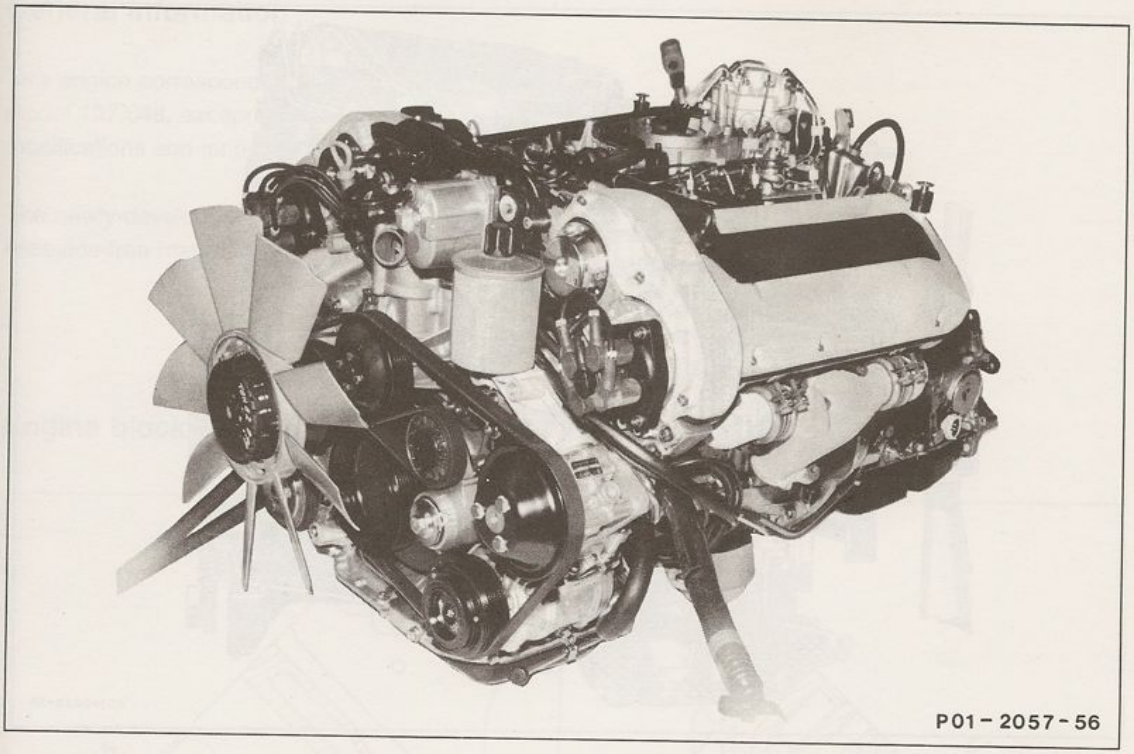
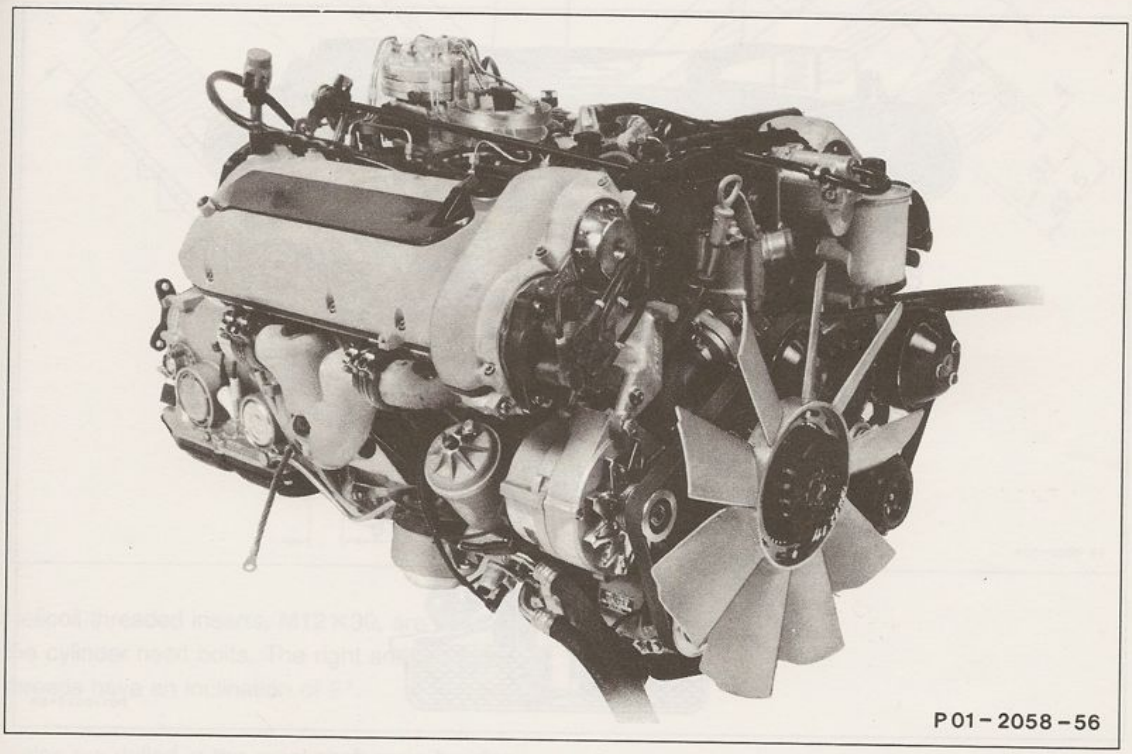
Engine views

