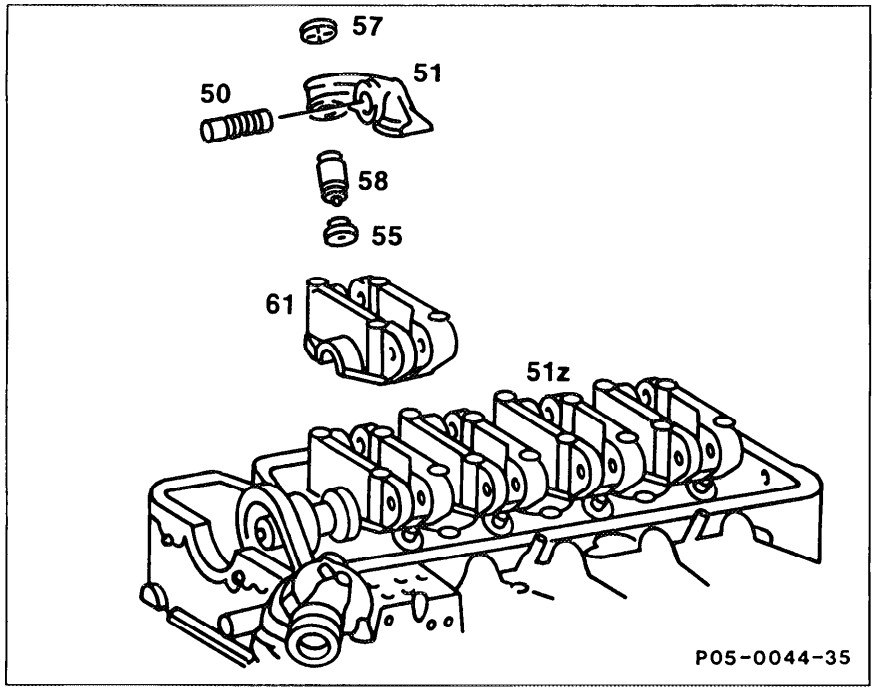
Job No.

05-211 Checking and replacement of hydraulic valve clearance compensation element

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).



Check

Cam . . . . . position hydraulic element under test on the base circle. Load hydraulic element for approx. 5 to 10 seconds. If the element drops, remove it. To do this remove corresponding rocker arm bearing support (OS- 235). If a leaking hydraulic element is not found, check fitting position (05-214).

Note

When pressure testing the compensating elements, do not press valves against the piston crown (Numbers 1 and 2).

Valve clearance compensating element (58) . . . .

Fill up reservoir chamber of valve clearance compensating element on test with engine oil. Press on ball valve with a suitable pin and vent working chamber by pumping set bolt up and down. Close ball valve, if necessary replenish oil. After this no oil shall escape at ball valve when compressed and set bolt may not drop. If this is not the case, replace compensating element (Number 3).

Note

If compensating element is satisfactory, check oil bores in cylinder head, rocker shaft and rocker arm for passage, and clean if required. If several compensating elements are soft, replace oil pipe in cylinder head (01-415), for this purpose remove cylinder head (01- 415).

Replacement

Valve clearance compensating element (58) . . . .

With oil reservoir chamber full and original washer (57) push into the rocker arm up to the stop on the snap ring (56) (Number 4).

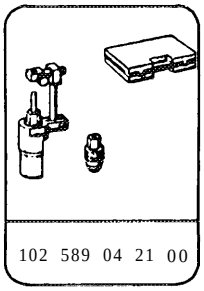
Rocker arm bearing support (61) . . . . . .

Install (05-235), at the same time fit original ball socket (55).

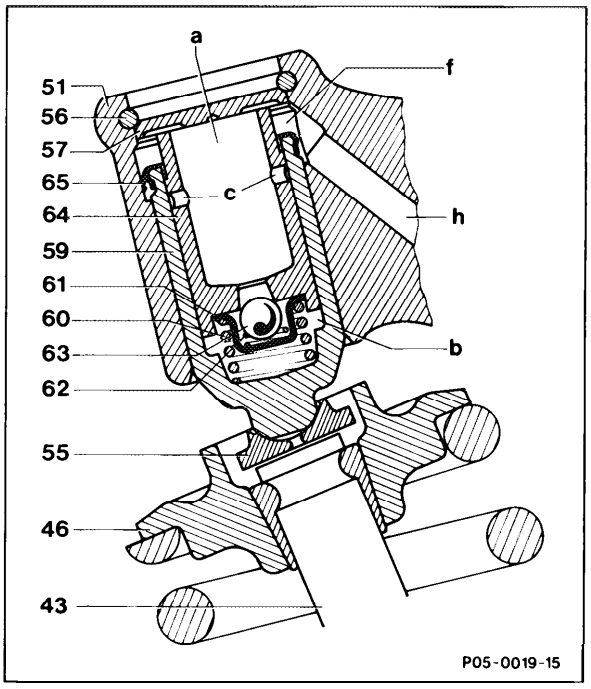
Note

Use ball socket 103 055 00 24, if a new ball socket is to be installed. Check and if required correct fitting position (05-214, Numbers 5 and 6).

Special tool



Hydraulic valve clearance compensation



43 Valve
46 Valve spring retainer
51 Rocker arm
55 Ball socket
56 Snap ring
57 Washer
59 Guide sleeve
60 Compression spring
61 Telescopic type ball bearing traveler
62 Compression spnng
63 Ball (5 mm 0)
64 Set bolt
65 Sealing cap
a Oil reservoir chamber
b Working chamber
c Return and venting bores

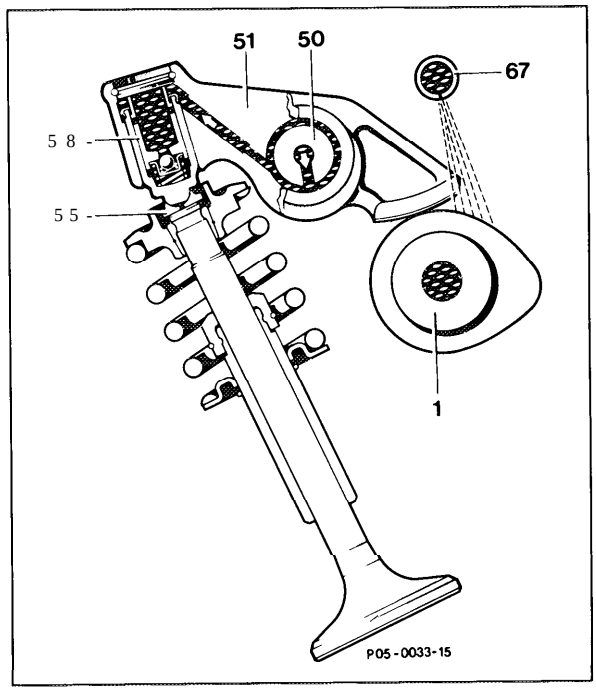
Valve adjustment Is no longer required when equipped with hydraulic valve clearance adjusters

The maintenance-free hydraulic valve clearance compensating elements located in the rocker arms eliminate valve clearance, i.e. dimensional changes in the valve train due to thermal expansion and wear are compensated by the elements. Valve train noise is low, because rocker arm is in continuous contact with the cam.

The hydraulic valve clearance compensating elements consist of the following components:

- Set bolt (64) with oil reservoir chamber (a) as well as return and venting bores (c) and a ball valve, consisting of a 5 mm Ø ball (63), telescopic type ball bearing traveler (61) and compression spring (62).

- Guide sleeve (59) with working chamber (b), compression spring (60) and sealing cap (65).



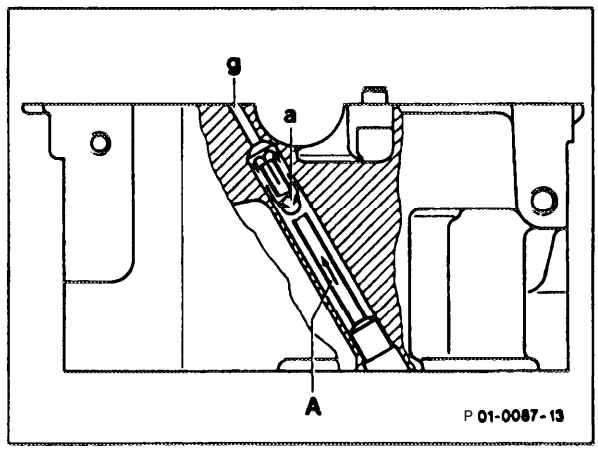
The element can drop completely when the engine is not running and the cam tip presses against the rocker arm and thus also against the element. Oil expelled from the working chamber (b) flows via the annular gap (built-in clearance between guide sleeve and set bolt) to the reservoir chamber (a).
When the cam tip moves away from the rocker arm, the set bolt (64) is relieved of load and the compression spring (60) presses the set bolt upwards until the rocker arm contacts the cam.

The vacuum, arising from the upward movement of the set bolt, opens the ball valve, and oil flows out of the reservoir chamber (a) into the working chamber (b).
As soon as the cam presses against the rocker arm and thus loads the set bolt, the ball valve closes. The oil in the working chamber acts as an “hydraulically rigid connection” and the respective valve is opened.
When the engine is running, depending on engine speed and cam position, the set bolt is only pressed slightly downwards.

The oil needed for operating the hydraulic valve clearance compensating elements, flows from the longitudinal channel and the transverse bores in the cylinder head to the rocker arm bearing points. From here it reaches the ring channel (f) through the bore (h) in the rocker arm and the reservoir chamber (a) via grooves in the washer (57).
Any air in the reservoir chamber can separate from the oil (solid oil), with the result that, if necessary, defoamed oil is led to the working chamber.

The oil quantity in the reservoir chamber is sufficient to fill the working chamber under all engine operating conditions. Any air in the reservoir chamber can escape to the ring channel (f) via the grooves in the washer (57) and from there via the annular gap between washer and rocker arm and the joint gap of the snap ring (56).

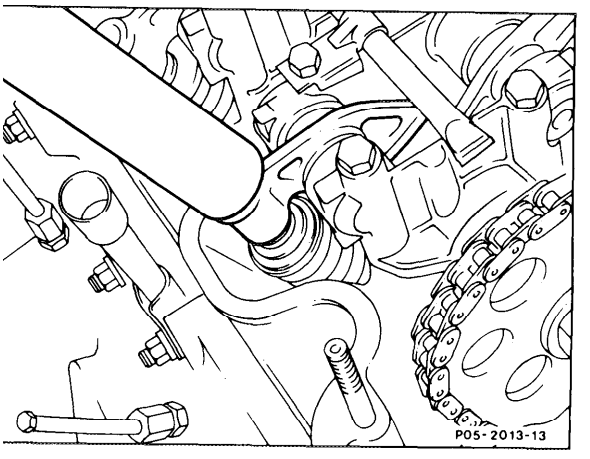
In order that the hydraulic valve clearance compensating elements can be supplied with oil pressure corresponding to the respective engine speed, oil flows unrestricted via nozzle (A) into the longitudinal channel (a) in the cylinder head (pressure-orientated oil feed). The nozzle simultaneously blocks off the oil return, preventing the channels up to the hydraulic elements emptying when the engine is not running.



The sealing cap (65) is shaped so that it secures the hydraulic valve clearance compensating element captive in the rocker arm.
Only store the compensating elements upright, and do not dismantle them. It is essential that rocker arm, compensating element, washer (57) and ball socket (55) are installed in their original position.

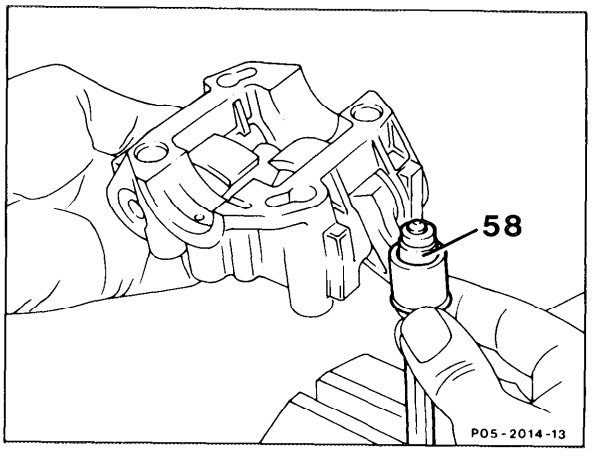
Checking

1 Position camshaft on the hydraulic element under test so that the rocker arms contact the cam base circle.



2 Press on the rocker arm with a hammer butt or similar above the hydraulic valve clearance compensating element for 5 - 10 seconds.

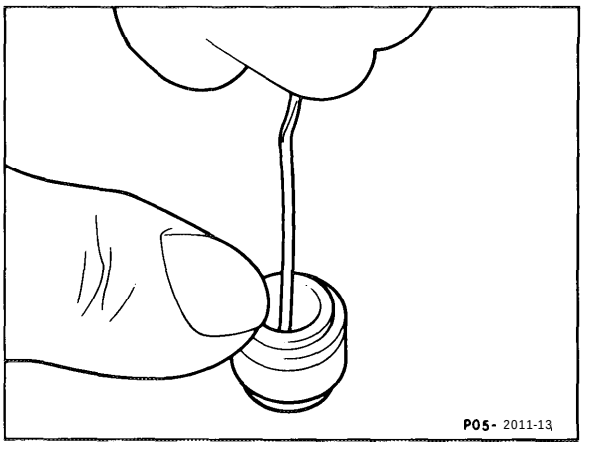
If one compensating element drops noticeably compared to others, compensating element should be removed. To do this, remove rocker arm bearing support (05-235) and press the compensating element (58) together with the washer carefully out of the rocker arm with an aluminium or brass mandrel.



If a leaking compensating element cannot be detected, try to move the rocker arm by hand. If play is detected when doing this, check and correct fitting position of the hydraulic valve clearance compensating elements (05-214).

Caution!
When testing compensating elements, do not press valves against the piston crown.

3 Fill reservoir chamber of the hydraulic valve clearance compensating element with engine oil, carefully press on ball valve in the setbolt with a wire (approx. 1.5 mm Ø) and press setbolt downwards as far as the stop and release. Repeat process two or three times.



After this, press compensating element setbolt heavily downwards for about 5 - 10 seconds with hammer butt or similar. If the setbolt drops noticeably when doing this, replace the compensating element.

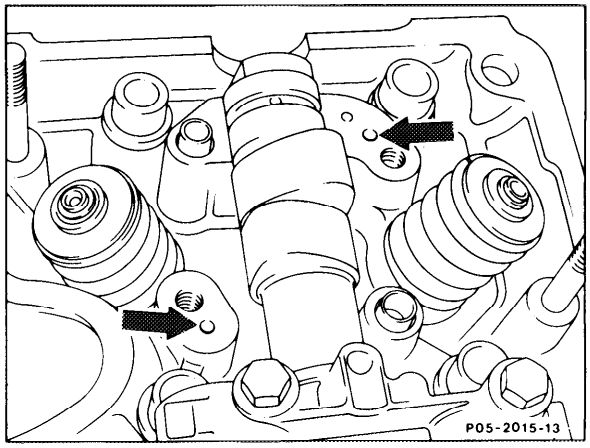
Note

Compensating element must be vertical when filling the working chamber as well as during the test.

If compensating element does not drop noticeably, check the respective oil bore in the cylinder head (arrow) as well as the oil bores in the rocker shaft and in the rocker arm for free passage, and clean if required.

To do this remove rocker arm (05240).

If several compensating elements are loud or soft the oil nozzle in the cylinder head should be checked for firm seating and replaced if required.



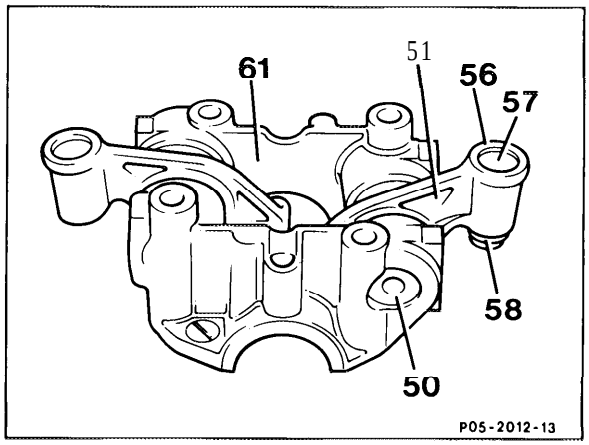
Replacement

4 Slide new valve clearance compensating element (58) with the original washer (57) into the rocker arm (51) as far as the stop on the snap ring (56).

Note

Install new compensating element with the working chamber and reservoir chamber filled with oil. (See Figure 3 for filling the hydraulic valve clearance compensating element).

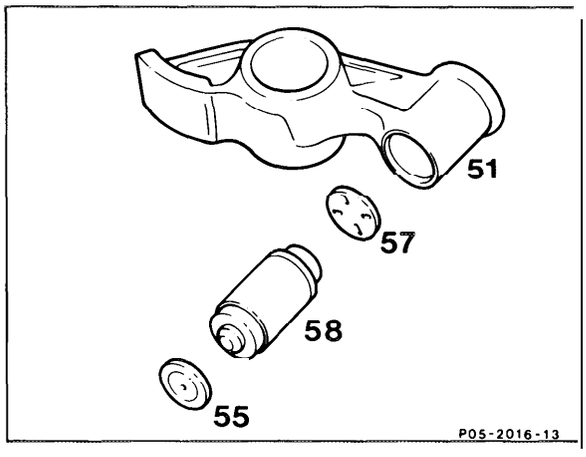
The grooves in the washer (57) must point to the compensating element (58) (Figure 5).



5 Install rocker arm bearing support (05-235). In so doing install the original ball socket (55).

Note

Use ball socket Part No. 103 055 00 24 if a new ball socket is installed.

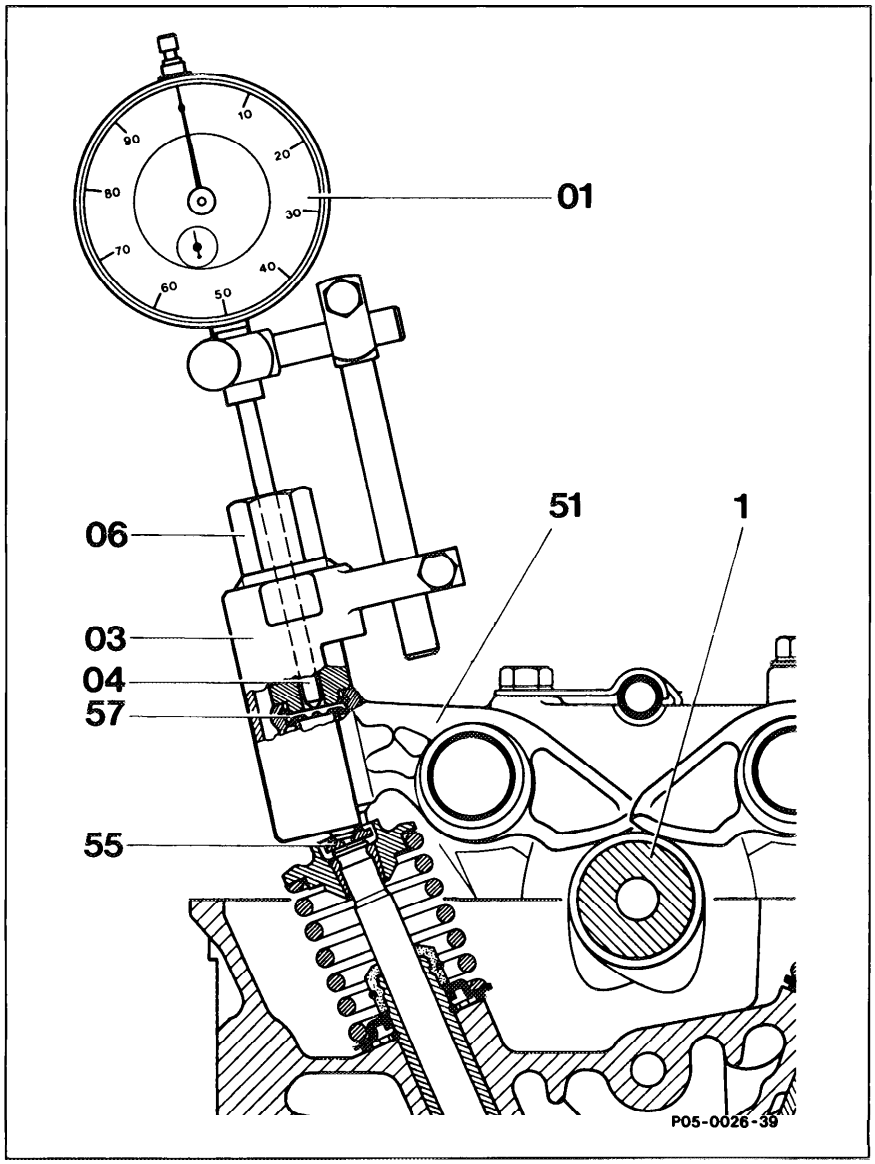


6 Check the installation position of the new valve clearance compensating element, correct if necessary (05-2 14).

7 Install in the reverse sequence.

05-214 Checking and correcting the installation position of hydraulic valve clearance compensating elements

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).



Camshaft (1)	position the cylinder under test so that rocker arm (51) contacts the cam base circle (Number 1).
Measuring fixture	mount, set dial gauge with 5 mm pretension, set dial gauge pointer to "0".

Checking . . . . . Turn pressure pad (06) to the right until a detectable pressure point is reached.
Read setting range (residual stroke) on the dial gauge. Reference value 0.5 - 2.4 mm. Correct the fitting position if the residual stroke is larger or smaller (Number 2).

Adjusting the residual stroke . . . . . Remove and install rocker arm bearing support (05235). Remove hydraulic valve clearance compensating element and slide into the rocker arm again up to the snap ring stop. If residual stroke is too small use a thinner washer (57), or a thicker washer if residual stroke is too large. Measure residual stroke again. If the specified residual stroke has still not been achieved, a thinner or thicker ball socket (55) can be fitted (Numbers 3 to 6), if necessary.

Note

Before installation of the hydraulic valve clearance compensating element fill reservoir chamber with engine oil.

Rocker arm bearing support . . . . . Install, repeat test (Numbers 7 and 8). Prior to this, turn the engine with the starter and contact handle a few times.

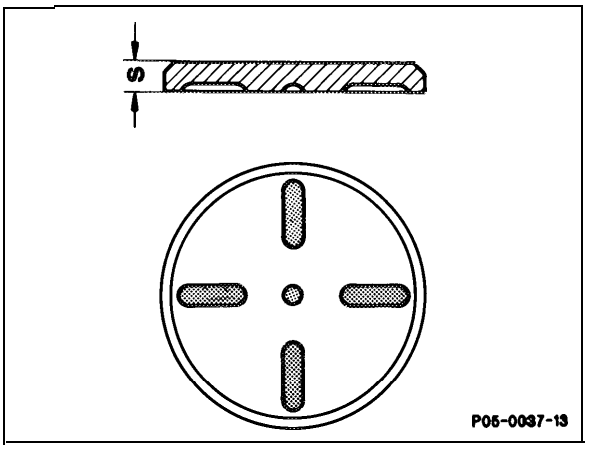
Installation specification of washer and ball socket

Assembly condition	Washer		Ball socket	
	Dimension "s" mm	Part No.	Dimension "a"	Part No.
Standard [1])	1.5	103 055 07 76	3.0	103 055 00 24
Standard[2])	1.8	103 055 06 76	3.5	103 055 02 24
Repair [3])	2.2	103 055 09 76		

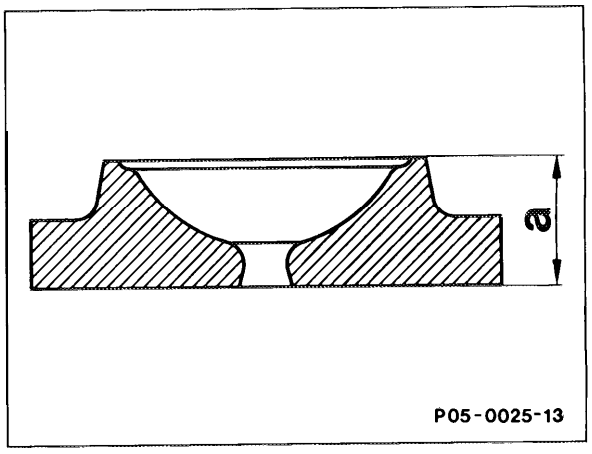
[1]) Production: install in the case of repair, when valve timing parts (rocker arm beanng supports, rocker arms, camshaft, etc.) are renewed. Camshaft with normal cam base circle without identification letter next to the camshaft identification number.

