenoid valve N75 with a variable duty cycle signal as required by the overboost pressure needs.

IN THE EVENT OF A FAULT

The engine power output is reduced because the turbocharger can only work with the vanes in fixed position.



D123-81

MOTOR FOR THE SPIRAL SWIRL FLAPS V157

It is placed on the side of the inlet manifold and cannot be replaced independently from it.

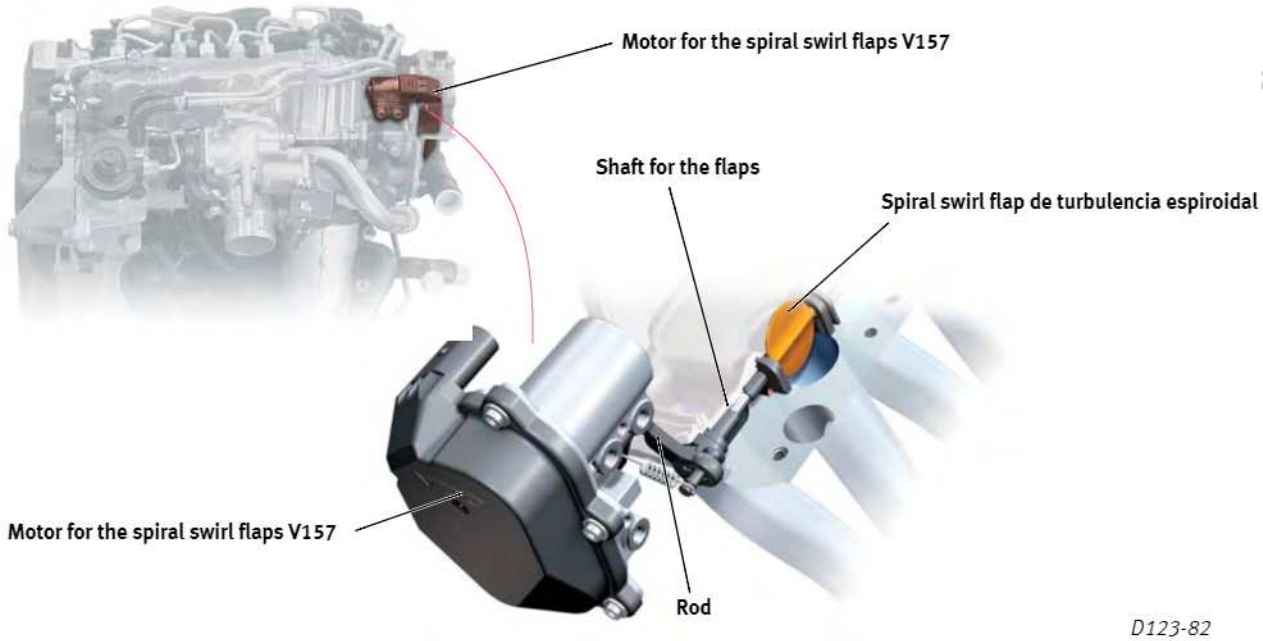
The motor moves a connection rod that allows for a 90o turn of the shaft onto which the manifold flaps are fitted.

ENERGISING

The engine control unit energises the V157 motor with a 5V variable duty cycle signal.

IN THE EVENT OF A FAULT

The flaps **remain wide open** from the action of the spring of the connecting rod drive shaft that opposes the rotation of the motor.



D123-82

MOTOR FOR THE INLET MANIFOLD 'SMOOTH STOP' FLAP J338

It is a motor activated by the engine control unit by means of a 5V variable duty cycle signal.

The motor regulates the degree of opening of the hrottle for the following functions:

- To limit the intake air flow to the cylinders **during the particles filter regeneration**.
- To contribute to the entry of recirculated exhaust gases to the intake passage.
- To close when stopping the engine for the **smooth stop function**.

IN THE EVENT OF A FAULT

Neither the active particles filter regeneration nor the smooth stop are carried out.

D123-83

EXHAUST GASES RECIRCULATION VALVE N18

It is placed just after the inlet manifold butterfly throttle.

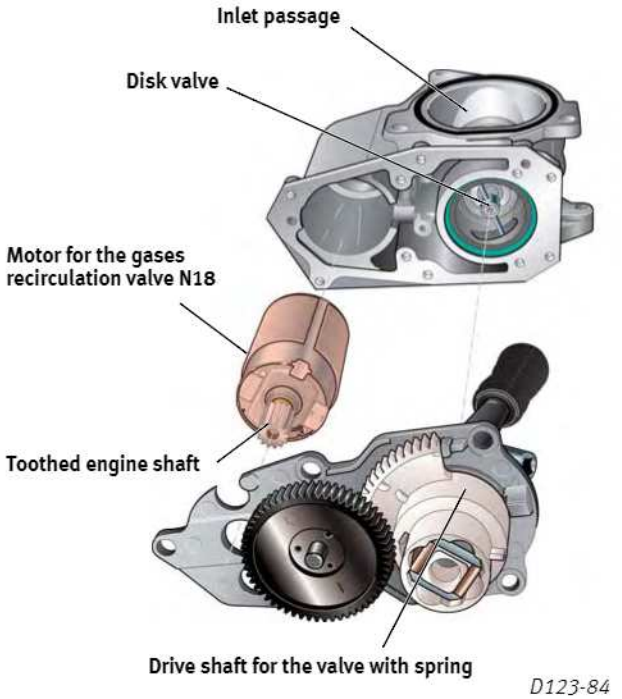
It is made of a motor with a shaft that moves the **plate valve** longitudinally. Depending on the degree of opening of the plate valve, a bigger or smaller amount of exhaust gases will flow through.

ENERGISING

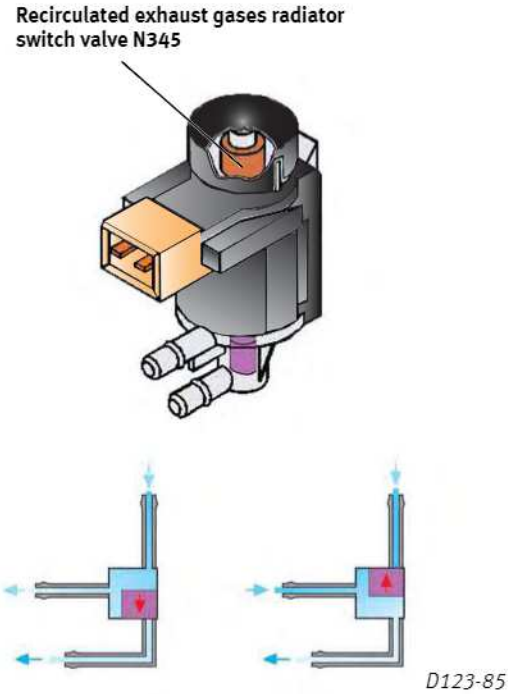
The engine control unit energises the motor with a 5V variable duty cycle signal.

IN THE EVENT OF A FAULT

The spring opposing the rotation of the motor closes the plate valve, meaning that there is no exhaust gases recirculation.



D123-84



D123-85

RECIRCULATED EXHAUST GASES RADIATOR SWITCH VALVE N345

It is a **combined valve** that regulates the flow of vacuum to the vacuum actuator that **moves the by-pass valve** of the recirculated exhaust gases heat exchanger.

ENERGISING

The solenoid valve is controlled by the engine control unit through a 12 V supply voltage.

IN THE EVENT OF A FAULT

The flap opens the passage to the by-pass permanently open, meaning that the exhaust gases being recirculated are not being cooled.

AUXILIARY PUMP FOR THE EXHAUST GASES HEAT EXCHANGER V400

It is a propeller type pump that drives the cold coolant from the main engine radiator to the heat exchanger for the recirculated exhaust gases.