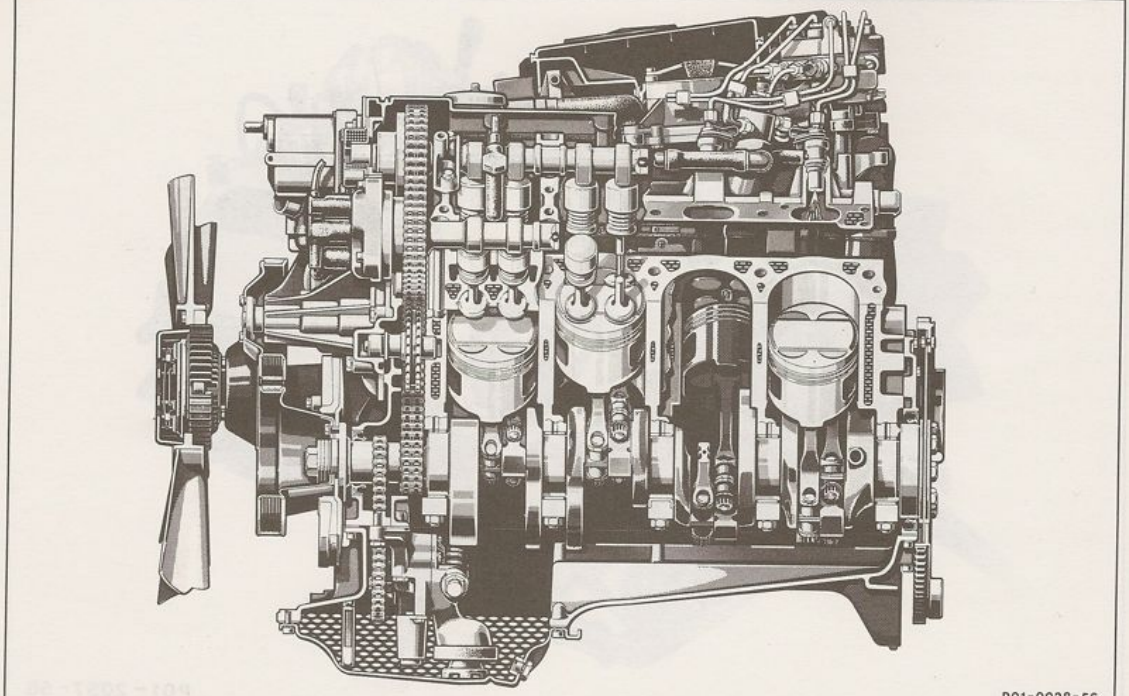


P01-2057-56

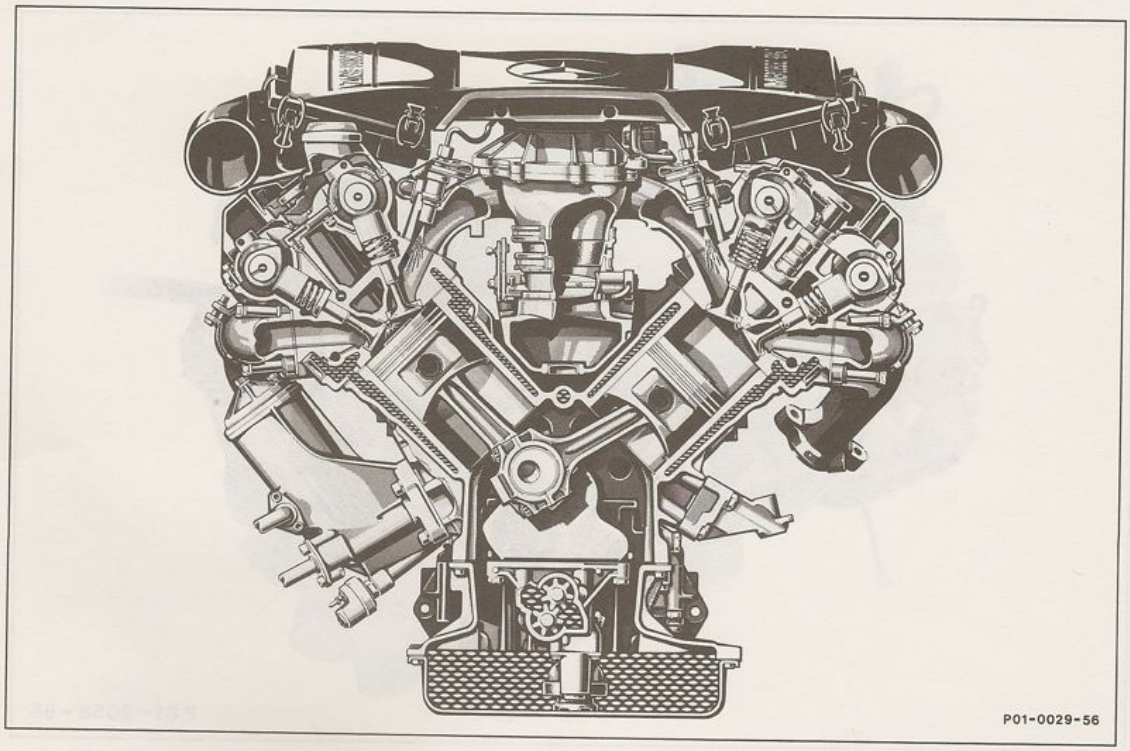


P01-2058-56

Longitudinal and cross-sectional views



P01-0028-56



P01-0029-56

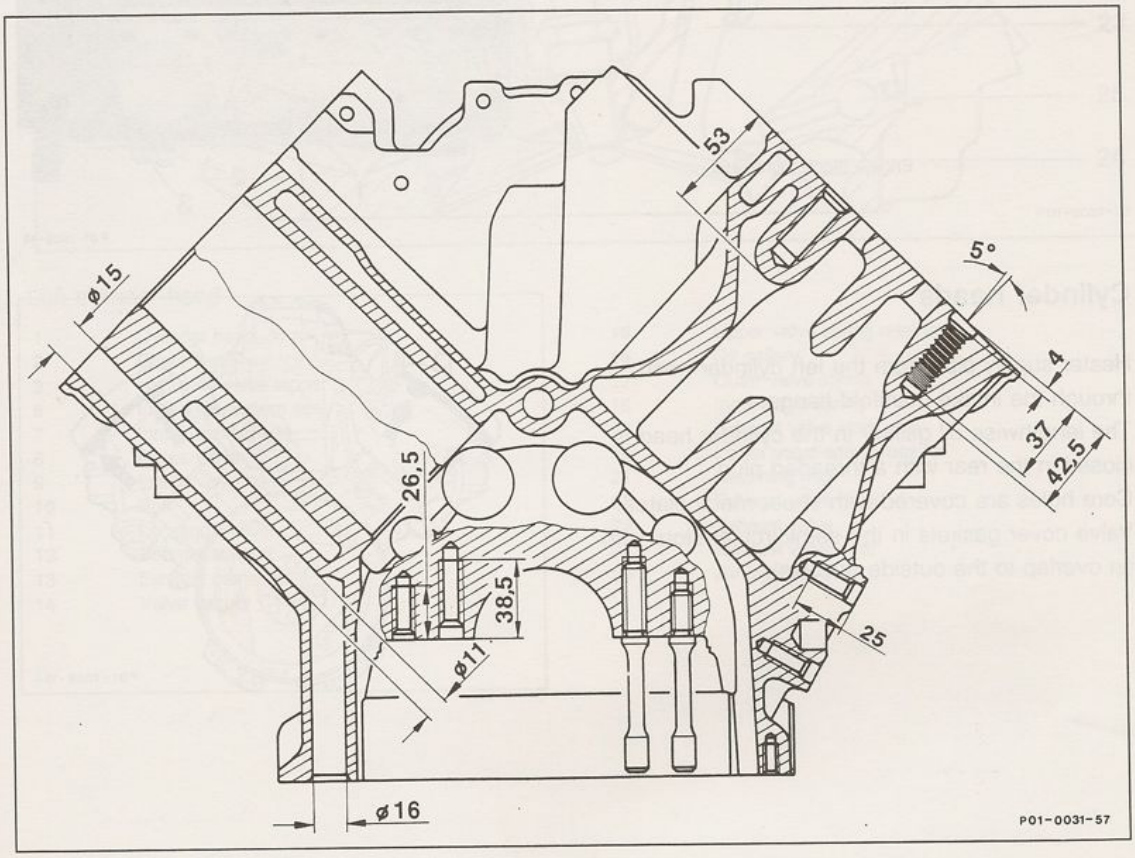
Engine block, cylinder head, crankcase ventilation

General information

This engine corresponds to engine 117.967 in model 107.048, except for the important modifications and innovations described below.

The newly-developed gaskets are made of an asbestos-free material.

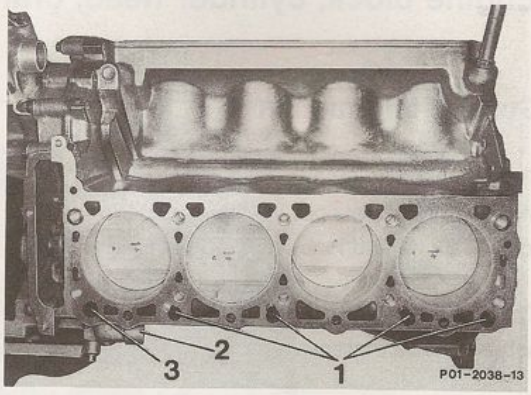
Engine block



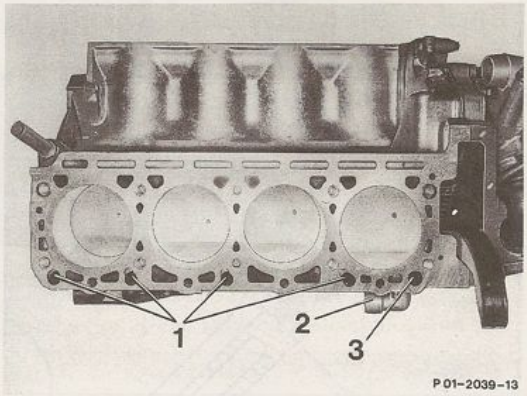
Helicoil threaded inserts, M12 × 30, are used for the cylinder head bolts. The right and left outer threads have an inclination of 5°.

