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# **N62 ENGINE**

**Model: E65 - 745i / E66 - 745Li**

**Engine: N62B44**

**Production Date: 11/2001 - E65, 01/2002 - E66**

## **Objectives of The Module**

After Completing this module, you will be able to:

- Describe the two stage oil supply.
- Distinguish the difference between the left and right drive chain tensioning assemblies.
- Explain the Bi-VANOS operation.
- Understand the function of the Variable intake manifold.
- Explain the cooling circuit flow.
- List what chamber A and chamber B is used for in the Bi-VANOS system.
- Identify the Secondary air components.
- Explain how the initial VANOS position is retained when oil pressure is not present.
- List the proper drive belt removal procedure.
- Describe the throttle valve functions.
- Identify the N62B44 designation.

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## N62 Engine

### Purpose of The System

The N62B44 engine is a completely new development from the NG (New Generation) series and is available as a B44 (4.4 liter).

The development objectives were:

- Reduction in fuel consumption
- Reduction in emissions
- Increased power
- Improved torque and torque curve
- Improved engine acoustics

To achieve these objectives, enhancements were made in the following areas:

- Engine mechanicals
- Treatment of exhaust emissions
- Valve timing
- Engine management control
- Intake air flow

The most important features of the new N62 engine are:

- 8 cylinders in a 90° V configuration
- 2 four-valve cylinder heads
- Light-alloy design
- Newly-developed variable intake manifold
- Valvetronic system



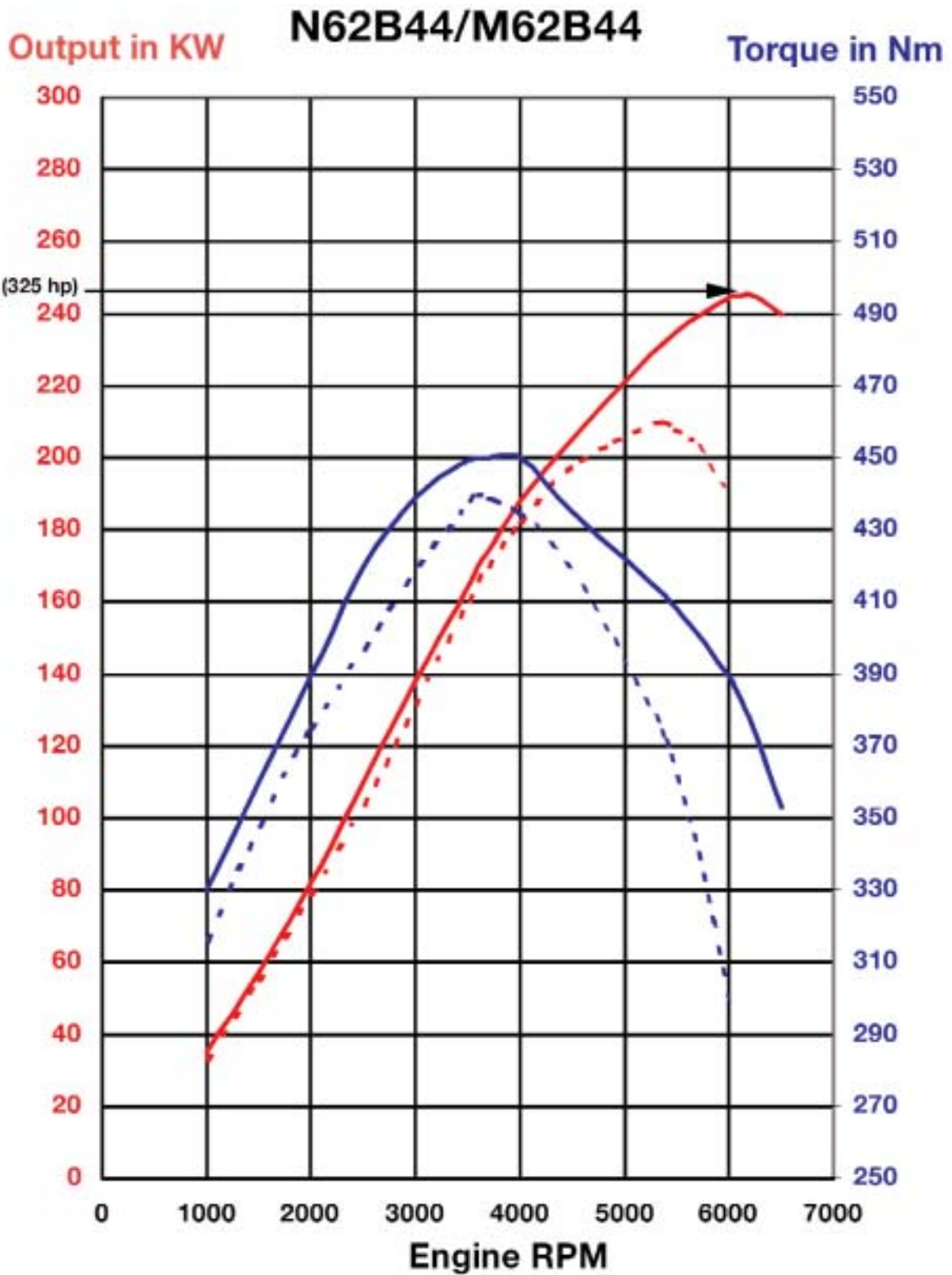
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In conjunction with the Variable Intake Manifold, the Valvetronic system adapts the intake valve lift to ensure optimum cylinder filling. The throttle valve use is limited during engine operation to maintain a constant intake manifold vacuum.

***The N62 is the best engine in its class. At this time there is no other engine on the market which uses comparable technology.***

## Technical Data

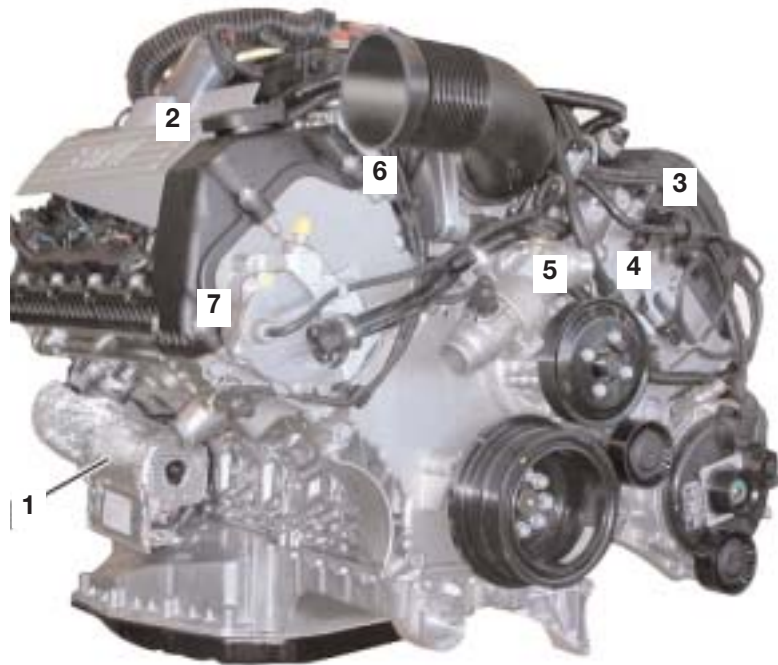
Engine	N62B44
Design	8 Cylinder V
V Angle	90°
Displacement (cm <sup>3</sup> )	4,398
Bore/Stroke (mm)	92/82.7
Cylinder Gap (mm)	98
Main Crankshaft Bearing Diameter (mm)	70
Output (kW) at speed (rpm)	325 6,100
Torque (Nm) at Speed (RPM)	330 3,600
Cut-off speed (RPM)	6.500
Compression Ratio	10.0
Valves / Cylinders	4
Intake Valve Diameter (mm)	35
Exhaust Valve Diameter (mm)	29
Intake Valve Lift (mm)	0.3 – 9.85
Exhaust Valve Lift (mm)	9.7
Cams Open Period (° crankshaft)	282/254
Engine Weight (kg)	213
Fuel	91 Octane
Firing Order	1-5-4-8-6-3-7-2
Knock Sensor	Yes
Variable Intake Manifold	Yes
Digital Motor Electronics	ME 9.2 with Valvetronic Control Unit
Complies with Exhaust Emission Regulations	EU-3 EU-4 LEV
Engine Length (mm)	704
Fuel Consumption Saving Compared with the M62	14%



42-02-02

## Engine Views

1. Starter Motor
2. Valvetronic Motor
3. Evaporative Emission Valve
4. VANOS Solenoid Valve
5. Thermostat Housing
6. Throttle Unit
7. Vacuum Pump



**N62B44 Engine (Front View)**

42-02-03

1. Camshaft Position Sensor  
Cylinder Bank 5-8
2. Valvetronic Eccentric Shaft  
Position Sensor, Cylinder  
Bank 5-8
3. Valvetronic Eccentric Shaft  
Position Sensor, Cylinder  
Bank 1-4
4. Camshaft Position Sensor  
Cylinder Bank 1-4
5. Secondary Air Non-return Valves
6. Servomotor for Variable Intake  
Manifold



**N62B44 Engine (Rear View)**

42-02-04

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## Fresh Air System

### Air Routing

The intake air passes through the air intake duct to the air cleaner, through the throttle section into the variable intake manifold and on to the two cylinder head intake ducts.

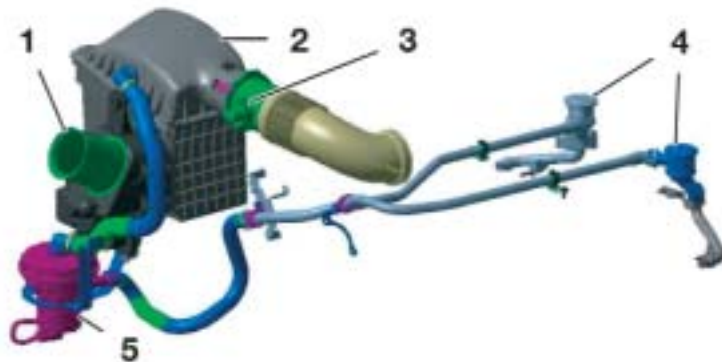
Increases in engine output and engine torque, as well as optimization of the engine torque curve, are largely dependent on an optimum engine volumetric efficiency over the entire engine speed range.

Long and short intake paths contribute to good volumetric efficiency in the lower and upper speed ranges. Long air intake paths ensure optimum volumetric efficiency in the lower to middle speed ranges. This optimizes the torque curve and increases the torque.

In order to optimize the power increase in the upper speed range, the engine requires short air intake paths for better cylinder filling. The air intake system has been completely redeveloped in order to eliminate this inconsistency in terms of air intake path length.

The air intake system consists of the following components:

1. Air Intake Duct
2. Air Cleaner Housing with Intake Air Silencer
3. Intake Pipe with HFM (Hot-Film Air-Mass Flow Sensor)
4. Secondary Air Valves
5. Secondary Air Pump



**Air Intake System**

42-02-05



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## Throttle Valve

The throttle valve on the N62 is not necessary for engine load control. This is carried out by the intake valves variable lift adjustment.

- Throttle Valve Housing with Throttle Valve.
- Throttle Valve Actuator
- Two Throttle Valve Potentiometers



42-02-25

**Throttle Valve**

The tasks of the throttle valve are:

### ***Starting the engine***

Airflow is controlled by the throttle valve during the starting procedure when the air temperature is between 20 °C and 60 °C, .

If the engine is at operating temperature, it will be switched to non-throttle mode approximately 60 seconds after start up. In cold conditions however, the engine is started with the throttle valve fully opened because this has a positive effect on the starting characteristics.

### ***Ensuring a constant vacuum of 50 mbar in the intake manifold***

This vacuum is needed to exhaust the blow-by gases from the crankcase and the fuel vapors from the activated charcoal filter.

### ***The backup function***

If the Valvetronic system should fail, the throttle valve implements conventional load control).

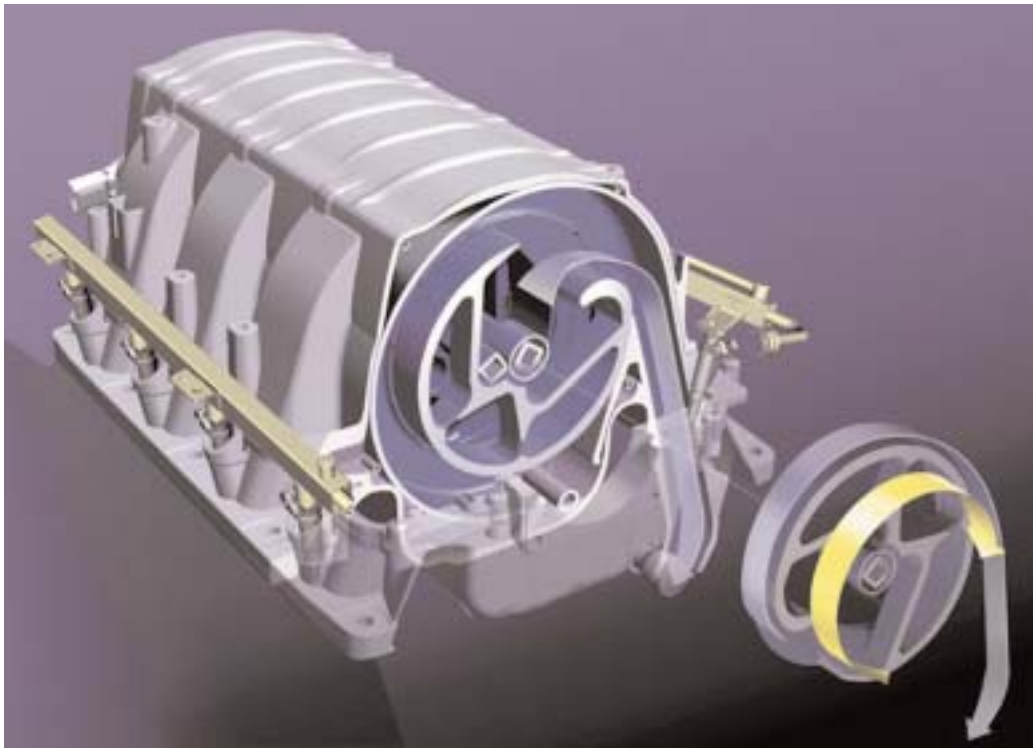
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## Intake Manifold

The N62 engine is equipped with a Variable Intake Manifold making it possible to reach a generous torque curve even at low engine speeds, without incurring losses in engine output at higher speeds. It ensures that the engine exhibits optimum volumetric efficiency through the entire range of speeds.