ENERGISING

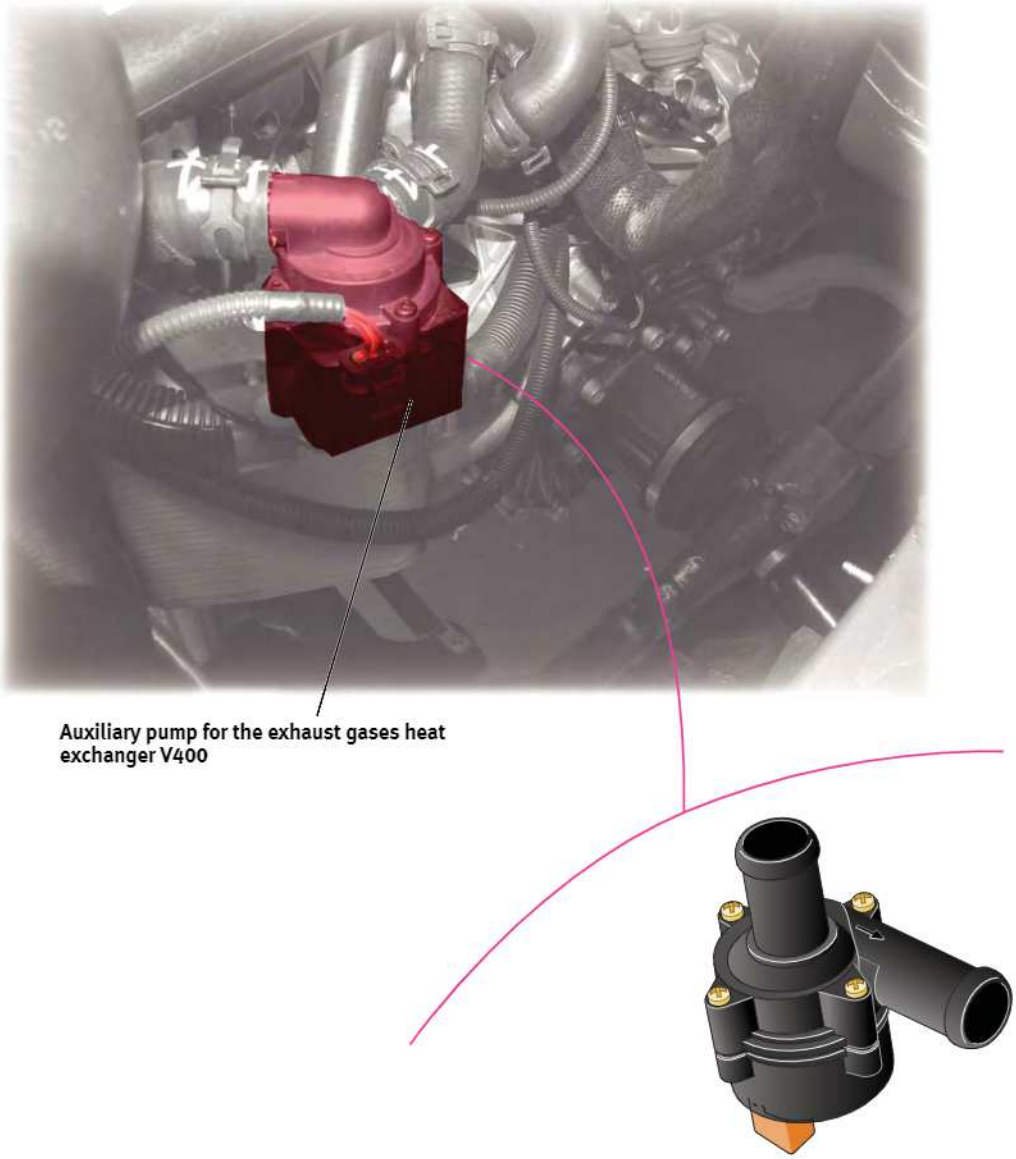
The pump is permanently supplied with terminal 30 voltage and incorporates an internal electronics which is controlled by the engine control unit that **activates the V400 pump after starting the engine**.

The activation signal arrives from the engine control unit to the pump electronics.

This configuration does not make it necessary to use the auxiliary relay for assuming the pump's electrical consumption.

IN THE EVENT OF A FAULT

The recirculated exhaust gases will not be cooled correctly.



Auxiliary pump for the exhaust gases heat exchanger V400

D123-86

HIGH PRESSURE PUMP STRUCTURE

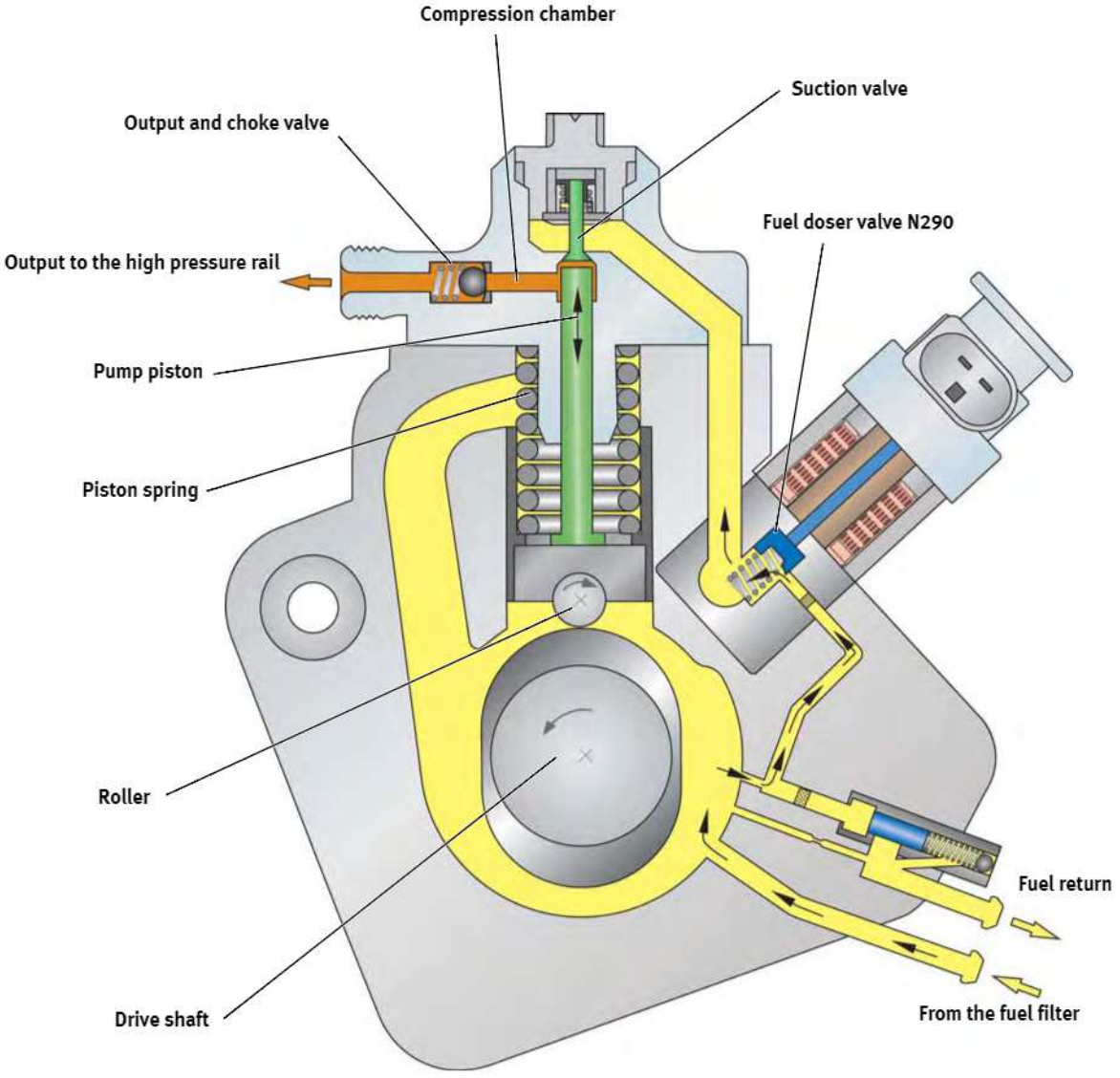
The high pressure pump is the component generating the necessary pressure so that the injection is carried out correctly.

The auxiliary fuel pump permanently provides fuel to the high pressure pump at a 5 bar pressure rate, regardless of the engine's working conditions.

The fuel flows through the **fuel doser valve N290** towards the suction valve and from there to the compensation chamber.

The drive shaft cams transfer alternating upwards and downwards movements to the piston.

In each downwards stroke the piston sucks in fuel to the compression chamber and during the upwards stroke it presses the fuel so that it enters the high pressure rail.



D123-87

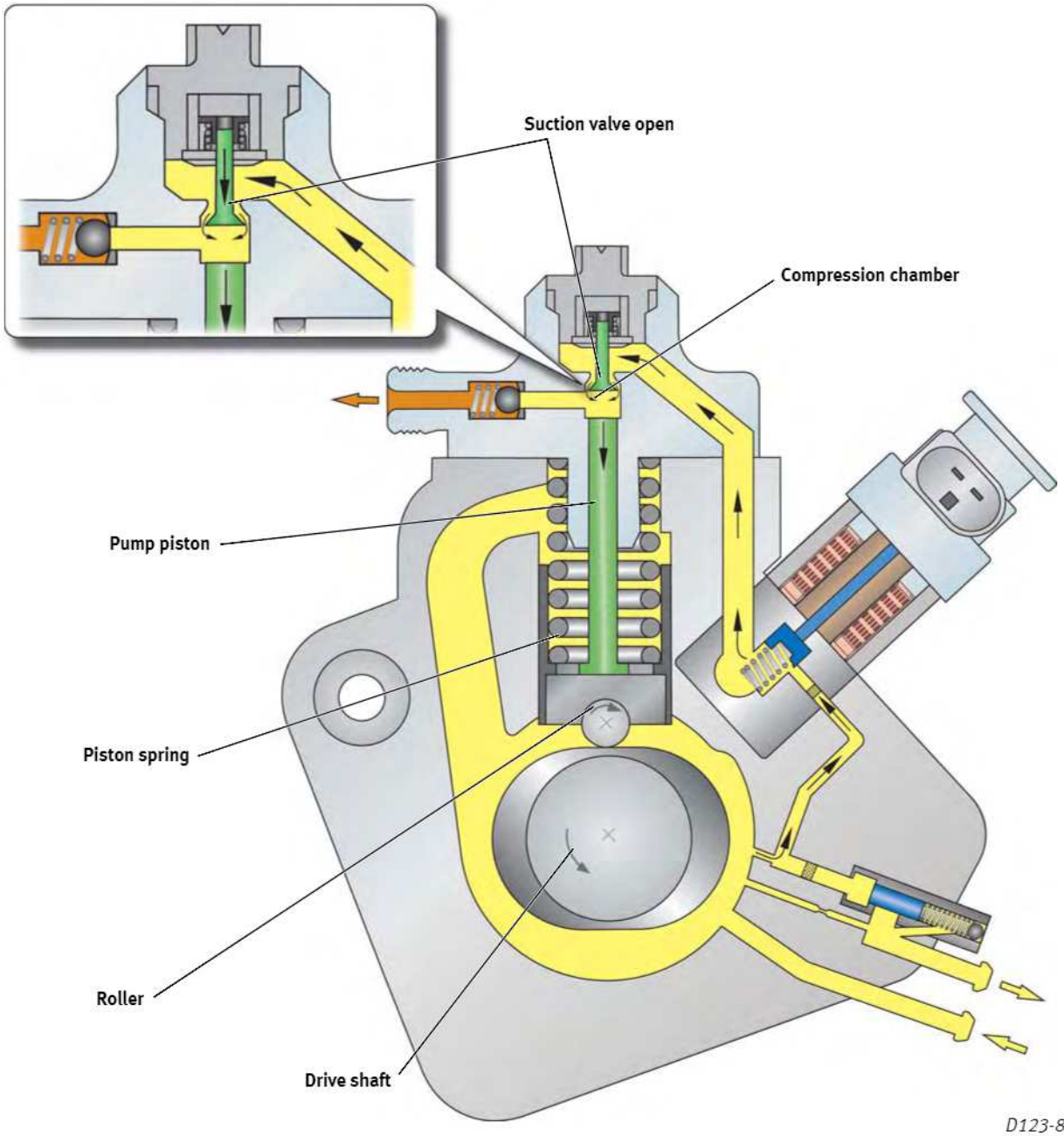
SUCTION STROKE

When the flattest part of the drive shaft strikes the roller, the spring drives the piston downwards.