Holes are drilled in the crankshaft main bearing webs to prevent oil foaming.

Lateral oil return bores (1) for the larger volume of return oil. There is a connector (2) with an opening (3) to the cylinder head for air injection. The cylinder head bolt hole pattern has been modified.



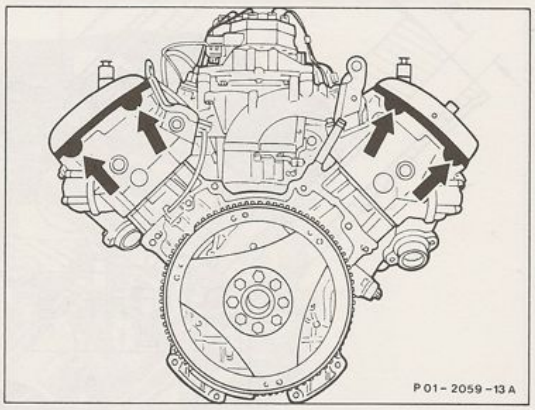
Engine block, left side

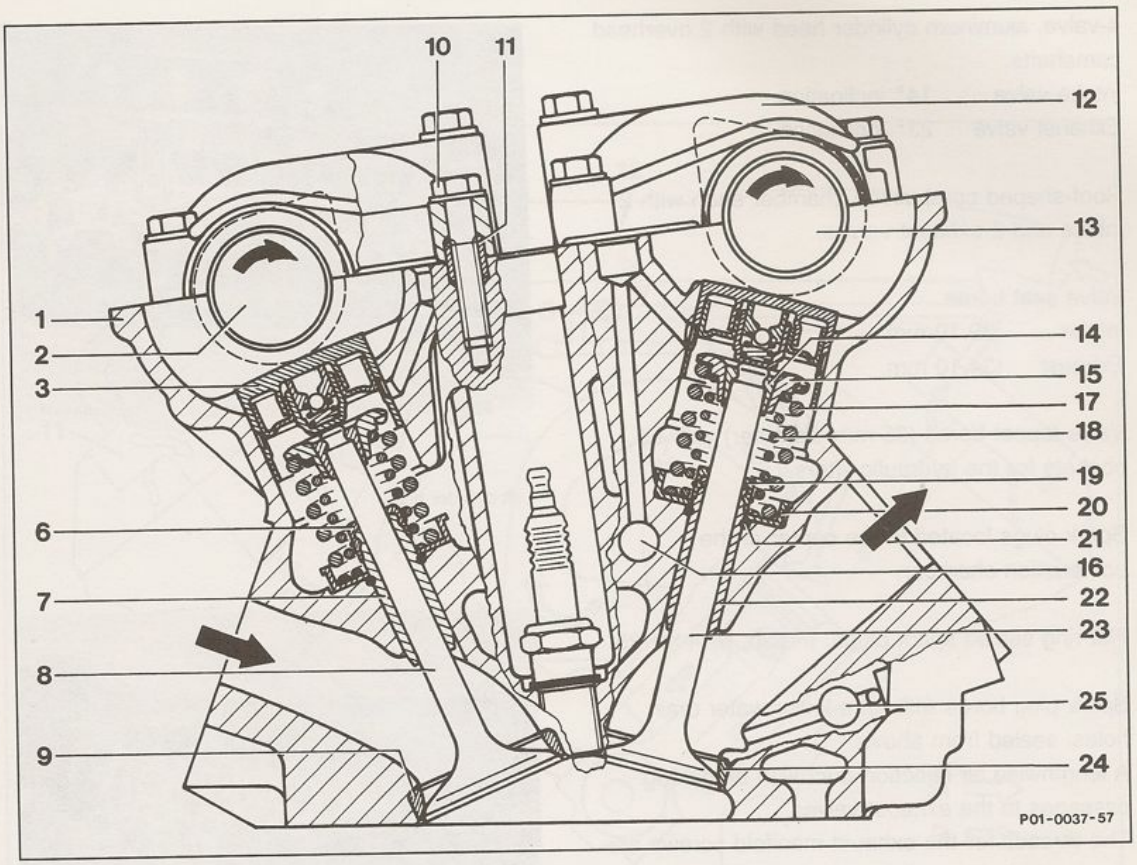


Engine block, right side

Cylinder heads

Heater supply pipe from the left cylinder head, through the intake manifold flange.
The lengthwise oil gallery in the cylinder head is closed in the rear with a threaded plug.
Core holes are covered with sheet metal plates.
Valve cover gaskets in the semicircular slots with an overlap to the outside (arrows).





Left cylinder head

1	Cylinder head
2	Intake camshaft
3	Hydraulic valve tappet
6	Intake valve stem seal
7	Intake valve guide
8	Intake valve
9	Intake valve seat
10	Bolt
11	Locating sleeve
12	Bearing support
13	Exhaust camshaft
14	Valve keeper
15	Upper valve spring retainer
16	Oil gallery
17	Outer valve spring
18	Inner valve spring
19	Exhaust valve stem seal
20	Lower valve spring retainer
21	Retaining ring
22	Exhaust valve guide
23	Exhaust valve
24	Exhaust valve seat
25	Air injection duct

4-valve, aluminum cylinder head with 2 overhead camshafts.
Intake valve 14° inclination
Exhaust valve 23° inclination

Roof-shaped combustion chamber each with 2 intake and 2 exhaust valves.

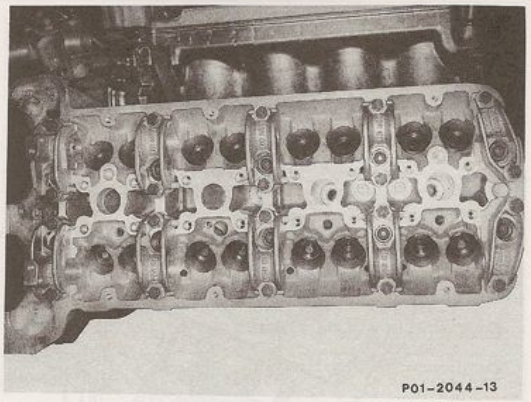
Valve seat bores
Intake 39.10 mm
Exhaust 34.10 mm

Valve tappet bores (35 mm diameter) with oil pockets for the hydraulic lifters.

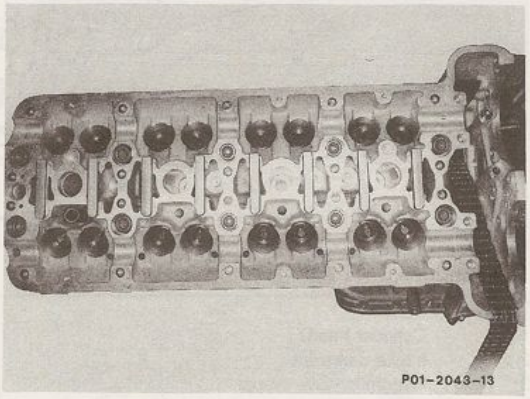
Spark plugs located in the center of the combustion chamber.

Flat ring sealed spark plugs, thread: M14 × 1.25.