[2]) Production: Install in the case of repair, when valve timing parts (rocker arm beanng supports, rocker arms, camshaft, etc.) are renewed. Camshaft with small cam base circle and identification letter "E" next to the camshaft identification number.

3) Install in the case of repair, when valves and/or valve seat inserts have been resunk by machining.

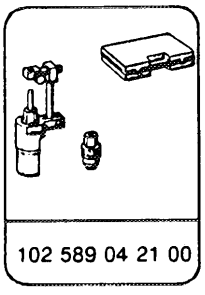


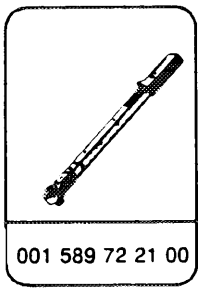
Washer

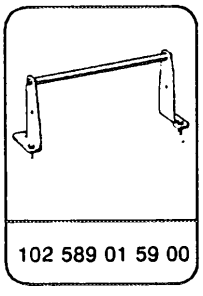


Ball socket

Special tools







Conventional tool

Dial gauge Al DIN 878	e.g. Mahr, D-7300 Esslingen Part No. 311000

Note

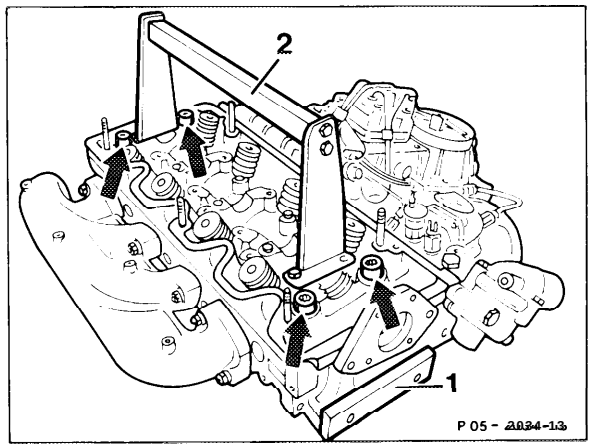
The fitting position of the hydraulic valve clearance compensating elements must be checked

a) If there have been complaints of valve train noise and no malfunctions have been established when checking the compensating element in accordance with 05211.

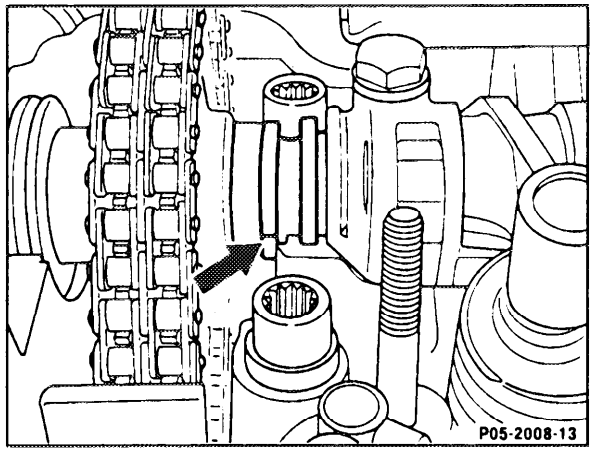
b) If valve timing parts, which are installed or mounted on the cylinder head (apart from the camshaft timing gear, valve guides, valve stem seals) have been renewed, or when valves and/or valve seat inserts have been machined.

For testing, all timing parts located on the cylinder head must be installed correctly and working chamber of valve clearance compensating elements must be filled with engine oil.

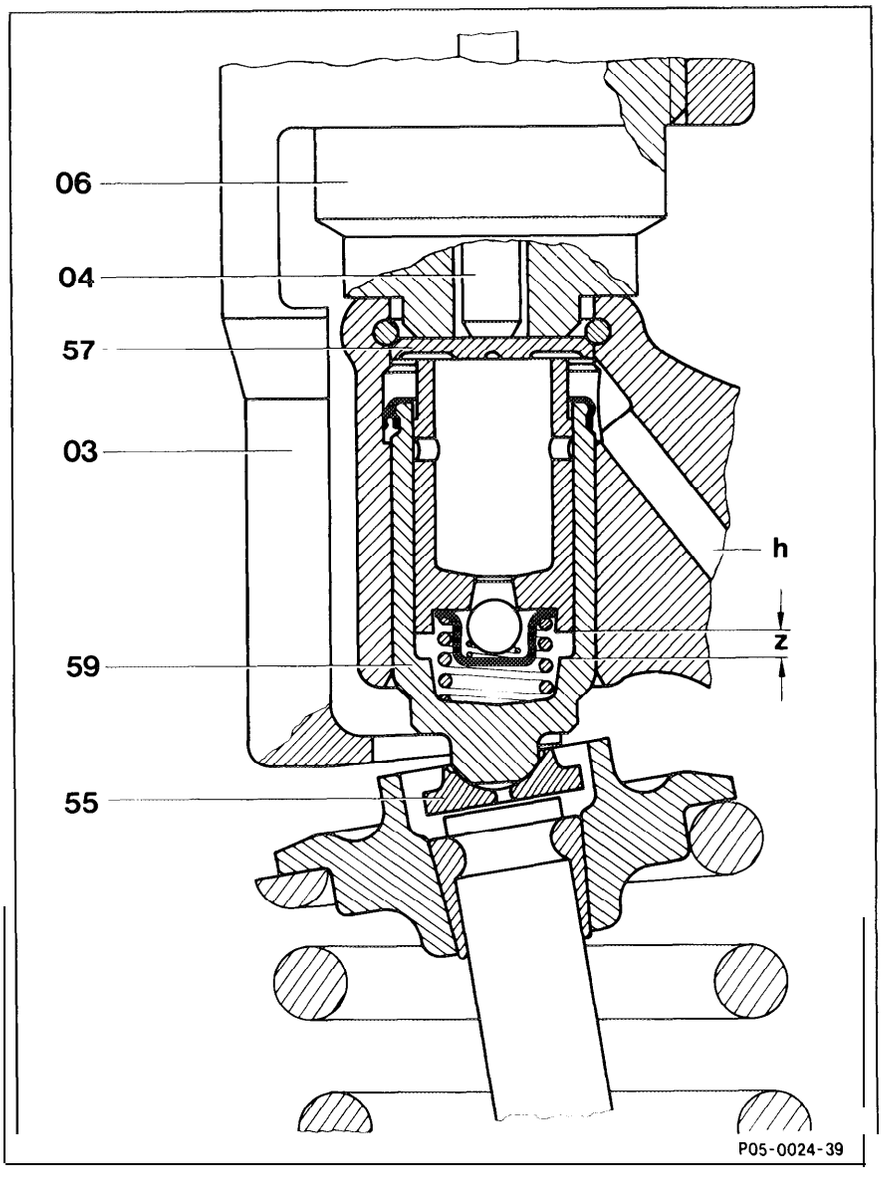
The tests can also be carried out when the cylinder head is removed. To do this clamp cylinder head with four cylinder head bolts (arrows) on assembly board 102 589 00 59 00 (1). In this case turn the camshaft on rear flats with a fork wrench (24 mm).



After the test, position camshaft so that indentation on the collar agrees with the edge on the cylinder head (arrow).



In order to determine the specified fitting position of the hydraulic valve clearance compensating element, the residual stroke "Z" of the compensating elements must be measured. The permitted **residual stroke** is 0.5 **to** 2.4 mm. If a residual stroke smaller than 0.5 mm or larger than 2.0 mm is measured despite installing a washer and a ball socket in accordance with the "installation specification" table, compensation is to be carried out with the next thinnest or thickest washer or ball socket.



Checking

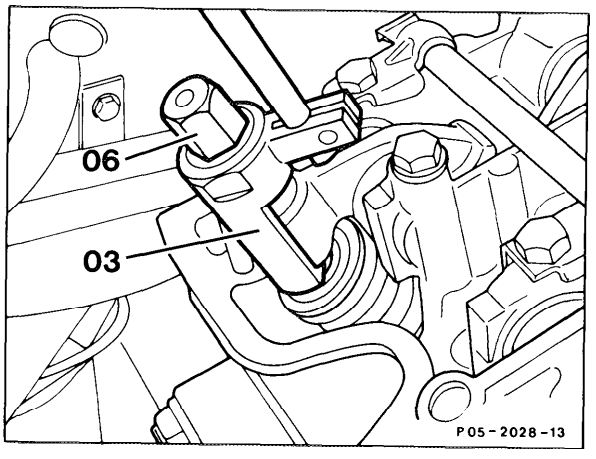
1 Position camshaft by turning the crankshaft so that the rocker arms contact the cam base circle on cylinder under test.

2 Place measuring fixture 102 589 04 21 00 so that the claws of the claw sleeve (03) contact the ring shaped area around the hemispherical mushroom pad of the guide sleeve (59).

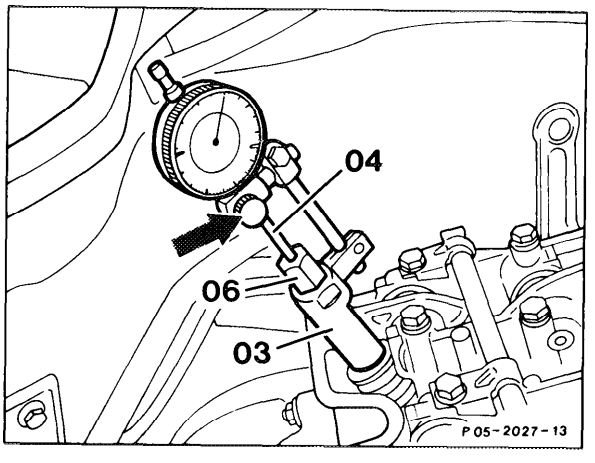
Turn the pressure pad (06) by hand to the right sufficiently until it contacts the washer (57, previous picture), and a clearly detectable pressure point is reached.

Note

The pressure pad must contact the washer and not the rocker arm.



3 Insert measuring pin adapter (04) in the central bore of the pressure pad (06), set dial gauge measuring pin on the measuring pin adapter with 5 mm pretension (small pointer) and attach the dial gauge to claw sleeve bracket (arrow). Position large dial gauge pointer on zero by turning the dial gauge scale.

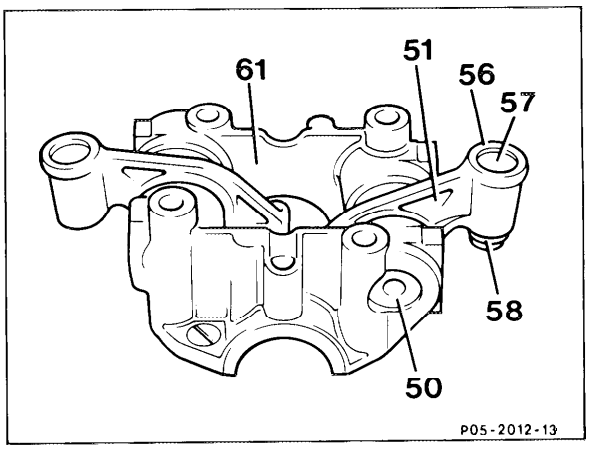


4 Turn pressure pad (06) slowly to the right with a fork wrench (17 mm) on the hexagon until a clearly detectable pressure point is reached. Read off setting range (residual stroke) on dial gauge. It must be 0.5 - 2.4 mm. In event of smaller or larger residual stroke, correct installation position of the hydraulic valve clearance compensating element.

Corrections

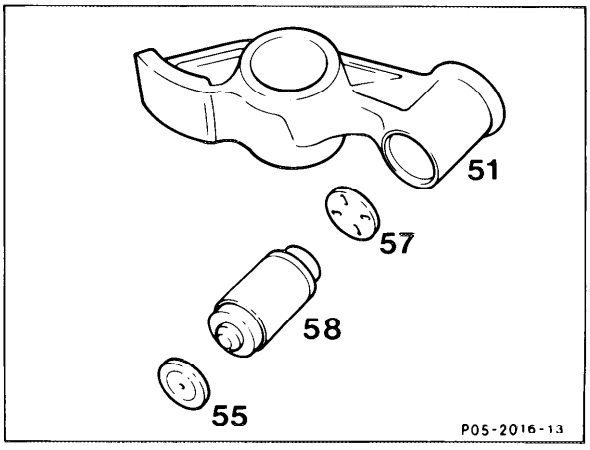
5 Remove rocker arm bearing support **(05235).**

6 Press hydraulic valve clearance compensating element (58), together with the washer (57), carefully out of the rocker arm with an aluminum or brass mandrel, and finally slide into the rocker arm up to the snap ring stop (56) again. Use a thinner washer (residual stroke too small) or a thicker washer (residual stroke too large).



If specified residual stroke cannot be achieved with the washers available (57), depending on residual stroke measured, use a thinner or thicker ball socket (55) (see note, on the washer and ball socket tables).

Caution!
Before carrying out the installation fill reservoir chamber of the hydraulic valve clearance compensating element with engine oil (05- 211, Number 3).



The grooves in the washer (57) must point in the direction of the compensating element setbolt.

7 Install rocker arm bearing support (05-235).

8 Repeat tests, Numbers 1 to 3.

Note
Before carrying out the test turn the crankshaft a few times by using the starter.

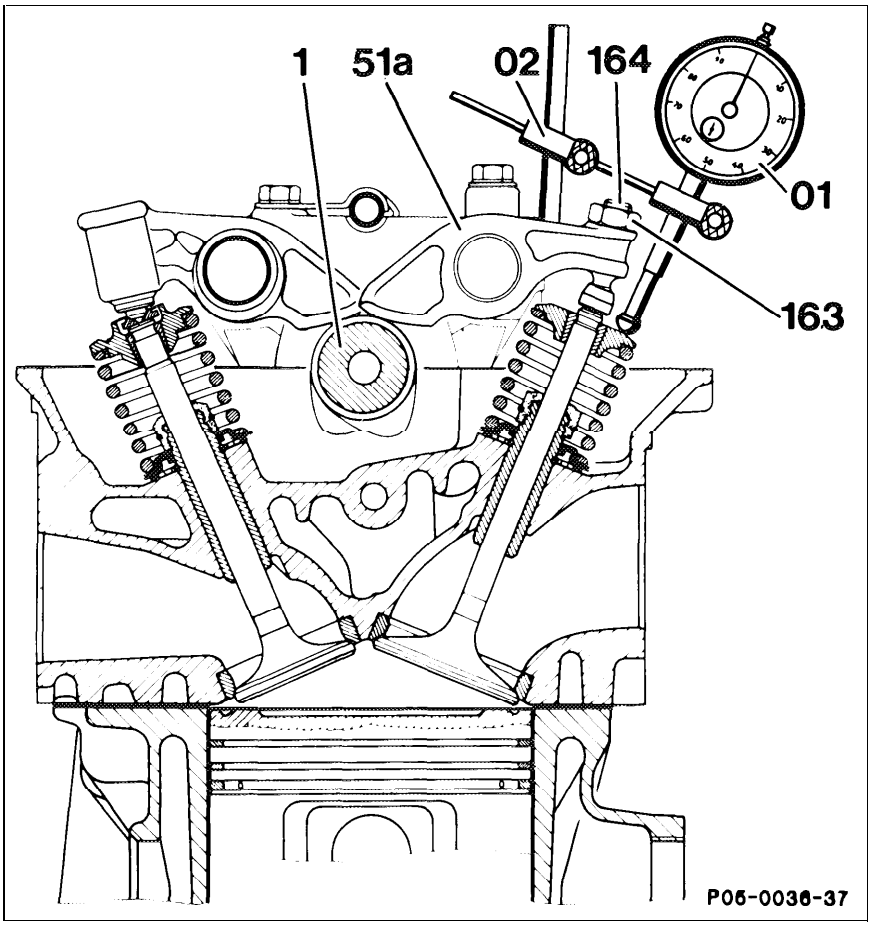
9 The installation is carried out in the reverse sequence of the removal.

10 Check for leaks when engine is running.

EXIT

05-215 Checking and adjusting camshaft timing

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).



Checking ..... Position the No. 1 cylinder camshaft so that the rocker arm (51a) contacts the cam base circle. Remove No. 1 cylinder rocker arm bearing support (05-235). Remove rocker arm and hydraulic valve clearance compensating element and adjustable rocker arm 102 055 00 01 together with adjusting screw 102 050 0220 (164) and fit locknut (163). Eliminate valve clearance by turning the adjustment screw (164) (Numbers 1 to 4).

Dial gauge bracket (02) ..... Screw onto stud bolt at front left part of cylinder head (Number 5).

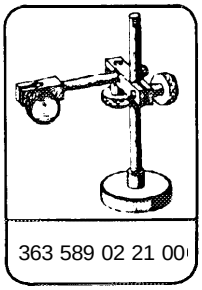
Dial gauge (01)	Insert and put tip vertically on valve spring retainer with 3 mm pretension (small pointer) (Number 6).
Crankshaft	Turn in the direction of rotation of the engine until the small pointer on the dial gauge has travelled back by 2 mm (valve stroke). The value now read off on the vibration damper must agree with the value in the table “Intake valve open” (Number 7).
Adjustment	Put engine on ignition TDC of No.1 cylinder (Number 8).
Chain tensioner locknut (40)	Unbolt and bolt up, replace sealing ring (41), 70 Nm (Numbers 9 and 19).
Oil pressure pump	Unbolt, set to one side with lines connected (Number 10).
Camshaft timing gear	Align with timing chain. Unbolt camshaft timing gear (Numbers 11 to 13 and 15).
Woodruff key (6)	Select from table and insert (Numbers 14 and 15).
Camshaft timing gear	Assemble, note color marking, only install set bolt. Repeat tests (Numbers 6 and 7). Tighten set bolt (9). 80 Nm (Numbers 16 to 18).
Dial gauge (01) and dial gauge (02)	Detach.
Rocker arm bearing support and rocker arm with hydraulic valve clearance compensating element	Install (Number 20). Proceed with installation in reverse sequence

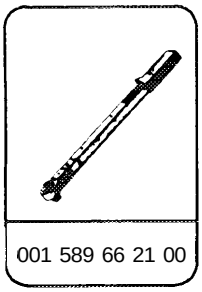
Valve timing with 2 mm valve stroke

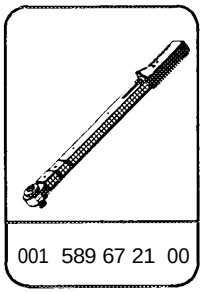
Engine	Identification number of camshaft stamped at the rear of the camshaft	Intake valve		Exhaust valve	
		Opens after TDC	Closes after BDC	Opens before BDC	Closes before TDC
102.96 102.985	27/28 [1]) 35 [3])/36 [1])/44[4])	11” (12°)	17”	32”	13°

Value for used chain in brackets.
[1]) Repair camshaft with 0.5 mm larger bearing diameter.
[2]) Camshaft with wider cam (19 mm) and tin-plated.
[3]) Chilled cast iron camshaft.
[4]) Chilled cast iron camshaft (with crowned cams) from 09/89.

. Special tools


363 589 02 21 00


001 589 66 21 00

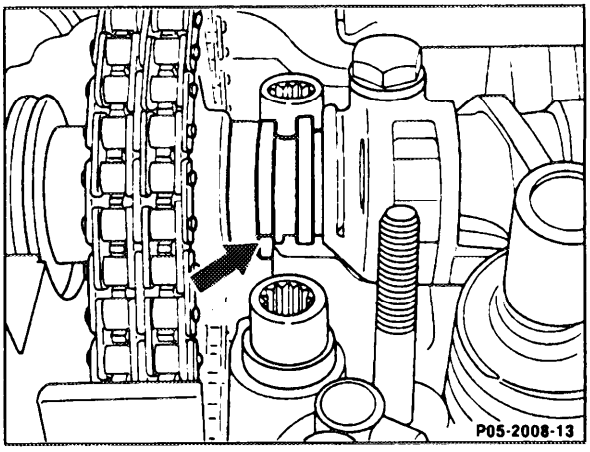

001 589 67 21 00

Conventional tool

Dial gauge A 1 DIN 878	e.g.	Mahr, D-7300 Esslingen Bestell-Nr. 311000

Note

It is sufficient during assembly work, if the marking on the camshaft agrees with the cylinder head edge in the ignition TDC position of the No 1. cylinder (arrow). In special cases, for example when there are performance problems, the start of opening of No. 1 cylinder intake valve is to be checked as described in the following, and to be adjusted, if required. The valve timings are measured at
2 mm valve stroke. Valve clearance must be eliminated for this purpose.



Checking

1 Turn crankshaft until cam tips of No. 1 cylinder intake valve point downwards (valve closed).

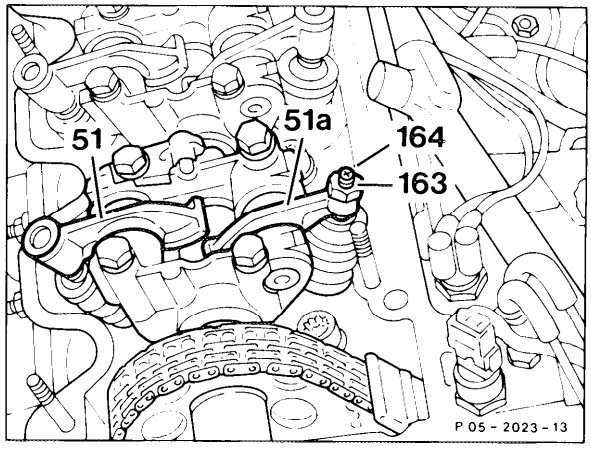
Caution!
The engine must not be turned at the camshaft timing gear fixing bolt.

Under no circumstances turn engine backwards during the measurement, otherwise considerable measuring errors result, and chain tensioner lock setbolt can spring forwards.

2 Remove rocker arm bearing support of No. 1 cylinder (05-235).

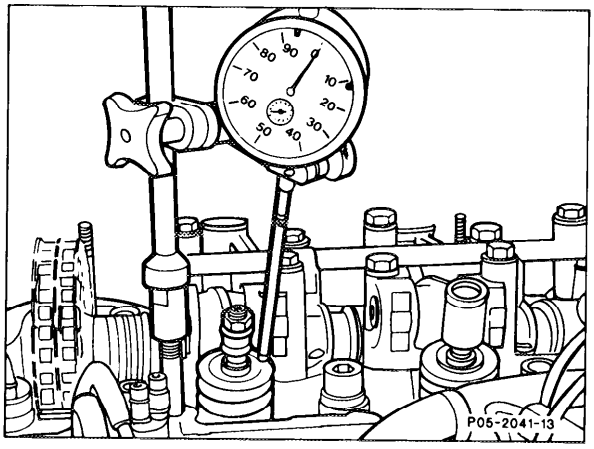
3 Install intake valve rocker arm against the rigid rocker arm (51a) Part No. 102 055 00 01 together with the adjustment bolt (164) Part No. 102 050 02 20 and the locknut (163) Part No. 000936 008009 (05-240).

4 Install rocker arm bearing support, 21 Nm.



5 Install the dial gauge bracket with threaded sleeve onto the stud on the front left part of the cylinder head.

6 Insert dial gauge and attach so that tip is **exactly vertical** on valve spring retainer with a pretension of 3 mm (small pointer on the dial gauge). Turn dial gauge clockface until large pointer is on "0".



7 Turn crankshaft in direction of rotation of the engine until dial gauge small pointer has returned by 2 mm (valve stroke). In this position the value on the vibration damper must agree with the value “intake valve opens after TDC” in the valve timing table.

Adjustment

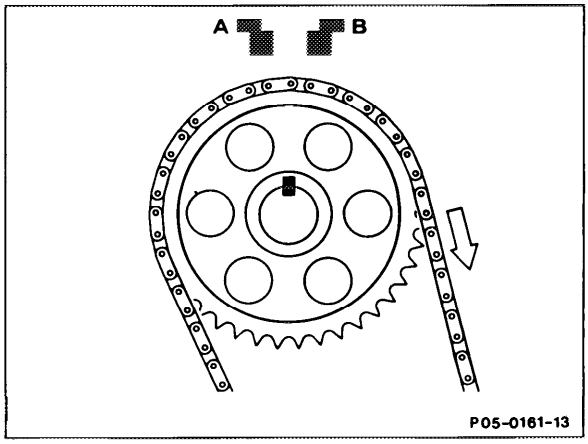
If valve timing settings have to be corrected, an offset Woodruff key has to be installed, and a new timing chain when chain length is excessive.