The new feature is the Variable Intake Manifold intake pipe length can be adjusted depending on the engine speed to provide efficient cylinder filling and scavenging. This is determined by the optimal matching of the intake pipe dimensions, the exhaust system and the valve timing.

The intake manifold is located in the engine “V” and is mounted on the cylinder head intake ports.



42-02-47

### Function

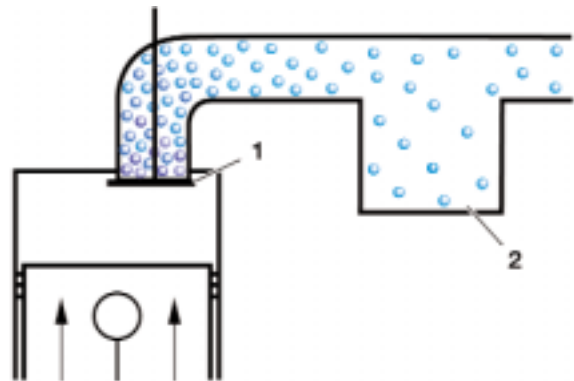
In order to understand how engine speed relates to volumetric efficiency, the physical processes within the intake pipe must be taken into consideration.

To ensure that there is good airflow to the engine cylinders, the intake pressure in front of the intake valve should ideally be high. This means that good airflow (high gas molecule density) in front of the intake valve is necessary.

This is only possible if the intake valve is closed and the mass inertia causes the intake air to flow in front of the closed intake valve. The air is compressed, the pressure and the air flow increase.

***Intake air flows in front of the closed intake valve.***

- 1. Closed intake valve
- 2. Intake manifold



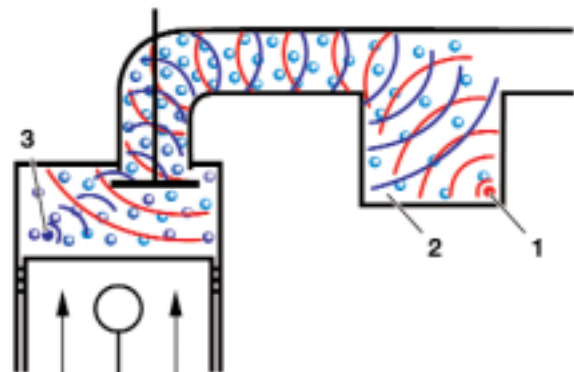
As soon as the intake valve is opened, the pressurized intake air flows into the cylinder, expands and draws the air molecules which follow into the cylinder. The suction waves form in the intake pipe (moving at sonic speed) in the opposite direction to the intake air.

42-02-07

These suction waves are reflected in the intake manifold and create pressure waves which then move once more at sonic speed in the direction of the intake valve.

***Movement of the intake air with the intake valve open.***

- 1. Pressure waves
- 2. Air manifold
- 3. Suction waves



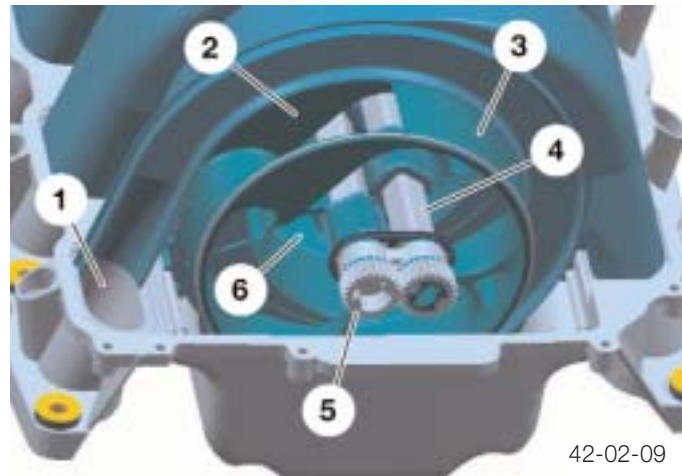
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The intake pipe is at the optimum length when the pressure waves are at the intake valve shortly before it is closed. The increase in pressure in front of the intake valve results in increased air flow to the cylinders once more. This process is described as recharge effect.

The opening angle of the intake valve remains unchanged as the engine speed increases. The opening time, however, is reduced proportionately (with conventional, non-Valvetronic engines).

Since the suction waves and pressure waves expand at sonic speed, the suction path length must be adapted depending on the engine speed to ensure that the tip of the pressure wave reaches the intake valve before it is closed.

1. Intake Port
2. Funnel
3. Rotor
4. Shaft
5. Spur Gears
6. Manifold Volume



**The Variable Intake Manifold**

Each cylinder has its own intake pipe (1) which is connected to the manifold volume (6) via a rotor (3). The rotors are supported by one shaft (4) per cylinder bank.

The second shaft, from which the rotor for the opposite cylinder bank is adjusted, is turned by spur gears (5) in the opposite direction from the driven shaft.

The intake air flows via the manifold volume through the funnel (2) and on to the cylinders. The intake path length is set as the rotor turns.

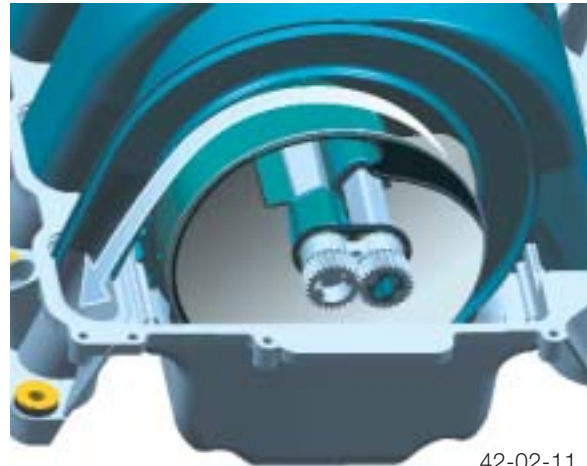
The intake path length can be adjusted according to the engine speed. Adjustment from the long to short intake path begins at 3,500 rpm. If the engine speed increases, the intake path length is progressively reduced, up to 6,200 rpm.

**Notes:** \_\_\_\_\_  
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The intake path length is determined by the funnel position. If the engine speed is less than 3,500 rpm, the funnel is in the longer intake path length position.

This means that the intake air must cover a longer path to reach the cylinders.

- ***Intake manifold set to longer intake path.***

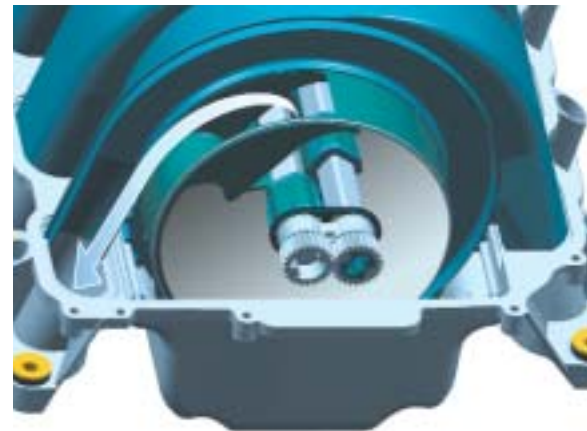


42-02-11

When an engine speed of 6,200 rpm is reached, the rotor is adjusted to the shorter intake path position. The intake path to the cylinders is now short.

The funnel can be progressively adjusted to any point between the long/short intake path positions.

- ***Intake manifold set to short intake path.***



42-02-10

Funnel adjustment is carried out by the drive unit, which is located on the rear of the intake manifold housing. The drive motor adjusts the drive shaft with funnels (cylinder bank 1-4). The second shaft with funnels for cylinder bank 5-8 is synchronously adjusted by the spur gears.

The drive motor is controlled by the ECM and provides feedback about the funnel position via an integral potentiometer.



42-02-81

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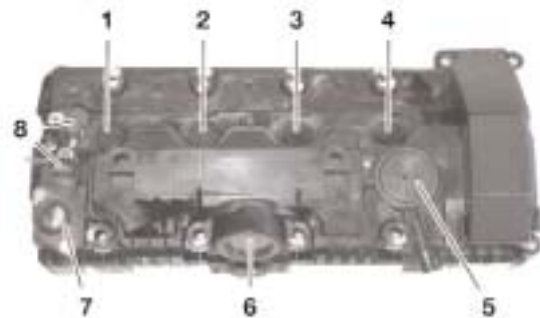
## Crankcase Venting System

The crankcase vapors (a result of combustion blow-by gasses) are led out of the crankcase and back into the combustion chamber via the intake manifold. The blow-by gasses contain droplets of oil which must be separated. The oil is returned to the sump while the blow-by gasses are led into the intake pipe for combustion.

The engine performance is affected by the introduction of crankcase vapors into the combustion process, particularly in idle speed ranges. This influence is monitored by lambda regulation.

The crankcase vapors are carried from the crankcase and into the cylinder head covers through labyrinth separators (one per cylinder head). The oil which accumulates on the walls of the labyrinth separators flows into the cylinder head via a siphon and from there back to the sump.

- 1-4. Opening for Spark Plugs
- 5. Pressure Control Valve
- 6. Opening Valvetronic Motor
- 7. Opening Valvetronic Sensor Connector
- 8. Camshaft Sensor



**Cylinder Head Cover**

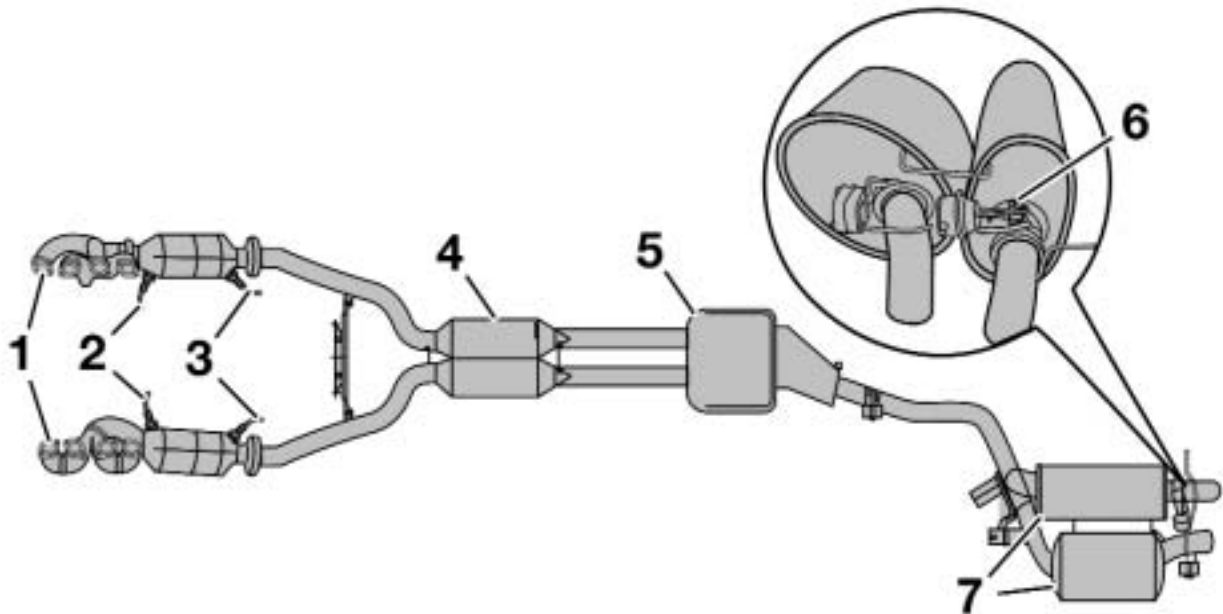
43-02-12

The remaining vapors are passed to the engine for combustion via the pressure control valve (5) in the intake manifold. One labyrinth separator with a pressure control valve is integrated in each of the two cylinder head covers.

The throttle valve is controlled so that there is always a 50 mbar vacuum in the intake manifold. The pressure control valve regulates the crankcase pressure to a low 0-30 mbar.