Spark plug bores without a lower water drain holes, sealed from above.
A lengthwise air injection duct with branching passages to the exhaust valves.
The threads for the exhaust manifold screws are surrounded with engine coolant through a system of drilled holes. These holes are sealed from the outside with steel balls.



Left cylinder head



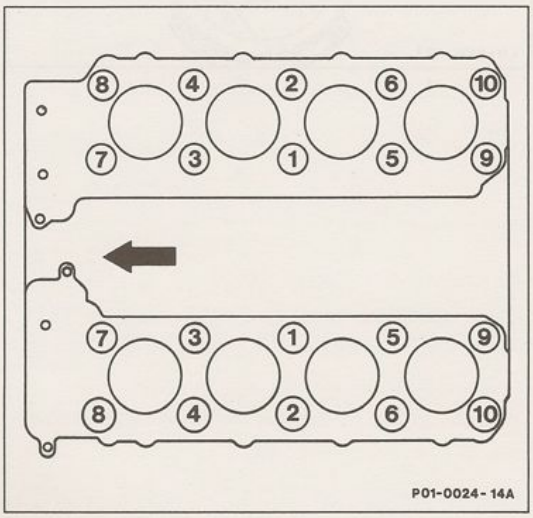
Right cylinder head

Cylinder head bolts

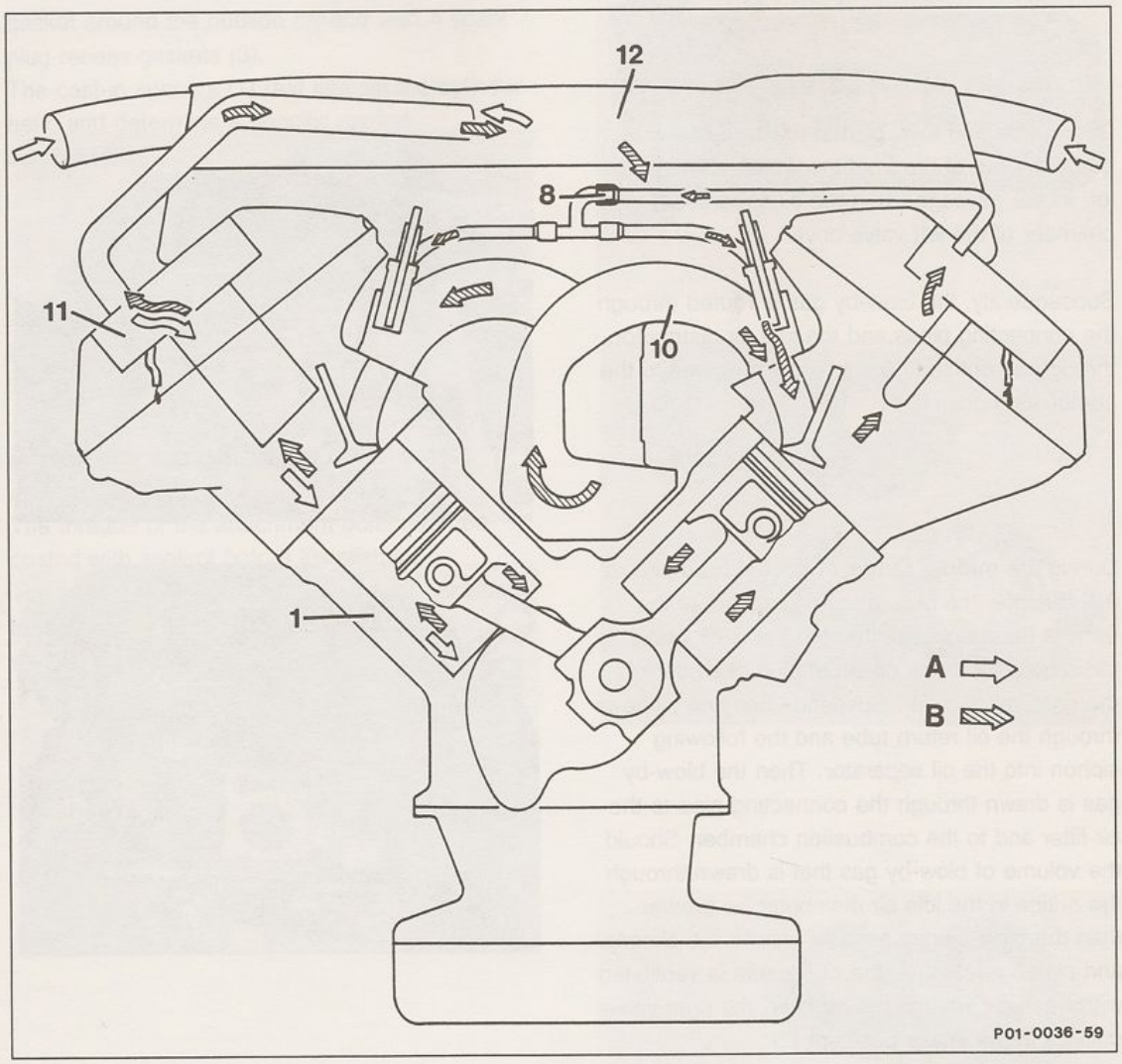
Tightening sequence according to the diagram, beginning with no. 1:

1. Initial torque: 55 Nm
2. Final torque angle: 2 × 90°

Use socket insert no. 119 589 00 01 00 for the cylinder head bolts.



Crankcase ventilation

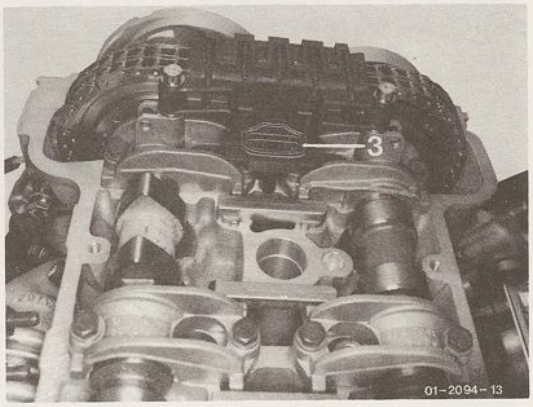


1	Crankcase	12	Air filter
8	Orifice, 1.5 mm diameter	A	Fresh air
11	Oil separation chamber	B	Blow-by gas

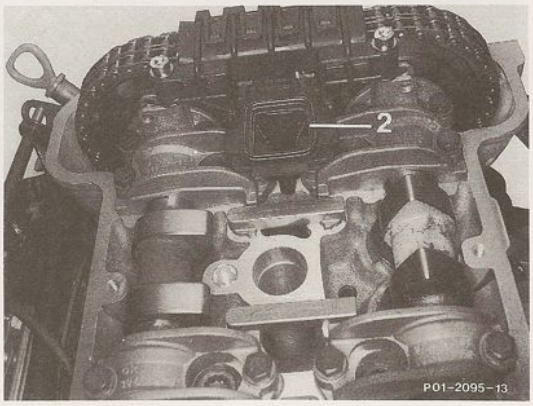
The closed crankcase ventilation system is maintenance-free and ventilates the crankcase with filtered fresh air.

During **idle** and **low, partial load**, the blow-by gas flows out of the front crankcase through the left intake passage (3) in the oil separation chamber of the left valve cover.