Woodruff keys are available in the following stages:

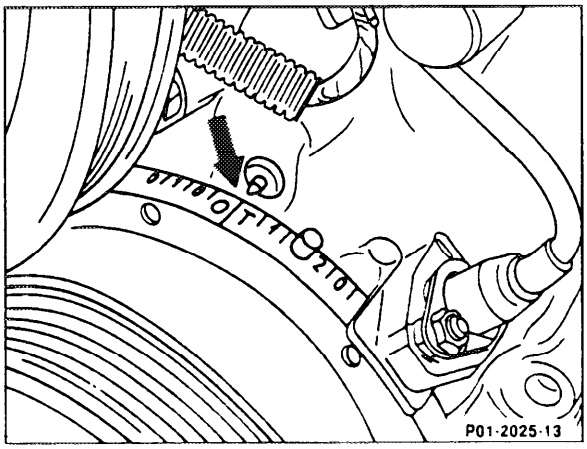
Offset mm	Part No.	for a correction of approx.
0.7	621 991 04 67	6” CKA
0.9	621 991 02 67	8” CKA
1.1	621 991 01 67	9.5” CKA
1.3	621 991 00 67	11.5” CKA

CKA = CranK Angle

An offset of one tooth on the camshaft timing gear produces approx. 20 at the crankshaft. Offsetting the Woodruff keys to the right (in direction of travel A) causes the valves to open earlier and an offset to the left (B) causes the valves to open later.

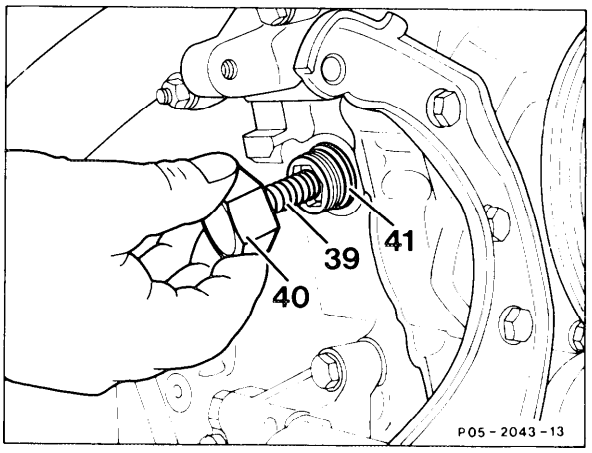


8 Position engine on ignition TDC of No. 1 cylinder.

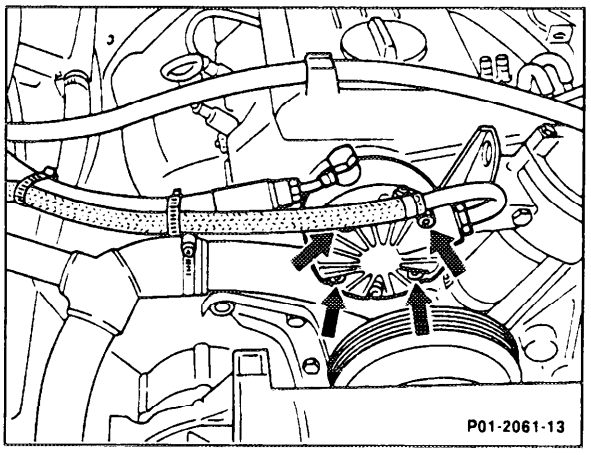


9 Unscrew hexagon cap nut (40) for chain tensioner and remove sealing ring (41) as well as compression spring (39) (see 05310).

Caution!
The chain tensioner hexagon cap nut is under pressure from the compression spring.

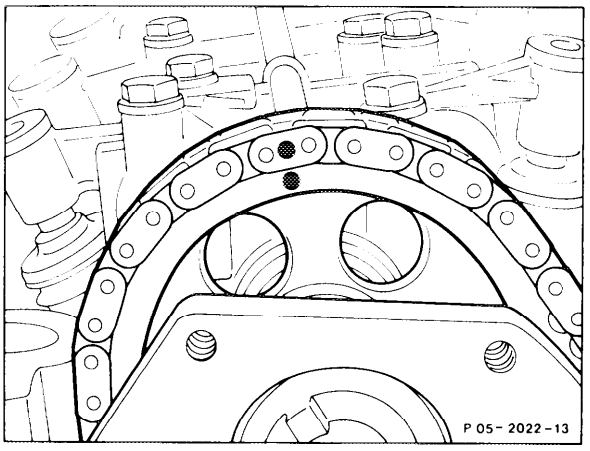


10 Unscrew oil pressure pump (arrows) and set to one side with the lines connected.



11 Align camshaft timing gear and timing chain.

12 Remove camshaft timing gear set bolt.

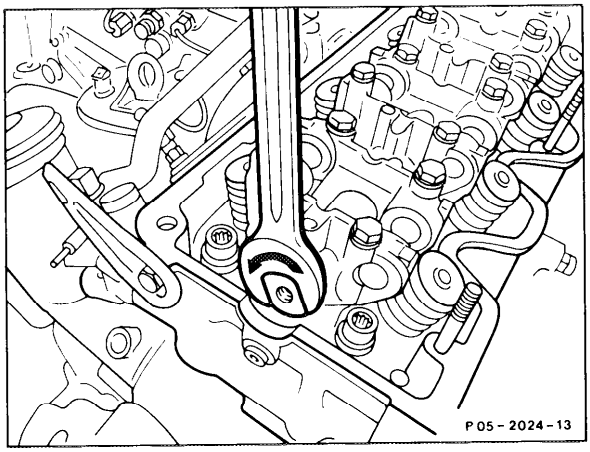


To do this hold in position with a fork wrench (24 mm) on flats at the rear end of the camshaft.

Note

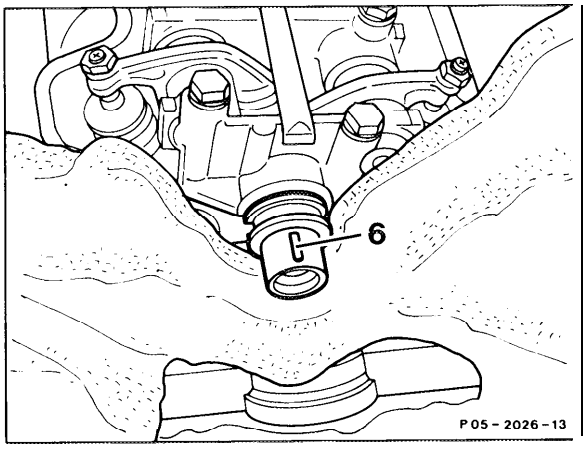
On vehicles with self-levelling suspension the camshaft timing gear and driving sleeve are attached by a bolt with hexagon recessed hole. Take out the driving sleeve.

13 Remove camshaft timing gear.



14 Place cleaning rag over the timing case and remove Woodruff key (6).

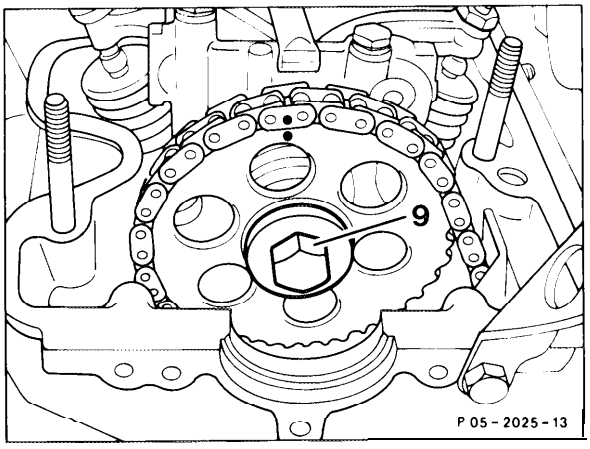
15 Insert selected Woodruff key.



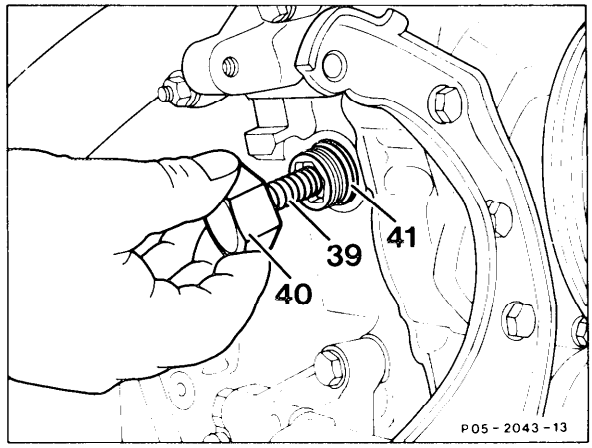
16 Put on camshaft timing gear. In the process note that the colour markings on the camshaft timing gear and the timing chain align.
Do not torque the set bolt (9) yet.

17 Repeat test Numbers 6 and 7.

18 Torque camshaft timing gear set bolt (9) to 80 Nm. For this hold in position with a fork wrench (24mm) on flats at the rear of the camshaft.

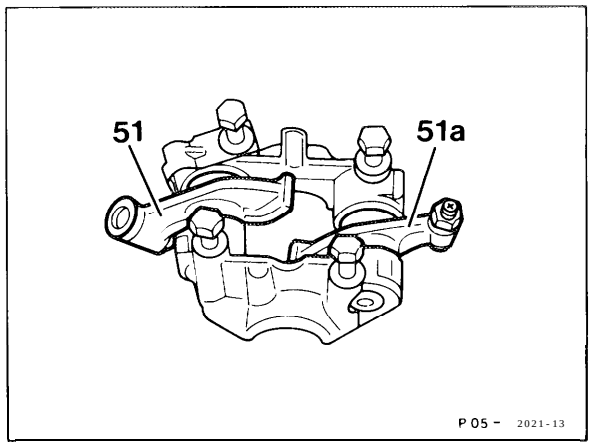


19 Insert compression spring (39), replace sealing ring (41), bolt in screw plug (40) and tighten to 70 Nm.



20 Unbolt rocker arm bearing support from **No.1** cylinder and withdraw rocker arm (51a) for hydraulic valve clearance compensation.

21 Install rocker arm bearing support, tightening torque 20 Nm (05- 235).



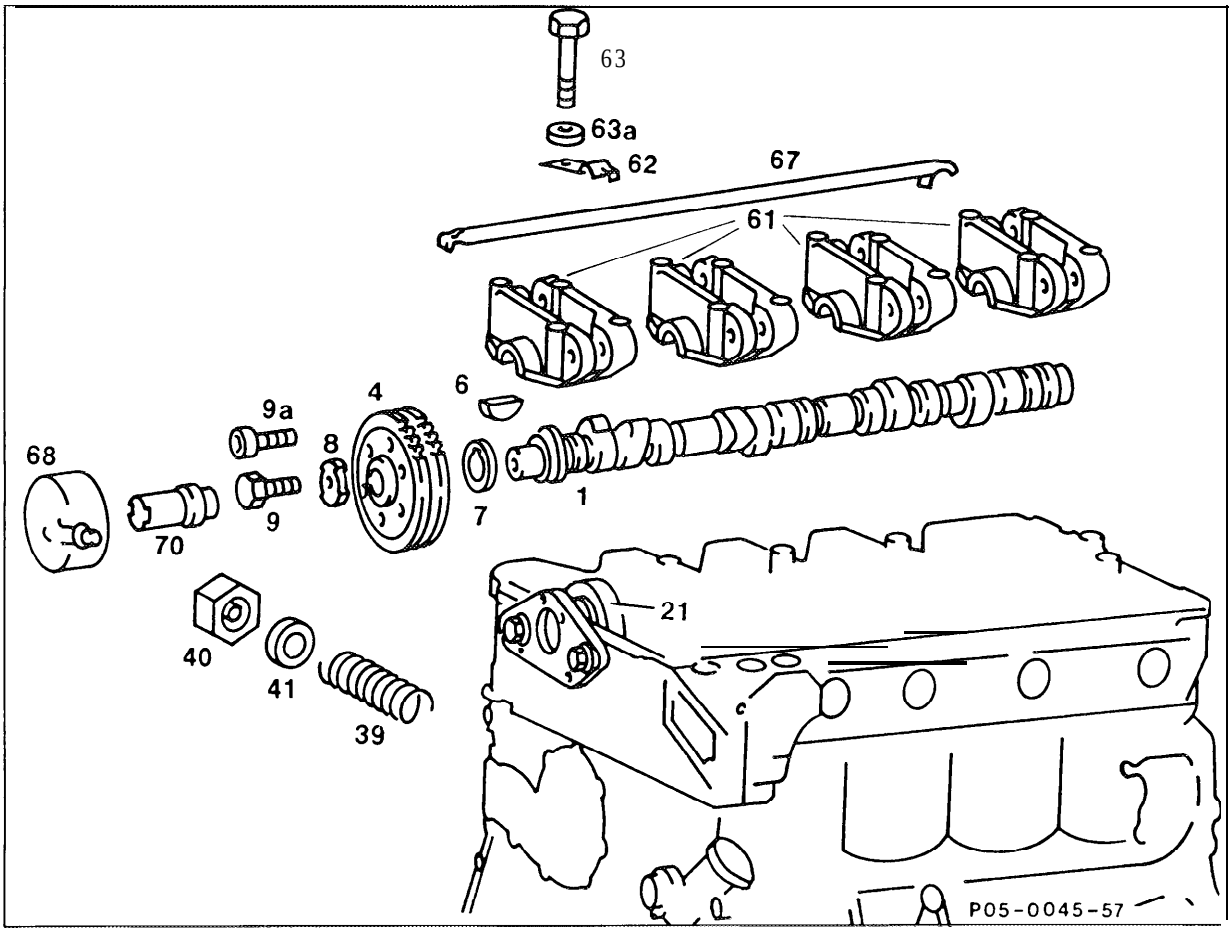
22 Remove dial gauge and dial gauge bracket.

23 The remaining installation takes place in the reverse sequence.

24 Check for leaks when engine is running.

05-220 Removal and installation of camshaft

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).

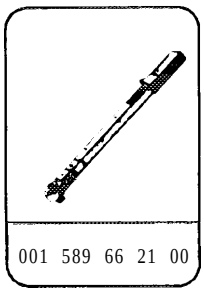


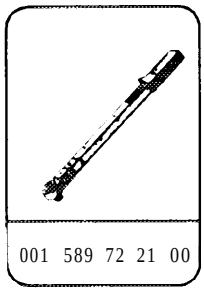
Piston of No. 1 cylinder	position on ignition TDC, note markings (Numbers 1 and 2).
Screw plug (40)	of the chain tensioner, unbolt, bolt in, 70 Nm.
	Warning! Screw plug is under pressure. Remove compression spring (39), replace sealing ring (41)(Numbers 3 and 11).
Oil pressure pump (68)	unbolt, bolt in, set to one side with lines connected (Number 4).
Camshaft timing gear (4) and timing chain	align. When installing note markings. Screw (9 and 9a), 80 Nm (Numbers 5 to 8).

All rocker arm bearing supports (61) with rocker arms and oil pipe (67) . . . . . unbolt, bolt on, 20 Nm. Note oil pipe designs (Number 9).

Camshaft (1) . . . . . remove, replace, oil bearing points with engine oil. Check condition of camshaft, note identification number. Position engine on ignition TDC and check markings on camshaft and vibration damper (Number 10).

Special tools





Test values

		New value	Wear limit
Permitted deviation from true running when locating camshaft in bearing positions 1 and 5	At the seat of camshaft timing gear	0.025	
	At the bearing points 2, 3 and 4	0.030	–
Camshaft bearing play	radial	0.050 – 0.091	0.11
	axial	0.070 – 0.150	0.18
Camshaft journals Ø	Normal dimension	32.000 – 32.025	–
	Repair stage	32.500 – 32.525	–
Scleroscope hardness of the cams		70 – 82	63

Camshaft identification numbers and valve timings with 2 mm valve stroke

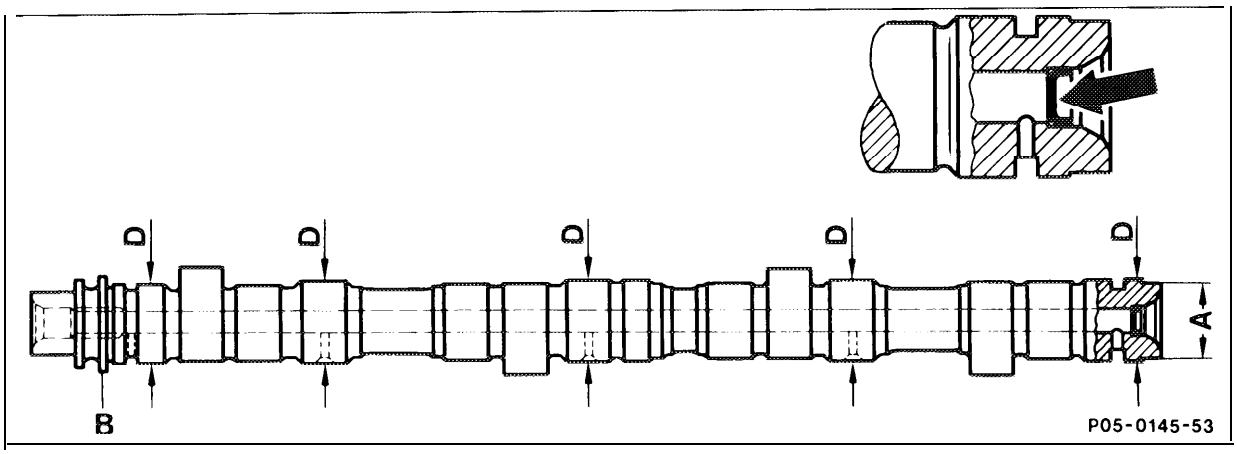
Engine	Camshaft identification number stamped at rear of camshaft	Intake valve		Exhaust valve	
		Opens after TDC	Closes after BDC	Opens before BDC	Closes before TDC
102.96 102.985	27128 [1]) 35 [3])/6 [1])/44[4])	11° (12°)	17°	32"	13°

Value for used chains in brackets.
[1]) Repair camshaft with 0.5 mm larger bearing diameter.
[2]) Camshaft with wider cams (19 mm) and tin-plated.
[3]) Chilled cast iron camshaft.
[4]) Chilled cast iron camshaft (with crowned cams) from 09/89.

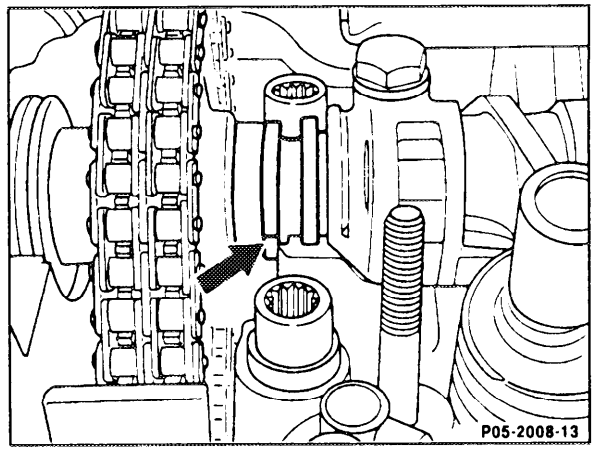
Note

The camshaft supported on 5 bearings is drilled hollow. The bearing points are supplied with oil via the longitudinal bore (10.5 mm Ø), which is sealed at the front with the camshaft timing gear set bolt and at the rear with a pressed cover (arrow). The oil feed takes place via a groove (360°) and a transverse bore (3.5 mm Ø) in the rear journals.
The diameter (D) of all 5 bearing points is 32 mm (repair stage 32.5 mm).

A fork wrench can be put on flats (A, 24 mm) at the rear end of the camshaft for turning the camshaft when camshaft timing gear is removed and for holding in position when loosening and tightening camshaft timing gear set bolt. The collar (B), which runs in a groove in the cylinder head, locates the camshaft axially.



The marking for the ignition TDC position of the No. 1 piston is placed on this collar. It must match up with the edge on the cylinder head (arrow).



The camshaft can be removed from above. The rocker arm bearing supports and the camshaft timing gear have to be removed for this.
If the camshaft is to be replaced, all the rocker arms have to be replaced as well.
In the event of scored bearings or pronounced striation, the camshaft bearings in the cylinder head and in the rocker arm bearing supports can be bored out by 0.5 mm and a camshaft with over dimensioned bearing spigots installed (01-419).

The running in and wear characteristics have been improved by short- stroke honed camshafts (formerly tin-plated).

Introduced in production: January 1986

Model	Engine	Engine end number		Vehicle identification end number	
		Manual transmission	Automatic transmission	A	F
201.024 (USA)	102.985	003326	030324		193767

Since October 1987 camshafts have been fitted with 19 mm wide tinplated cams (formerly 18 mm).
Identification number: 39

Note

As a temporary measure this camshaft has been given the identification number "3".

Introduced in production: October 1987

Model	Engine	Engine end number		Vehicle identification end number	
		Manual transmission	Automatic transmission	A	F
201.028	102.985	019320	062484	416851	435608

Since 1988, in order to avoid camshaft wear, chilled cast iron camshafts and rocker arms with soldered on hard metal pads have been equipped.
If the chilled cast iron camshaft has been installed on previous engines, rocker arms with hard metal cam follower must also be installed.
As a temporary measure this camshaft has been given the identification number “5”.

Introduced in production: October 1988

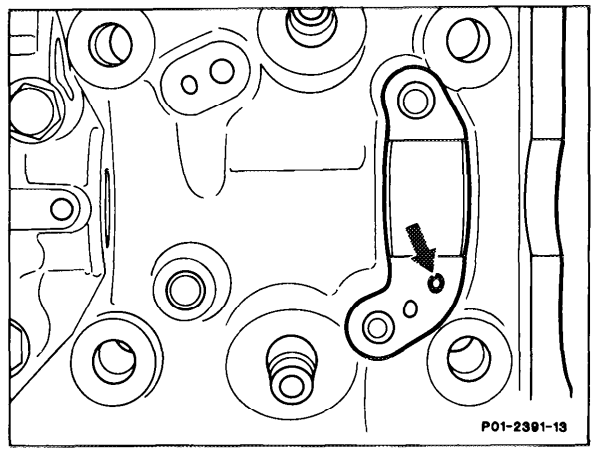
Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.028	102.985	027671	077053

From 09/89 a chilled cast iron camshaft with crowned cams has been installed. This camshaft is also supplied as a replacement part.
Identification number: 44

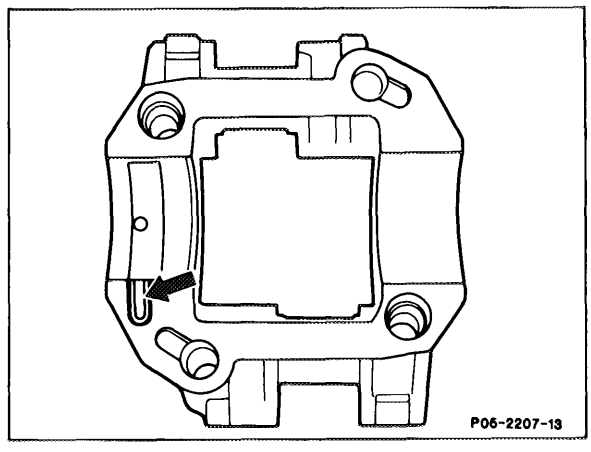
Introduced in production: September 1989

Model	Engine	Engine end number		Vehicle identification end number	
		Manual transmission	Automatic transmission	A/B	F
201.028	102.985	033962	080108	B 525380	–

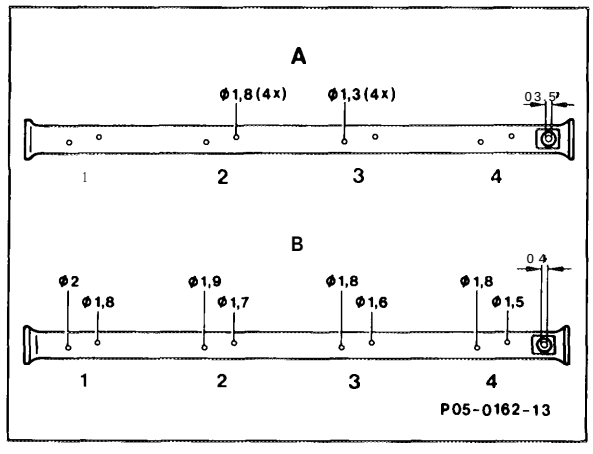
In order to improve camshaft lubrication the oil feed bore in the cylinder head has been enlarged from 3 mm to 4 mm Ø (arrow).



The oil groove in the rocker arm bearing support has also been widened from 4 mm to 5.5 mm (arrow).



The injection bores in the oil pipe for camshaft lubrication have a different diameter depending on position.