During this movement a pressure difference is generated between the upper and lower parts of the suction valve.

Thanks to this difference the suction valve opens and allows the fuel to flow to the compression chamber.

It must be taken into account that the flow of fuel arriving at the suction valve is adjusted by the fuel doser valve N290.



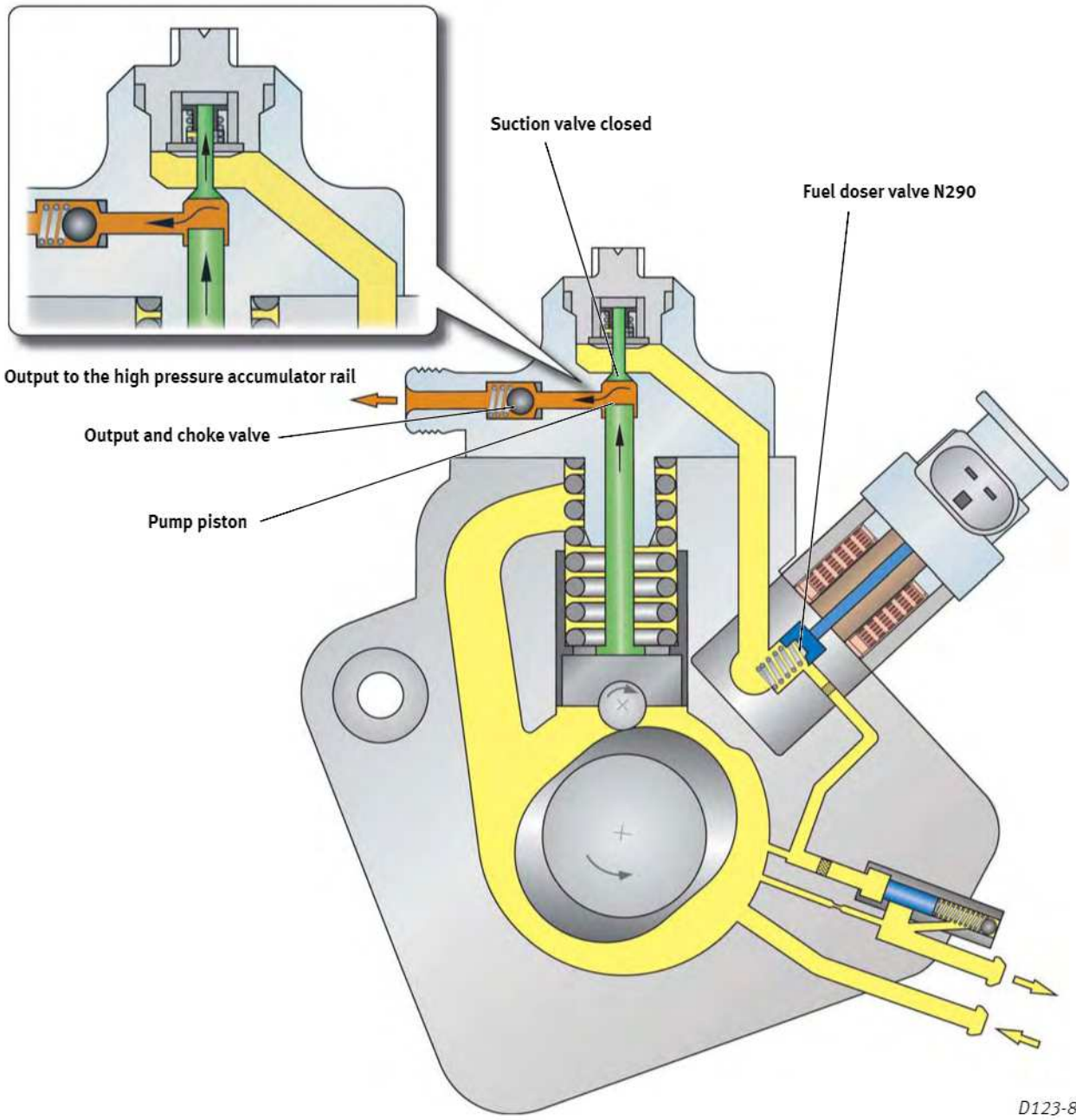
DRIVE STROKE

When the drive shaft strikes the roller with the cam peak the upwards stroke of the piston begins.

The suction valve closes, which is why **the pressure in the compression chamber rises**.

When the pressure in the compression chamber overcomes the accumulator rail pressure, the output and retention valve opens.

The fuel flows to the high pressure accumulator tube until the pressures before and after the output and retention valve are equalised.



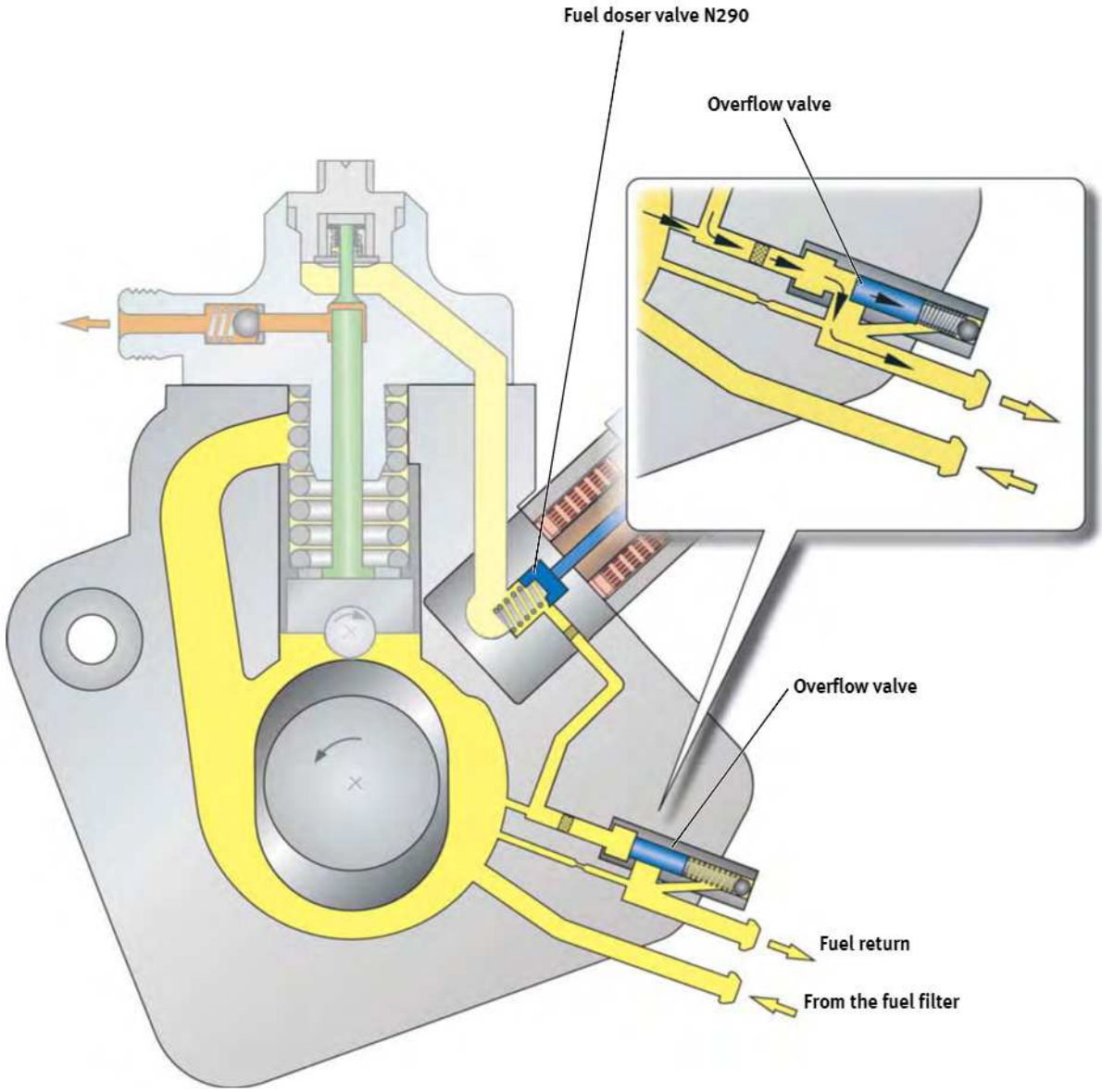
LOW PRESSURE ZONE

The fuel reaches the high pressure pump **driven by the auxiliary fuel pump V393** at an approximate rate of 5 bar pressure.