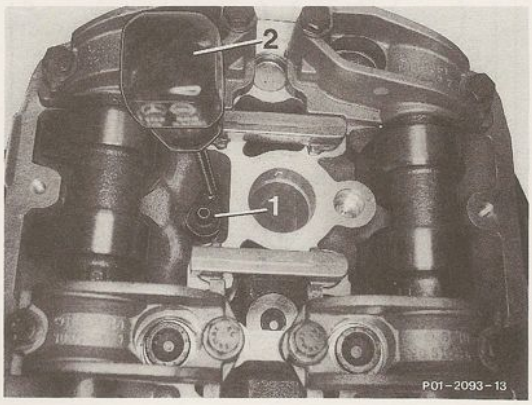
Subsequently, the blow-by gas is routed through the connecting pipes and the idle air distributor, through an orifice (1.5 mm diameter), and to the combustion chamber.



During the **middle range of partial load** and at **full throttle**, the blow-by gas flows out of the front of the crankcase through the right intake passage (2) into the oil separation chamber of the right valve cover. Suspended engine oil flows through the oil return tube and the following siphon into the oil separator. Then the blow-by gas is drawn through the connecting pipe to the air filter and to the combustion chamber. Should the volume of blow-by gas that is drawn through the orifice in the idle air distributor be greater than the blow-by gas passing around the pistons and piston rings, then the crankcase is ventilated with fresh air through the air filter, the right valve cover and the intake passage (2).

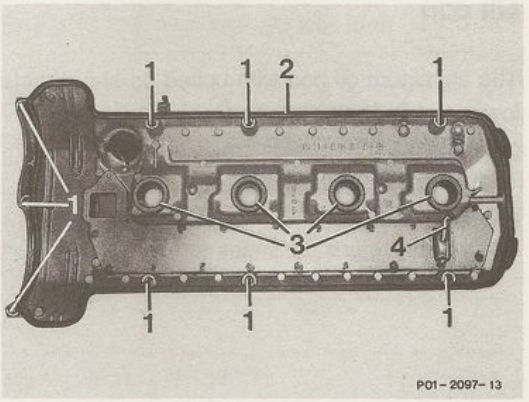


The return oil flows from the right oil separator chamber of the valve cover through an oil separator (1) to remove the foam. The oil separator with the attached rubber funnel is placed in a oil return passage of the cylinder head and can be removed with puller (2) 102 589 03 33 00.



Valve covers

The valve covers are sealed with a molded gasket around the outside (2) and with 4 spark plug recess gaskets (3).
The cast-in spacers (1) rest against the cylinder head and determine a specific gasket compression.

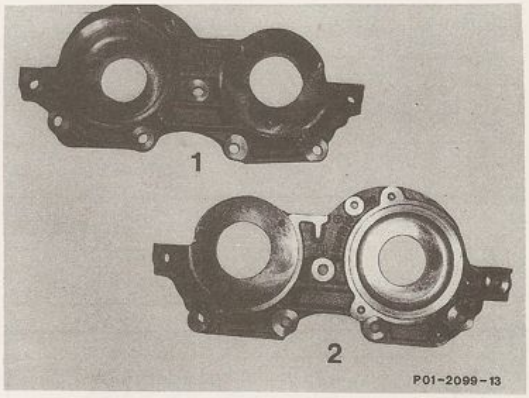


Right valve cover

4 Oil return passage

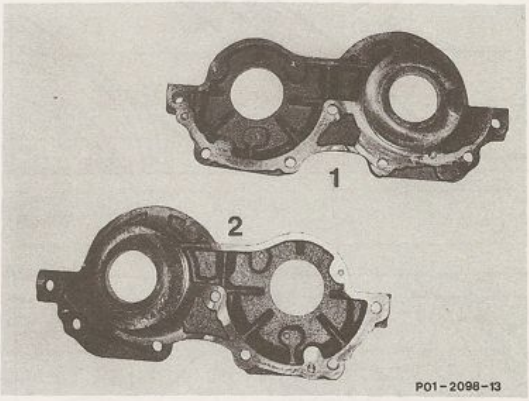
Upper front cover

The front covers are each located with 2 roll pins, sealed with sealant and bolted to the cylinder head.
The threads of the attachment bolts must be coated with sealant before installation.
The radial sealing ring for the exhaust camshaft is pressed in up to the stop. The solenoid is sealed with sealant.



Front cover, outside

1 Right
2 Left

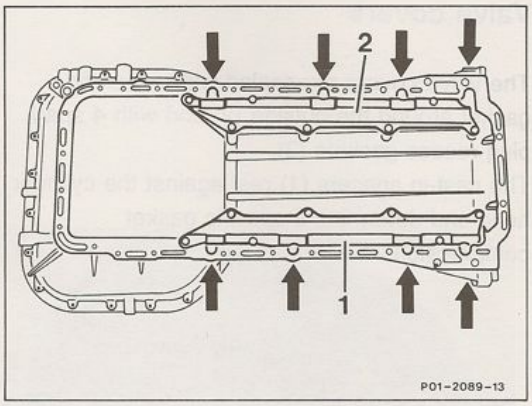


Front cover, inside

1 Right
2 Left

Oil pan

The aluminum oil pan with bolted on sheet metal lower pan is sealed to the crankcase with a gasket.
The bolted-on oil baffles, (1) left and (2) right, prevent foaming of the engine oil returning through the return passages (arrows).



Crankshaft and pistons

Connecting rods

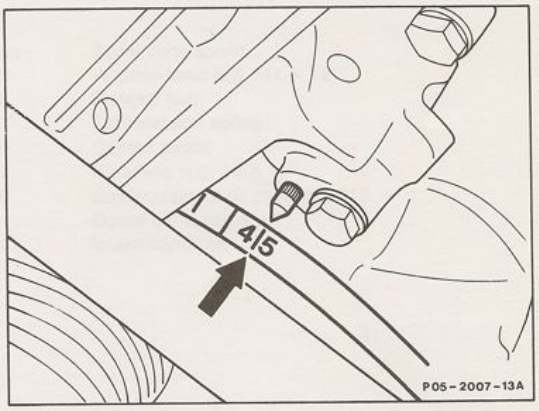
Forged connecting rods with a lengthwise bore (4 mm diameter) for oil spray cooling of the pistons.

Pistons

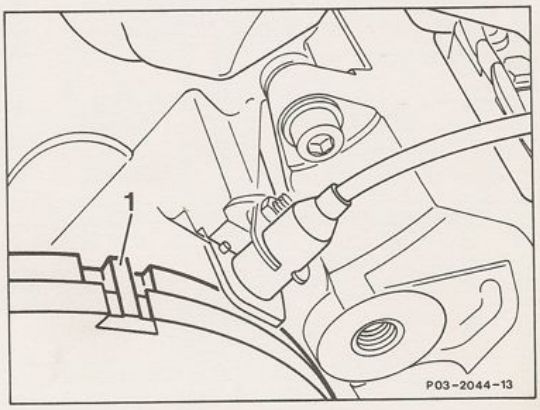
Cast aluminum pistons with iron-coated running surfaces.
Flat piston crown with 4 identical valve recesses.
Piston cooling by oil spray through the connecting rod bore.
All piston rings are chrome-plated.

Vibration damper

The vibration damper has a newly adapted harmonic frequency.
The 45° before TDC mark (arrow) is stamped on the circumference as an assembly mark. When the no. 1 piston is at 45° before TDC, each camshaft can be turned by hand without any valves colliding with pistons. In this position, heads can be installed without valves touching pistons.

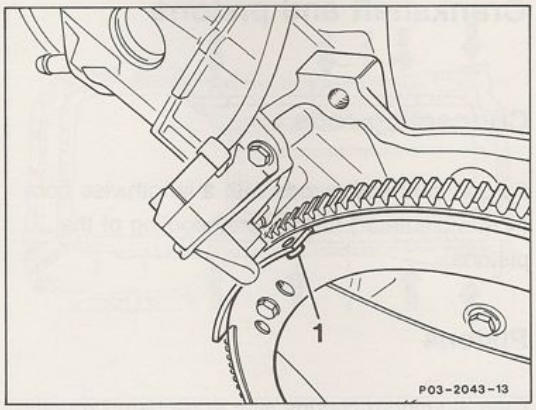


In place of the steel pin for the TDC transmitter, a recessed dove tail key is inserted at 25° BTDC.