## Exhaust System

The exhaust system is completely redesigned for the N62B44 engine. It has been optimized in terms of cylinder filling, scavenging, sound level and rapid catalytic converter light-off.



Exhaust System

42-02-13

1. Manifold with Integrated Catalytic Converter
2. Broadband Planar Oxygen Sensors
3. Secondary Oxygen Sensors
4. Exhaust Pipe with Front Silencer
5. Center Silencer
6. Exhaust Gas Flap
7. Rear Silencers

### Exhaust Manifold with Catalytic Converter

Each cylinder bank is equipped with a four into two into one exhaust manifold. The manifold and the catalytic converter housing together form one component. A ceramic-bed pre-catalytic converter and a ceramic-bed main catalytic converter are arranged one behind the other in the catalytic converter housing.

The mounting for the broadband planar oxygen sensors (Bosch LSU) and the secondary oxygen sensors is located in front of and behind the catalytic converter.

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## Silencers

- A 1.8 liter capacity front silencer has been fitted for each cylinder bank.
- A single 5.8 liter center silencer is fitted downstream of the two front silencers.
- The resonator type rear silencers have capacities of 12.6 and 16.6 liters.

## Exhaust Gas Flap

The 12.6 liter rear silencer is fitted with an exhaust gas flap to keep noise to a minimum at engine idle speed and low rpm. The exhaust gas flap is opened allowing additional flow when:

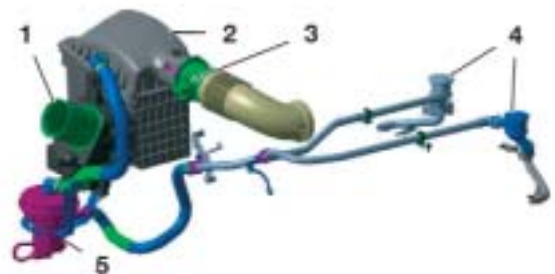
- The a transmission gear is engaged *and*
- The engine speed is above 1,500 rpm

A vacuum-controlled diaphragm (actuator mounted on the silencer) opens and closes the exhaust gas flap. The exhaust gas flap is closed with vacuum, and is sprung open by the actuator (when vacuum is not present). The procedure is carried out using a solenoid valve which is electrically controlled by the ECM.

## Secondary Air System

Blowing additional air (secondary air) into the cylinder head exhaust ducts during the warm-up phase results in a thermal secondary combustion which results in a reduction of the non-combusted hydrocarbons (HC) and carbon monoxide (CO) in the exhaust gas. The energy generated during this process heats up the catalytic converter faster during the warm-up phase, and increases it's conversion rate.

1. Air Intake Duct
2. Air Cleaner housing with Intake Air Silencer
3. Intake Pipe with HFM (Hot-Film Air-Mass Sensor)
4. Non-return Valves
5. Secondary Air Pump



43-02-05

**Secondary Air System**



## Secondary Air Pump (SLP)

The electrically-operated secondary air pump is mounted to the vehicle body. The pump draws out filtered fresh air from the air cleaner housing during the warm-up phase and supplies it to the two secondary air Non-return Valves.

Once the engine has been started, the secondary air pump is supplied with voltage by the ECM via the secondary air pump relay. It remains switched on until the engine has taken in a certain amount of air.

The **ON** period may be a maximum of 90 seconds and it depends on the following engine operating conditions:

- Coolant temperature (from -10 °C to approximately 60 °C)
- Air temperature (NTC sensor in HFM)
- Engine speed

1. Cylinder Head Lead
2. Non-return Valve (SLV)
3. Secondary Air Pump Connection



**View From Rear of The Cylinder Head**

One non-return valve is mounted on each cylinder head (see also Engine Views).

The non-return valves are opened by the pressure generated from the secondary air pump. The secondary air is led through a pipe to the secondary air ducts (integral in the cylinder heads) for distribution into the exhaust ports.

The non-return valves are sprung closed when the secondary air pump is deactivated. This prevents exhaust vapors, pressure and condensation from flowing back into the secondary air pump.

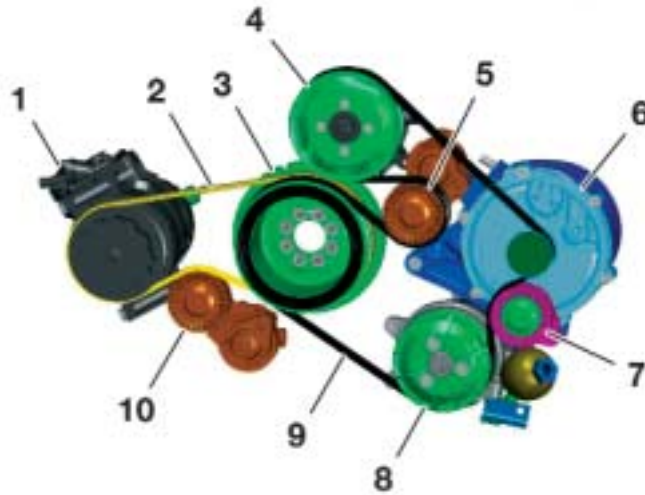
## Ancillary Components and Drive Belts

### Drive Belts

The belt drive has two components and is subdivided into the main and A/C drives. Both belts are driven by the crankshaft pulley.

A 4 rib belt is used to drive the air conditioning compressor and a 6 rib belt is used for the main drive. Each drive belt has a maintenance free tensioning unit with tensioning pulley and torsioner.

1. Air Conditioning Compressor
2. 4 Rib A/C Drive Belt
3. Crankshaft Pulley
4. Water Pump
5. Tensioning Unit Main Drive Belt
6. Alternator
7. Deflection Pulley
8. Power Steering Pump
9. 6 Rib Drive Belt
10. Tensioner Unit A/C Drive Belt



Ancillary Components and Drive Belts

42-02-15

### *To remove the drive belt:*

The tensioning pulley is pushed back using a Torx tool in the recess provided (1) and fixed in this position by inserting a locking pin as shown (2).



42-02-16

## Alternator

Due to the high power capacity of 180 A, the alternator is cooled by the engine's cooling system to enhance heat dissipation. The brushless Bosch alternator is installed in an aluminum housing which is mounted to the engine block. The exterior alternator walls are surrounded with circulated engine coolant. The function and design of the alternator is the same as in the M62, with only minor modifications. The BSD interface (bit-serial data interface) for the ECM is new.

1. Watertight Housing
2. Rotor
3. Stator
4. Seal



Alternator

42-02-17

1. Coolant Return Flow
2. Coolant Inlet Flow

\* Further details found in the cooling circuit section



Alternator Coolant Flow

42-02-18

## Regulation

The alternator communicates with the Engine Control Module (ECM) via the BSD (bit-serial data interface). The alternator conveys data such as model and manufacturer. This is necessary to allow the engine management system to adapt its calculations and specific control to the type of alternator fitted.

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The ECM takes on the following functions:

- Activation/deactivation of the alternator.
- Informing the alternator regulator of the nominal voltage value to be set.
- Controlling the alternator's response to load.
- Diagnosing the data line between the alternator and the ECM.
- Storing alternator fault codes.
- Activating the charge indicator lamp in the instrument cluster.

The connection with the ECM makes it possible to equalize the alternator load torque for nearly all operating conditions. This supports the engine idling speed control and the battery load balance. In addition, the ECM receives information from the Power Module about the battery's calculated temperature and charge status. This means that alternator output can be adapted precisely to the temperature and load status of the battery which increases the battery service life.

The charge indicator display strategy has not changed in comparison with the alternators currently in use. Regulating the alternator output is particularly important when activating Valvetronic operating motors.

A temperature protection function is implemented in the voltage regulator. If the alternator overheats, the alternator voltage is reduced until an appropriate temperature has been reached.

***The ECM can recognize the following faults:***

- Mechanical faults such as blockages or belt drive failure.
- Electrical faults such as exciter diode defects or over/under voltage caused by regulation defects.
- Connection defects between the ECM and the alternator.

***Coil breaks and short-circuits cannot be recognized. The basic alternator function is in operation even if the BSD interface fails.***

---

**Note:** The alternator regulator voltage is influenced by the ECM - BSD interface. The battery charge voltage can therefore be up to 15.5 V, depending on the battery temperature. If a battery charge voltage of up to 15.5 V is measured, the regulator is not faulty. A high charge voltage indicates a low battery temperature.

## Air Conditioning Compressor

The “clutch free” A/C compressor is manufactured by Denso. It functions continuously with the engine running. The compressor is a 7-cylinder swash plate type. The displacement can be reduced to less than 3% when air conditioning is not requested (no refrigerant is supplied to the refrigerant circuit).

There is an internal compressor refrigerant circuit to maintain lubrication. The IHKA electronics regulate the compressor output via an external control valve (1).



42-02-19

## Starter Motor

The starter motor is located on the right-hand side of the engine below the exhaust manifold, and is a compact planetary drive starter with a 1.8 kW output.

1. Starter motor with heat protective cover.



42-02-03

## Power Steering Pump

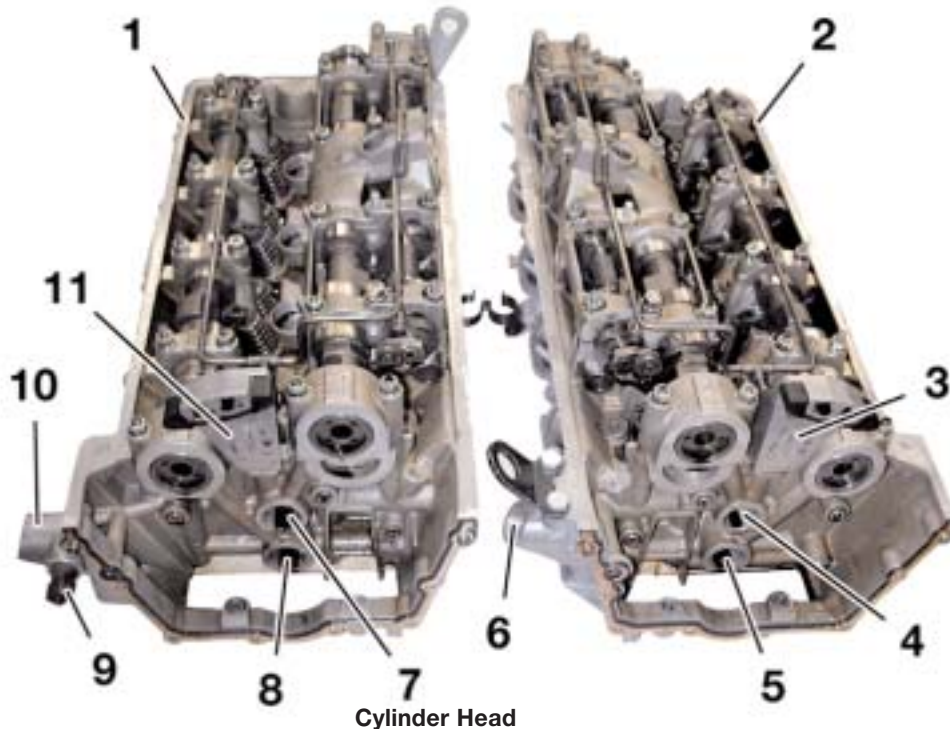
The power steering pump is a tandem radial piston pump on vehicles equipped with Dynamic Drive. A single vane pump is installed on vehicles without the Dynamic Drive.

Further information about the power steering pump can be found in the Chassis Dynamics section.

## Cylinder Heads

The two N62 cylinder heads are a new development from BMW. They are fitted with the Valvetronic system. The secondary air ducts for subsequent exhaust gas treatment are integrated in the cylinder heads. The cylinder heads are cooled by the “cross-flow” principle.

The inlet camshaft and the Valvetronic eccentric shaft are jointly guided by a bridge support. The cylinder heads are made from aluminum and are manufactured using gravity die-casting. The upper timing chain housing is now an integral part of the cylinder head.



43-02-20

- |  |   |
|--|---|
| 1. Cylinder Head for Cylinder Bank 1-4   | 7. Mounting VANOS Intake Solenoid         |
| 2. Cylinder Head for Cylinder Bank 5-8   | 8. Mounting VANOS Outlet Solenoid         |
| 3. Upper Timing Chain Guide with Oil Jet | 9. Oil Pressure Switch                    |
| 4. Mounting for VANOS Intake Solenoid    | 10. Chain Tensioner Mount                 |
| 5. Mounting for VANOS Outlet Solenoid    | 11. Upper Timing Chain Guide with Oil Jet |
| 6. Chain Tensioner Mount                 |   |

## Engine Covers

Each cylinder head has a plastic cover for the ignition coil cabling and top of the cylinder head. The covers “push fit” into rubber grommets on the cylinder head covers.

A sound absorption cover for the top of the engine also covers the two Valvetronic motors. This cover is fixed to the intake manifold housing using four bolts.