The fuel in the low pressure zone is permanently adjusted at 4.3 bar by the **overflow hydraulic valve**.

This valve is placed in the fuel return circuit and is made of a piston and a rated spring.

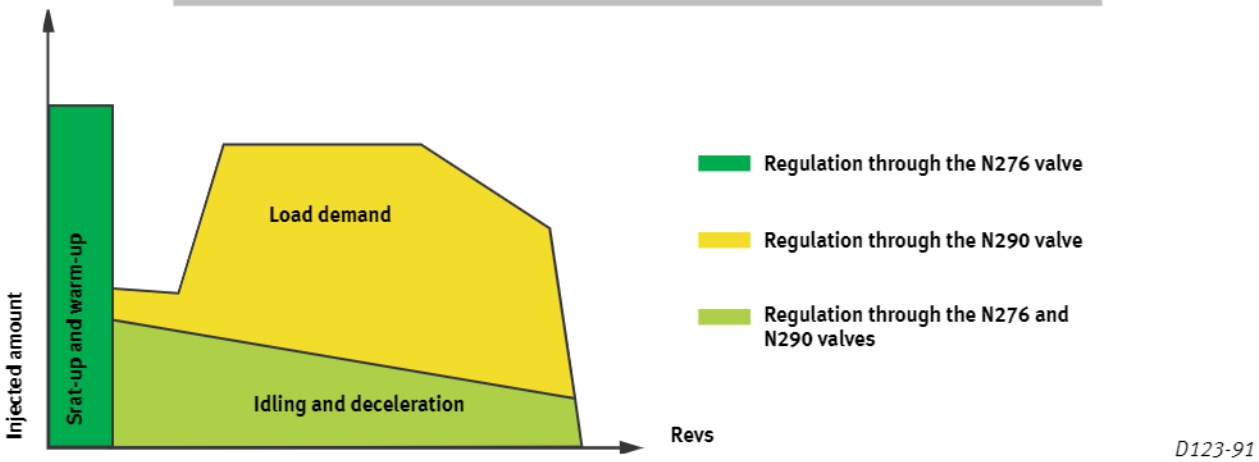
When the fuel pressure is higher than 4.3 bar, the valve opens and allows the fuel to flow to the return passage. This is how a **constant pressure** is guaranteed at the fuel doser valve N290 intake.



D123-90

FUEL PRESSURE REGULATION

FUEL PRESSURE REGULATION WITH VALVE N276 AND VALVE N290



D123-91

REGULATION PRINCIPLE

The 2.0 l TDi engine "Common Rail" injection system uses two regulator valves to control the fuel injection pressure:

- The fuel pressure regulator valve N276, placed at the fuel accumulator.
- The fuel doser valve N290, placed at the high pressure pump.

To regulate the injection pressure, the engine control unit activates one or the two valves as required by the engine operation conditions.

It is possible to define three phases for the engine's conditions of operation:

- Engine start-up and warming.
- Load demand.
- Idling and deceleration

ENGINE START-UP AND WARMING

The engine control unit activates the fuel pressure regulator valve N276 during the first moments of start-up, while the fuel doser valve N290 remains inactive, and therefore, wide open. This is how the fuel heats up rapidly because the high pressure pump is driving more fuel than needed.

The high pressure fuel return is carried out by the valve N276 placed in the high pressure accumulator.

LOAD DEMAND

In this phase it is necessary to have high pressure and a great flow of fuel to be injected.

The engine control unit holds the accumulator rail fuel pressure regulator valve N276 closed.

The fuel pressure regulation is controlled by the engine control unit with the fuel doser valve N290. This is how unnecessary heating of the fuel is prevented and the energy absorbed by the high pressure pump is adapted to the engine's needs.

IDLING AND DECELERATION

During this phase, the engine control unit regulates the pressure with both **valves, the fuel pressure regulator valve N276 and the fuel doser valve N290.**

That is, the injection pressure is adjusted by regulating:

- The pressure in the pressure accumulator
- The flow of fuel entering the high pressure pump.

With this system precise regulation of the necessary fuel pressure is achieved, thus improving:

- The engine's performance when idling.
- Engine transition to the deceleration phase without jertking.
- Reducing of the polluting emissions

FUEL PRESSURE REGULATION

FUEL PRESSURE REGULATOR VALVE N276 OPERATION

IDLE POSITION

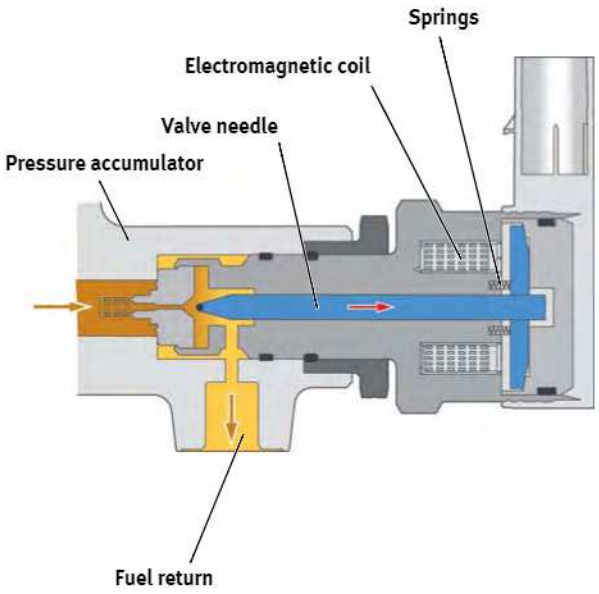
Without voltage supply, the valve remains open from the action of the springs.

In this position, the high pressure passage is connected with the fuel return to the tank.

This is how, when the engine stops, the following is improved:

- Compensation between fuel volumes between the high and low pressure circuits.
- Elimination of bubbles that might originate when the engine is cooling down.

These characteristics improve engine cold start.



D123-92

ENERGISING POSITION

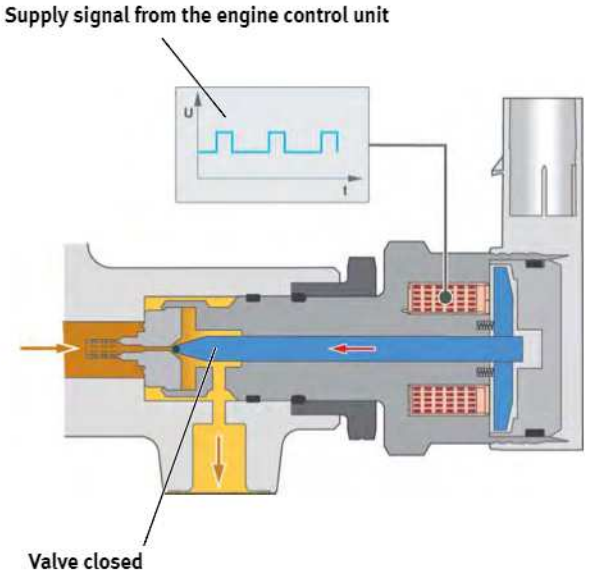
The control unit energises the fuel pressure regulator valve N276 with a variable duty cycle modulated signal.

The pressure is adjusted between 230 and 1,800 bar in the pressure accumulator rail.

During the engine start phase, the engine control unit energises the valve permanently until 120 bar pressure is generated in the acummulator tube.

The flow of fuel to the return is regulated by the **needle valve** depending on the width of the signal's pulse.

This regulation system allows compensating for the pressure fluctuations in the accumulator due to pressure waves generated by the alternating opening of the injectors.



D123-93

IN THE EVENT OF A FAULT

The valve remains open, connecting the accumulator pressure with the fuel return.

The engine does not work because it is not possible to generate the minimum injection pressure in the accumulator.

The engine sops when the pressure in the accumulator is less than 100 bar.

INJECTION CYCLE DEVELOPMENT

The brief response times of the piezoelectric injectors allow controlling in a flexible and accurate way:

- The amounts of fuel injected in each injection phase.
- The number of phases carried out in each cycle.
- The development of each injection phase throughout each cycle.

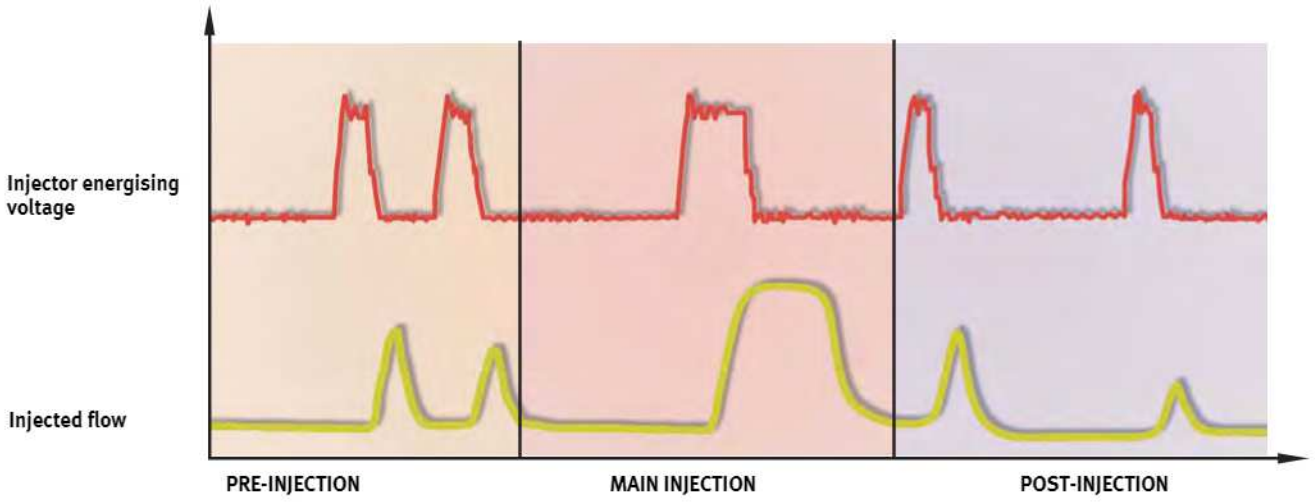
This makes it possible to adapt the injection cycle to the different engine performance conditions.