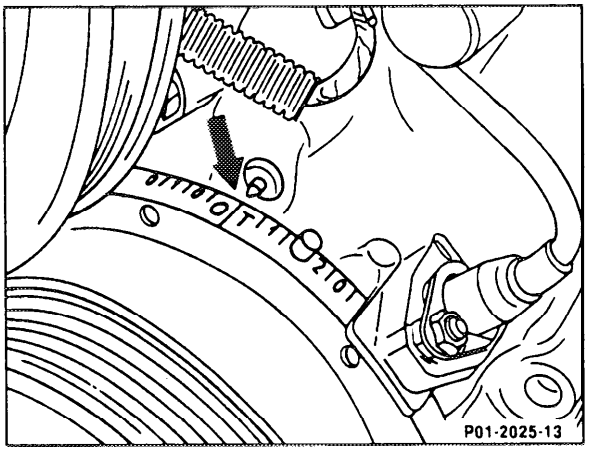
A Oil pipe - first design
B Oil pipe - second design

Introduced in production: January 1988

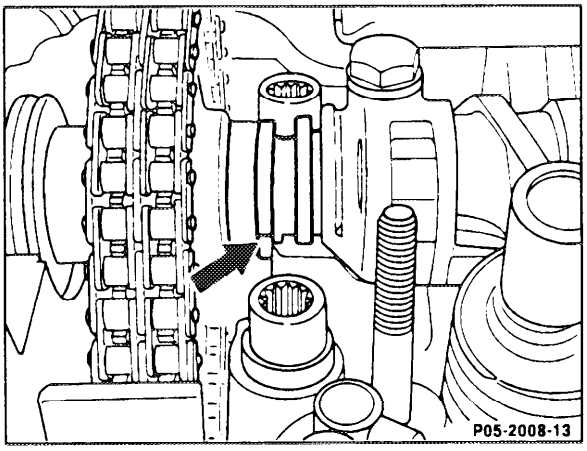
Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.028	102.985	022013	067143

Removal and installation

1 Position piston of No. 1 cylinder on ignition TDC.



2 Marking on camshaft collar must align with the edge on the cylinder head (arrow).
Before turning the crankshaft, switch off the ignition and remove the plug for the inductive sensor at the switching unit.

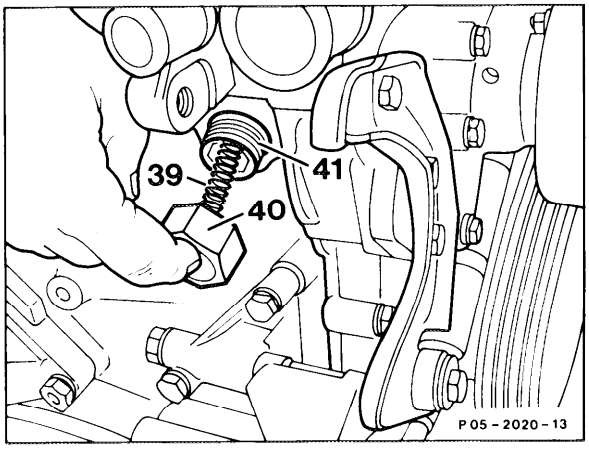


Caution!

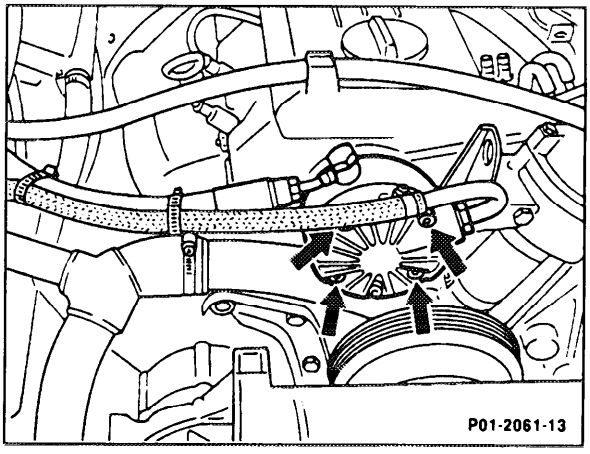
Do not turn the engine by the camshaft timing gear set bolt.
Do not turn the crankshaft backwards.

3 Unscrew the chain tensioner hexagon cap nut (40) and remove sealing ring (41) as well as compression spring, tightening torque 70 Nm (05-310).

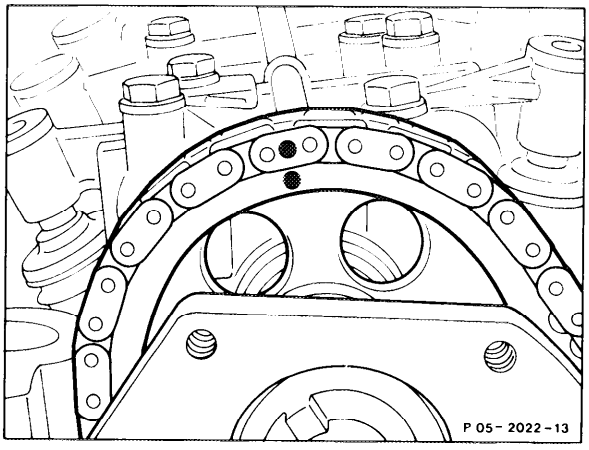
Caution!
The chain tensioner hexagon cap nut is pressurized by the compression spring.



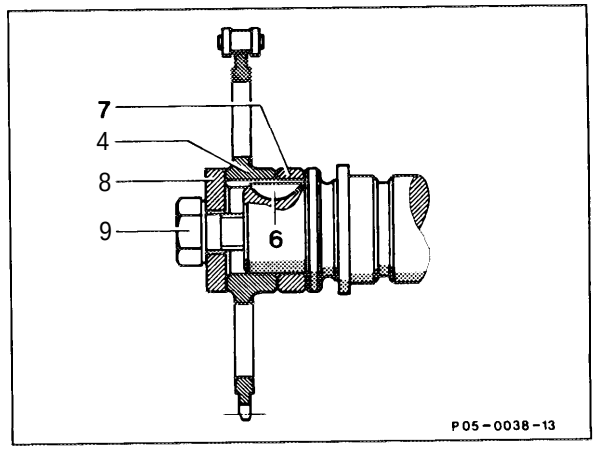
4 Unbolt, bolt on oil pressure pump (68) (arrows) and put to one side with the lines connected.



5 Align camshaft timing gear and timing chain.



6 Remove camshaft timing gear, remove timing chain and place in the timing case, tightening torque 80 Nm.



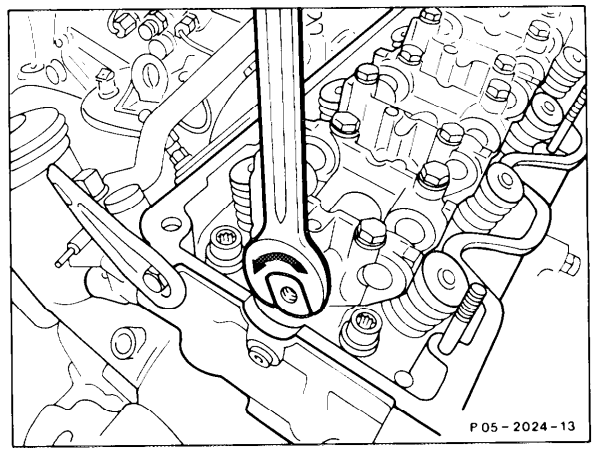
7 Remove and install Woodruff key (6) and spacer washer (7).

Installation note

Note color markings on camshaft timing gear and timing chain.

Assemble camshaft timing gear so that on the single roller chain the wide collar points to the camshaft and on the dual roller chain the curvature points to the camshaft.

8 In order to loosen or tighten up camshaft timing gear hold in position with flats at the rear of camshaft with a fork wrench (24 mm).

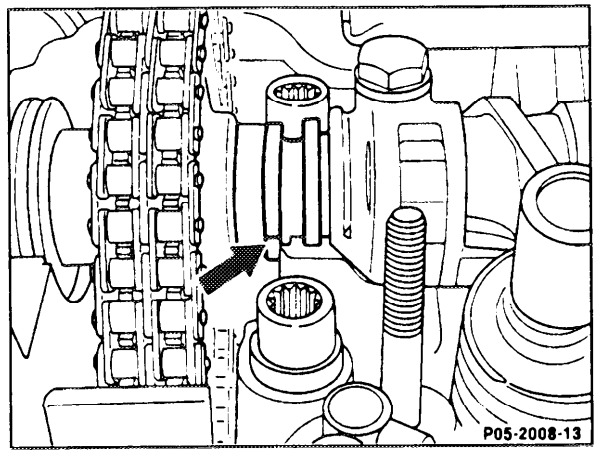


9 Remove and install rocker arm bearing supports (61) (05-235), tightening torque 20 Nm.

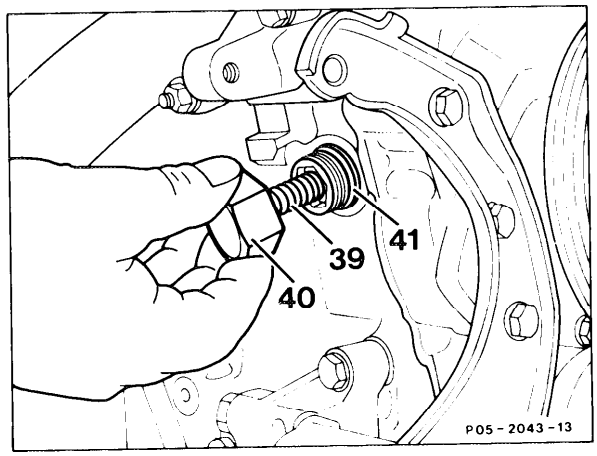
10 Remove camshaft. Before installing lubricate all bearing points with engine oil. Check, whether the marking on set collar aligns with edge on the cylinder head.

Installation note

If camshaft is to be replaced, all rocker arms and rocker shafts have to be replaced as a set.



11 Install hexagon cap nut (40) and compression spring (39) with new sealing ring (41), tightening torque 70 Nm.

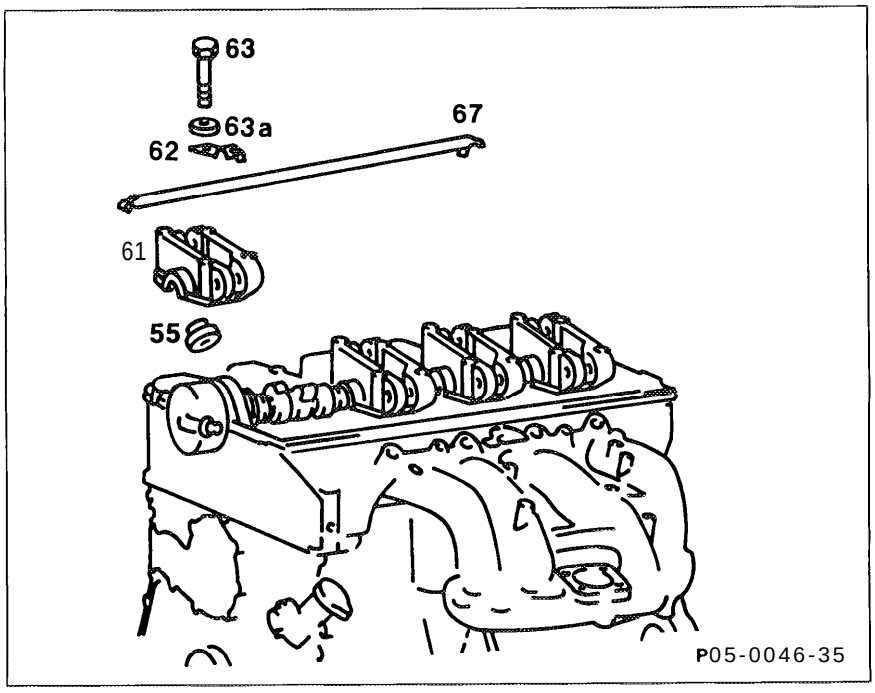


12 The installation proceeds in reverse sequence.

13 Check for leaks when engine is running.

05-235 Removal and installation of rocker arm bearing supports with rocker arms

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).



Engine ..... turn, so that rocker arm of bearing support being removed is on base circle of cam (cam tips pointing downwards).

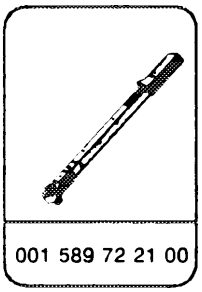
Oil pipe (67) ..... remove, install (Number 2).

Rocker arm bearing support (61) ..... remove, install, 20 Nm (Number 3).

Installation note

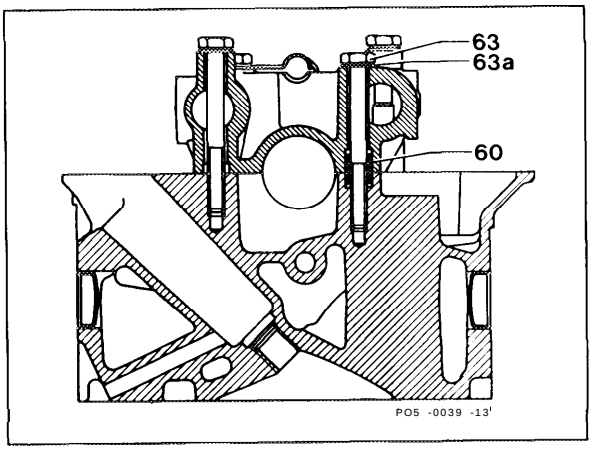
Install ball socket (55) in original position.
Note identification number on cylinder head and camshaft bearing cap.

Special tool



Note
The five bearing bores for camshaft support are each located half in the cylinder head and on top in the four rocker arm bearing supports. The front rocker arm bearing support has two half bearing bores.

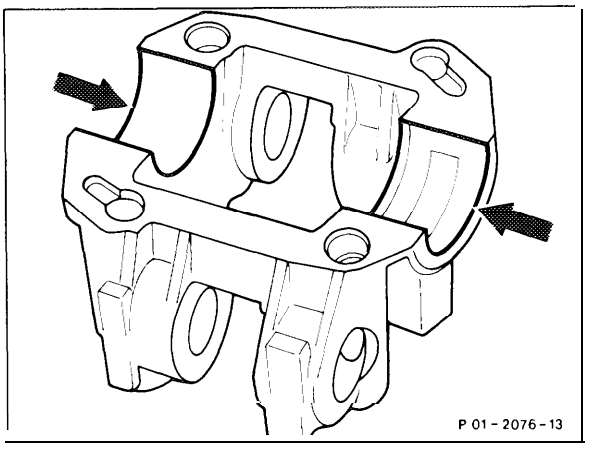
Each of the four bearing supports is attached with four bolts (63) and with two installation sleeves (60). Each bearing support simultaneously acts as a rocker arm carrier.



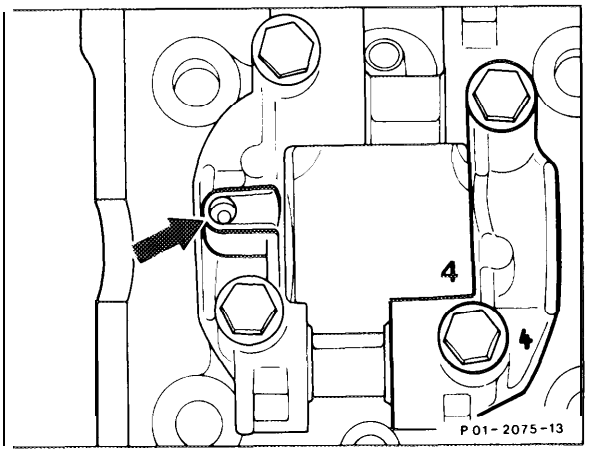
The rocker arm bearing supports can be distinguished by the following features.

Front bearing support
Code No. 1. Two bearing positions (arrows).

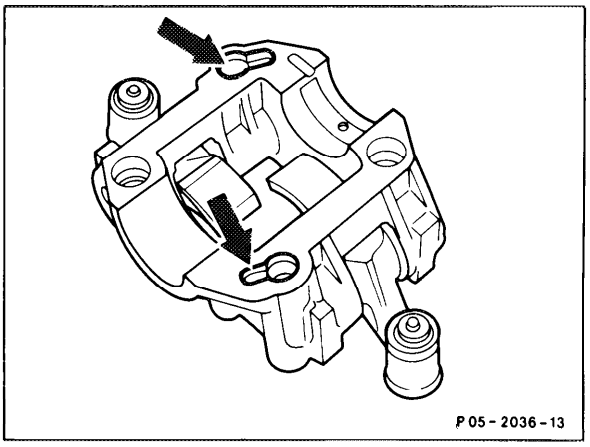
Center bearing supports
Code No. 2 and 3. These two bearing supports are the same apart from the identification numbers.



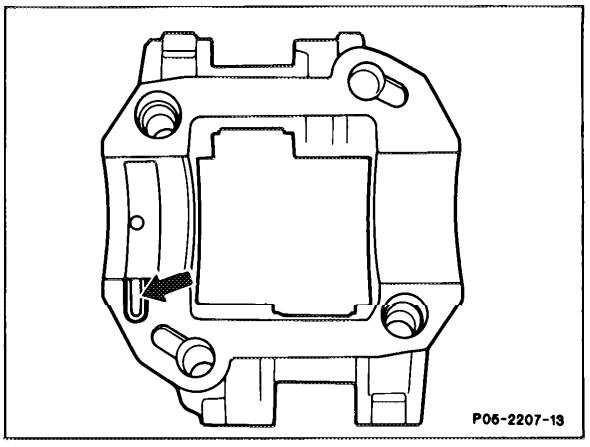
Rear bearing support
Code No. 4. Connection bore for oil pipe (arrow).



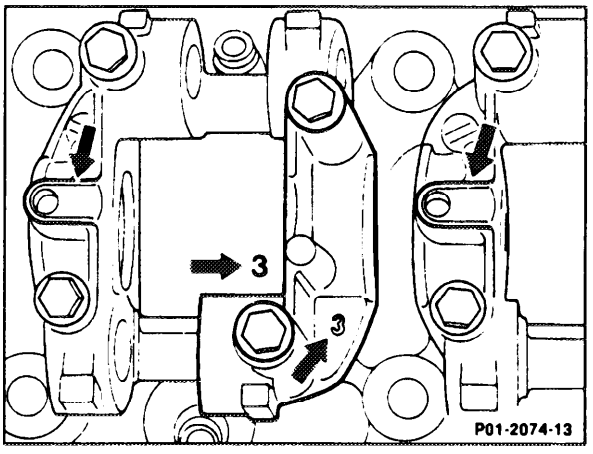
The two oil grooves (arrows) act as oil supply to the hydraulic valve clearance compensating elements.



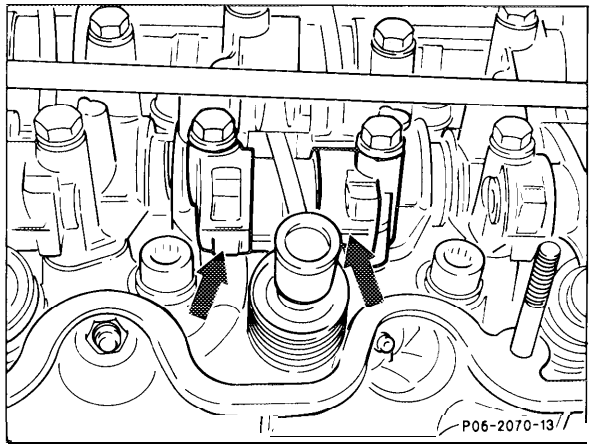
The oil pipe for camshaft lubrication is supplied with oil via the groove (arrow) on the rocker arm bearing support.



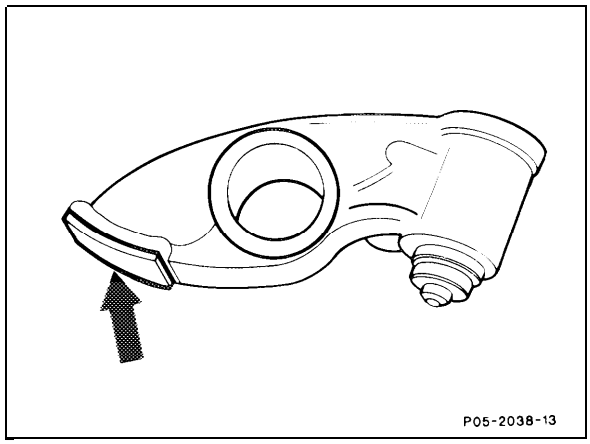
The rocker arm bearing supports should not be confused with each other. They are therefore identified on the right-hand side with the Numbers 1, 2, 3 and 4 from the front to the back. The identification of the bearing support must agree with the number, which is cast in the cylinder head (arrows).
In the replacement parts area the bearing supports are made individually and without code numbers stamped on. The corresponding code number is to be applied after installation.



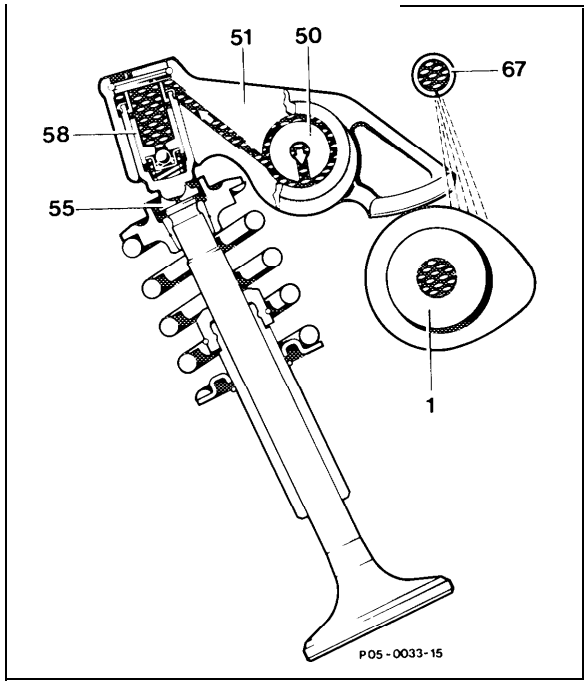
The rocker arms for operating the valves are supported individually on a rocker shaft fitted in a bearing support on both sides (arrows).



Rocker arms with soldered on cemented carbide tips have been installed since October 1988 (arrow).

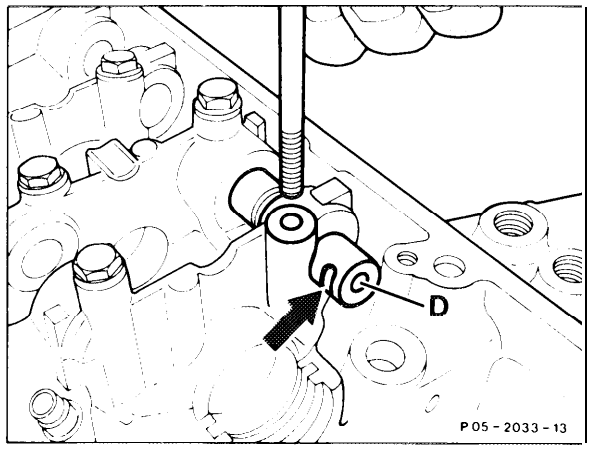


The oil required for lubricating the rocker arm bearings reaches the rocker arm bearing shaft (50) and hydraulic valve clearance compensating element via a longitudinal channel in the cylinder head and a feed bore in the bearing support (which is also the set bolt bore).



1 Camshaft
50 Rocker shaft
51 Rocker arm
55 Ball socket
58 Hydraulic valve clearance compensating element
68 Oil pipe

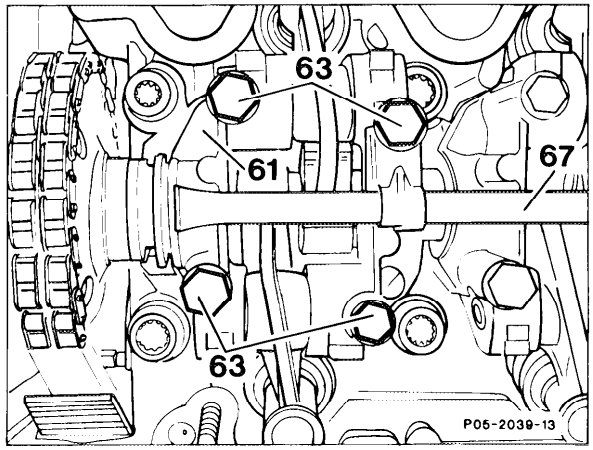
The rocker shaft is secured in the axial and rotary direction by a bearing support set bolt. For this a half bore is attached to the shaft, in which one half of the screw shaft is located (arrow).
An M8 thread (D) has been incorporated in the front face for installation and removal of the rocker shaft.



Removal, installation

1 Turn engine so that the camshaft tips of the bearing support being removed point downwards and rocker arms are on the base circle.