1. Cylinder Head Top Cover
2. Sound Absorption Engine Cover

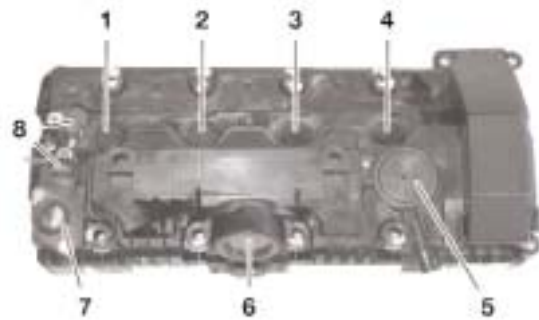


42-02-21

**Engine Covers**

The cylinder head covers are made from plastic. The retaining sleeves for the ignition coils have molded-on gaskets. The sleeves must be replaced if any hardening or damage is visible on the gaskets. The sleeves are inserted into the cylinder head through the cylinder head cover (nos. 1 through 4).

- 1-4. Opening for Spark Plugs
5. Pressure Control Valve
6. Opening for Valvetronic Motor
7. Opening for Valvetronic Sensor Connector
8. Camshaft Sensors (Intake and Exhaust)



**Cylinder Head Cover**

43-02-12

**Notes:** \_\_\_\_\_  
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## Cylinder Head Gaskets

The cylinder head gasket is a multi-layer steel gasket with a rubber coating. This type of gasket has previously been used on other engines.

The B44 head gasket has a 6 mm hole in a flap on the outlet side of the cylinder head gasket.

The cylinder head bolts for the N62 engine are M10x160 necked-down "stretch" bolts.



42-02-23

*Note: These bolts should always be replaced when repairs are performed.*

The lower part of the timing chain housing is bolted to the cylinder head using two M8x45 bolts.



## Camshafts

42-02-22

The camshafts are made from chilled cast iron and are hollowed to reduce weight. The camshafts are weighted with counterbalances for equalizing imbalances in the valve gear.

1. Camshaft sensor wheels (sintered metal)
2. Thrust bearing area with oil ducts for the VANOS units



42-02-24

**Notes:** \_\_\_\_\_

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## Valvetronic

Over the entire speed and load range, the gasoline engine needs a combustible fuel-air mixture within the ideal ratio ( $\lambda = 1$ ). The mixture quantity must be altered to vary the speed and output. This variation is effected by the throttle valve. The mixture, which falls within the narrow range of  $\lambda = 1$ , is formed outside the combustion chamber using the fuel injection system (external mixture formation).

The mixture control is influenced by the throttle valve and is not optimal in all the different load ranges. This is particularly true in the idle to part-load ranges, since the throttle valve is only opened slightly in these ranges. The consequences are less than optimal cylinder filling, torque and increased fuel consumption.

Technical measures were previously introduced; such as the optimization of air/fuel mixing, improved valve overlap, introduction of DISA and the steady improvement of mixture control all depend on the throttle valve. This is where the new completely unique Valvetronic design comes in.



The Valvetronic system simultaneously varies the valve opening time and the valve opening lift between 0.3 mm and 9.85 mm, according to engine speed and load. This means that the air/fuel mixture volume is controlled according to engine requirements. This type of mixture and volume control makes the typical throttle valve control unnecessary.

---

## Physical considerations:

On engines with throttle valve control, the throttle valve is slightly open in the idling and part-load ranges. This results in the formation of up to 500 mbar vacuum in the intake manifold, which prevents the engine from aspirating freely and in turn prevents optimum cylinder filling. The Valvetronic system with an open throttle valve largely counteracts this disadvantage. The air-mass flow to the intake valves is unrestricted. The full ambient pressure is available directly at the intake valves for cylinder filling and scavenging.

The Valvetronic system primarily controls the fill by adapting the valve opening time and the valve lift (short opening time/small valve lift = lower fill, and vice versa). During the valve opening phase the engine aspirates more freely via the intake valves even with small valve lifts vs. a throttle valve which is continuously blocked.

The slower cylinder filling from the intake valves with partial lift results in more turbulence in the combustion chamber, thus faster and better mixture control and more efficient combustion. At lower engine speeds this effect is intensified by opening the intake valves later, after top dead center (ATDC) using VANOS. This increases vacuum in the combustion chamber which accelerates filling and turbulence when the intake valves are opened.

*In summary*, the additional variability of the Valvetronic system results in optimization of cylinder filling and scavenging throughout the engine's entire operating range. This has a positive effect on output, torque and a decrease in fuel consumption and exhaust emissions.

### Features:

- Valve lift adjustment
- VANOS for intake and outlet
- Variable intake manifold
- Mixture control and ignition control
- Other individual engine design measures

### The main benefits of these features are:

- Improved cylinder filling with air/fuel mixture
- Improved mixture control before the cylinder inlet
- Improved combustion procedure

### This results in:

- Improved engine idling
- Improved engine torque
- Improved engine torque curve
- Fewer pollutant emissions

*These benefits result in a clear improvement in performance and fuel consumption reduction (14%) for the driver.*

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## Principle of Operation

*The Valvetronic system is a combination of VANOS and valve lift adjustment.* This combination of abilities allows the ECM to control when the intake valves are opened and closed, and also the opening lift. The intake air flow is set by adjusting the valve lift while the throttle valve is fully opened. This improves cylinder filling still further and reduces fuel consumption.

Each cylinder head in the N62 engine has a Valvetronic assembly. This Valvetronic assembly consists of a bridge support with eccentric shaft, intermediate levers with retaining springs, drag lever and the intake camshaft.

In addition, the following components belong to the Valvetronic system:

- A Valvetronic motor for each cylinder head
- A Valvetronic control module
- A Valvetronic sensor for each cylinder head



42-02-30

The intake valve lift can be adjusted to anywhere between 0.3 mm and 9.85 mm.

The cylinder heads are precision manufactured together to ensure precise flow rate and uniform distribution. The valve gear components on the intake side are precisely matched together to the tightest limits.

The bridge support, lower eccentric shaft and inlet camshaft bearings are matched together in the cylinder head once it is assembled. If the bridge support or the lower bearings are damaged, the entire assembly must be replaced.

**Notes:** \_\_\_\_\_

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## Valvetronic Motors

One Valvetronic motor is located on top of each cylinder head towards the inside of the engine “V”. The motors are capable of traveling from minimum to maximum lift in 300 milli-seconds.

1. Cylinder Head Cover, Cylinder Bank 1-4
2. Valvetronic Motor for Eccentric Shaft Adjustment



**Valvetronic Motor**

**Note:** The Valvetronic motor must first be removed in order to remove the cylinder head cover. The eccentric shaft must be in the minimum lift position and the motor must be wound out from the eccentric shaft. The worm gear could otherwise be damaged when separating the worm shaft and the worm wheel as the eccentric shaft springs back (due to the torque compensation spring).

*If it is not possible to remove the motor, due to mechanical failure or sticking, the worm shaft can be moved using an Allen key to release the motor. A hole must be drilled in the rear plastic motor cover in order to access the motor shaft (worm shaft) using the Allen key. The motor can then no longer be used.*

The Valvetronic motor worm gear rotates the eccentric shaft clockwise or counterclockwise at a very quick rate (1).

Due to the progressive “lobe” on the eccentric shaft, this rotation positions the intermediate lever (2) closer or further to the camshaft lobe.



**Notes:** \_\_\_\_\_  
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## Eccentric Shafts



43-02-32

The eccentric shafts (one per cylinder head) are driven by the Valvetronic motors and are supported by four caged needle bearing assemblies for a smooth rotation.

To assist in maintaining the set positions and counter the valve train torque, a torque compensation spring is mounted on the end of the shaft for tension.

Magnets are fitted in the (removable) magnetic wheel at the end of the eccentric shaft. Together with the position sensor, the Valvetronic Control Module determines the exact shaft position. The eccentric shaft sensor is mounted through the cylinder head cover (one per cylinder head) at the back.

The magnetic wheel is secured to the shaft by a bolt and is indexed by a tab (arrow) to prevent incorrect installation.



42-02-36



## Intermediate Lever and Roller Finger

The intermediate lever is positioned further (minimum valve opening) or closer (maximum valve opening) to the camshaft by the progressive “lobe” on the eccentric shaft as it is rotated. This offers a variable ratio effect for valve actuation. The roller finger is used to actuate the intake valve.

The intermediate levers and roller fingers are matched (by classification) to ensure uniform valve lift.

*Note: When disassembling/assembling the valvetrain, the intermediate levers and roller fingers must be returned to the original positions to prevent uneven cylinder charging which can result in rough idle and engine performance complaints.*

*Refer to the Repair Instructions for tolerance numbers!*



43-02-38

## Valve Lift

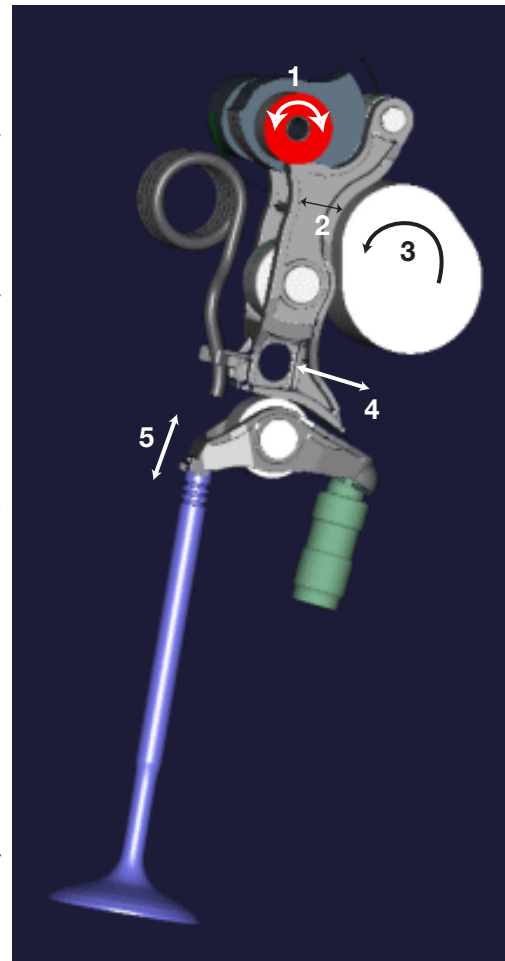
The Valvetronic motor worm gear rotates the eccentric shaft clockwise or counterclockwise at a very quick rate (1).

Due to the progressive “lobe” on the eccentric shaft, this rotation positions the intermediate lever (2) closer or further to the camshaft lobe.

As the camshaft is rotating (3), the cam lobe will pivot the intermediate lever (4) and the “heel” of the intermediate lever will depress the roller finger. A spring is located on each intermediate lever to maintain constant contact with the camshaft.

The roller finger is cushioned by the HVA and will open the intake valve (5).

The Valvetronic system varies the valve opening lift between 0.3 mm and 9.85 mm by rotating the eccentric shaft during engine operation to increase or decrease intake (flow) into the cylinder based on throttle request.



\* This is an assembly that affects all of the intake valves (per cylinder head) to work in unison.

**Notes:** \_\_\_\_\_

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## Bi-VANOS (Variable Camshaft Adjustment)

The N62 features compact infinitely variable vane-type VANOS for the intake and exhaust camshafts. The VANOS unit is easy to remove and install. The VANOS unit is designed as an integral component of the chain drive and is secured to the respective camshaft with a central bolt. The camshaft adjustment rate is 60° (as compared with the crankshaft).

1. VANOS Unit Exhaust Side
2. VANOS Central Bolt
3. Spring Plate
4. VANOS Unit Intake Side
5. Toothed Chain Gear Teeth



**VANOS Units**

43-02-39

The VANOS unit gear teeth are visibly different to match the new toothed chain. The VANOS unit for the cylinders 1-4 exhaust shaft has mounting provisions for the vacuum pump drive. A spring plate is fitted between the VANOS unit and the vacuum pump drive to reduce wear (3). The *VANOS units are labeled "In/Out"* for intake and exhaust installation positions.

The VANOS units are supplied with oil via ports in the camshafts. The oil ports are located on the left and right of the thrust bearing. Depending on the individual VANOS adjustment direction, the VANOS is supplied with oil via either the rear oil ports (1 & 2) or the front oil ports (3 & 4). The oil moves through the camshaft to the VANOS units.

- 1&2. Rear Oil Duct with Four Holes
- 3&4. Front Oil Duct with Four Holes
5. Front Oil Duct Outlets
- 6&7. Hook Sealing Washer.



**VANOS Oil Ports**

## Camshaft Sensors

The cam shaft sensors (Hall effect) are mounted through the cylinder head cover. There are two sensors per cylinder head to monitor the intake and exhaust camshaft positions.

The sensors monitor the impulse wheels attached to the ends of the camshafts.

1. Valvetronic Position Sensor
2. Intake Camshaft Position Sensor
3. Exhaust Camshaft Position Sensor



Camshaft Sensors

## Solenoid Valves

42-02-48

The VANOS solenoid valves are mounted through the upper timing case front cover. There are two solenoids per cylinder head to control the oil flow to the camshaft ports for the intake and exhaust VANOS units.

The 4/3 way proportional solenoid valve is activated by the ECM to direct oil flow. The solenoid valve is sealed to the front cover by a radial seal and secured by a retaining plate.