Every injection phase is divided in up to five phases, depending on the needs:

- **Two pre-injections**
- **One main injection**
- **Two post-injections**

The number of phases per injection cycle basically depens on the engine temperature and the degree of particles filter saturation.

INJECTION CYCLE



D123-94

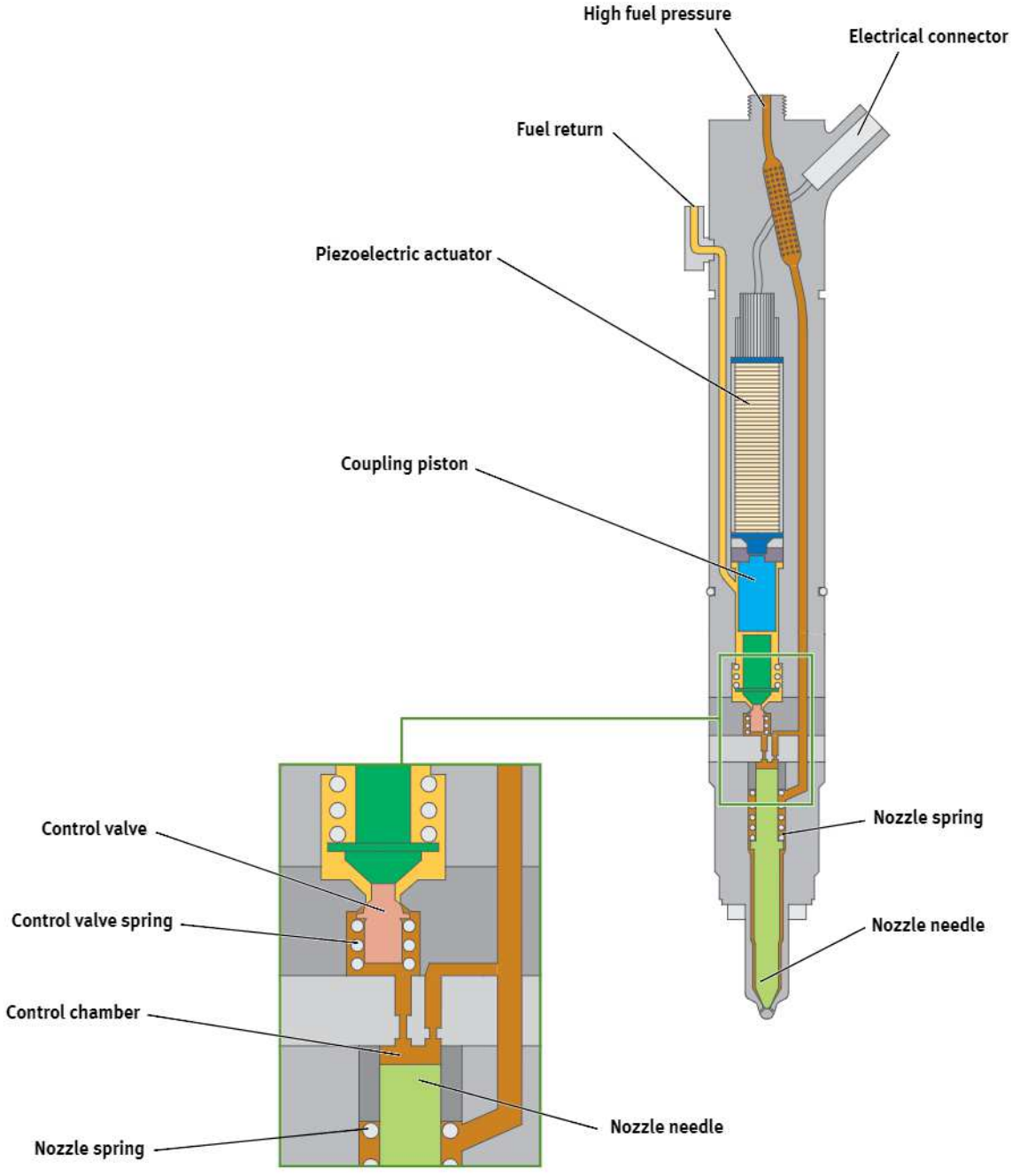
IDLE POSITION

When at rest the injector is closed and **is not energised by the engine control unit**.

A great deal of high pressure fuel from the accumulator tube strikes the **injector control chamber**.

This pressure closes both the control valve on its seat and the injector nozzle needle.

The return passage starts from the control valve. The pressure in the return passage, when at rest, is 10 bar thanks to the action of the injectors' return pressure restraint valve.



D123-95

START OF INJECTION

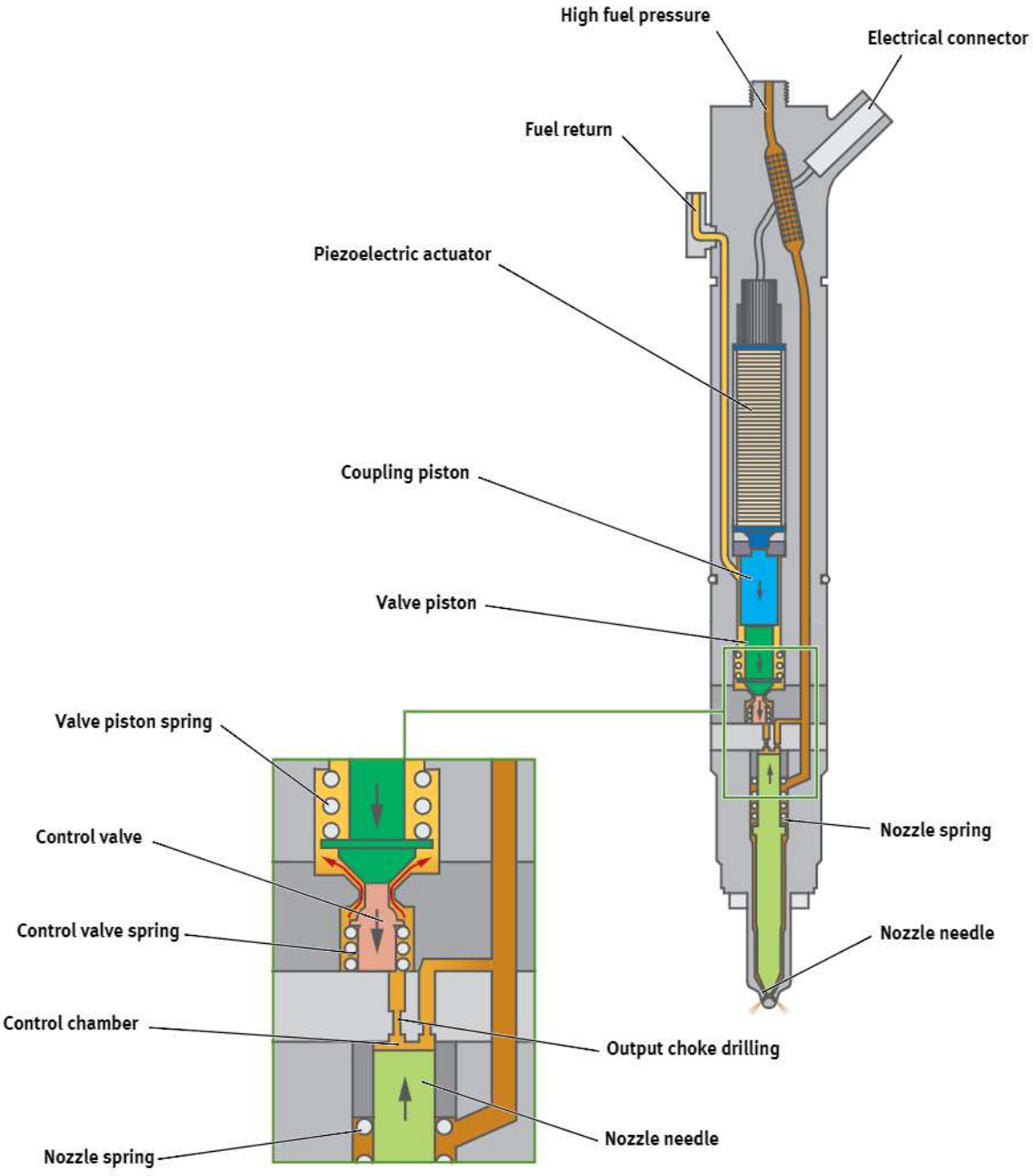
The control unit energises the piezoelectric actuator, which **moves the coupling module**.

When the coupling module pistons move donwards, hydraulic pressure is generated on the control valve.