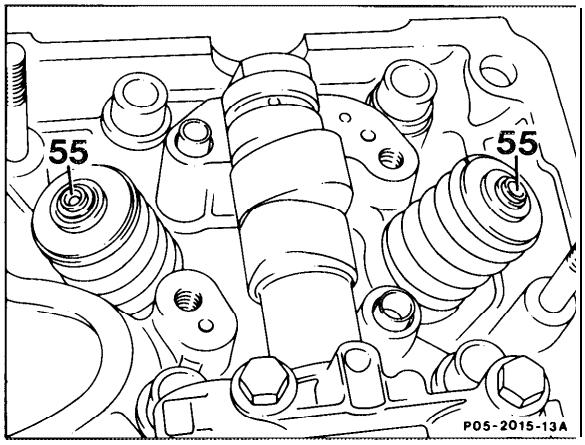
2 Remove oil pipe (67), to do this unbolt, bolt up the two bolts (63) on the pipe clamps, tightening torque 20 Nm.



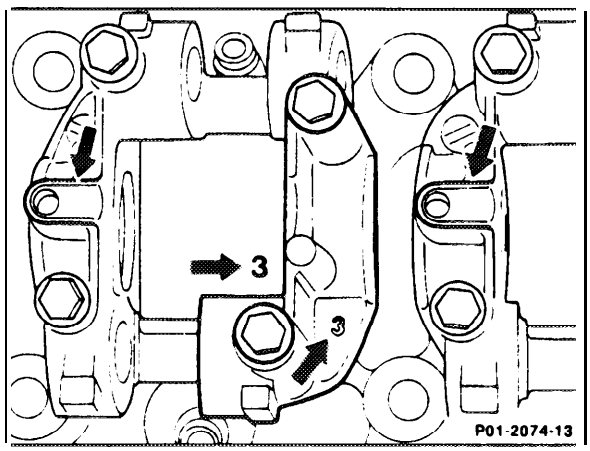
3 Remove, install relevant rocker arm bearing support, tightening torque 20 Nm.

Note

Loosen seized bearing supports using light blows with a plastic hammer.
The ball sockets (55) on the hydraulic elements can stick or fall down when removing the bearing support. Install ball sockets in their original positions.

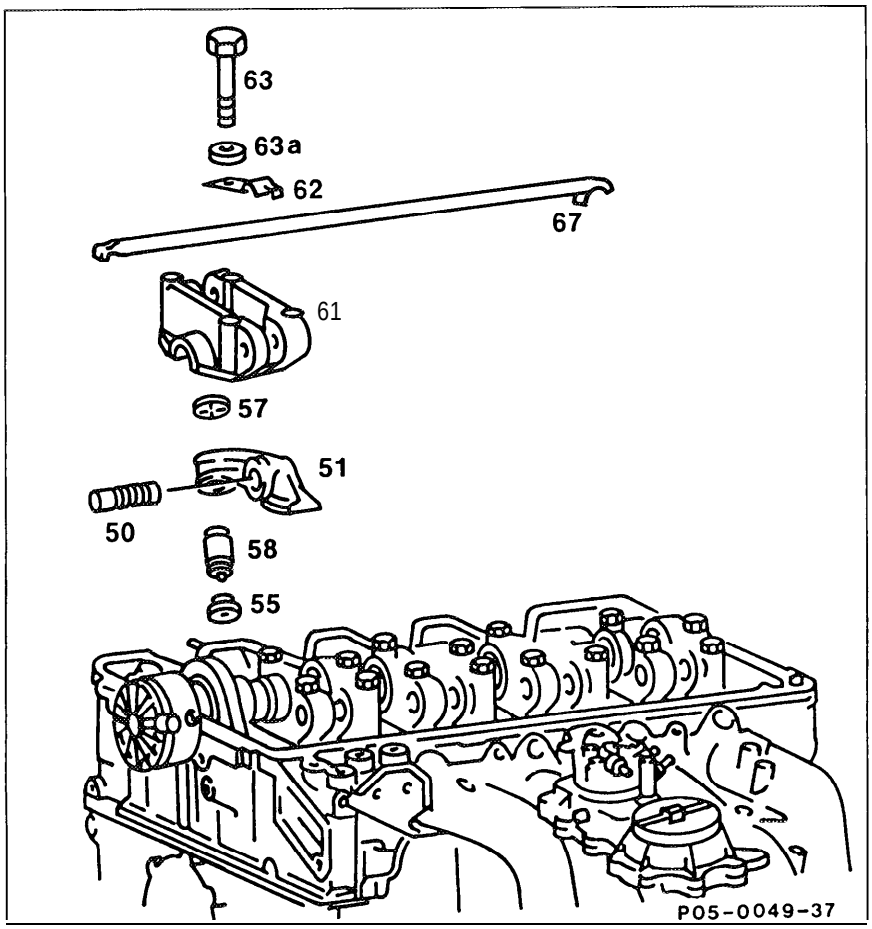


install the rocker arm bearing support so that the support areas for the oil pipe point rear-wards, the code numbers of the bearing supports are on the right-hand side (direction of travel) and correspond to the number cast on the cylinder head (arrows).



05-240 **Replacement** of rocker arms and rocker arm bearing supports

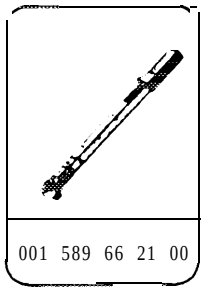
Preceding work:
Air cleaner removed (09-400 and 09-410)
Cylinder head cover removed (01-406).



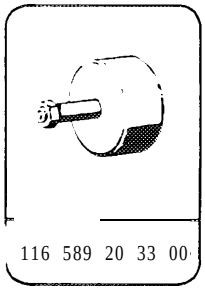
Camshaft	position so that rocker arms of bearing support being removed is on base circle of the cam (Number 1).
Oil pipe (67)	remove, install (Number 2)
Bearing support (61)	remove.
Rocker shaft (50)	pull out with impact extractor 116 589 20 33 00 and extension 616 589 00 34 00. Lubricate new rocker arm and rocker shaft and install. Prior to this rebuild hydraulic valve clearance compensating element (05-211, Numbers 4 and 5).
New bearing support (61)	install with rocker shaft without rocker arm, 20 Nm (Numbers 6 and 7).

Camshaft	turn and check for smooth running, possibly fit new bearing support (Number 8).
Bearing support (61)	remove, complete with rocker arm (51) and install rocker shaft (50) and bearing support (Numbers 9 and 10), 20 Nm.

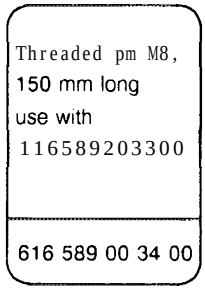
Special tools



001 589 66 21 00



116 589 20 33 00



616 589 00 34 00

Data

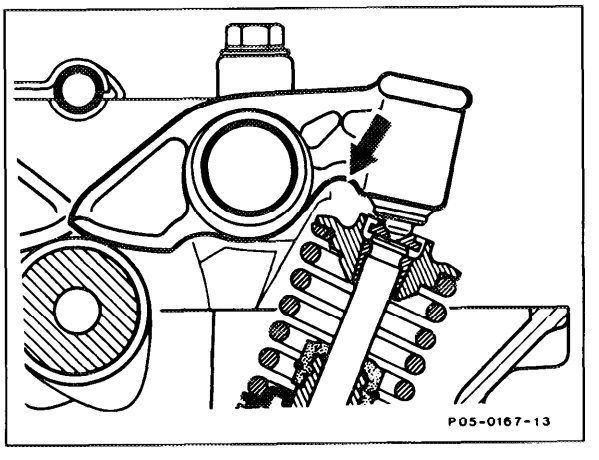
Rocker arm bore	18.016 18.027
Rocker shaft diameter	17.089 18.000
Radial clearance between rocker arm and rocker shaft	0.016 0.038
Rocker arm bearing support bore	18.000 18.018

Note

Only one bearing support can be replaced on an engine, otherwise camshaft binding will result.

Only rocker arm bearing supports where camshaft bearing half bore is 0.05 mm larger than on production parts are supplied as spare parts. This prevents the camshaft binding when replacing a bearing support.
In the event of bearing seizure or pronounced striation the camshaft bearings can be bored out by 0.5 mm and a camshaft with oversized journals installed (01-419). These camshafts have different code numbers
(05-215 and 05-220).
If the bearing supports are put together without rocker shafts, tighten the set bolts to max. 15 Nm, otherwise the shaft bores distort.

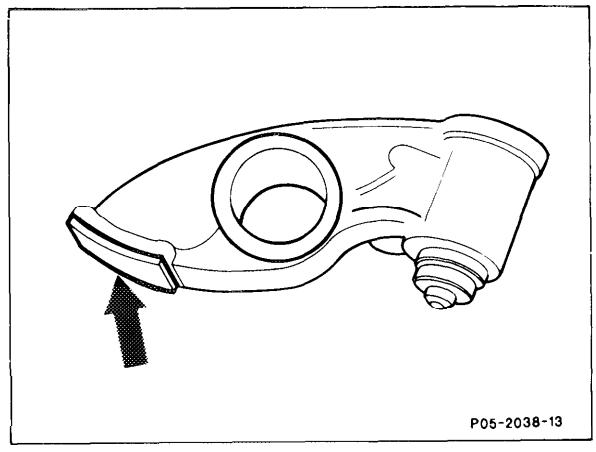
The radius on the rocker arm has been changed in order to increase the clearance between the rocker arm and the valve spring retainer (arrow).



Introduced in production: December 1984

Model	Engine	Engine end number		Vehicle identification end number	
		Manual transmission	Automatic transmission	A	F
201.024	102.985	000871	007129	172188	063323

In order to avoid camshaft wear, rocker arms with soldered on cemented carbide tips have been installed (arrow).
Only this rocker arm is still supplied as a replacement part.
These rocker arms may only be installed together with the chilled cast iron camshaft.



Introduced in production: October 1988

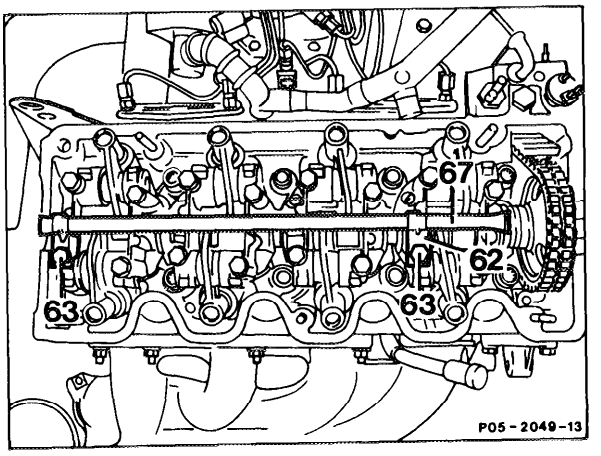
Model	Engine	Engine end number Manual transmission	Engine end number Autom. transmission
201.028	102.985	027671	077053

Replacement

a) Rocker arms and rocker shafts

1 Turn the engine so that the cam tips of the bearing support being removed point downwards and the rocker arms are on the base circle.

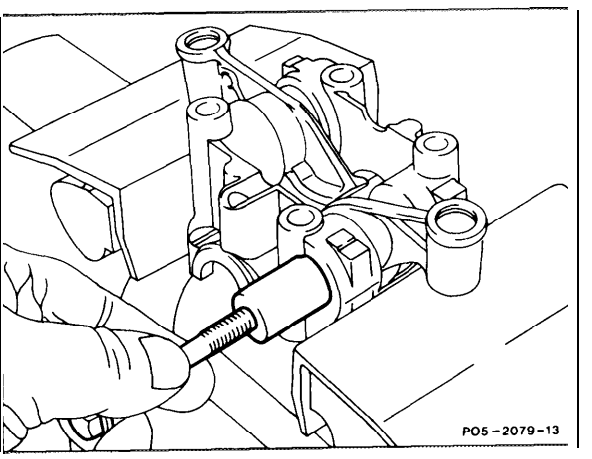
2 Remove, install oil pipe (67).



3 Remove bearing support.

4 Pull out rocker shaft with the impact extractor 116 589 20 33 00 and extension 616 589 00 34 00 or with an M8 bolt.

5 Lubricate new rocker arm and rocker shaft and install.

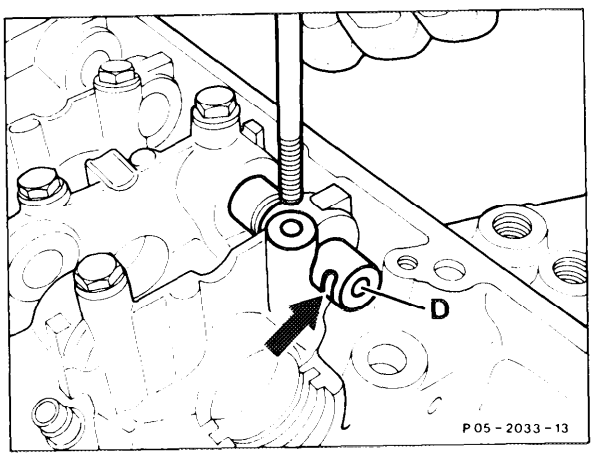


b) Bearing support

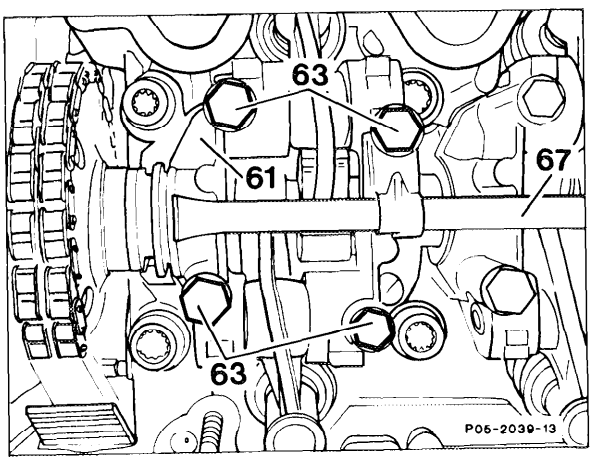
6 Lubricate new rocker shaft and install without rocker arm in the new bearing support.

Note

Insert the rocker shaft so that the half-bore (arrow) is located in one half of the screw shaft.



7 Put on bearing support, tighten set bolts (63) to 20 Nm, install oil pipe (67).

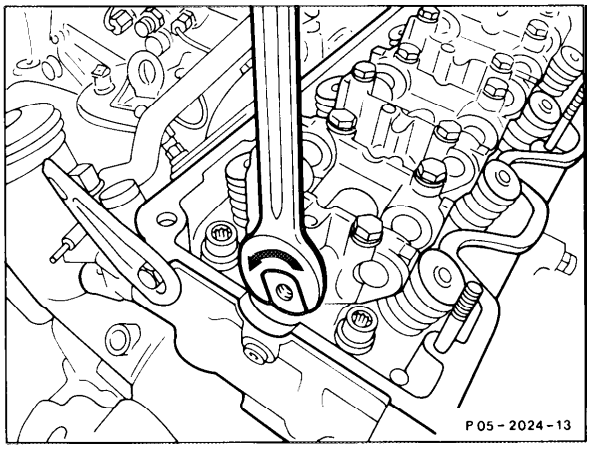


8 Turn camshaft by the fiats with a fork wrench (24 mm) and check for ease of movement. If binding occurs, remove the bearing support again and replace with another.

9 Remove new rocker arm bearing support and pull out rocker shafts (Figure Number 4).

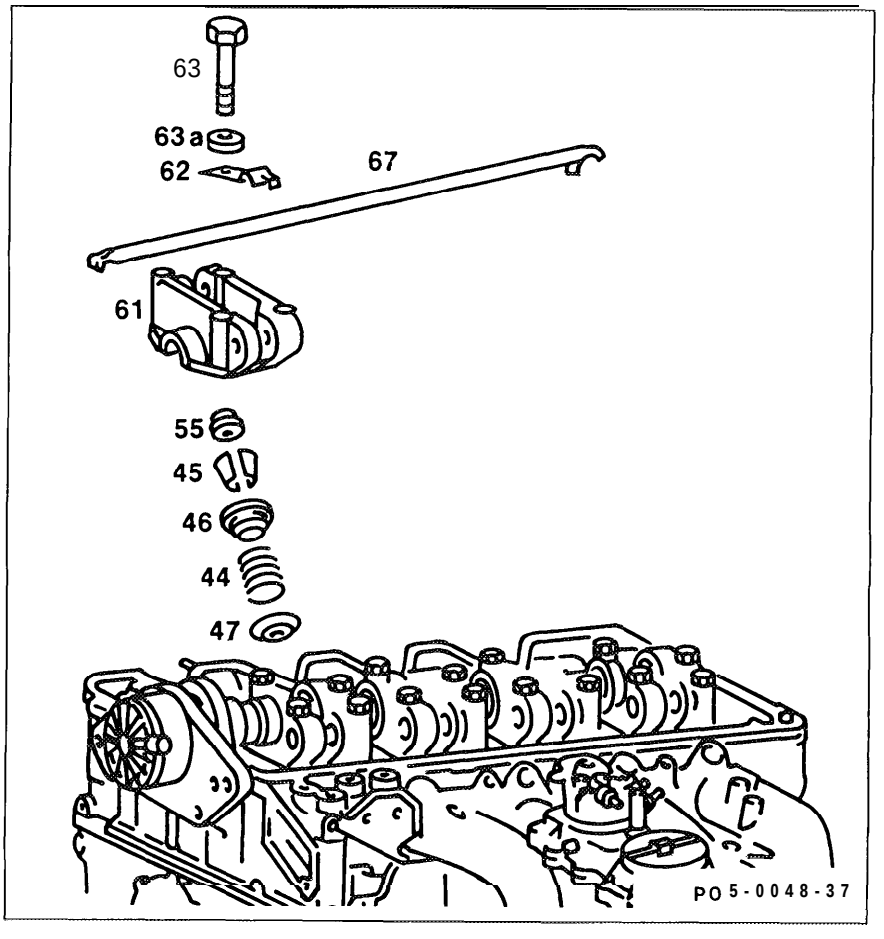
10 Lubricate rocker arms and rocker shafts and install in bearing support.

11 The installation proceeds in the reverse sequence.



05-250 Removal and installation of valve springs

Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed **(01-406).**
Spark plugs removed **(15-018).**



A. Cylinder head removed

Cylinder head ..... clamp on assembly board 102 589 00 59 00. Remove, install rocker arm bearing supports. Attach support bridge 102 589 01 59 00 to cylinder head. Remove, install valve springs with the lever compressor 601 589 02 61 00.

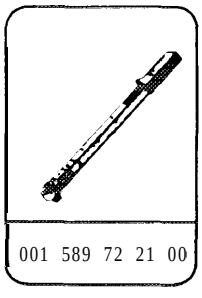
B. Cylinder head installed

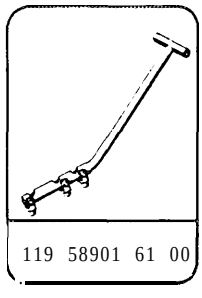
Piston of the relevant cylinder ..... position on ignition TDC (Number 1).

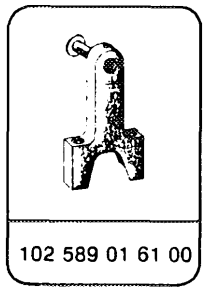
Oil pipe (67) ..... remove, install (Number 2).

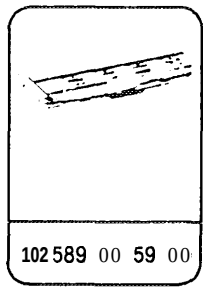
Rocker arm bearing support (61)	remove, install, 20 Nm (Number 3). **Repair note** Lubricate camshaft journals. Ball sockets (55) must be installed in the same position again. Note installation position of the rocker arm bearing bolt.
support	install 102 589 01 61 00 (Number 4).
Cylinder leakage tester	Disconnect, connect to the relevant cylinder (Number 5). Pressurize cylinder.
Valve cotters (45)	remove and install with the lever compressor 601 589 02 61 00 and magnet 116 589 06 63 00. Remove, insert valve springs (Numbers 7 to **9).** **Installation note** Install valve spring so that the color marking and the narrower coil point downwards.

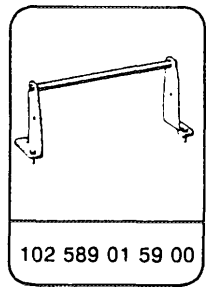
Special tools

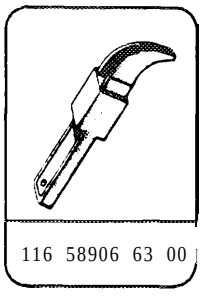

001 589 72 21 00


119 58901 61 00


102 589 01 61 00


102 589 00 59 00


102 589 01 59 00

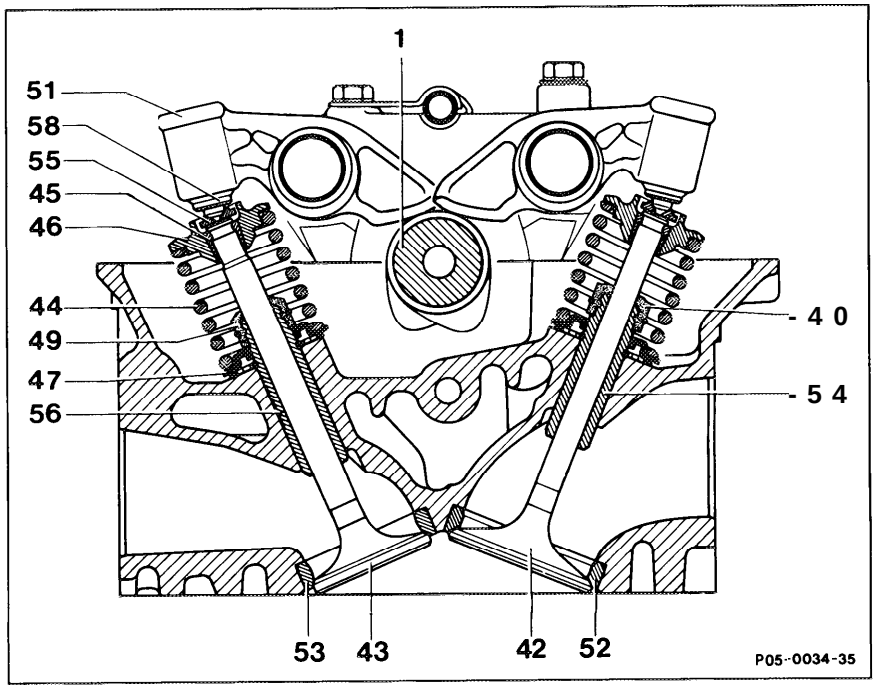

116 58906 63 00

Conventional tool

Cylinder leakage tester	e. g.	Bosch, E F A W **210** A **Sun,** CLT 228

Note

Valve springs and valve spring retainers with scoring on the mounting surfaces must be replaced.



The valve springs act progressively and must be installed so that the color marking (narrow coil) points towards the thrust collar (47).

Color marking : yellow/red or
violet/red

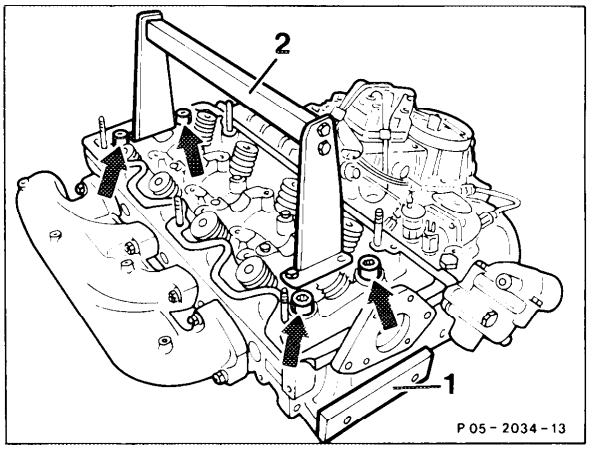
A thrust collar (47) is inserted under the valve springs, which is supported on the cylinder head via anti-rotation lugs.

As on all other engines, the valve spring thrust bearing at the top forms valve spring retainers (46), which are attached to the valves with valve cone halves (45).

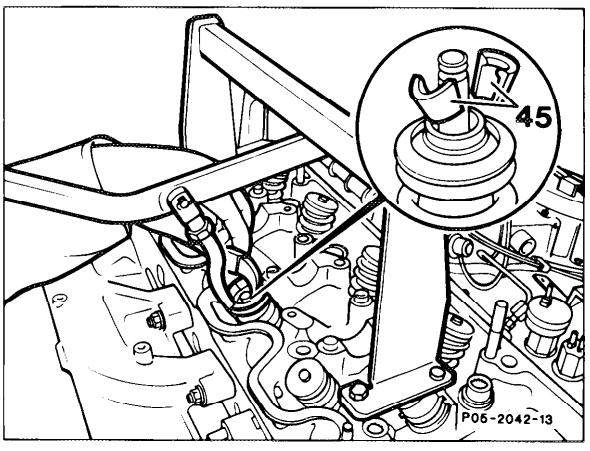
A. Cylinder head removed

When the cylinder head is removed the valve springs can be removed as follows:

Clamp cylinder head with four cylinder head bolts (arrows) on assembly board 102 589 00 59 00 (1). Remove rocker arm bearing supports with rocker arms and camshaft.