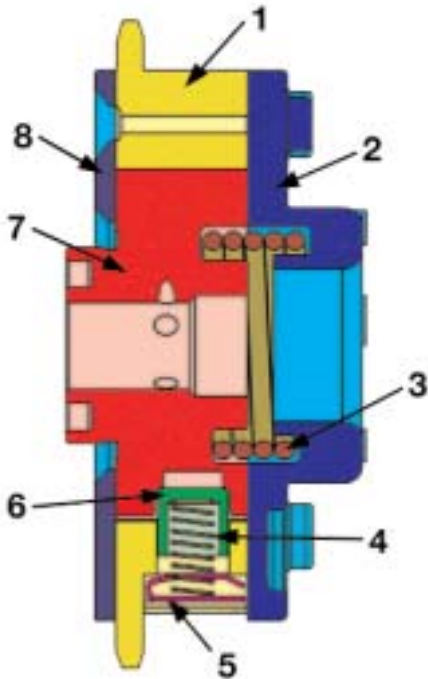


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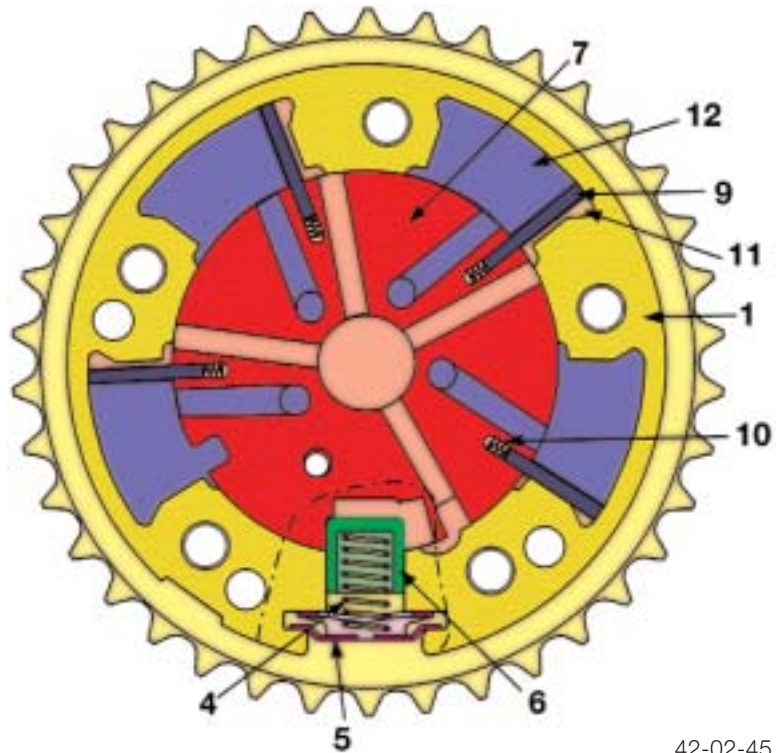
**Notes:** \_\_\_\_\_  
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## VANOS Sectional Views



42-02-49



42-02-45

### VANO'S Components

- |                                    |                        |
|------------------------------------|------------------------|
| 1. Housing with Sprocket           | 7. Hub                 |
| 2. Front Plate                     | 8. Black Plate         |
| 3. Torsion Plate                   | 9. Blade               |
| 4. Lock Spring                     | 10. Spring             |
| 5. Retaining Plate for Lock Spring | 11. Pressure Chamber A |
| 6. Spring Loaded Locking Pin       | 12. Pressure Chamber B |

### *Mechanical Layout:*

The figures above show a sectional view of one VANOS unit. The VANOS unit is secured by a central bolt through the hub (7) to the camshaft. The timing chain connects the crankshaft with the housing of the unit.

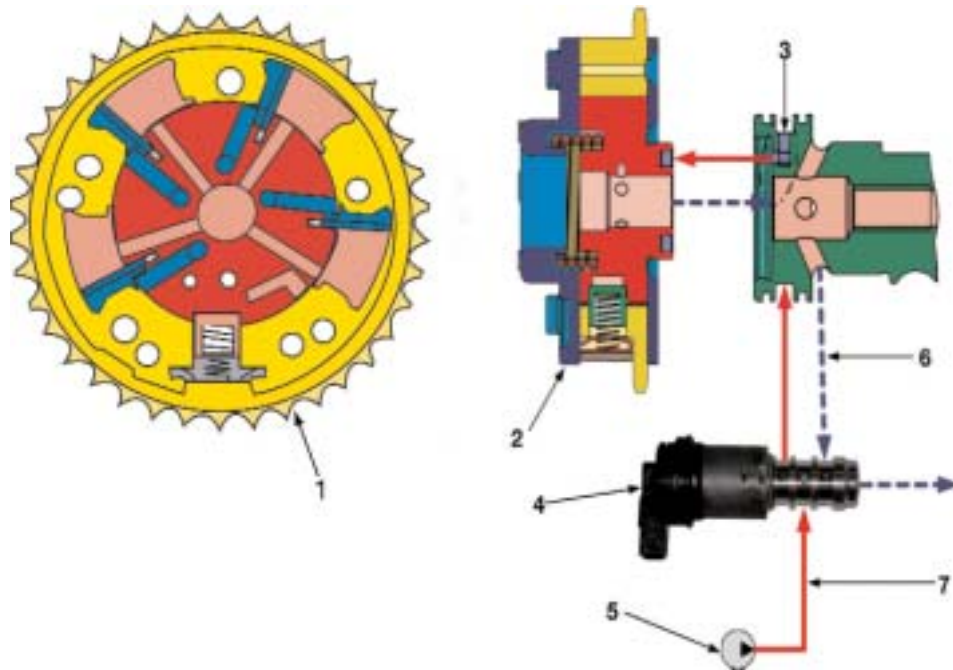
There is a recess in the hub in which the locking pin (6) engages without oil pressure (sprung). When the solenoid valve is activated to supply oil pressure to the VANOS unit, the locking pin is compressed and releases the VANOS for adjustment.

The internal blades (9) are spring loaded (10) to provide a seal between the oil pressure chambers (11 and 12). The torsion spring (3) acts against the camshaft torque.

### Hydraulic Actuation:

When oil pressure is applied to chamber A, the blades are forced away from the VANOS housing (counterclockwise). The blades are keyed into the hub which results in the hub position being rotated in relation to the housing (with sprocket). The hub is secured to the camshaft which changes the camshaft to sprocket relationship (timing).

The example below shows the *adjustment* procedure together with the pressure progression based on the VANOS unit for the exhaust camshafts.



43-02-45

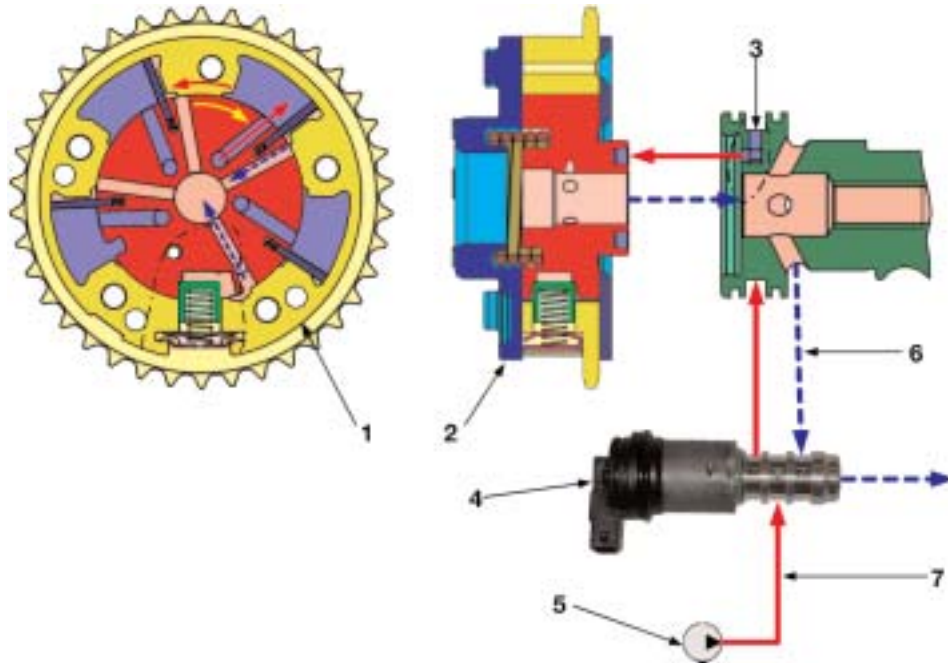
#### Hydraulic Actuation - Chamber A

1. Front View of Vanos Unit
2. Side View of Vanos Unit
3. Camshaft Oil Port (Chamber B)
4. Solenoid Valve
5. Engine Oil Pump
6. Supplied Oil from Pump (Switched Through Solenoid)
7. Supplied Oil Pressure (From Engine Oil Pump)

During this adjustment chamber B is open (through the solenoid) to allow the oil to drain back through the cylinder head (internal reservoir).

When the solenoid valve switches over, oil pressure is applied to chamber B. This forces the blades (and hub) in a clockwise direction back to the initial position, again changing the camshaft timing.

The example below shows the **reset** procedure together with the pressure progression based on the VANOS unit for the exhaust camshafts.



**Hydraulic Actuation - Chamber B**

42-02-44

- |                                  |   |
|----------------------------------|---|
| 1. Front View of VANOS Unit      | 5. Engine Oil Pump                              |
| 2. Side View of VANOS Unit       | 6. Oil Return (Switched through Solenoid)       |
| 3. Camshaft Oil Port (Chamber B) | 7. Supplied Oil Pressure (From Engine Oil Pump) |
| 4. Solenoid Valve                |   |

During this adjustment chamber A is open (through the solenoid) to allow the oil to drain back through the cylinder head (internal reservoir).

**Notes:** \_\_\_\_\_  
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The chart below shows the VANOS unit camshaft adjustment possibilities. The valve lift adjustment has also been incorporated.

The special feature of Valvetronic is that the air mass drawn in the cylinders can be easily determined by the valve lift and closing time. The air mass can then be limited, thus the term “load control”.

With the help of VANOS, the valve closing point can be easily selected within a defined range. With valve lift control, the opening duration and cross section of the valve opening can also be easily selected within a defined range.

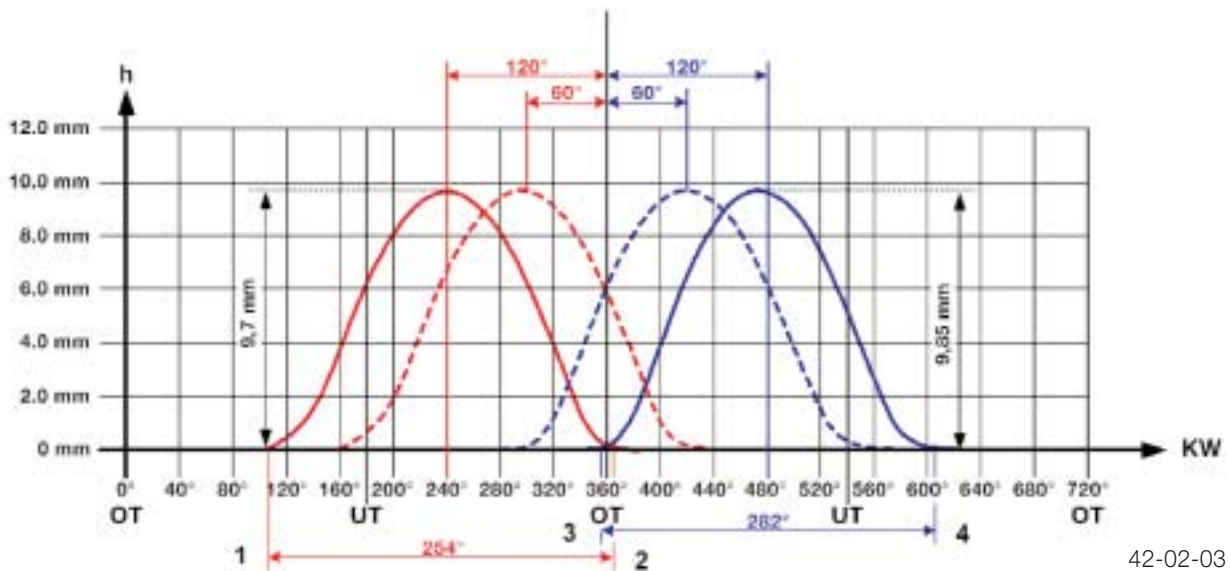


Chart Exhaust & Intake Valve

1. Exhaust Valve Open
2. Exhaust Valve Closed
3. Intake Valve Open
4. Intake Valve Closed

## Vacuum pump

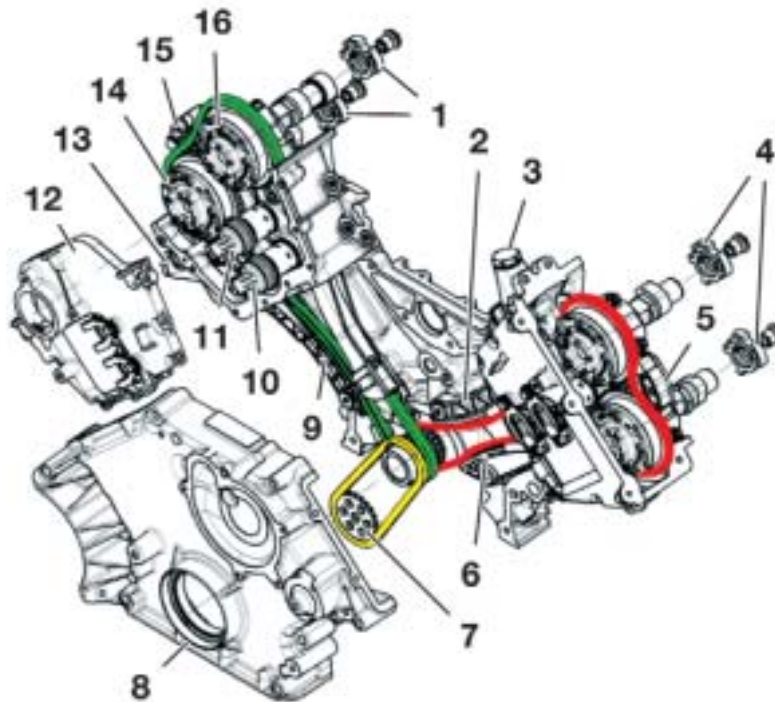
The N62 engine requires a vacuum pump for the vacuum assisted brake booster. With the throttle valve open while the car is being driven, additional vacuum is needed.