The pressure on the control valve makes it overcome the high pressure of the fuel and as a result open.

When the control valve opens, the high pressure fuel at the upper part of the needle flows to the return through the choke at the output of the coupling module.

Sudden drop of pressure at the upper part of the needle makes it lift from its seat and fuel is injected into the cylinder.



D123-96

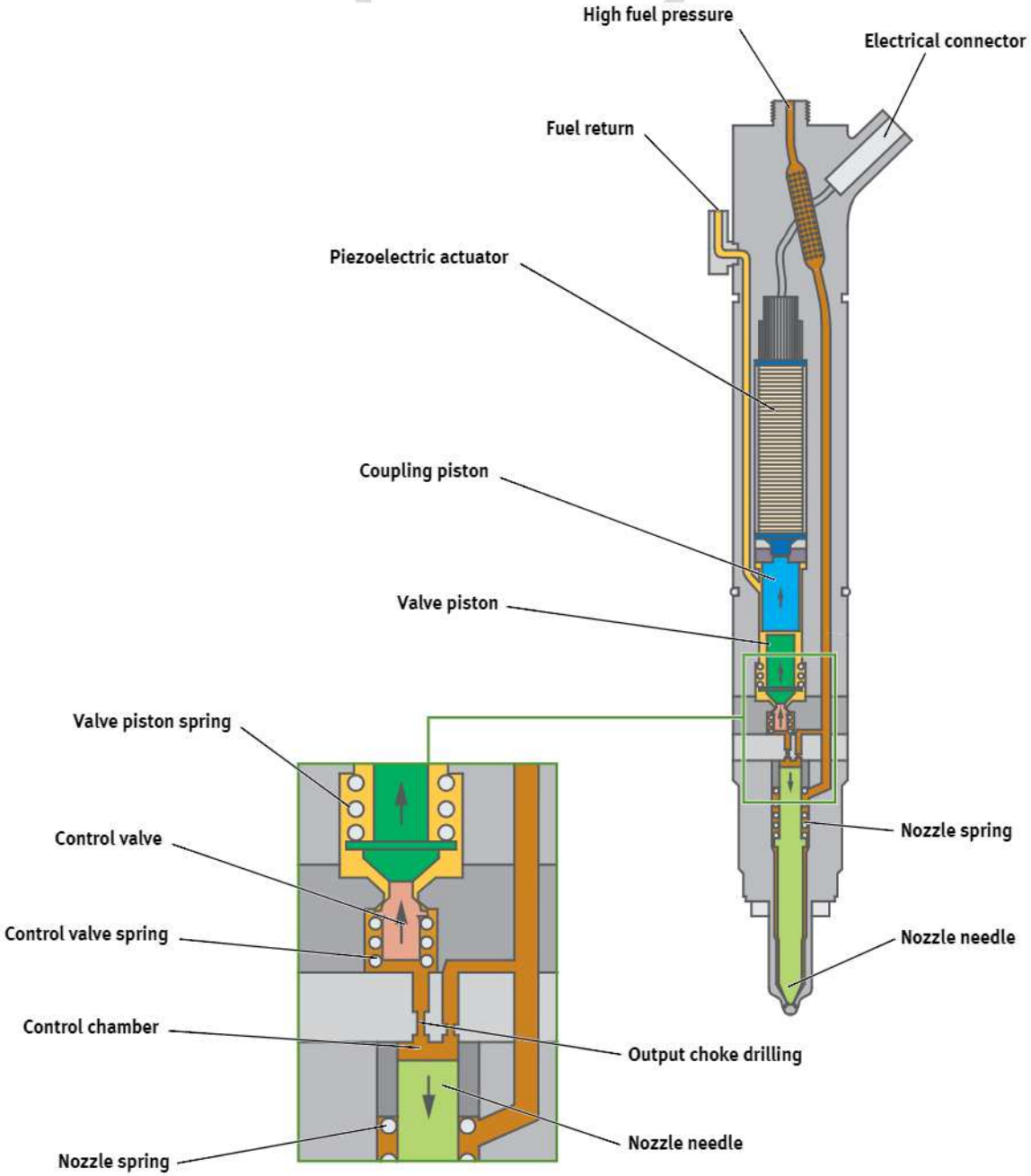
END OF INJECTION

It takes place when the piezoelectric actuator is not energised by the engine control unit. In that moment **the piezoelectric actuator moves back** and the cooupling module stops pressing the control valve.

The high pressure fuel at the top of the needle **closes the control valve** against its seat.

When the control valve closes the pressure between the upper and lower parts of the nozzle needle equalises, so the nozzle spring presses the needle on its seat and the injector closes.

The amount of fuel injected depends on the amount of time the actuator is being energised.



D123-97

INJECTOR BALANCING

It is a **diagnosis function** that has to be done every time an injector or the engine control unit is replaced.

MEANING OF THE 'IMA' VALUE

The IMA value is a **7 digit code printed on the upper part of every injector**.

With this code, the engine control unit is informed about the difference between the theoretical injection value and the real value for that particular injector.

This is because, by nature, the piezoelectric actuators have an ample range of tolerance between the pressure being applied and the expansion they undergo.

With the IMA value the engine control unit adapts the voltage applied to the injector so as to obtain the calculated injection flow.

INJECTOR ADAPTATION

It has to be done with the diagnosis tester, in Guided Functions or Guided Fault Finding.

Depending on the IMA code the injector flow calibration (IFC) is carried out based on the injector voltage calibration (IVC).

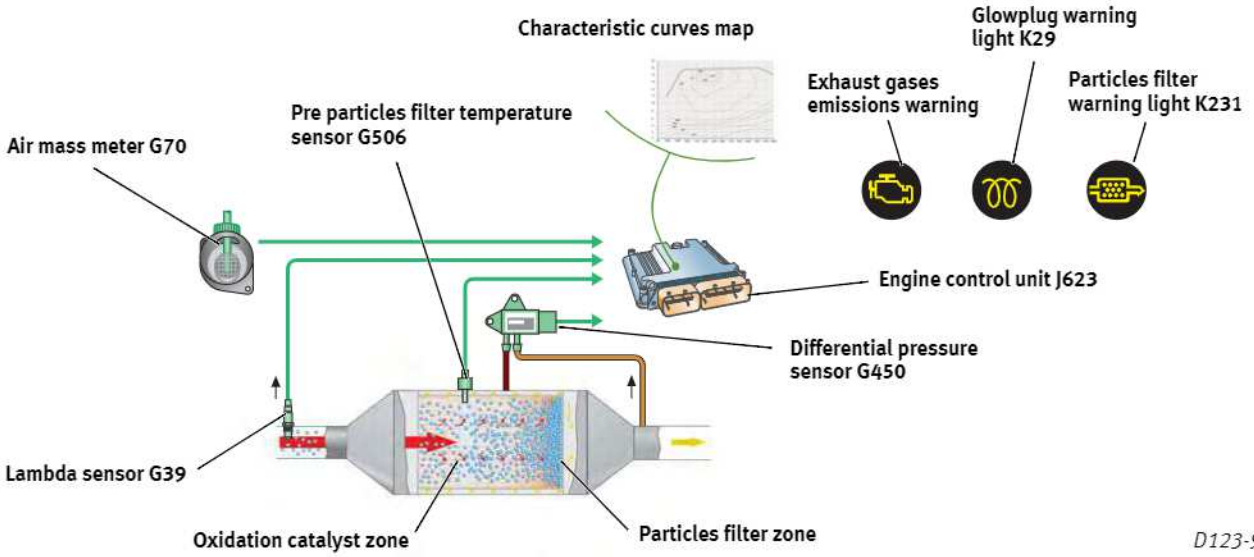
Thanks to this function it is possible to obtain the following advantages.

- Reduction of fuel consumption.
- Reduction of polluting gases emissions.
- A balanced engine performance.

If the adaptation of the injectors according to their IMA code is not carried out correctly, it could be the case that **the engine might not start**.

D123-98

PARTICLES FILTER REGENERATION



D123-99

The 2.0 l TDi CR engine particles filter regeneration strategy is the same as the one for the 2.0l TDi PD engines.

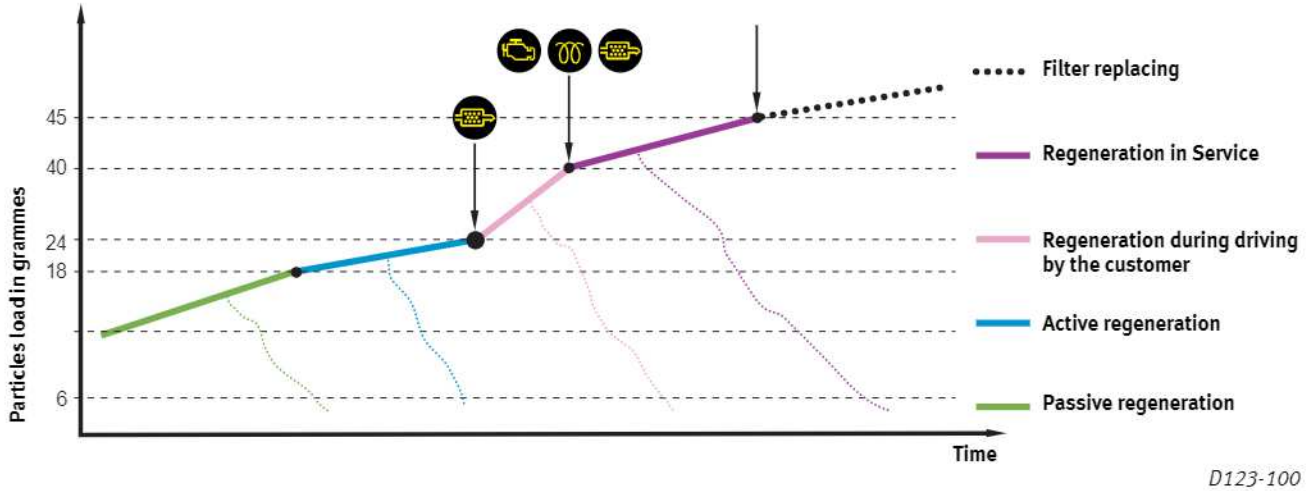
The engine control unit will establish a **different regeneration process depending on the saturation** detected in the filter.