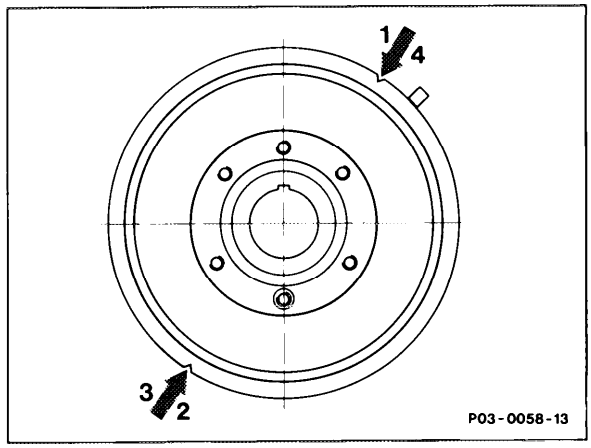


Attach support bridge 102 589 01 59 00 to the cylinder head and remove the valve springs with the lever compressor.



B. Cylinder headl installed

Removal, installation

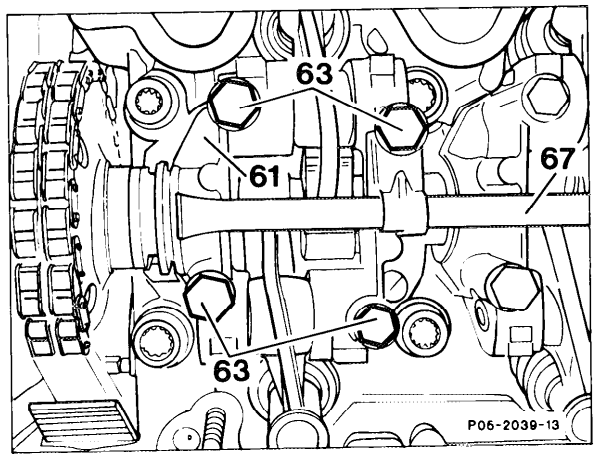


1 Put piston of the relevant cylinder on ignition TDC.

Note

The respective pistons are in the ignition TDC position, when the markings on vibration damper shown in the adjacent drawing are beneath the TDC pointer.

Marking	TDC	180"
Piston at TDC on cylinder	1 and 4	2 and 3



2 Removal and installation of oil pipe (67).

3 Remove and install the required rocker arm bearing support (61), tightening torque 20 Nm.

Installation note

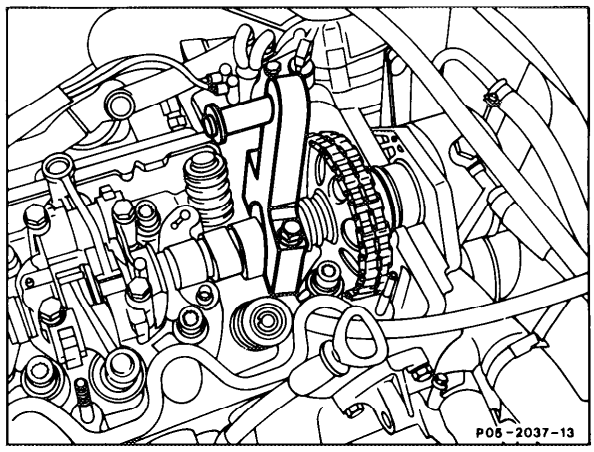
Before installing rocker arm bearing support lubricate camshaft journals.

Install the rocker arm bearing support so that the support area for the oil pipe points rearwards and the code number is on the right (in the direction of travel).

The ball sockets (55) must be installed in the same position again.

4 Bolt up, unbolt support for lever compressor,

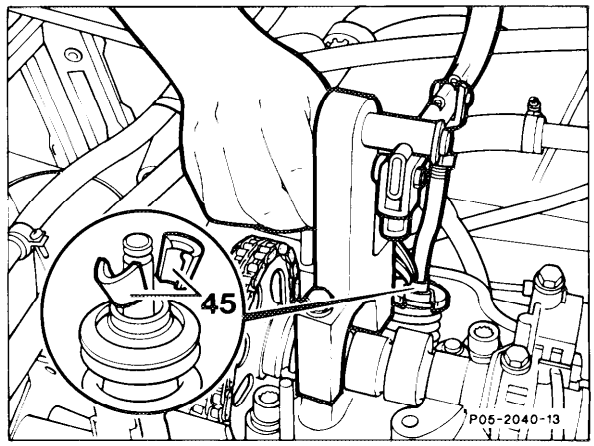
5 Connect cylinder leakage tester and pressurize cylinder.



6 Mount lever compressor on the support and install the valve spring retainer.

7 Compress valve spring and take out valve cone halves with the magnetic lever.

Caution!
Do not remove the valve springs without compressed air in the cylinder, otherwise damage can occur due to contact between the valves and the piston.

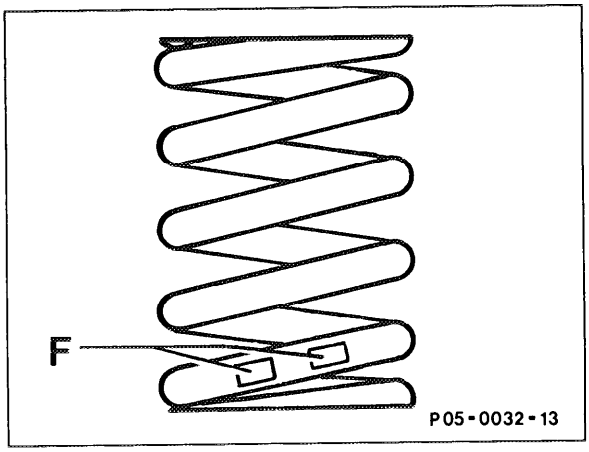


8 Remove, install valve spring retainers and valve spring.

9 Check valve spring (05-260) and valve spring retainers, replace as necessary.

10 Installation is the reverse of removal.

05-260 Checking valve springs



Data

	Valve spring Part no.	Colour identification (F)	Out-side Ø mm	Wire Ø mm	Free length mm	Spring force at the pre-loaded length		
						mm	New value N	Limit value N
1st design	102 053 02 20	yellow-red or violet-red	34.7	5.0	49	30.4	1084 + 30 - 50	−760
2nd design	102 053 11 20	violet-yellow orange or yellow-yellow orange						

Note

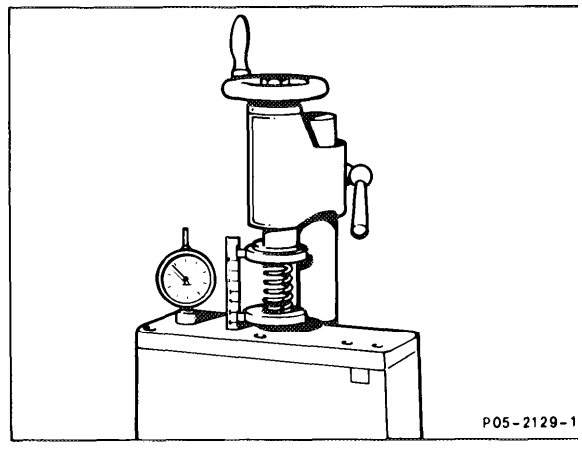
When carrying out repairs valve springs are to be checked for corrosion before re-use and to be replaced as necessary.

Checking

1 Check valve springs with a valve spring tester or with a spring test scale.

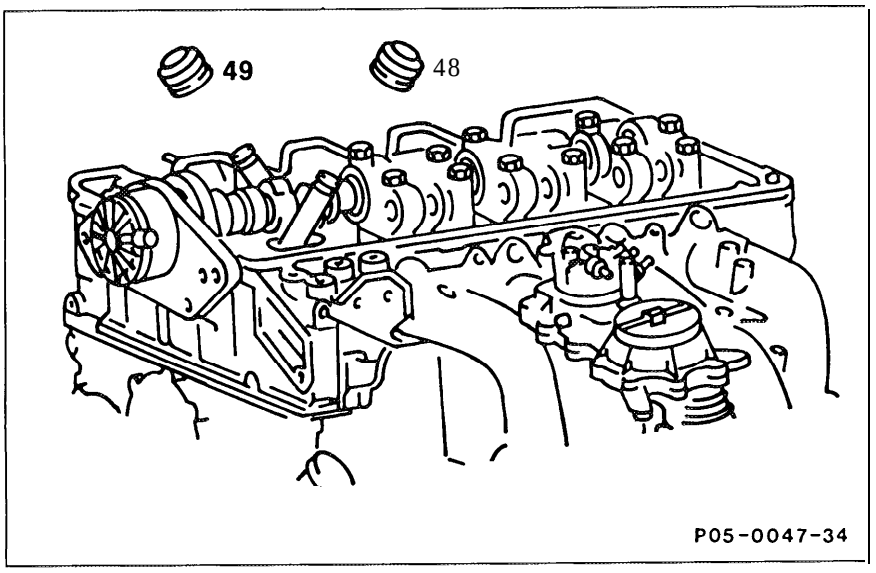
2 Check spring force at the specified length.

3 If the limit value is not achieved, replace valve springs.



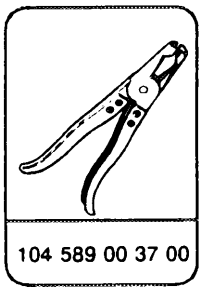
05-270 Replacement of valve stem seals

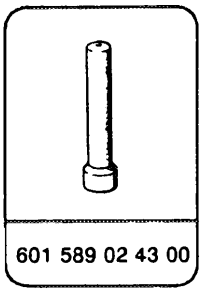
Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).
Spark plugs removed (15-018).
Valve springs removed (05-250).



Valve stem seal (48 and 49) . . . . . extract with special tool 104 589 00 37 00. Deburr valve stem at the groove. Replace hammered valve cone halves, spring seats and thrust collars.
Lubricate valve stem seal and insert.
Special tool 601 589 02 43 00. Note color marking, use assembly sleeve.

Special tools


104 589 00 37 00

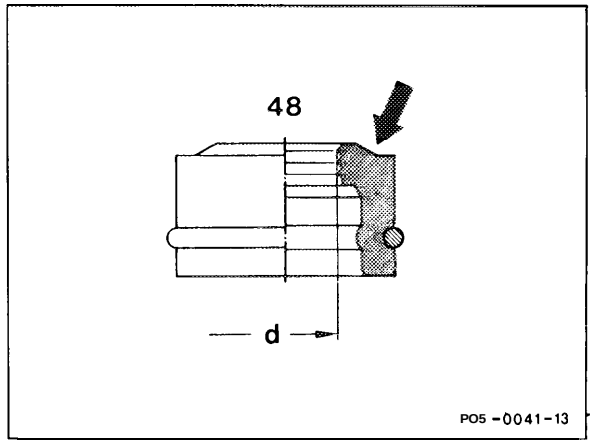

601 589 02 43 00

Note

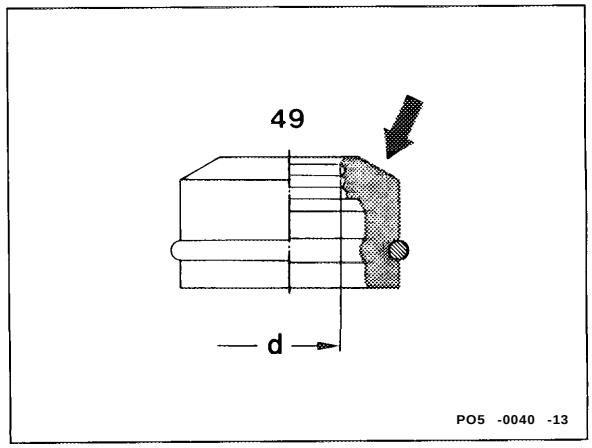
The valve stem seals including assembly sleeves are supplied in the repair set. Since September 1988 standardized valve stem seals in Viton (formerly Polyacrylic) are installed for intake and exhaust valves. The valve stem seals must not be interchanged due to the different inside Ø.

Distinguishing features:

Intake valve stem seal **(48)**
Chamfer (arrow) relieved
d = 7.3 mm
Wire ring : phosphated (black)
Color: brown



Exhaust valve stem seal (49)
Chamfer (arrow) inclined
d = **8.2** mm
Wire ring : bright galvanized (yellow)
Color: brown

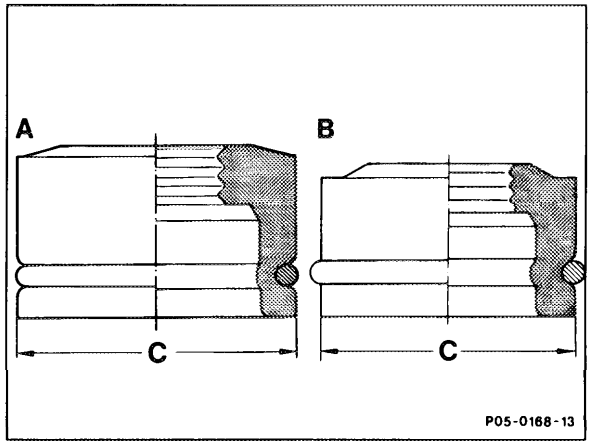


Valve guides, which are opened out at the retaining groove for the valve stem seal, must be replaced.
When installing the valve stem seal on the intake valves it is absolutely essential that the plastic sleeve, which is enclosed in the repair set, is placed on the valve stem, because without the sleeve damage to the sealing lip of the valve stem seal is unavoidable.

As a temporary measure valve stem seals with a smaller inlet ∅ c = 16 mm (previously 17.5 mm) have been installed.

Identification: revised outside contour

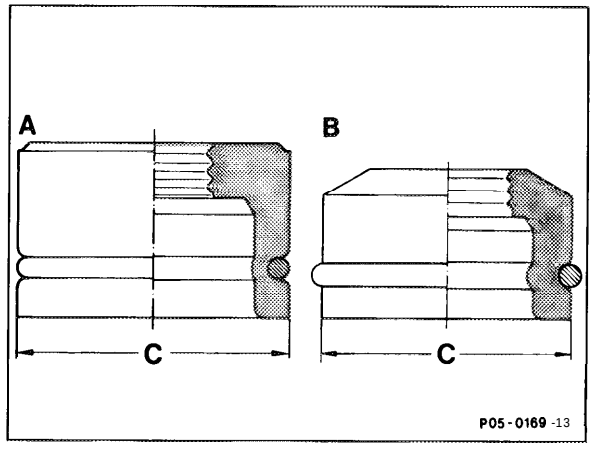
A Temporary design
B Production design



Intake valve stem seal

Introduced in production: January to February 1986

Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.024	102.985	003217 – 003513	029482 – 031994



Exhaust valve stem seal

Introduction of Viton valve stem seal

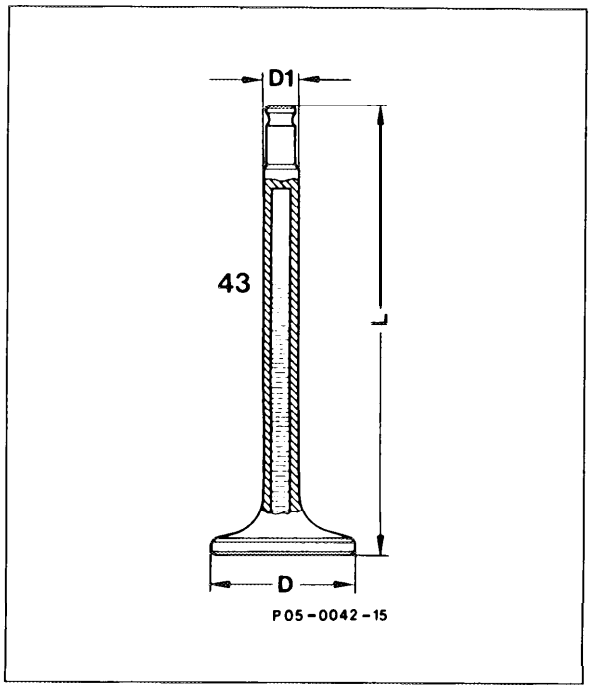
Color identification: brown

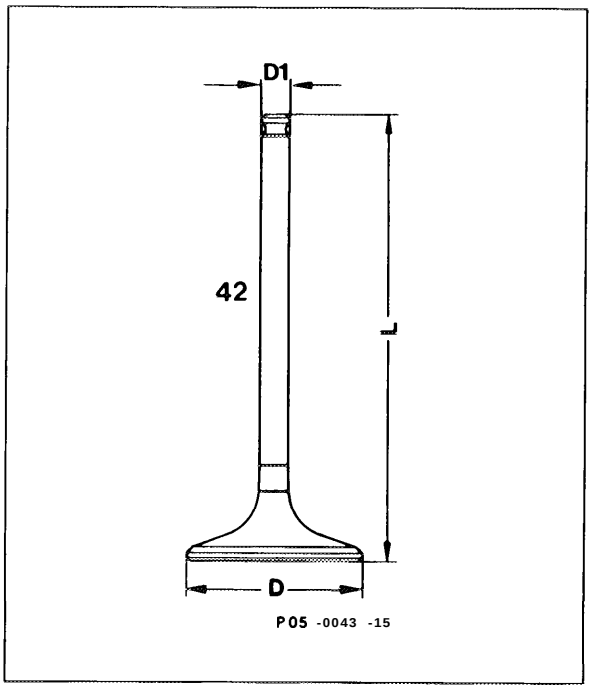
Introduced in production: June 1988

Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.028 (USA)	102.985	025442	074595

EXIT

05-280 Checking and machining valves





Checking	clean valves. Visual inspection: Valves with burnt valve heads, insufficent valve head height (h) worn or grooved valve stem must be replaced (Number 1).
Checking	Measure valve stem eccentricity. Replace valve when eccentricity is more than 0.03 mm (Number 2).
Machining valve seat	Note operating instructions for machining equipment. Note adjustment angle “a” 45 + 15°. Replace valve when maximum tolerances are reached (Numbers 3 and 4).

Conventional tools

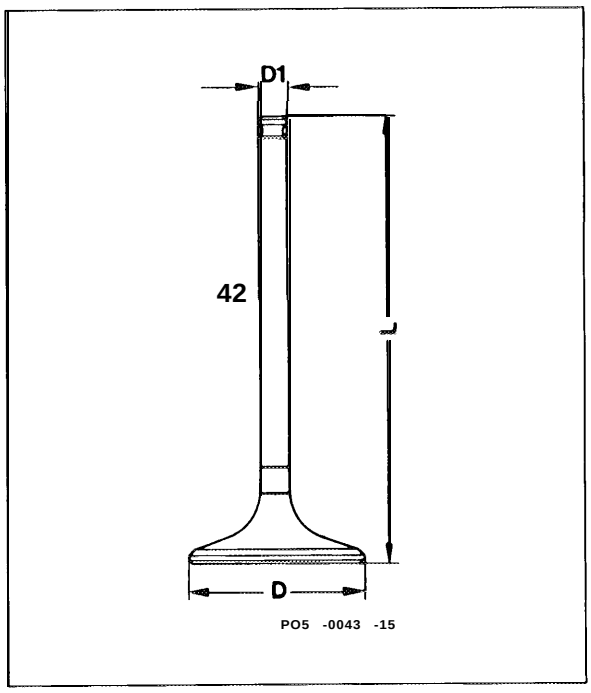
Valve cone grinding machine or	e.g.	Krupp, D-5309 Meckenheim VS Model
Valve cone turning equipment	e.g.	Hunger, D-8000 München 70 Type VKDR1, Part Number 203.00.200

Data

		Intake valve (42)	Exhaust valve (43)
Engine		102.985	102.985
Valve head Ø D		45.90 46.10	38.90 39.10
Height "h" of the valve head (Figure Number 1):	New value	1.6	2.7
	Limit Value	1.0	2.0
Adjusting angle „∝" for machining the valve (Figure Number 1)		45° + 15'	45° + 15'
Valve stem Ø D1		7.970 7.950	8.960 8.938
Valve seat reinforcement		without	with
Sodium filled		without	with
Valve length		114.70 115.10	115.60 116.00
Width of valve seat		1.8 – 2.5	1.5 – 2.5
Permitted eccentricity on valve stemand valve seat max.		0.03	0.03

Identification on end of stem

Engine	Inlet valve	Exhaust valve
102.985	E 102 08	A 102 03 27

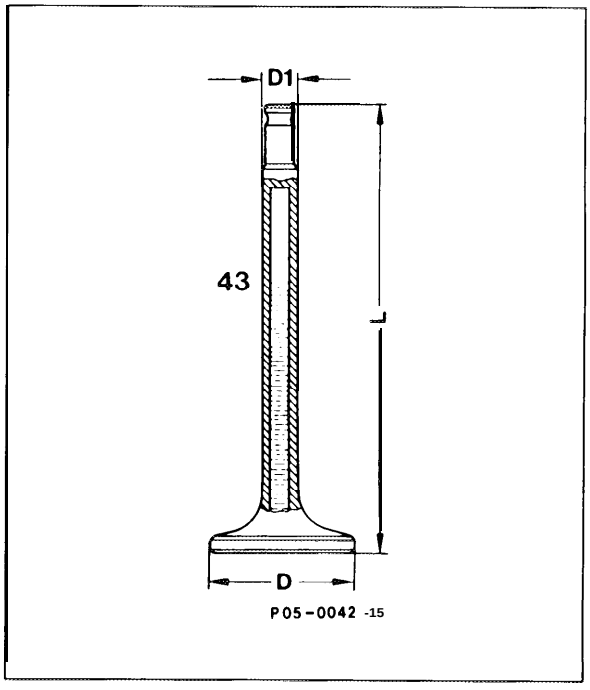


42 Intake valve

Note
The exhaust valve stem is chrome-plated on these engines and filled with sodium due to high temperatures in the combustion chamber.

Warning!
Unserviceable sodium filled valves must be neutralised before scrapping. They must therefore be collected and sent to:

Mercedes Benz AG
Werk Marienfelde
Daimlerstraße 145
Anlieferstelle KST 3153
Arbeitsvorbereitung TAI

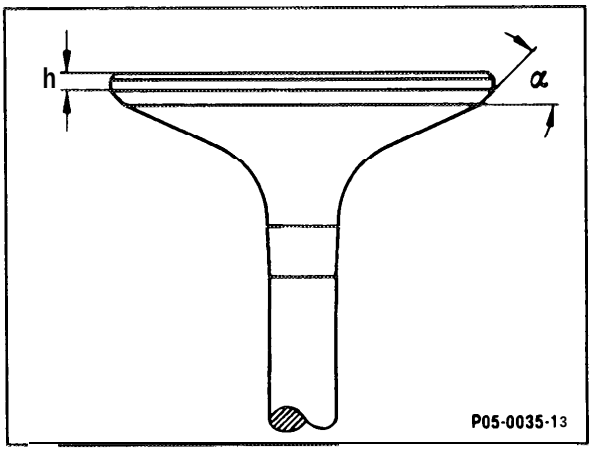


43 Exhaust valve

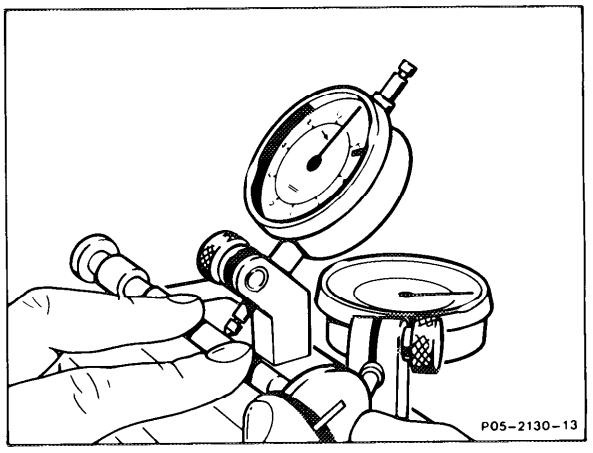
After machining or replacing valves, the installed length of hydraulic valve clearance compensating elements must be checked and corrected if necessary (05214).

Checking and machining

1 Clean valves and carry out visual inspection. Valves with burnt valve heads with insufficient valve head height "h" and with worn or scored valve stem are to be replaced.