The N62 vacuum pump has a second vacuum connection (small hose) for the exhaust flap adjustment. The vacuum pump is driven by cylinders 1-4 exhaust camshaft via the VANOS unit. The pump is lubricated through an oil gallery from the cylinder head.



## Chain Drive

The camshafts are driven by a toothed chain, one for each cylinder bank. The oil pump is driven by a separate roller chain.



Chain Drive

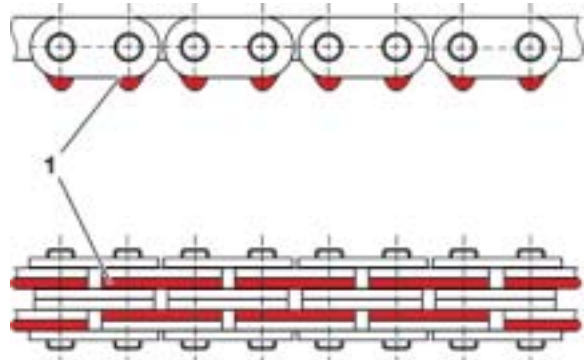
43-02-50

1. Sensor wheels for the camshaft position sensor, cylinder bank 1-4
2. Tensioner Rail, Cylinder 5-8
3. Chain Tensioner, Cylinder Bank 5-8
4. Sensor Wheel for the camshaft position sensor, cylinder bank 5-8
5. Upper timing chain guide with integrated oil jet
6. Guide rail
7. Sprocket for Oil Pump Drive
8. Timing case lower section
9. Tensioning rail, cylinder bank 1-4
10. Solenoid Valve, VANOS exhaust camshaft
11. Solenoid Valve, VANOS intake camshaft
12. Upper Timing Chain Cover
13. Chain Tensioner, Cylinder Bank 1-4
14. VANOS exhaust camshaft Bank 1-4
15. Upper Timing Chain guide with integrated oil jet
16. VANOS intake camshaft 1-4

## Toothed Chain

The camshafts are driven by the crankshaft using newly developed maintenance free toothed chains.

The toothed chain gear wheels are located on the crankshaft and on the VANOS unit. Use of the new toothed chains (1) optimizes the drive chain rolling process and reduces noise.



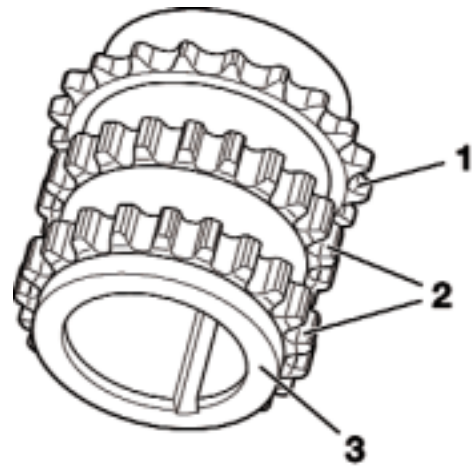
42-02-51

## Crankshaft Sprocket

The crankshaft sprocket (3) has three sets of gear teeth:

1. One roller chain gear wheel for the oil pump drive.
2. Two toothed chain gear wheels for the camshaft drives.

**Note:** The sprocket will also be fitted to a 12-cylinder engine variant which will be available in the future. Please observe the installation instructions and the relevant labels (V8 Front/V12 Front) when installing the sprocket.



42-02-52

## Chain Tensioner (cylinder bank 1-4)

A chain tensioner is mounted in the side of the cylinder head for each camshaft drive chain. There is a guide ball in the chain tensioner tip that moves in an arched groove in the tensioning rail.

The tensioner seal must be replaced each time the tensioner is disassembled. The tensioners are the same for both the left and the right cylinder heads.

1. Chain Tensioner
2. Tensioning Rail
3. Bearing Pin



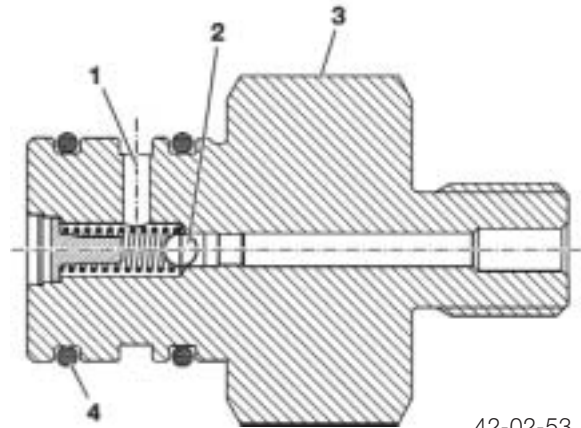
42-02-55

Chain Tensioner

## Tensioning Rail Bearing Pin

The bearing pin for the cylinder bank 1-4 drive chain tensioning rail is hollowed. There is a ball (check) valve in the bearing pin. The valve opens at an oil pressure of 1 bar and allows engine oil to flow to the tensioning rail via a port (1).

1. Engine Oil Port to Tensioning Rail
2. Ball (check) Valve
3. Bearing Pin
4. Sealing Rings for Sealing the Tensioning Rail



42-02-53

Tensioning Rail Bearing Pin

## Chain Tensioner (cylinder bank 5-8)

An oil jet has been fitted to lubricate the cylinder bank 5-8 drive chain. There is a valve in the oil jet which opens at a pressure of 1 bar and supplies the drive chain with engine oil.

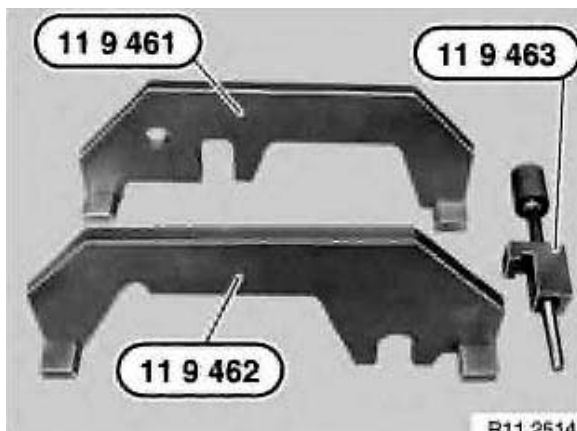
1. Chain Tensioner
2. Tensioning Rail
3. Oil Jet



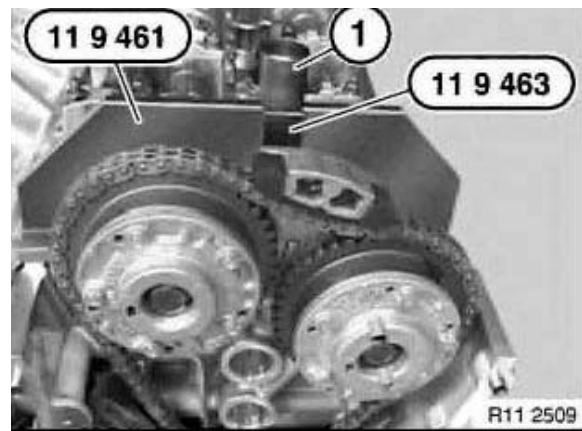
42-02-54

Chain Tensioner

**Note:** Refer to the Repair Instructions when using the Special Tools shown below to adjust the camshaft timing.



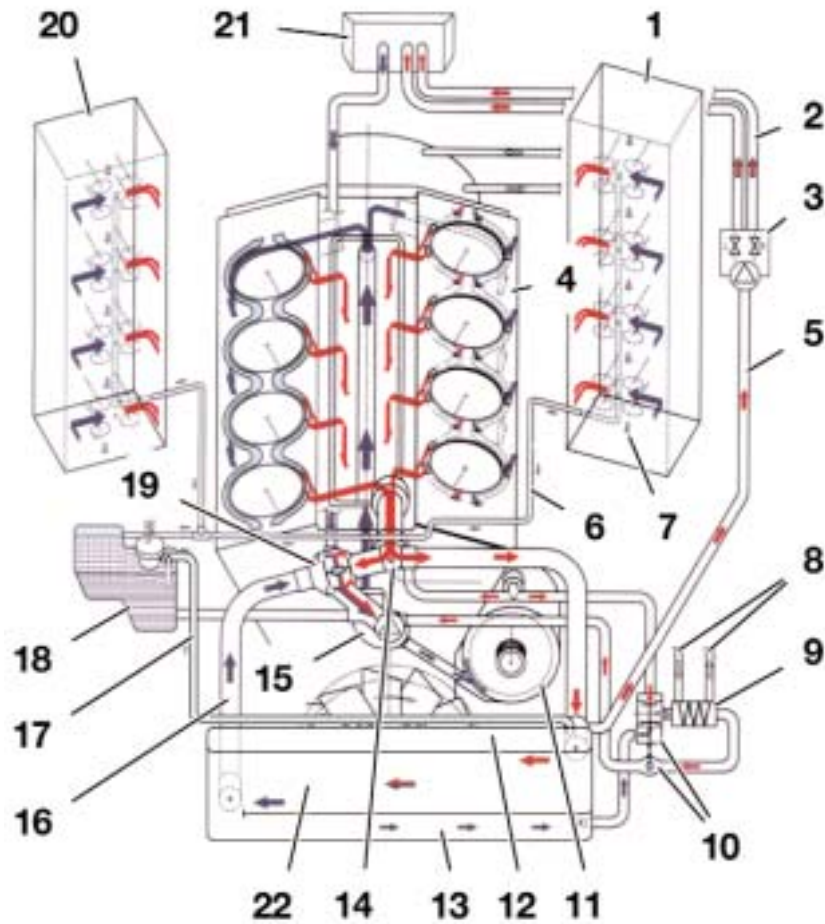
R11 2514  
42-02-78



R11 2509  
42-02-79

# Cooling System

## Coolant Circuit - 14 Liter Coolant Capacity



42-02-56

**Cooling System (Circuit Flow)**

- |  |   |
|--|---|
| 1. Cylinder Head Bank 5-8                                | 12. Radiator                              |
| 2. Coolant Supply (heater core)                          | 13. Radiator Partition (low temp section) |
| 3. Water valve with electric water pump                  | 14. Temperature Sensor                    |
| 4. Cylinder Head Gasket                                  | 15. Water Pump                            |
| 5. Coolant Supply Line                                   | 16. Radiator Return Flow                  |
| 6. Cylinder Head Ventilation Lines                       | 17. Radiator Ventilation Line             |
| 7. Hole (crankcase venting system)                       | 18. Expansion Tank                        |
| 8. Transmission oil lines                                | 19. Thermostat                            |
| 9. Oil/water heater exchanger for automatic transmission | 20. Cylinder Head Bank 1-4                |
| 10. Thermostat for transmission oil heat exchanger       | 21. Vehicle Heater                        |
| 11. Alternator Housing                                   | 22. Radiator (High Temperature Area)      |



## Coolant Circuit

The coolant flow has been optimized allowing the engine to warm up as quickly as possible after a cold start as well as even and sufficient engine cooling while the engine is running. The cylinder heads are supplied with coolant in a cross-flow pattern. This ensures more even temperature distribution to all cylinders. The cooling system ventilation has been improved and is enhanced by using ventilation ports in the cylinder heads and in the radiator. The air in the cooling system accumulates in the expansion tank. When a pressure of 2 bar is reached in the expansion tank, the air is bled out by the pressure relief valve in the reservoir cap.

**Note:** The ventilation ports in the front of the cylinder heads provide quicker “self bleeding” during a routine coolant exchange. The complex cooling system and the small ventilation ports require that time should be allowed after the cooling system has been filled for the air to escape.

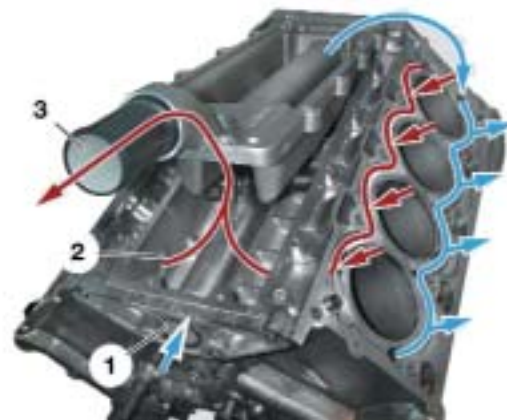
## Coolant flow in the Engine Block

The coolant flows from the water pump through the feed pipe (1) in the engine's V and to the rear of the engine block. This area has a cast aluminum cover (see following illustration). From the rear of the engine, the coolant flows to the external cylinder walls and from there into the cylinder heads.