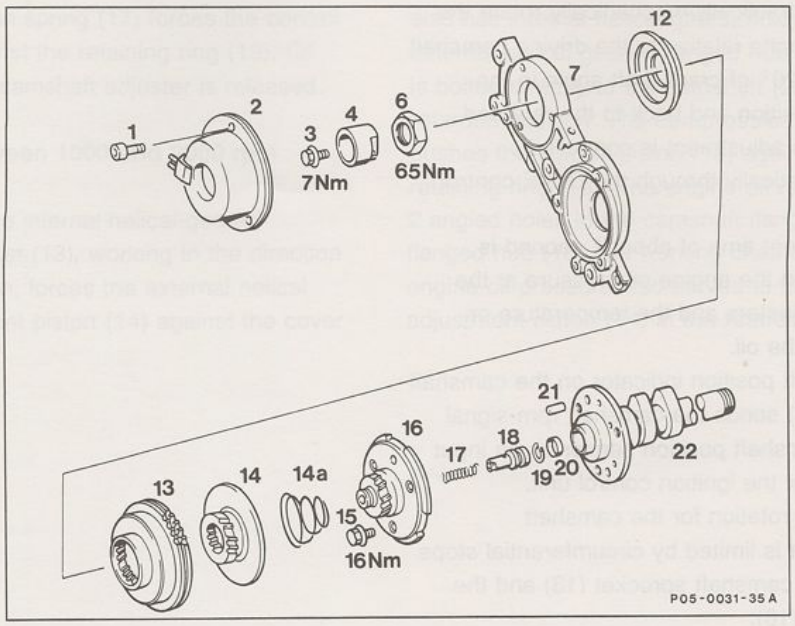


Ring gear

In order for the position sensor to distinguish the two cylinder banks (cylinders 1 to 4 and 5 to 8) by magnets (1) are installed on two segments of the ring gear.



Engine timing, valves



1	Bolt, M6 X 18
2	Solenoid with 2-pole plug
3	Washer-head bolt, M5 X 12
4	Armature with roll pin
6	Nut, M20 X 1.5, wrench size 30 mm
7	Front left cover
12	Cover
13	Camshaft sprocket
14	Adjustment piston
14a	Spiral cone spring
15	Washer-head bolt, M7 X 12
16	Flanged hub
17	Compression spring
18	Control piston
19	Retaining ring, 18 X 1
20	Sealing cap for oil passage, A18
21	Dowel pin in camshaft
22	Intake camshaft

Camshaft timing adjusters

With the engine running both camshaft timing adjusters hydraulically/mechanically rotate the intake camshafts relative to the driving camshaft sprocket by 20° of crankshaft angle in the advanced position and back to the retarded position. The adjustment is controlled electromagnetically through the CIS-E control unit.
The adjustment time of about 1 second is dependent on the engine oil pressure at the camshaft adjusters and the temperature or viscosity of the oil.
The camshaft position indicator on the camshaft sprocket (13) sends the camshaft rpm signal from the camshaft position sensor as an input parameter for the ignition control unit.
The angle of rotation for the camshaft advancement is limited by circumferential stops between the camshaft sprocket (13) and the flanged hub (16).
A spiral cone spring (14a) prevents gear play from causing noise during cranking.

Camshafts adjustment

Adjustment points at engine rpm [1])	Adjustment position	Effect on the combustion sequence
From 0 to between 1000 and 2000 rpm	retarded	Improved idle, improved cylinder scavenging, reduced valve overlap
From between 1000 and 2000 rpm up to 4700 rpm [2])	advanced	Increased torque, reduced waste of intake charge
Above 4700 rpm [3])	retarded	Intake valves open and close later, improved volumetric efficiency
Engine shut off	retarded	–

1) The indicated engine rpm ranges should not be used as test specifications.
2) Depending on load.
3) Depending on engine rpm.

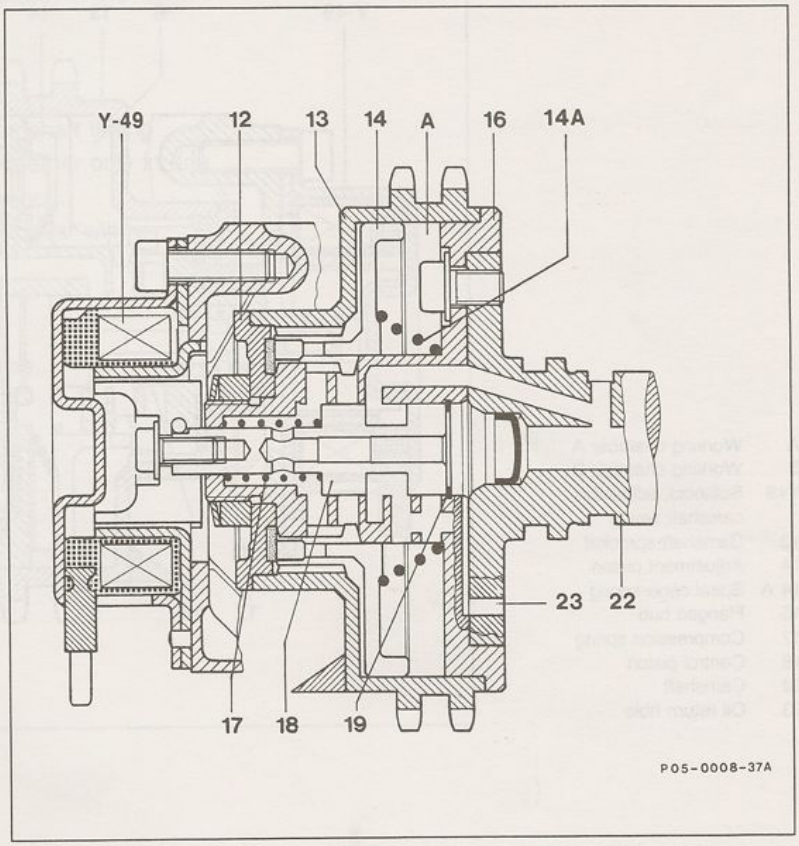
Function

Engine off (retarded)
The compression spring (17) forces the control piston (18) against the retaining ring (19). Oil pressure in the camshaft adjuster is released.

From 0 to between 1000 and 2000 rpm (retarded)
The torque of the internal helical-geared camshaft sprocket (13), working in the direction of engine rotation, forces the external helical geared adjustment piston (14) against the cover (12).

In this way the adjustment piston (14), which also has internal helical gears, holds the external helical geared flanged hub (16), which is bolted directly to the camshaft (22), in the retarded position. The compression spring (17) pushes the control piston (18) against the retaining ring (19). The engine oil runs through 2 angled holes in the camshaft flange and in the flanged hub (16) into working chamber A. This engine oil pressure also serves to hold the adjustment piston (14) in the retarded position.