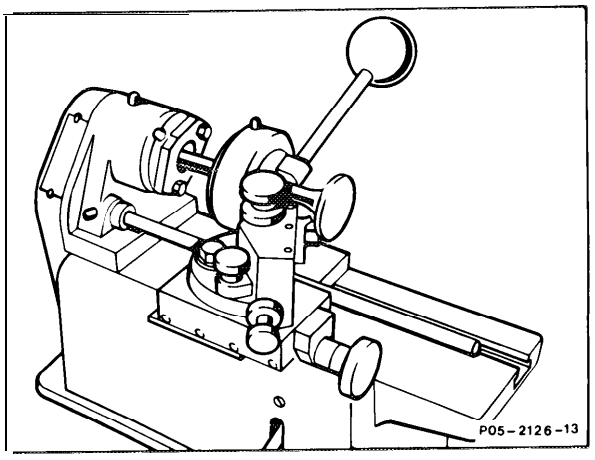


2 Measure valve stem eccentricity. Replace valve when an eccentricity of more than 0.03 mm is measured.

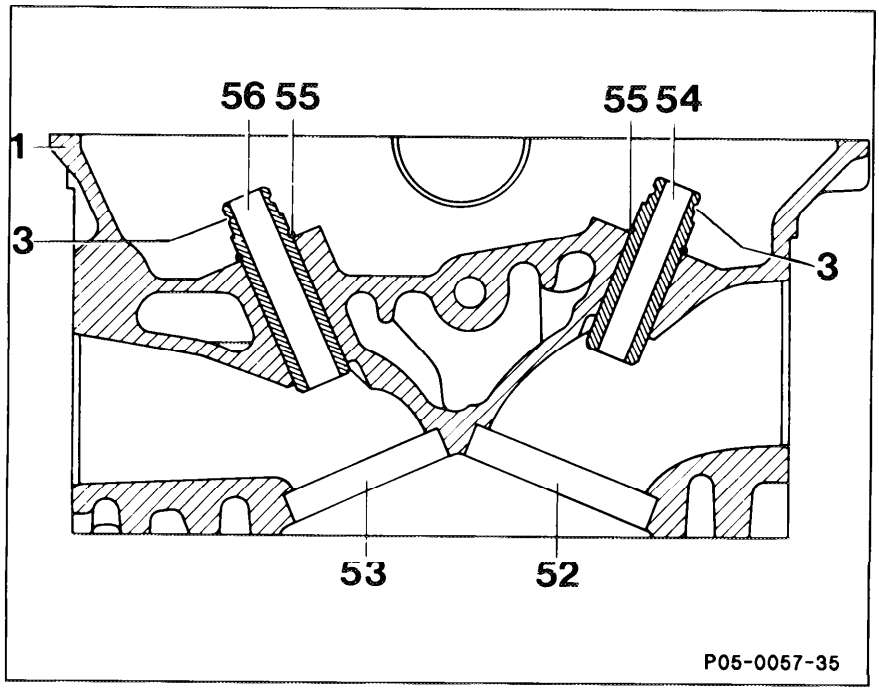


3 Machine valve seat. Note operating instructions of the machining equipment and adjustment angle "α" 45 + 15'.

4 Measure valve seat eccentricity and valve head height "h". Replace valve if the limit values are reached.



05-285 Checking and replacing valve guides



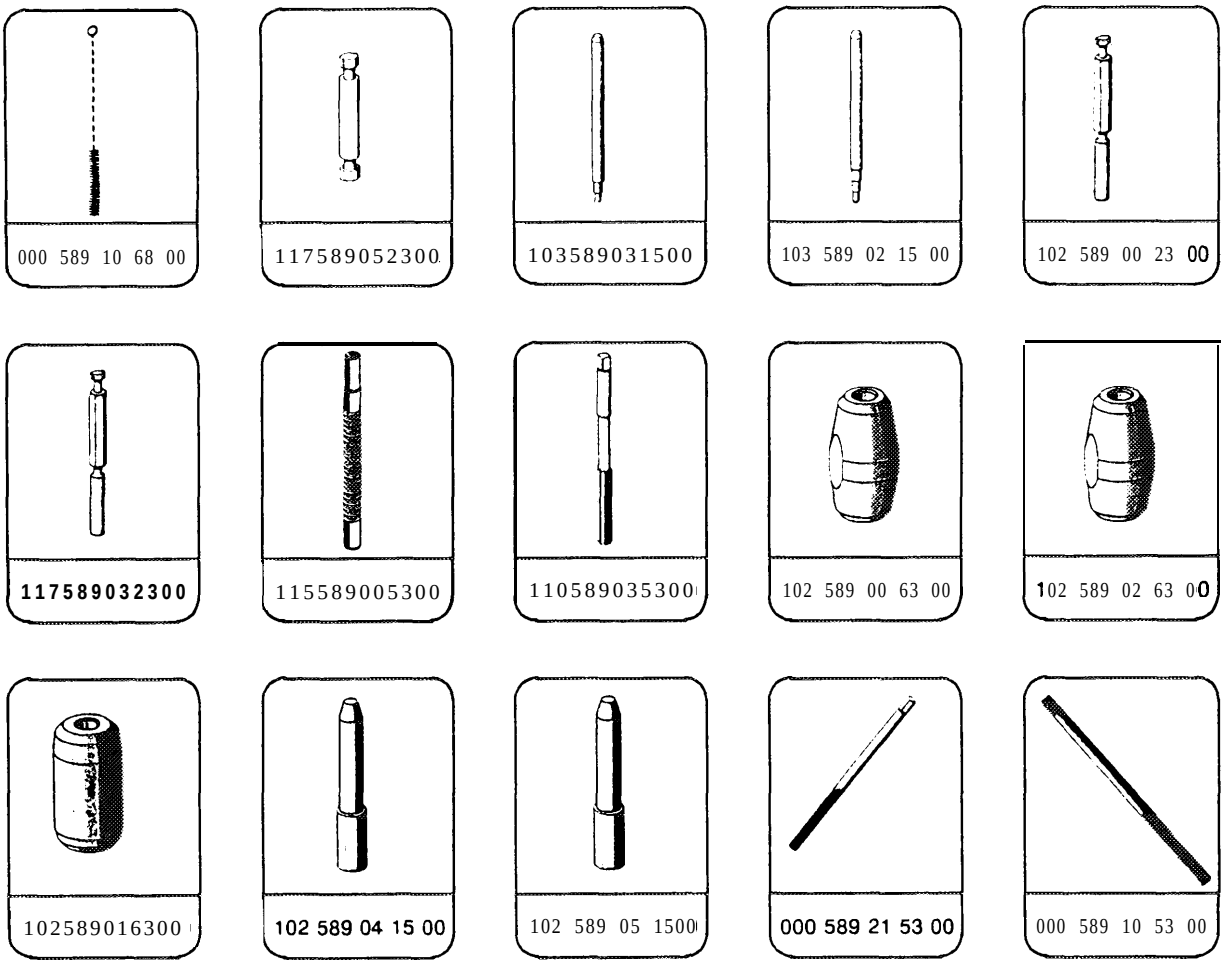
Valve stem seal seat (3) . . . . . check for wear. If the valve stem seal is no longer firmly seated, replace valve guide, special tools 103 589 02 15 00, 103 589 03 15 00.

Valve guide (54 and. 56) . . . . . clean, check, special tools 000 589 10 68 00, 102 589 00 23 00 and 117 589 03 23 00. If the go pin of the checking mandrel can be slid in longitudinally or laterally to the full extent (6.5 mm), replace valve guide. Special tools 103 589 02 15 00 and 103 589 03 15 00. Insert: Super cool in liquid nitrogen approx. (3 minutes), special tools 102 589 04 15 00 and 102 589 05 15 00. See repair note. After insertion check inside Ø with testing mandrel, special tools 102 589 00 23 00 and 117 589 03 23 00; if required, ream, special tools 000 589 21 53 00 and 000 589 10 53 00.

Base bore for valve guide
in the cylinder head (1) . . . . . check before inserting a valve guide.
Special tool 117 589 05 23 00. If normal dimension valve guide can be used;
Ream base bore with reamer 14.035 mm Ø, 1105890300
When the checking pin can be inserted to the full extent, broach base bore to 14.2 mm Ø.
Special tools 115 589 00 53 00, 102 589 00 63 00, 102 589 01 63 00 and 102 589 02 63 00.
See repair note.

Valve seat ring (53 and 54) . . . . . after installing a new valve guide check for eccentricity, if necessary machine (05-291).

Special tools



Conventional tool

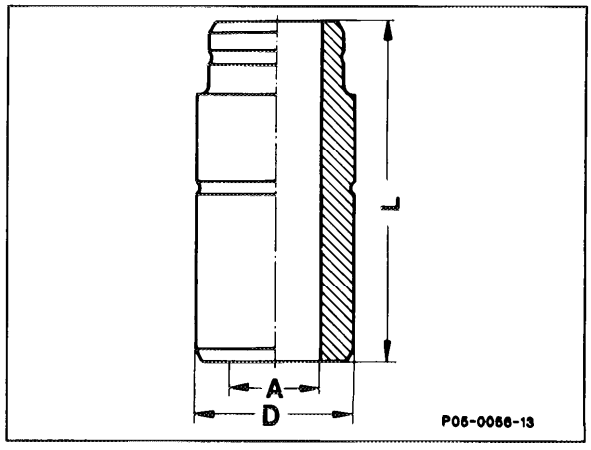
Cylinder head clamping fixture	e.g.	f-lunger, D-8000 München 70 Part Number 221.60.000

Valve guides

	Intake valve		Exhaust valve	
	Normal dimension	Repair stage	Normal dimension	Repair stage
Part Number	11020501724	11020501024	11020501824	11020501324
Outside Ø (D)	114.044 – 14.051	114.214 – 14.222	114.044 – 14.051	14.214 – 14.222
Color identification	grey-brown	red	grey-brown	red
Base bore in cylinder head	14.030 – 14.035	114.198 – 14.203	114.030 – 14.035	114.198 – 14.203
Overlap	0.009 – 0.021	0.011 – 0.024	0.009 – 0.021	0.011 – 0.024
Valve guide inside Ø (A)	8.000 – 8.015	8.000 – 8.015	9.000 – 9.015	9.000 – 9.015
Length (L)	46.0	46.0	51.0	51.0

Note

Valve guides are made of different materials on the intake and exhaust side.
Intake valve guide (54): copper olours
Exhaust valve guide (56): brass colors



Valve guides produced by another manufacturer have been installed between June and September 1986.

Introduced in production: June - September 1986

Model	Engine	Engine end number		Vehicle identification end number	
		Man. transmission	Auto. transmission	A	F
201.024 (USA)	102.985	003910 – 004391	036130 – 040796	–	262533 – 277581

[1]) not recorded

Broach base bore in cylinder head (repair stage)

Remove rust and clean the cylinder head thoroughly, particularly the inside of valve seat rings.

Select correct guide sleeve (2) and remove swarf from the cutting edge of broach (1) with a stiff plastic brush or similar.

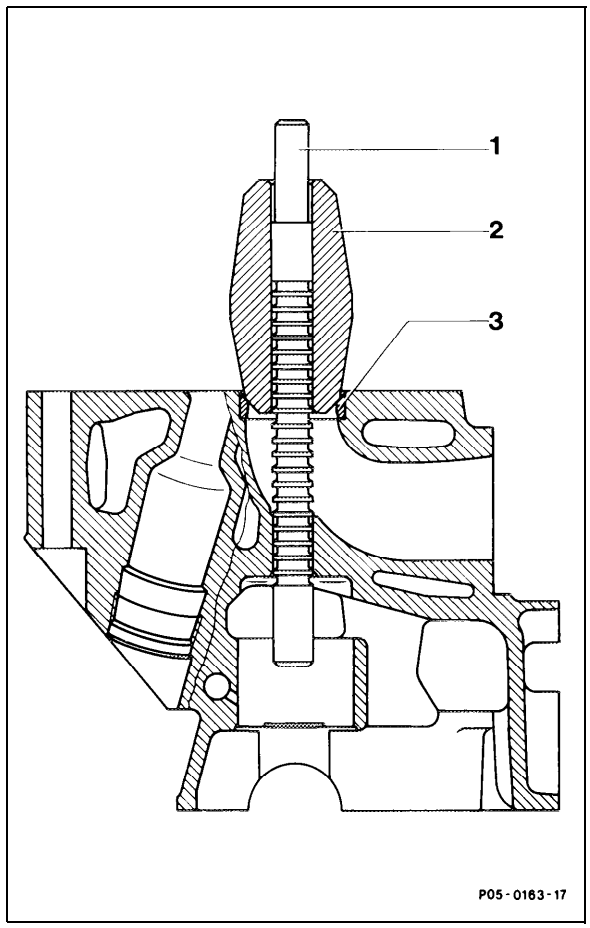
Note

The broaching tool cutting edges must be cleaned before every broaching process. Provide guide sleeve, base bore and complete broach with ample supply of kerosene.

Slide broaching tool in direction of broaching into the guide sleeve, so that when putting the guide sleeve on the valve seat ring (3) the first broach cutter is inserted in the base bore. When doing this, note that the correct side (A or B) of the guide sleeve is placed on the valve seat. Center guide sleeve by rotary movements in valve seat ring.

Note

Drive home the broach briskly with an aluminium mandrel, approx. 130 mm long, and a plastic hammer of approx. 250 g.



1 Broach
2 Guide sleeve
3 Valve seat ring

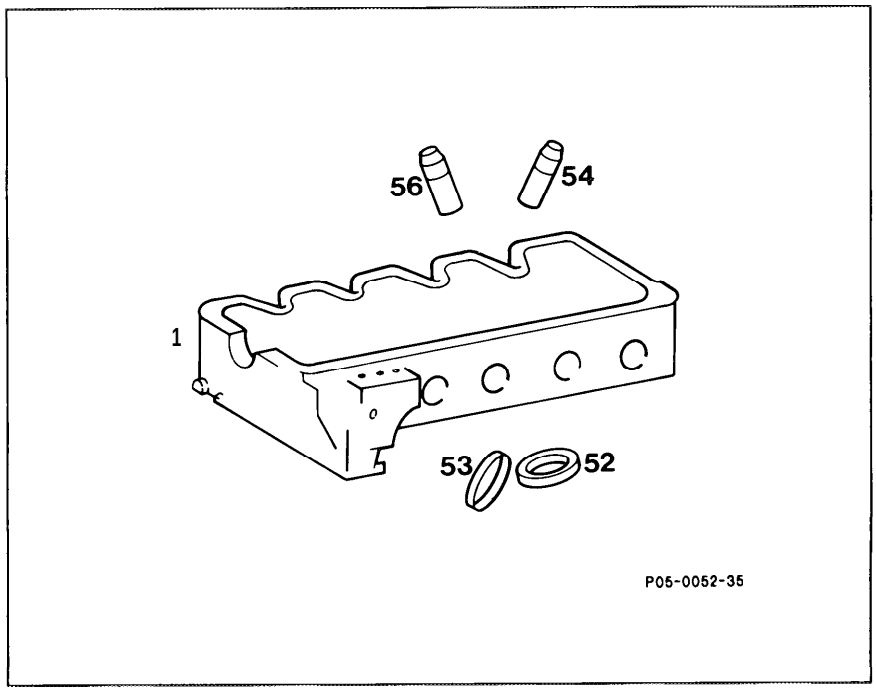
Inserting valve guide

Drive in the valve guides with impact mandrel and hammer, when the valve guides are not super cooled and cylinder head is not heated up. Coat valve guides with wax or oil before driving in.

Guide sleeve - valve seat allocation to enaine

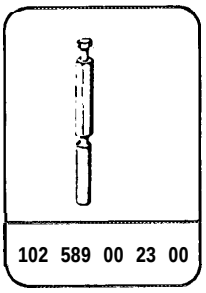
Valve seat	Engine	Guide sleeve Part No.	Base bore Ø in cylinder head
Intake	102.922/924 102.962.963	102 589 01 63 00	14. 2 mm
	102.985	102 589 02 63 00	
Exhaust	102.985	102 589 00 63 00	

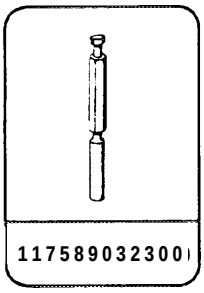
05-290 Replacing valve seat ring



Valve seat ring (52 and 53)	unscrew with seat ring turning tool Note turning tool operating instructions.
Valve guides (54 and 56)	check, replace if necessary (05-285).
Base bore (D2)	measure. **Note** A new valve seat ring with normal dimensions can be used, when specified overlap is present. If minimum overlap is not achieved, machine base bore for valve seat ring.
Machined base bore	measure.
Valve seat ring repair stage	skim, so that the specified overlap is achieved.
Cylinder head (1)	heat up in water bath.
Valve seat ring	Super cool with liquid nitrogen and stamp with a suitable mandrel. Machine valve seat (05-291).

Special tools



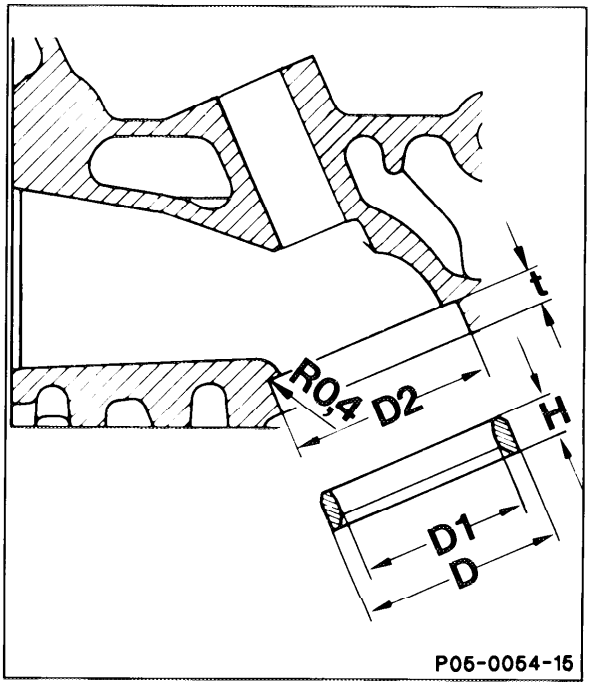


Conventional tools

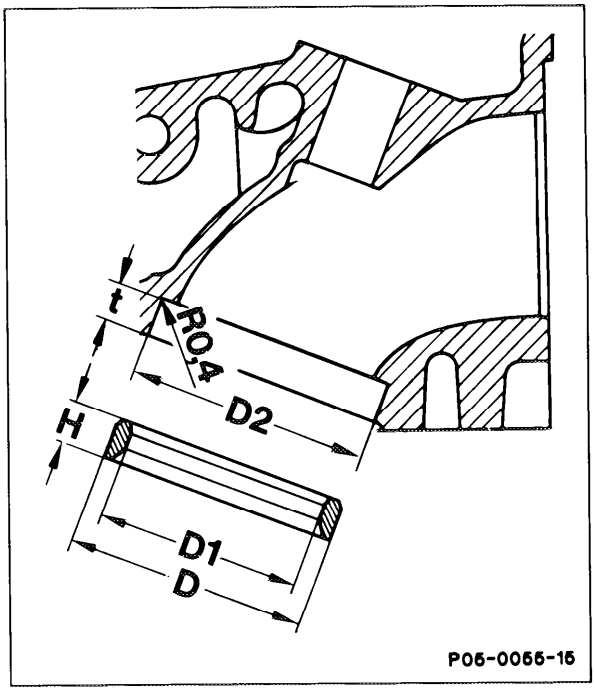
Cylinder head clamping fixture	e.g.	Hunger, D-8000 München 70 Part No. 221.60.000
Ring seat turning tool	e.g.	Hunger, D-8000 München 70 Size 2, Part No. 220.03.110
Valve seat turning device	e.g.	Hunger, D-8000 München 70 Type VDSN 1/45/30, Part No. 236.03308
Test set for valve seats	e.g.	Hunger, D-8000 München 70 Part No. 216.93.300
Internal measuring instrument (measuring range 35 - 100 mm)	e.g.	Mahr, D-7300 Esslingen Part No. 844 N
External micrometer (measuring range 25 - 50 mm)	e.g.	Mahr, D-7300 Esslingen Part No. 40 S H

Data

		Intake		Exhaust
Engines		102.922/924 102.962/963	102.982/985	102.922/924 102.962/963 102.982/985
Overlap of valve seat rings in cylinder head		+ 0.074 to + 0.100	+ 0.074 to + 0.100	+ 0.074 to + 0.100
D2	Normal dimension	46.000 46.016	49.000 49.016	42.000 42.016
	Repair stage max. to	47.0	50.0	43.0
D	Normal dimension	46.090 46.100	49.090 49.100	42.090 42.100
	Pre-turning dimension	47.3	50.3	43.3
D1		38	42.0	35.0
H	Normal dimension and repair stages	7.910 8.000	7.910 8.000	7.910 8.000
t	(New value)	8.0	8.0	8.0



Exhaust

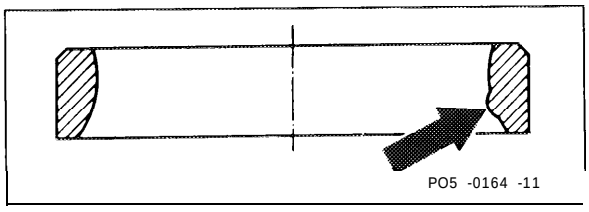


Intake

Note

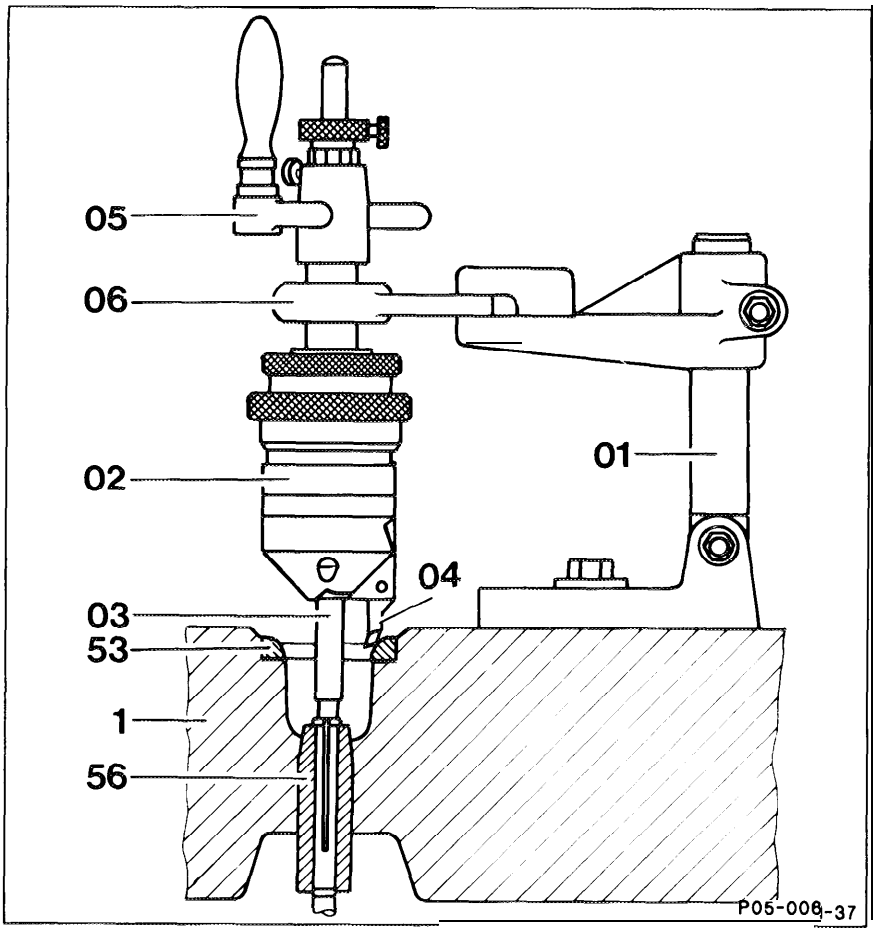
The valve seat rings are sintered metal on account of lead free fuel.

These hardened valve seat rings temporarily had a step (arrow) on the inside of the ring.



This step must be turned off in order to machine the valve seat ring. There is a repair valve seat ring with larger outside diameter as a replacement part for all valve seat ring designs. After renewing valve seat rings, the fitting condition of the hydraulic valve clearance compensating elements must be checked and corrected if necessary (05-214).