The coolant then flows from the cylinder heads into the engine block V and through the return connection (3) to the thermostat housing. When the coolant is cold it flows from the thermostat (closed) directly into the water pump and back to the engine (recirculating for faster warm up).

When the engine reaches operating temperature (85 °C-110 °C), the thermostat opens the entire cooling circuit to include the radiator.

1. Coolant from the water pump through the feed pipe to the rear of the engine.
2. Coolant from the cylinder walls to the thermostat housing.
3. Return connection to water pump/thermostat.



42-02-57

**Engine Block Coolant Flow**

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The coolant flows to the rear of the engine block, from there through the side channels to the cylinder walls and then into the cylinder heads (lower left picture). The cast aluminum cover at the rear of the engine block (with sealing bead) is shown on the lower right.



42-02-59

## Water Pump/Thermostat Housing

The water pump is combined with the thermostat housing and is bolted to the timing case lower section.

1. Map-controlled thermostat (radiator cool return flow).
2. Electrical connection for Thermostat Heating element.
3. Thermostat Mixing Chamber
4. Temperature Sensor (hot coolant from engine)
5. Radiator in-flow (hot coolant from engine)
6. Heat exchanger (transmission oil return flow)
7. Leakage Chamber (evaporation space)
8. Alternator in-flow (cool supply)
9. Water Pump
10. Expansion Tank Connection



**Water Pump / Thermostat Housing**

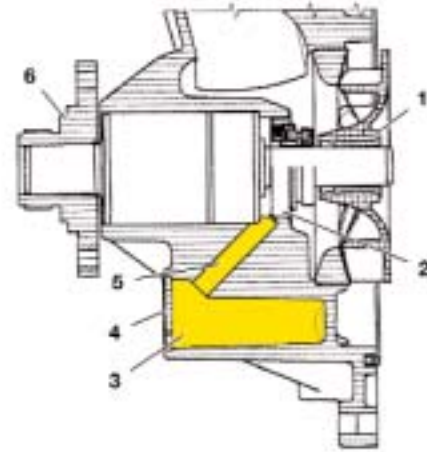
**Caution during installation of the water pump:** The impeller is made from reinforced plastic.

## Leakage Restraint System in the Water Pump

The water pump has a leakage restraint system for the functional leakage from the pump shaft piston ring type seal. The coolant which escapes through the pump shaft sliding ring seal usually accumulates and evaporates through a hold in the leakage chamber (evaporation area).

If the sliding ring seal is faulty, the leakage chamber fills completely with coolant. Sliding ring seal leakages can be detected by monitoring the fluid level in the leakage chamber (inspection hole).

1. Impeller
2. Sliding Ring Seal
3. Leakage Chamber / Evaporation Space
4. Leakage Chamber Cover
5. Delivery from the sliding ring seal to the leakage chamber
6. Hub of pulley and viscous clutch



Water Pump

42-02-61

**Note:** In the past, fully functional water pumps were often replaced because the functional sliding ring seal leakage which is necessary for water pump operation resulted in evaporation residues being left on the external walls of the water pump.

The leakage restraint system has the advantage in that the coolant escaping from the sliding ring seal (normal, functional leakage) evaporates without a trace and cannot be mistakenly identified as a water pump defect during visual inspections.

## Timing Chain Cover Lower Section

The waterpump mounts to the lower section to channel coolant to the engine block.

1. Coolant to Engine
2. Rear Water Pump Housing in Lower Section
3. Mount for Drive Belt Tensioner Pulley
4. Crankshaft Radial Seal



Timing Chain Cover Lower Section

42-02-62

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## Map-controlled Thermostat

The map-controlled thermostat allows the engine to be cooled relevant to operating conditions. This reduces fuel consumption by approximately 1-6%. The electrical connections, the design and the map-controlled thermostat response have been enhanced. The map-controlled thermostat function is the same as previous engines (M62).

1. Radiator Return Flow To Thermostat
2. Connection for Thermostat Heating Element
3. Temperature Sensor
4. Radiator in-flow (hot coolant from engine)



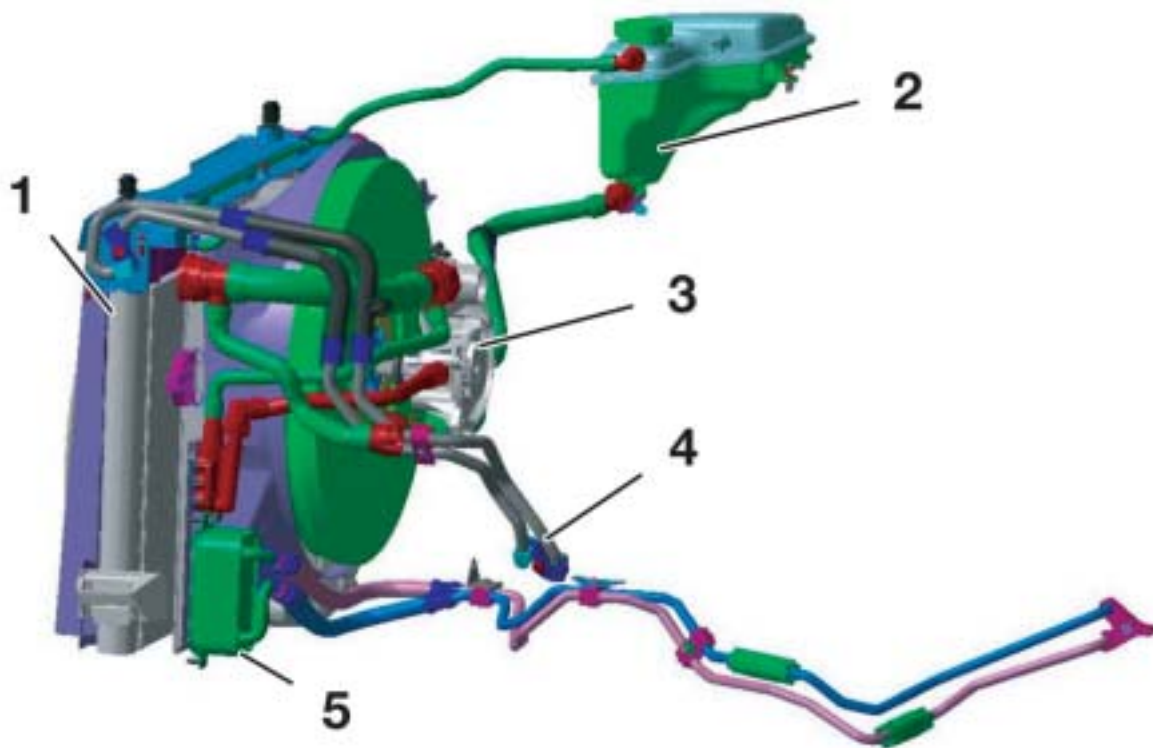
**Maped-Controlled Thermostat**

## Cooling Module

The cooling module contains the following main cooling system components:

- Cooling radiator
- Air conditioning condenser
- Transmission oil/water heat exchanger
- Hydraulic fluid radiator
- Engine oil radiator
- Main electric fan
- Fan shroud for viscous coupling fan

All the components (with the exception of the transmission oil radiator) can be removed for repairs without disassembling any other coolant circuit. All connections have been fitted with the quick-release coupling which are used in current models.



**Cooling Components**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1. Cooling Radiator</li> <li>2. Expansion Tank</li> <li>3. Water Pump</li> </ul> | <ul style="list-style-type: none"> <li>4. Engine oil/air heat exchanger connection<br/>(hot countries only)</li> <li>5. Transmission oil/coolant heat exchanger</li> </ul> |
|---|--|

## Cooling Radiator

The radiator is made from aluminum and is divided into a high-temperature section and a low-temperature section by a partition wall (see coolant circuit diagram). The coolant first flows into the high-temperature section and then back to the engine, cooled.

Some of the coolant flows through an opening in the radiator partition wall to the low-temperature section where it is cooled further. The coolant then flows from the low-temperature section (when the ÖWT thermostat is open) into the oil/coolant heat exchanger.

## Coolant Expansion Tank

The expansion tank is mounted on the right hand wheel housing (engine compartment). **Note:** The expansion tank should never be filled above the Max marking. Excess coolant is expelled by the pressure relief valve in the cap as it heats up. Avoid overfilling the expansion tank because the cooling circuit design ensures very good “self bleeding”.

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## **Transmission Oil/Coolant Heat Exchanger**

The transmission oil/coolant heat exchanger ensures that the transmission oil is heated up quickly and also that it is appropriately cooled. When the engine is cold, the transmission oil/coolant heat exchanger thermostat switches into the engine's recirculated coolant circuit. This allows the transmission oil to heat up as quickly as possible (with the engine coolant).

When the return flow water temperature reaches 82 °C, the thermostat switches the transmission oil/coolant heat exchanger to the low-temperature coolant radiator circuit (refer to the cooling circuit diagram) to cool the transmission oil.

## **Electrically Operated Fan**

The electric fan is integrated in the cooling module and is mounted directly in front of the radiator. The speed is regulated by the ECM.

## **Viscous Coupling Fan**

The viscous coupling fan is driven by the water pump. The noise output and the performance of the fan coupling and the fan wheel have been optimized as compared with the E38M62. The viscous coupling fan is used as the final level of cooling and switches on at an air temperature of 92 °C.

**Notes:**

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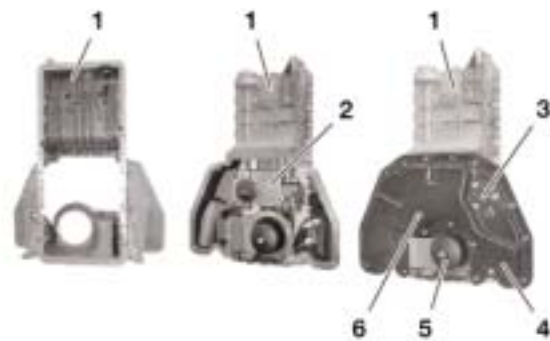
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## Engine Block

### Oil Sump

The oil sump consists of two parts. The upper section of the oil sump is made from cast aluminum and is sealed to the crankcase with a rubber-coated sheet steel gasket. This section of the oil sump has a cross shaped cut out oil filter element recess. The upper section of the oil sump is inter connected to the oil pump and is sealed with a sealing ring. The double panel (noise insulation) lower section of the oil sump is flanged to the upper section of the oil sump.

1. Upper Section of The Oil Sump
2. Oil Pump
3. Oil Level / Condition Sensor
4. Lower Section of The Oil Sump
5. Oil Filter Housing
6. Oil Drain Plug



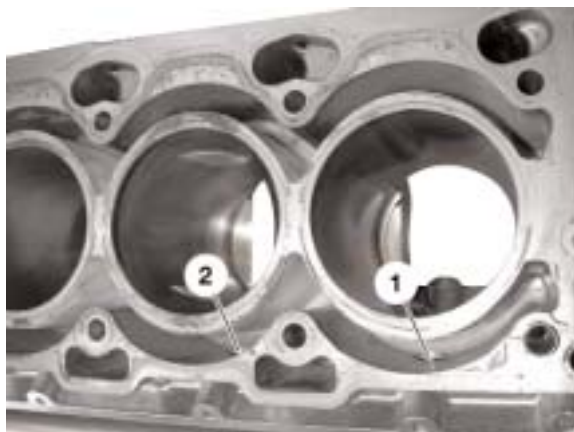
Oil Sump Components

42-03-65

### Crankcase

The crankcase has a one-piece “open deck” design and is made entirely from AluSil. The cylinder walls are hardened using a specific procedure (exposure honing). Exposure honing involves treating the cylinders with a special “soft stripping”. This removes the aluminum from the cylinder surface and the hard silicone particles remain.

*Open Deck = Exposed cylinder coolant chamber*



42-02-67

1. Flow to engine “V” (return coolant collection area)



42-03-66

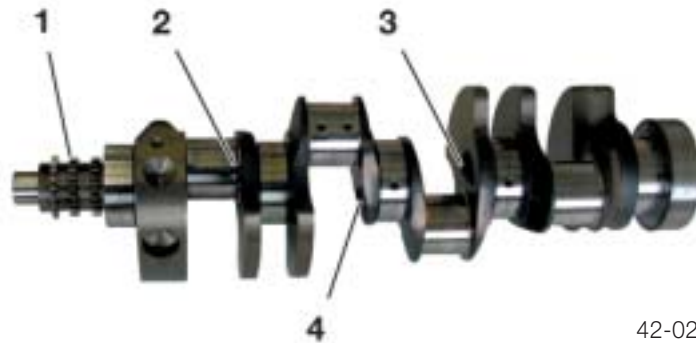
2. External cylinder bank wall

## Crankshaft

The N62 uses an inductively hardened cast-iron crankshaft. The crankshaft has five main bearings (familiar 4 bolt cast iron caps) and is hollowed around bearing journals 2, 3, and 4 for weight reduction. The fifth bearing is also the “thrust” bearing.

The crankshaft stroke for the B44 is 82.7 mm.

1. Crankshaft Sprocket
- 2-4. Hollowed Area (Weight Reduction)



Crankshaft

42-02-68

## Crankshaft Thrust Bearing

The thrust bearing halves are multiple pieces that are assembled as one part for the the number five main bearing at the rear of the engine. The bearing thickness conforms to the familiar triple classification system (yellow - green - white).