Also, when the engine is cold, the engine control unit starts a post-injection cycle after the main injection in order to rapidly increase the temperature in the oxidation catalyst.

The control unit also takes into account the load of ashes to calculate the filter's saturation. This value must be adapted to the new unit when replacing the engine control unit. And the opposite, the value needs to be reset if the particles filter is replaced.

In the graph below you can see the regeneration strategy implemented by the engine control unit depending on the grammes of soot retained in the particles filter.

***Note**: For further information about the particles filter consult Self Study Programme No. 111 "Altea FR".*



D123-100

PRE-HEAT SYSTEM

The engine control unit controls the activation of the glowplugs indirectly through the automatic pre-heat cycle control unit J179.

This unit is in fact a relay placed in the Exeo engine compartment relays box.

The engine control unit sends out a variable duty cycle signal to the control unit J179. Depending on this signal, the glowplugs will be activated with a higher or lower voltage.

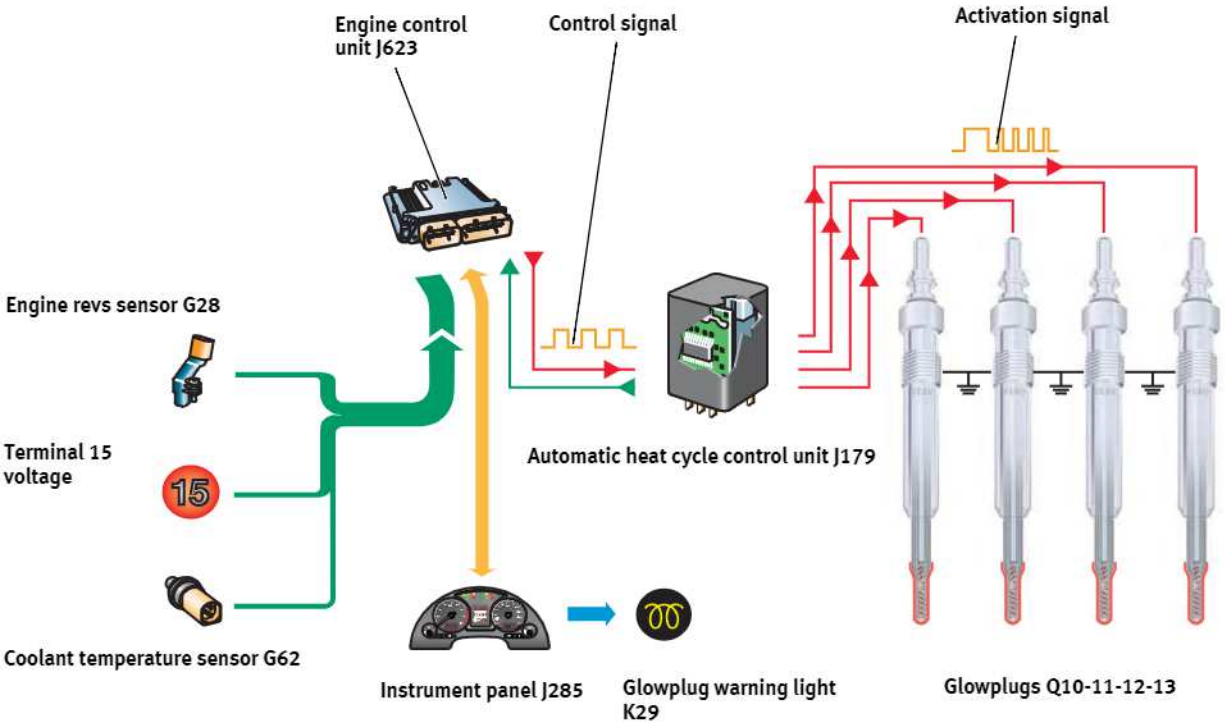
It is posible to establish two operation modes for the pre-heat system:

- **Pre-glow**: Allows for fast engine start-up. Below a temperature of 15°C a voltage of 11.5 V is applied to the plugs for a maximum of 2 seconds. This is how the highest warming temperature is achieved in the least possible time.

- **Post-glow**: Once the engine is running the plugs are maintained active for a maximum of 5 minutes until the coolant temperature reaches 25°C.

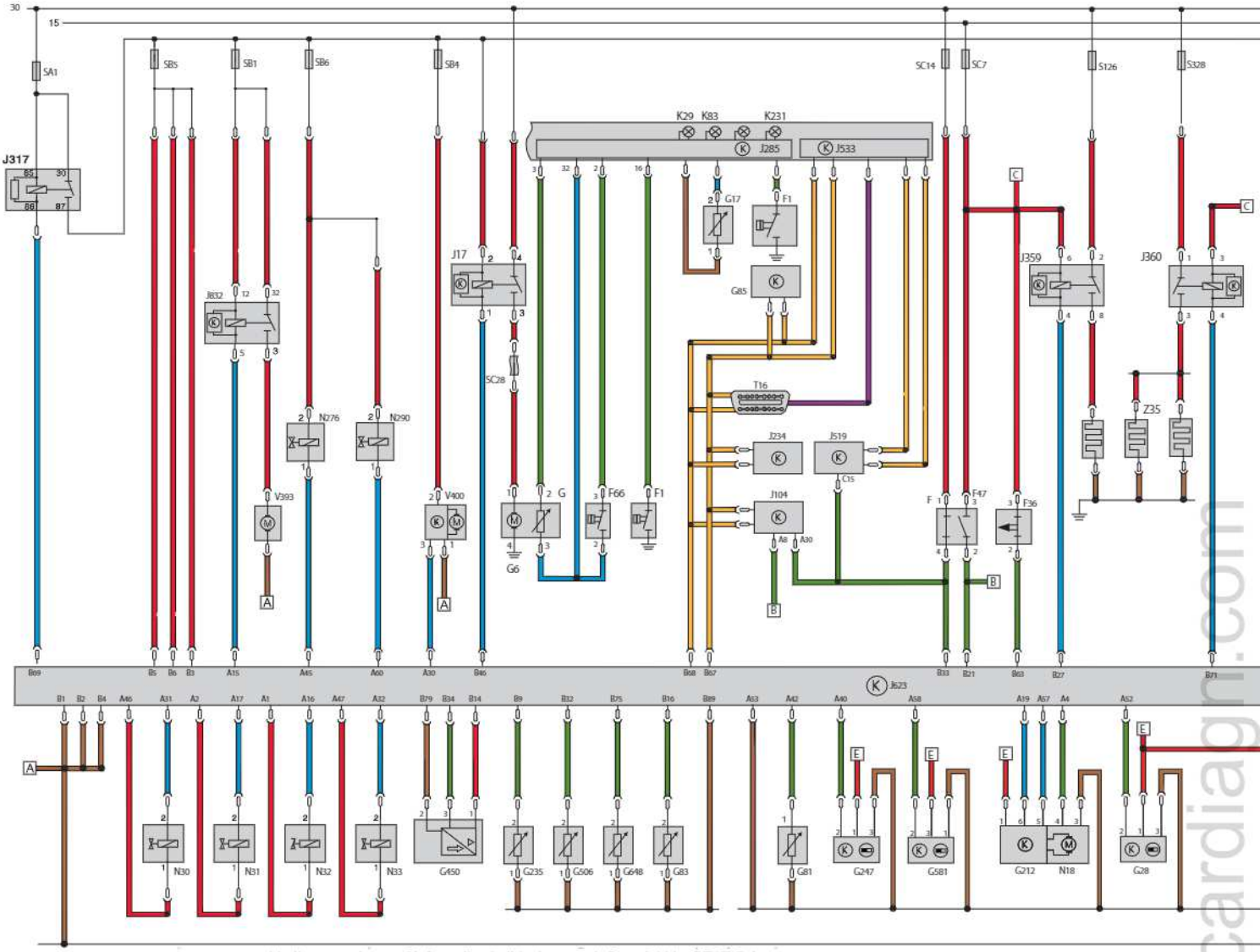
By reducing the positive duty cycle of the activation signal the voltage supply to the glowplugs is reduced to 7V.

The postglow cycle reduces the unburnt hydrocarbons emissions (HC) and reduces engine noise during the first phases of operation.