Retarded



A Working chamber
Y49 Solenoid, adjustable camshaft timing
12 Cover with ring insert
13 Camshaft sprocket
14 Adjustment piston
14 A Spiral cone spring
16 Flanged hub
17 Compression spring
18 Control piston
19 Retaining ring 18x1
22 Camshaft
23 Oil return hole

From 1000 to 2000 rpm up to 4700 rpm (advanced)

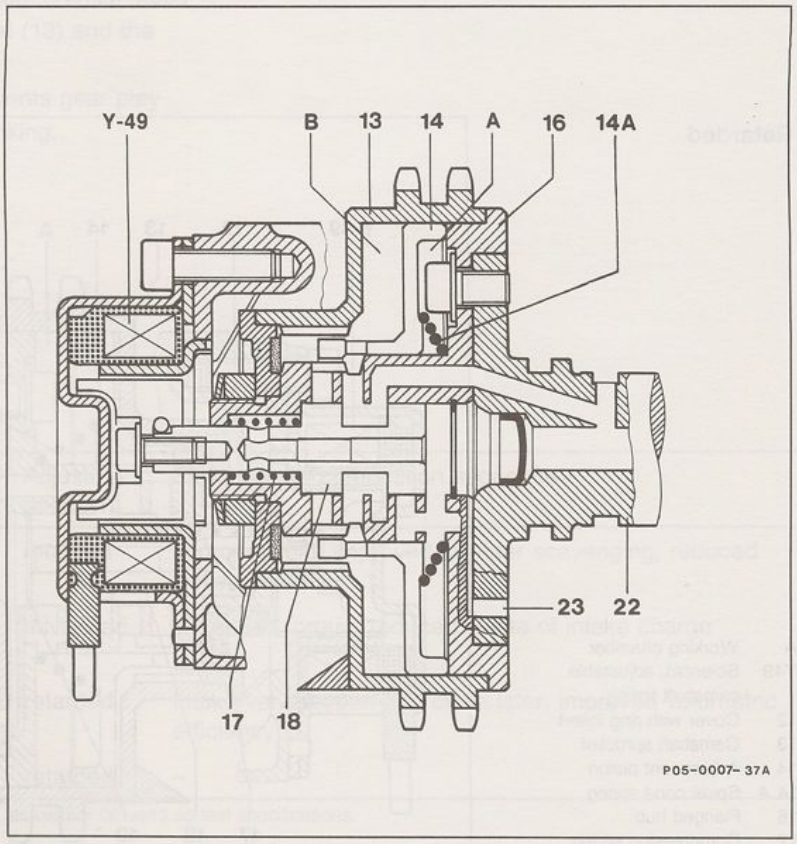
The control piston (18) is pulled forward by the adjustable camshaft timing solenoid (Y49) against the compression spring (17) up to the stop in the flanged hub (16).

The control piston (18) closes the oil supply passage to working chamber A and simultaneously opens the oil supply passage to working chamber B through two holes in the flanged hub (16) and in the adjustment piston (14). Oil pressure moves the adjustment piston (14) against the stop in the flanged hub (16).

Because of the axial movement of the adjustment piston (14), the camshaft (22), bolted to the flanged hub (16), turns to the advanced position. The camshaft advance results from the effect of the helical teeth in the camshaft sprocket (13), the adjustment piston (14), and flanged hub (16).

At the same time, pushed by the adjustment piston, the engine oil in working chamber A flows out through the flanged hub (16) and the 2 holes (23) drilled through the camshaft flange.

Advanced



A	Working chamber A
B	Working chamber B
Y49	Solenoid, adjustable camshaft timing
13	Camshaft sprocket
14	Adjustment piston
14 A	Spiral cone spring
16	Flanged hub
17	Compression spring
18	Control piston
22	Camshaft
23	Oil return hole

Above 4700 rpm (retarded)

The adjustable camshaft timing solenoid (Y49) has no voltage applied and releases the control piston. The control piston (18) is driven by the compression spring (17) against the retaining ring (19). The oil supply passage to working chamber "B" is closed off, and the passage to working chamber "A" is opened through the 2 holes in the flanged hub (16). The control piston (18) is moved against the cover (12) by the engine oil pressure.

This axial movement of the adjustment piston (14) turns the camshaft (22), bolted to the flanged hub (16), to the "retarded" position. The camshaft retard results from the effect of the helical teeth in the camshaft sprocket (13), the adjustment piston (14), and flanged hub (16). At the same time engine oil in working chamber "B", pushed by the adjustment piston, runs out through the 2 holes in each of the adjustment piston (14), the flanged hub (16) and the control piston (18) and the two holes (23) in the camshaft flange (22).

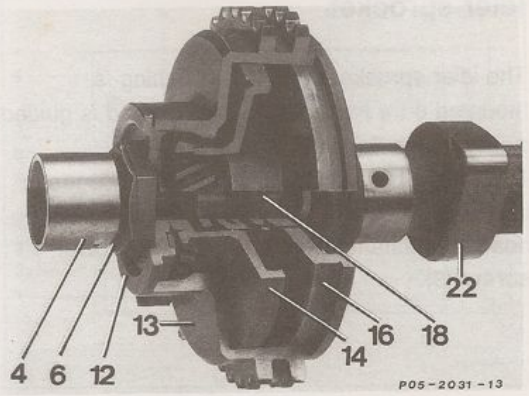
Assembly note

The individual parts of the camshaft timing adjuster can be assembled together only in one specific, predetermined sequence.

The solenoid is sealed to the cover with a sealant.

Testing

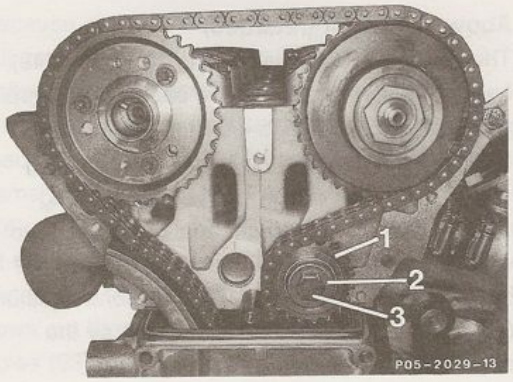
See Diagnostic Manual, Engine.



4 Armature
6 Nut
12 Cover with ring insert
13 Camshaft sprocket
14 Adjustment piston
16 Flanged hub
18 Control piston
22 Intake camshaft

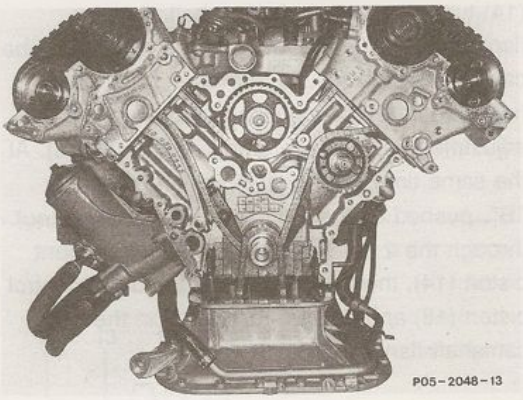
Idler sprocket

The idler sprocket (1) with its bushing is mounted on a hardened journal (2) and is guided axially by the timing chain.
The hollow-bored journal with 2 oil passages to the bushing surface is mounted in the cylinder head and fastened with a **left-hand-thread screw (3)**.



Timing chain, guide and tensioning rails

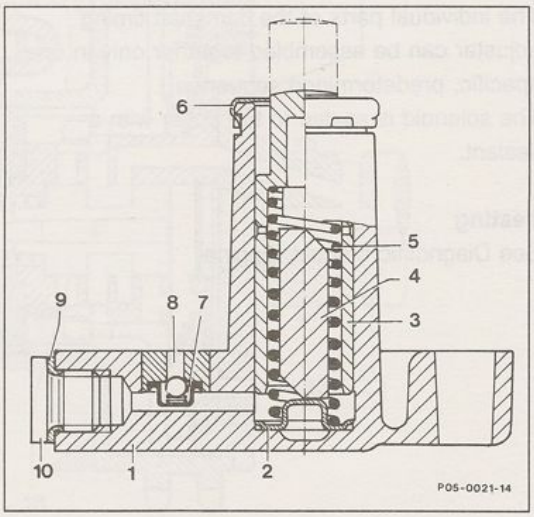
One double roller timing chain drives the four camshafts. For improved wear resistance, the rollers are calibrated.
Both the upper left and right guide rails are also designed as suction ducts for crankcase ventilation.