42-02-70

## Piston and Connecting Rod

The reduced weight cast piston contains integrated valve reliefs in the piston crown. The pistons are made from high-temperature aluminum alloy equipped with three piston rings.

- First piston ring groove = square ring
- Second piston ring groove = taperface ring
- Third piston ring groove = three-part oil control ring

The forged steel connecting rod and cap is separated by the familiar “cracked” process. The connecting rod (large end) is angled at 30° allowing sufficient articulation in a very compact space. The pistons are cooled by oil jets spraying under the exhaust side of the piston crown.



42-03-70



## Flywheel

The lightweight flywheel is made from a laminated plate. The starter ring gear is also the increment wheel for engine speed and crankshaft positioning/misfire detection.

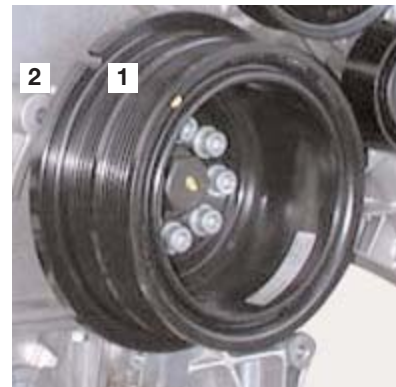
The ring gear is riveted directly to the flexplate (6). The flywheel diameter is 320 mm.



## Vibration Damper

The vibration damper is a torsional vibration absorber (axial design). The outer edge of the damper has a notch (1) to accept the locating tool when positioning the crankshaft for initial setting.

The locating tool inserts into the raised mount in the front cover (2). *Refer to the Repair Instructions for the proper engine timing procedure.*



## Engine Mounting

The engine is secured by two hydraulic damping mounts that are located on the front axle carrier (structure and function are the same as the E38/M62).

*Notes:* \_\_\_\_\_

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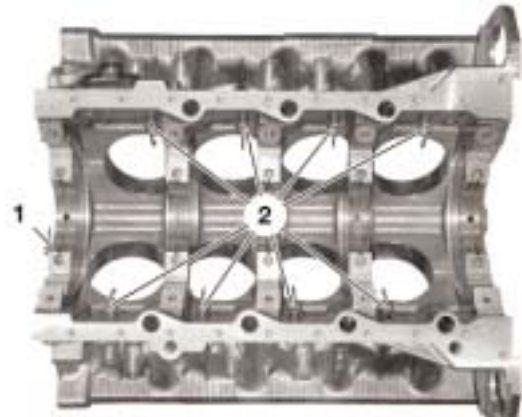
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## Lubrication System

### Crankcase with oil jets

1. Oil Jet for Drive Chain Cylinder Bank 5-8
2. Oil Jets for Piston Cooling



**Crankcase with Oil Jets**

42-02-71

The engine oil is supplied by the oil pump to the lubrication points in the engine block and is pumped into the cylinder heads. The following components in the crankcase and cylinder head are supplied with engine oil:

#### Crankcase

- Crankshaft bearings
- Oil jets for piston cooling
- Oil jet for the drive chain (bank 5-8)
- Tensioning rail for drive chain (bank 1-4)

#### Cylinder head

- Chain tensioner
- Guide rail on cylinder head
- Hydraulic valve adjustment elements (HVA)
- VANOS supply
- Camshaft bearings
- Overhead oil tubes for the valve gear

### Oil Check Valves

Three oil check valves are inserted into each cylinder head from the outside. This prevents the engine oil from draining out of the cylinder head and the VANOS units.

*The check valves are accessible from the outside, therefore; cylinder head removal is not necessary when changing the check valves.*

1. Oil Check Valve for VANOS Intake
2. Oil Check Valve for VANOS Exhaust
3. Oil Check Valve for Cylinder Head Oil Supply



**Oil Check Valves**

42-02-72

*Note: The oil check valves are different in design and should not be mixed up on installation.*



42-02-73

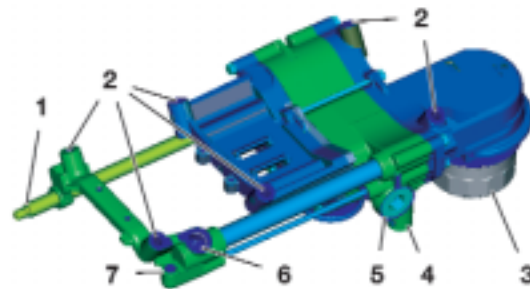
## Oil Pressure Switch

The oil pressure switch is located on the side in the bank 1-4 cylinder head.

## Oil Pump

The oil pump is mounted at an angle to the crankshaft bearing cap and is driven by the crankshaft using a roller chain. The oil pump is a two-stage gear oil pump with two parallel switched gear clusters.

1. Drive Shaft
2. Mounting Points
3. Oil Filter
4. Pressure Relief Valve (over 15 Bar)
5. Control Valve (Pump Stage/Pressure Control)
6. Oil supply from the oil pump to the engine
7. Oil pressure control tube from the engine to the control valve.



42-02-75

**Oil Pump**

The two pair of gear clusters are stacked one behind the other and work in two stages.

Stage two (both pump supply circuits) is only active in the lower engine speed range up to approx. 2,000 rpm to provide sufficient oil pressure for the VANOS at high oil temperatures.

Stage two is deactivated hydraulically at a pressure of 2 bar.

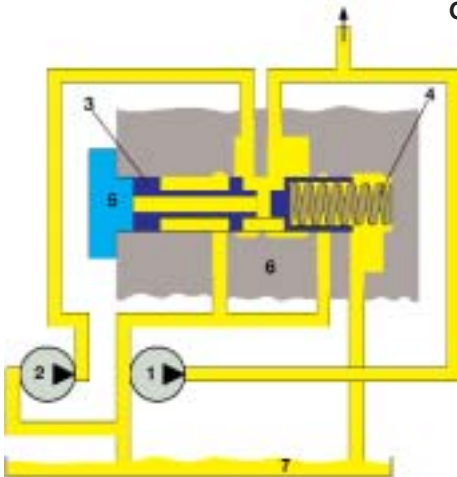


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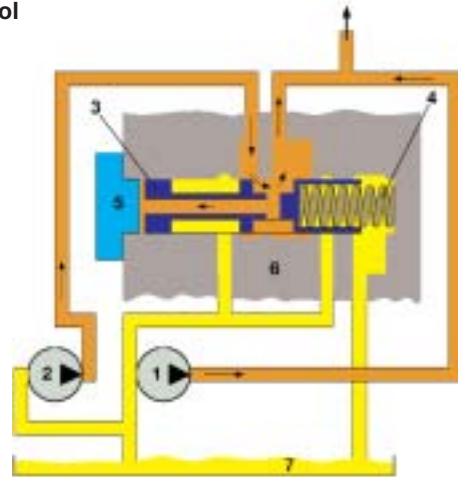
## Oil Pressure Control

1. Oil Pump Stage 1
2. Oil Pump Stage 2
3. Pressure Control Valve Piston
4. Pressure Control Valve Spring
5. Sealing Plug
6. Oil Pump Housing
7. Oil Sump

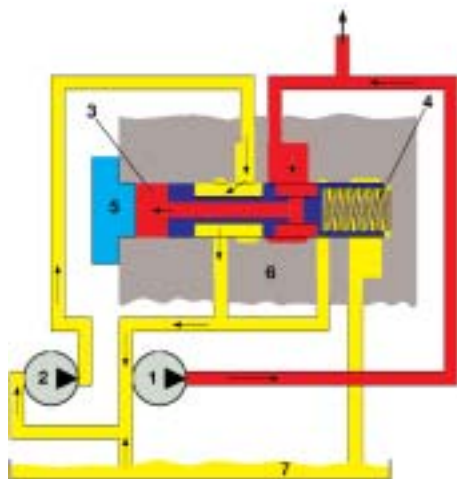
### Oil Pressure Control



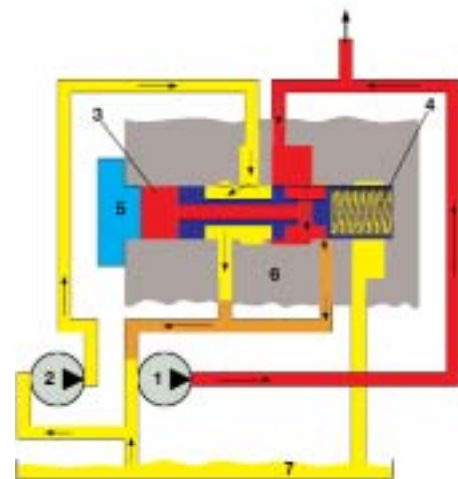
*Oil pressure control valve in initial position, without pressure.*



*Stage two = Both pump supply circuits activated with oil pressure less than 2 bar.*



*Stage two deactivated = Oil pressure above 2 bar, pressure control valve opens channel for stage two to oil sump.*



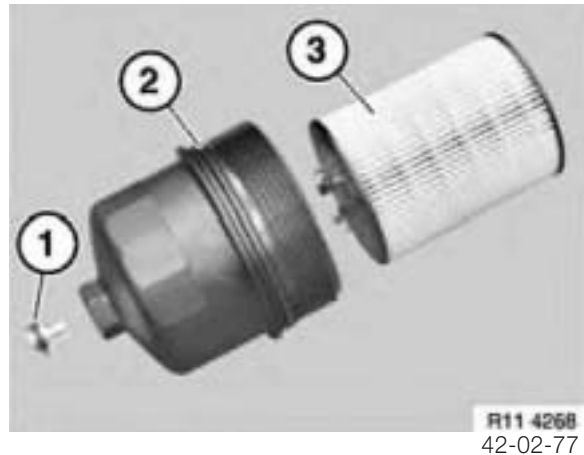
*Main pressure control = Oil pressure above 6 bar, pressure control valve opens channel for stage one (slightly) to oil sump relieving excessive pressure.*

## Oil Filter

The canister type oil filter (3) is located under the engine by the oil sump. The support for the oil filter is integrated in the rear oil pump cover.

The oil filter housing (2 with o-ring) is threaded into the rear of the oil pump cover through an opening in the oil sump.

*A drain plug is integrated in the oil filter housing for draining the filter assembly before the housing is removed (1 with o-ring).*



The filter element support dome contains an over pressure relief valve. If the filter element is blocked, this valve bypasses unfiltered engine oil around the element to the supply lubrication to the engine.

## Pressure Control

The oil pressure control valve in the oil pump has two functions:

1. Deactivates stage two oil pump circuit above 2 bar. Stage two is only active in the lower speed range. This is to ensure that there is always sufficient oil pressure for the VANOS units even at high oil temperatures and low speeds. The oil pump power consumption is reduced by deactivating stage two.
2. Monitoring the required oil pressure for the engine. The piston in the control valve is moved by a spring against the engine control pressure which is returning from the engine. This means that precise monitoring of the actual engine oil pressure is possible.

*A separate pressure relief valve in the oil pump automatically opens at the maximum pressure of approximately 15 bar. This prevents damage in the oil pump especially at low oil temperatures.*

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## Oil Cooling (if equipped)

An oil cooler is used in hot countries. The oil cooler is located in front of the radiator above the A/C condenser. The engine oil flows from the oil pump through a channel in the crankcase to a connection on the generator support. The generator support has an oil thermostat. A wax element in the oil thermostat continuously opens the inflow to the oil cooler when the oil temperature is between 100 °C to 130 °C.

Some of the engine oil always flows past the oil thermostat and through the engine without being cooled, even when the oil thermostat is fully open. This ensures a minimum amount of oil is supplied when the cooler is faulty. A modified generator support, without connections for the oil thermostat, is fitted to vehicles which do not have an oil cooler.

## Technical Data - Lubrication System

### The recommended oil is BMW High Performance 5W-30 Synthetic Oil

\* P/N 07 51 0 017 866

Oil Capacity in Liters	Explanation
8.0	Filling Capacity for Service with Oil Filter Change

Oil Pressure	Explanation
1.0	Minimum Oil Pressure at 20°C
4.0 - 8.0 Bar	Maximum Oil Pressure at 20°C

Oil Delivery Capacity	Explanation
9-12 l/Min	At Idle Speed (700 rpm) at 20°C
50-55 l/Min	At Maximum Engine Speed (6500 rpm) and 20°C

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## Review Questions

1. What is the function of the throttle valve? \_\_\_\_\_  
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2. What are the conditions that will result in stage two oil supply? \_\_\_\_\_  
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3. What does the term “cracked” connecting rod mean? \_\_\_\_\_  
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4. What does the low temperature area refer to in the cooling system? \_\_\_\_\_  
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5. What is the difference between the left and right drive chain tensioning assemblies?  
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6. How is the funnel adjustment made on the 5-8 Variable intake manifold if only one actuating motor is used? \_\_\_\_\_  
\_\_\_\_\_
7. What is minimum and maximum valve lift provided by the Valvetronic system?  
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8. What is chamber A and chamber B used for in the Bi-VANOS system? \_\_\_\_\_  
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9. What retains the initial VANOS sprocket to hub position when oil pressure is not present? \_\_\_\_\_  
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10. How should the drive belt be removed? \_\_\_\_\_  
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