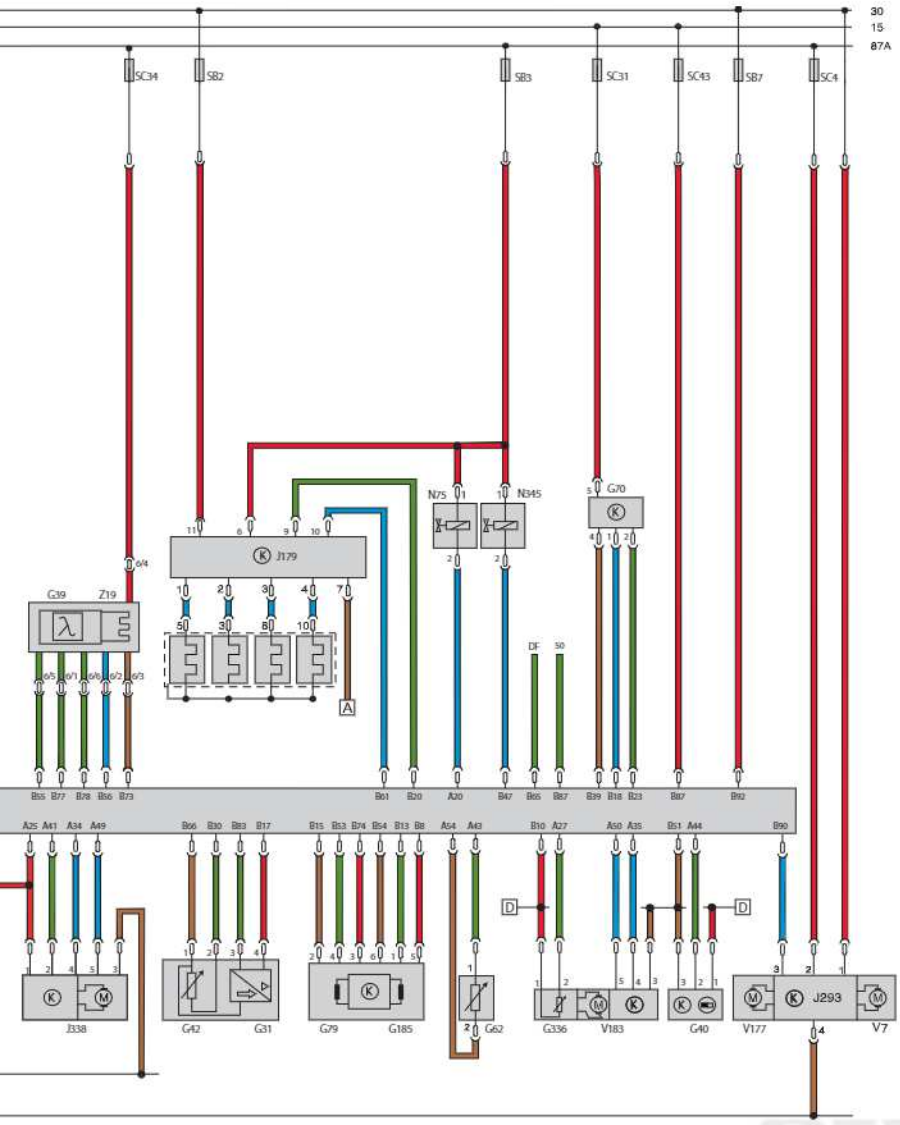


D123-101

FUNCTIONS WIRING DIAGRAM



F/F47	Brake position sensors
F36	Clutch position sensors
F1	Oil pressure sensor
F66	Sensor-level liquid cooling
G6	Fuel pump
G17	Outside temperature sensor
G28	Engine revs sensor
G31	Overboost pressure sensor
G39	Lamba Probe
G40	Cmshaft position sensor
G42	Intake air temperature sensor
G62	Coolant temperature sensor
G69	Smooth stop throttle position sensor
G70	Air mass meter
G79	Accelerator position sensor
G81	Fuel temperature sensor.
G83	Coolant temperatura sensor
G85	Steering angle sensor
G185	Accelerator position sensor
G212	Exhaust gases recirculation valve position sensor
G235	Turbocharger temperature sensor
G247	Fuel pressure sensor
G336	Spiral turbulence flaps position sensor
G450	Exhaust gases pressure sensor
G581	Turbocharger vanes position sensor 581
G506	Pre particles filter temperature sensor 648
G648	Post particles filter temperature sensor 648
J17	Fuel pump relay
J104	ABS/ESP control unit
J179	Glow-plugs control unit



COLOUR CODING

- Input signal.
- Output signal.
- Positive supply.
- Earth.
- Bidirectional signal.
- CAN-Bus signal.

D123-102

J234	Airbag control unit
J285	Instrument panel.
J293	Fans control unit.
J317	Terminal 30 supply relay.
J338	Motor for the inlet manifold flap
J359	Low heating power relay
J360	High heating power relay
J519	On-board network control unit.
J533	*Gateway*
J623	Engine control unit.
J832	Auxiliary fuel pump relay
K29	Pre-heat warning light
K31	The cruise control warning light.
K83	Exhaust emissions warning light
K231	Diesel particles filter warning light
N18	Exhaust gases recirculation valve EGR
N276	Fuel pressure regulator valve
N290	Fuel doser valve
N30/31/32/33	Piezoelectric valves of the injectors
N75	Overboost pressure regulation valve
N345	Exhaust gases radiator switch valve
Q10/11/12/33	Glow plugs
V7	Coolant fan
V177	Auxiliary fan for the coolant.
V183	Motor for the spiral turbulence flaps.
V393	Auxiliary fuel pump.
V400	Auxiliary pump for the exhaust gases exchanger.
Z19	Lamba probe heating
Z35	Auxiliary heating heater element

NOTES:

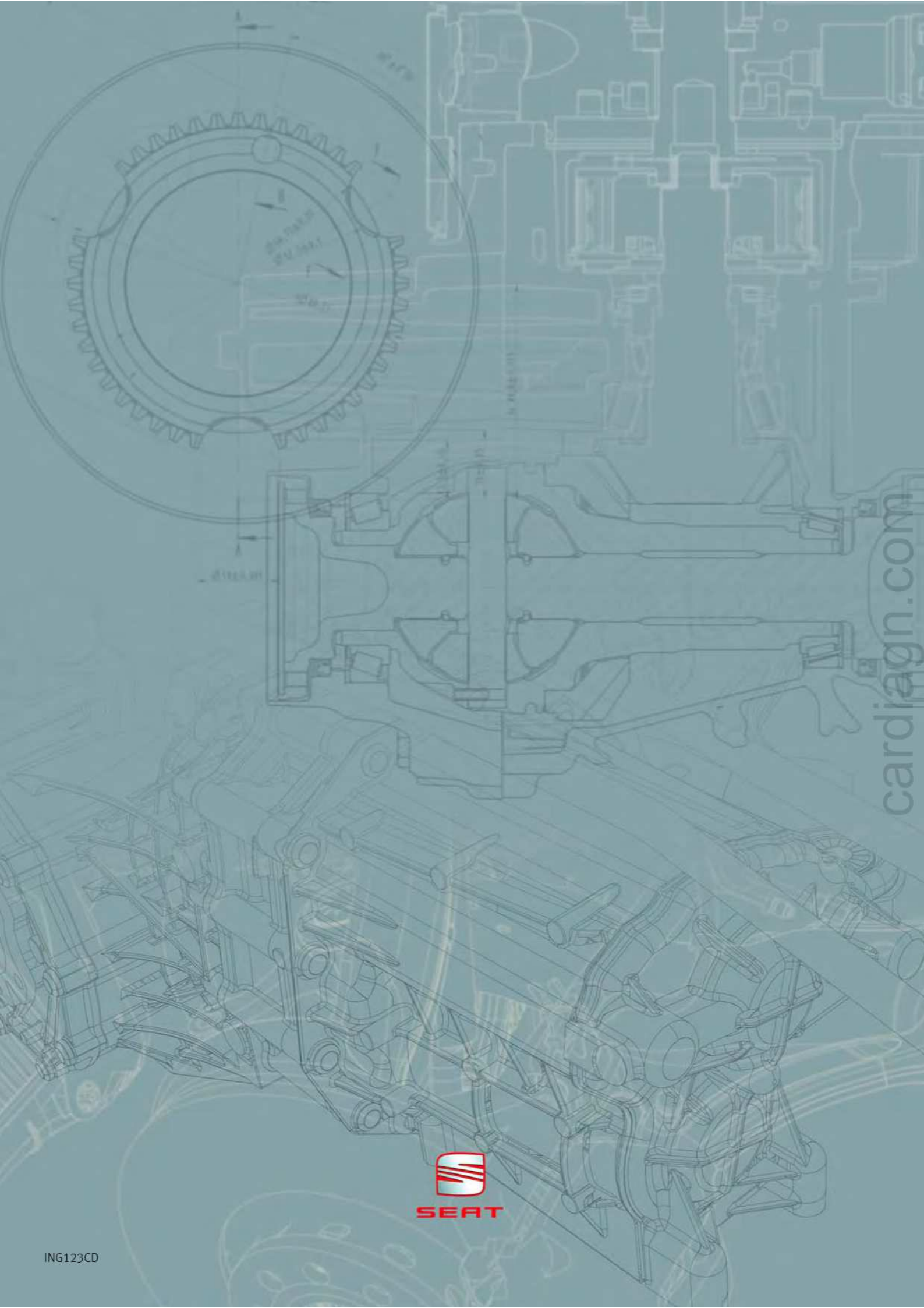
SEAT

Technical status 12.08. Due to constant product development and improvement, all data displayed is subject possible changes.

TITLE: "Common Rail" 2.0 L TDi Engine
AUTHOR: Service Institute
Copyright 2008, SEAT, S.A. All rights reserved.
Autovía A-2, Km 585, 08760 - Martorell, Barcelona (españa)

1st. edition

DATE OF PUBLISHING: xxx 08
LEGAL REGISTER: B-XX.XXX - 2008
Preprinting and printing: TECFOTO, S.L.
C/ Ciutat de Granada, 55 - 08005 - BARCELONA



SEAT

ING123CD