Timing chain tensioner

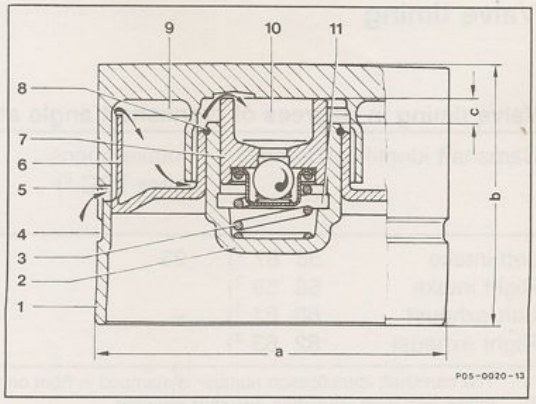
The hydraulic timing chain tensioner with compression spring tensions the timing chain via the tensioning rail. The chain tensioner cannot be disassembled.

1 Housing
2 Spring retainer
3 Thrust bolt
4 Push rod
5 Compression spring
6 Sealing cap
7 Return flow check valve
8 Oil supply bore
9 Sealing ring, 10×14
10 Screw plug, M10×1 mm



Hydraulic valve lifters

The hydraulic valve lifters are carbon nitrated and manganese phosphate treated on the running surfaces of the camshafts.
The integral oil return check valve (6) prevents the valve lifters from draining when the engine is shut off.
The valve lifters must be stored with the running surface downward. They cannot be disassembled.
The manufacturer's identifying mark is stamped on the sealing cover.

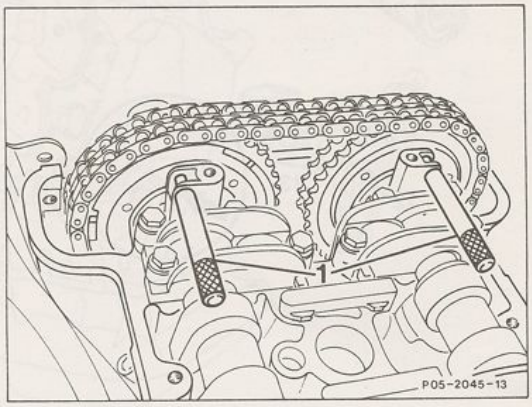


1 Hydraulic valve lifter
2 Thrust piece
3 Compression spring
4 Oil supply groove (circumferential)
5 Oil supply hole
6 Oil return flow check valve
7 Piston with check valve
8 Retaining ring
9 Oil accumulator
10 Oil supply space
11 Working chamber
a Diameter 35 mm
b Height: 26.5 mm
c Minimum valve lift: 2.3 mm

Camshafts

The hollow chilled cast iron camshafts are supported by 5 bearings each in the cylinder head and guided axially at the second bearing.

The positioning hole in the camshaft flange of all 4 camshafts is located for a crankshaft position of 45° before compression TDC of cylinder no. 1, with the camshaft adjuster in the retarded position.
Positioning is attained with 4 locator pins (1) 119 589 00 15 00 (1 set) using the hole in the no. 1 camshaft bearing cap.

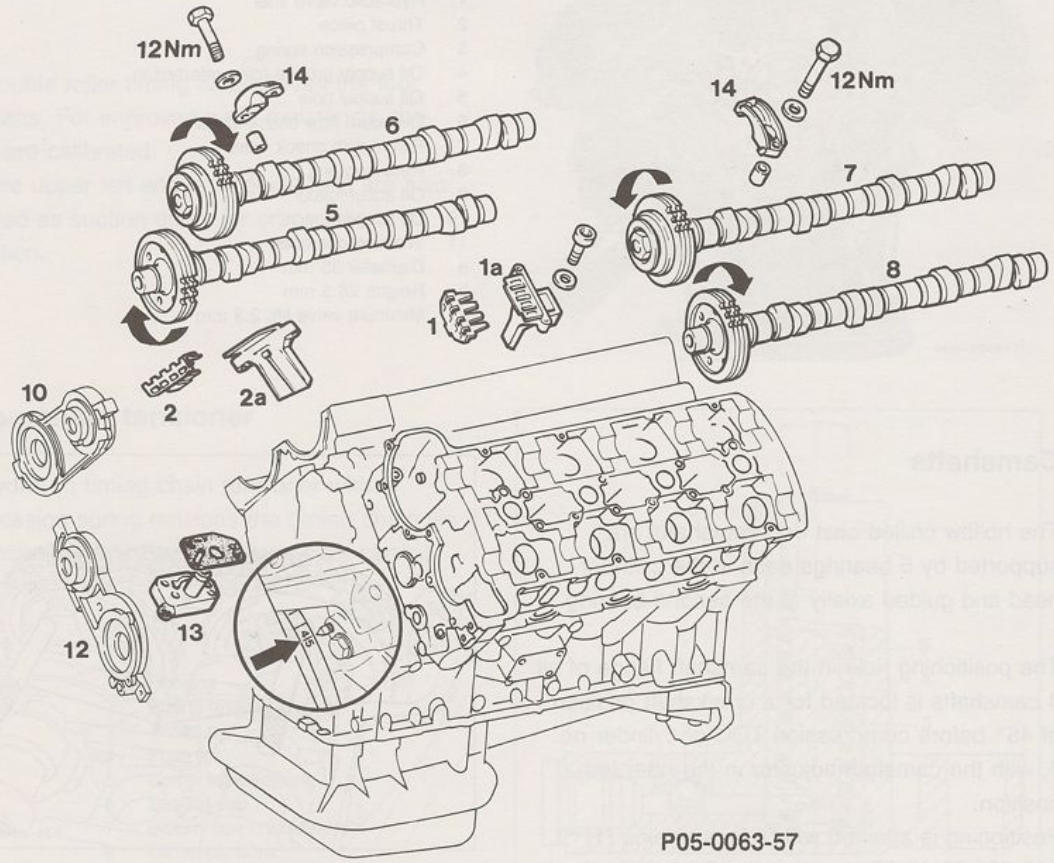


Valve timing

Valve timing in degrees of crankshaft angle at 2 mm valve lift

Camshaft identification no.[1]		Intake opens after TDC [2]	Intake closes after BDC	Exhaust opens after BDC	Exhaust closes before TDC
Left intake	56 57 [3]	23	35	–	–
Right intake	58 59 [3]				
Left exhaust	60 61 [3]	–	–	13	13
Right exhaust	62 63 [3]				

1) The camshaft identification number is stamped in front on the camshaft flange.
2) Intake camshaft (camshaft adjuster) retarded.
3) Replacement oversize camshaft with 30.5 mm diameter bearing journals.



Removal and installation of camshafts
(only when camshaft lobes are not depressing any valve lifters). For this purpose, position crankshaft at 45° before compression TDC of no. 1 cylinder (front right) and with the timing chain removed turn camshaft with open end wrench 119 589 00 01 00 accordingly.

Valves

The valves were made smaller and reduced in weight.
The exhaust valves have hardened seats and are sodium-filled.
The Viton valve shaft seals are metal banded.

	Valve shaft diameter	Valve head diameter
Intake	8 mm	38 mm
Exhaust	9 mm	33 mm

Valve springs

Opposite-wound double springs with rotating valve spring retainer.