05-291 Machining valve seats

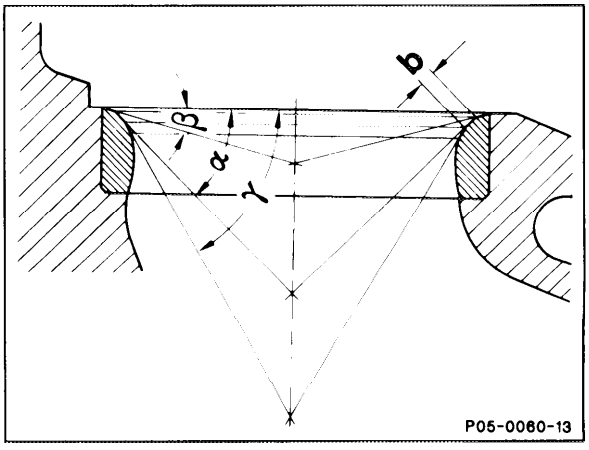


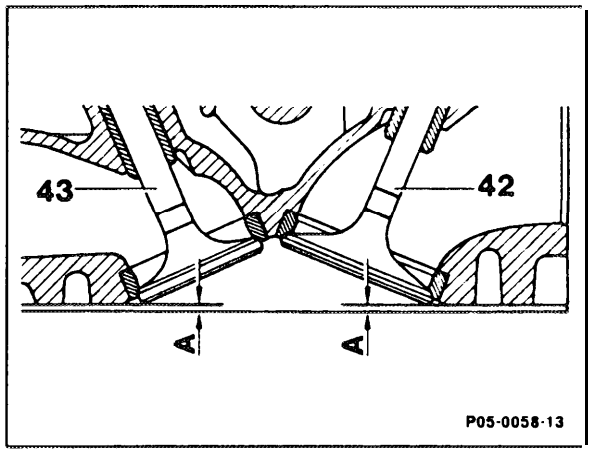
Valve guides (56)	check (05285).
Valve seats (53)	machine in accordance with manufacturer's operating instructions. See data for adjustment. **Note** Only loosen pilot, when eccentricity of valve seat ring has been checked.
Valve seat eccentricity	check (Number 3).
Valve seat width (b)	measure, correct if required (Number 4).
Valves	insert and measure, stand off (A).

Conventional tools

Cylinder head clamping fixture	e.g.	Hunger, D-8000 München 70 Part No. 221.60.000
Valve seat turning equipment	e.g.	Hunger, D-8000 München 70 Type VDSN 1/45/30, Part No. 236.03.308
Test set for valve seats	e.g.	Hunger, D-8000 München 70 Part No. 216.93.300
60" correction steel No. 13 for correction angle below(y)	e.g.	Hunger, D-8000 München 70 Part No. 216.64.622

Data	Inlet	Exhaust
Valve seat width b	1.8 – 2.5	1.5 – 2.5
Valve seat angle α	45° –15'	45° –15'
Correction angle upper β	15°	15°
Correction angle lower γ	60°	60°
Permitted deviation in valve seat concentricity	0.05	0.05





Valve distance to cylinder head parting surface

Engines		102.922/924 102.9621963	102.982/985
Minimum distance A with new valve seats and new valves	Intake (42)	1.7	1.2
	Exhaust (43)	0.5	0.5
Largest distance A with reworked valve seats and reground valves	Intake (42)	2.6	2.1
	Exhaust (43)	1.4	1.4

Largest distance A reduces by the same dimension, by which the cylinder head parting surface has been reworked.

Note

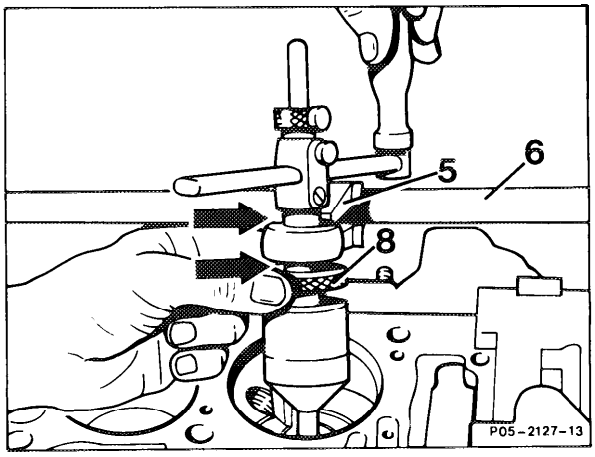
Clamp cylinder head in clamping fixture for stripping down and machining.
Machine valve seats with valve seat turning equipment, with valve seat grinding machine or with valve seat miller. After machining the valve seat rings the installation position of the hydraulic valve clearance compensating elements must be checked and corrected if necessary (05214).

Machining valve seats

1 Check valve guide, replace if necessary (05-285).

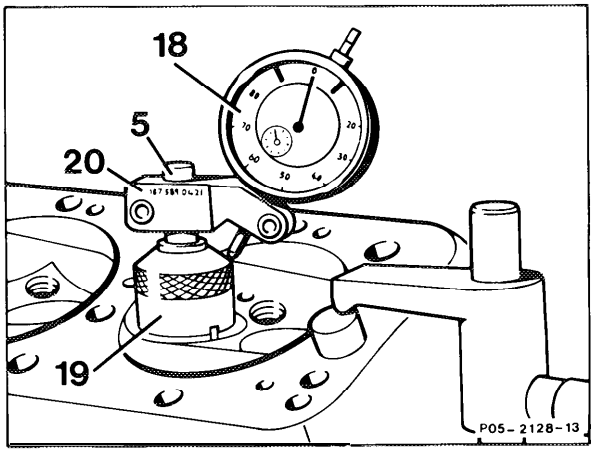
2 Machine valve seats (see manufacturer's operating instructions).

Caution!
Only loosen pilot, when eccentricity of valve seat has been checked (Number 3).

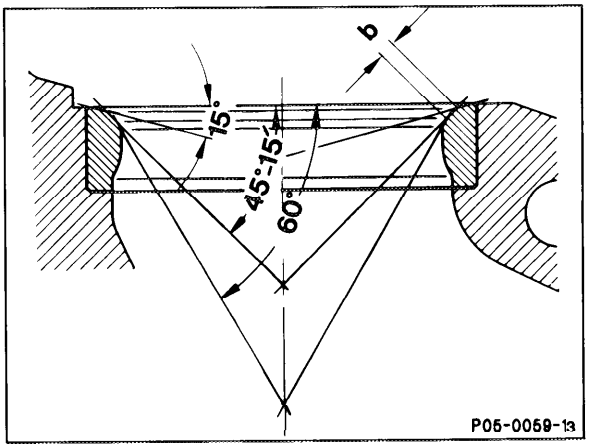


3 Check valve seat eccentricity. For this push test sleeve (19) with dial gauge bracket (20) and dial gauge on the pilot (5).

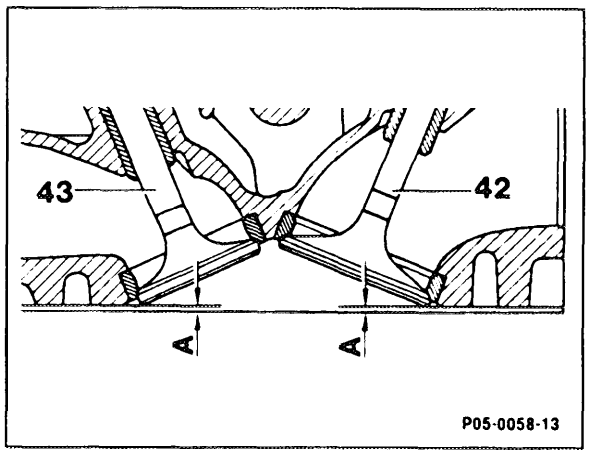
5 Pilot
18 Dial gauge
19 Test sleeve
20 Dial gauge bracket



4 Measure valve seat width (b), and if required correct top(P) 15° angle and the bottom (y) 60° angle.

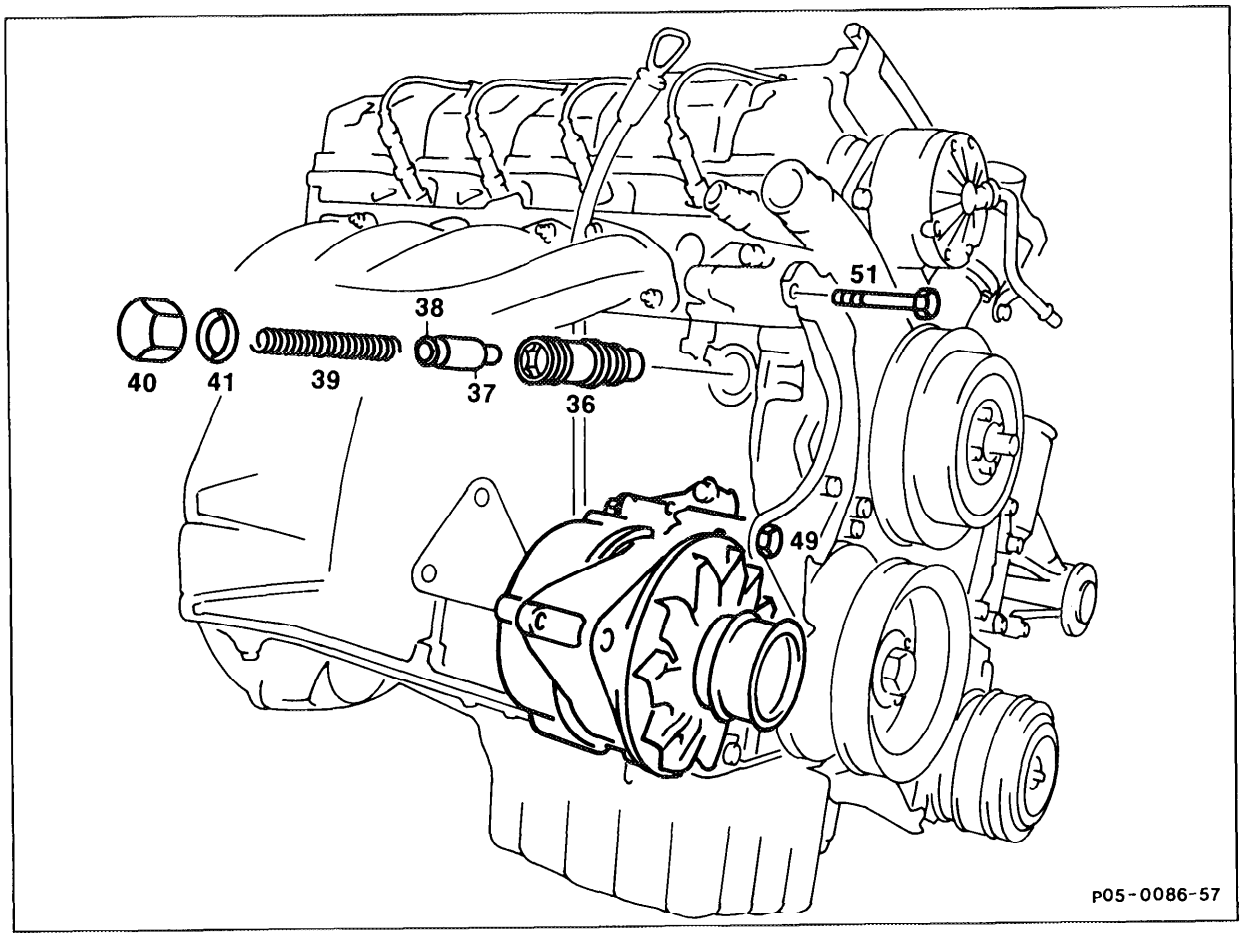


5 Insert valves and measure distance A.



EXIT

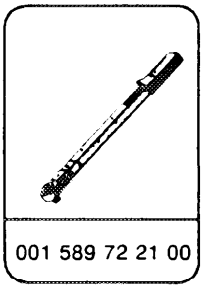
05-310 Removal and installation of chain tensioner

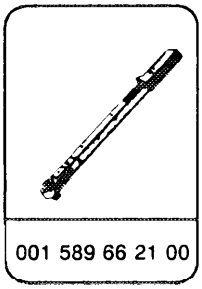


V-ribbed belt	detach, assemble (13-342).
Bolt (49)	loosen (Number 2).
Bolt (51)	unbolt (Number 3).
Alternator	swing outwards.
Sealing plug (40)	unbolt.
	Note The sealing plug is under pressure (Number 4).
Sealing ring (41)	replace.
Compression spring (39)	remove, install.
Chain tensioner casing (36) with setbolt (37)	unbolt (Number 5).

Setbolt (37) with locking spring (38)	press out of chain tensioning casing in the direction of pressure. Check individual parts for wear (Number 6).
Chain tensioner casing (36)	screw into cylinder crankcase, 15 Nm (Number 7).
Setbolt (37) with locking spring (38)	push in (Number 8).
Sealing plug (40) with compression spring (39) and new sealing ring (41)	screw in, 70 Nm (Number 9).
Alternator	mount (Number 10).
V belt	assemble (13-342).
When engine is running	check for leakage.

Special tools



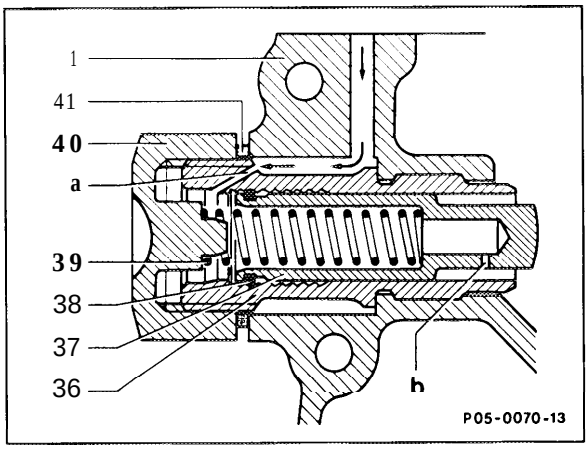


Conventional tool

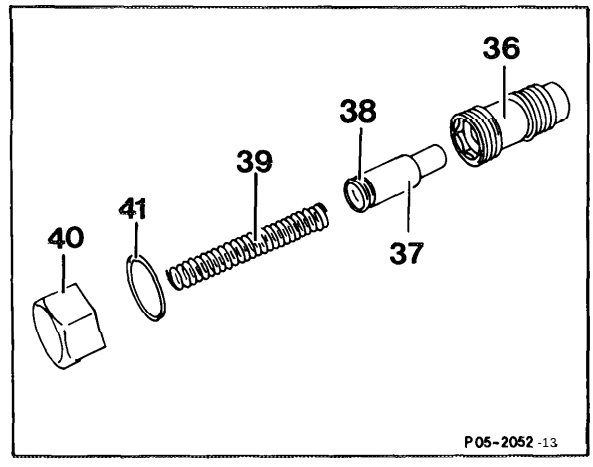
Stud driver insert 17 mm, 1/2" square	e.g.	Hazet, D-5630 Remscheid Part No. 985/1 7

Note

The housing (36) of valveless, hydraulic lock chain tensioner is bolted to the crank case (1). The application force required to tension the chain is comprised of the force from compression spring (39) and oil pressure in the chain tensioner, depending on engine oil pressure.



In the event of sudden load the oil feed bore with 1.1 mm Ø (a) and an orifice bore (b) in the setbolt of 1.2 mm Ø prevents the oil escaping rapidly and thus has a damping effect. An embossing is provided in the chain tensioner casing (36) and a locking spring (38) on the setbolt.

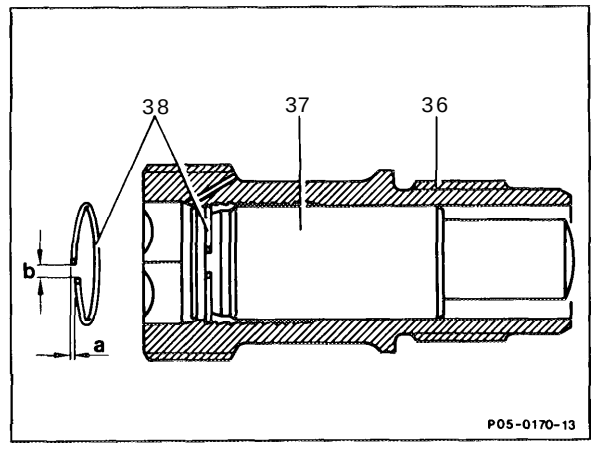


36 Chain tensioner casing
37 Setbolt
38 Locking spring
39 Compression spring
40 Cap nut
41 Sealing ring

The locking spring (38) has been modified in order to improve the function of the chain tensioner.

Changes:

- Ends free from burrs
- Smaller twist
  (dimension "a" = 0.1 mm, was 0.5 mm)
- Improved material
- Dimension "b" = 3.5 mm, was 4.0 mm.



Introduced in production: December 1985

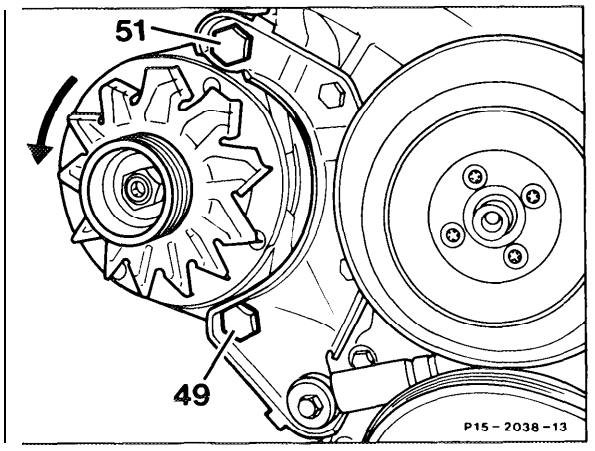
Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.024 (USA)	102.985	003199	**029429**

Removal and installation

1 Removal and installation of Poly V- belt (13-342).

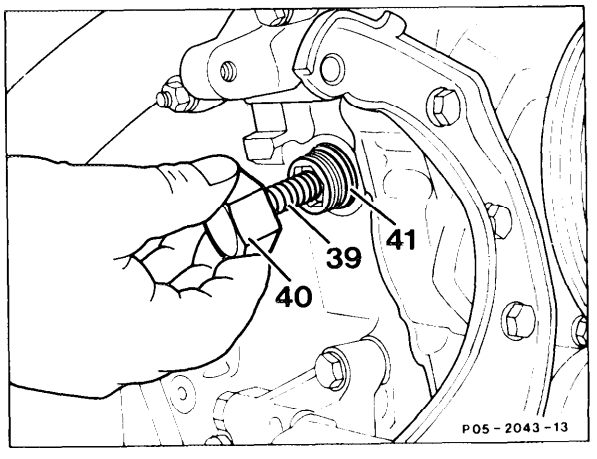
2 Loosen lower bolt (49) for alternator positioning.

3 Remove upper bolt (51), swing alternator outwards (arrow).

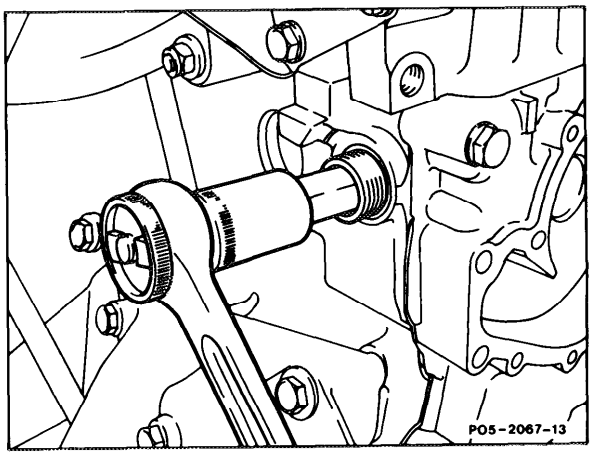


4 Unscrew sealing plug (40) and sealing ring (41) and remove compression spring (39).

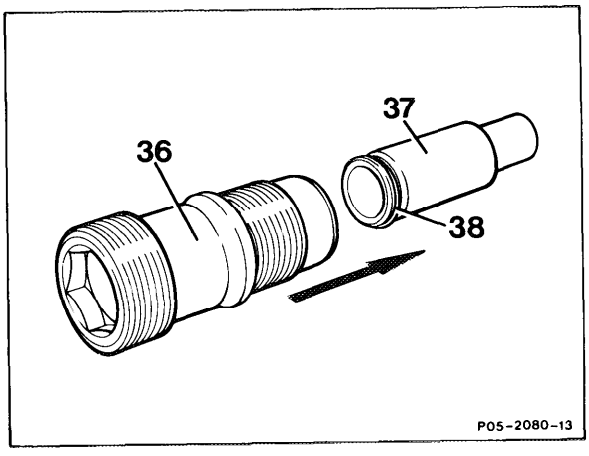
Caution!
Sealing plug is pressurized by the compression spring.



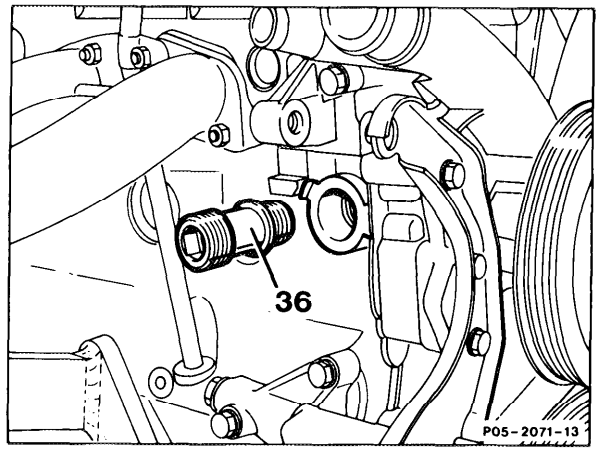
5 Unbolt chain tensioner case (36) from the cylinder crankcase with the stud driver insert.



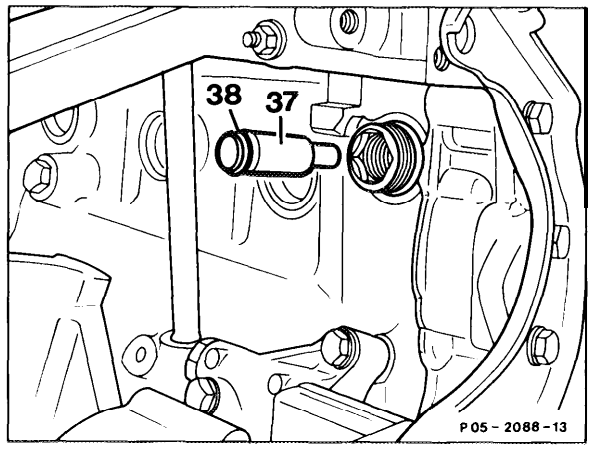
6 The chain tensioner must be stripped down before assembly. To do this press the setbolt (37) and locking spring (38) out of chain tensioner casing (36) in the direction of the arrow. Clean parts and check for wear.



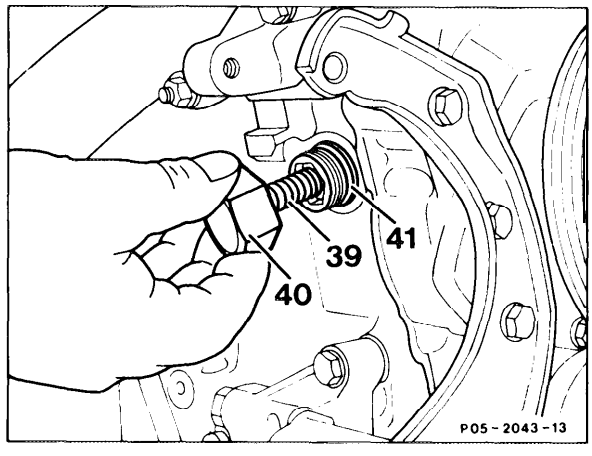
7 Bolt chain tensioner casing (36) onto crankcase, tightening torque 15 Nm.



8 Push setbolt (37) and locking spring (38) into the assembled chain tensioner casing.



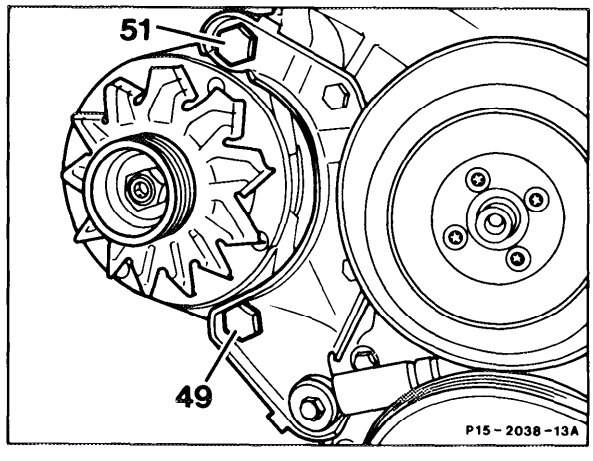
9 Mount compression spring (39) and sealing plug (40) with new sealing ring (41), tightening torque 70 Nm.



10 Mount alternator, tightening torque of the bolts (49 and 51), 25 Nm.

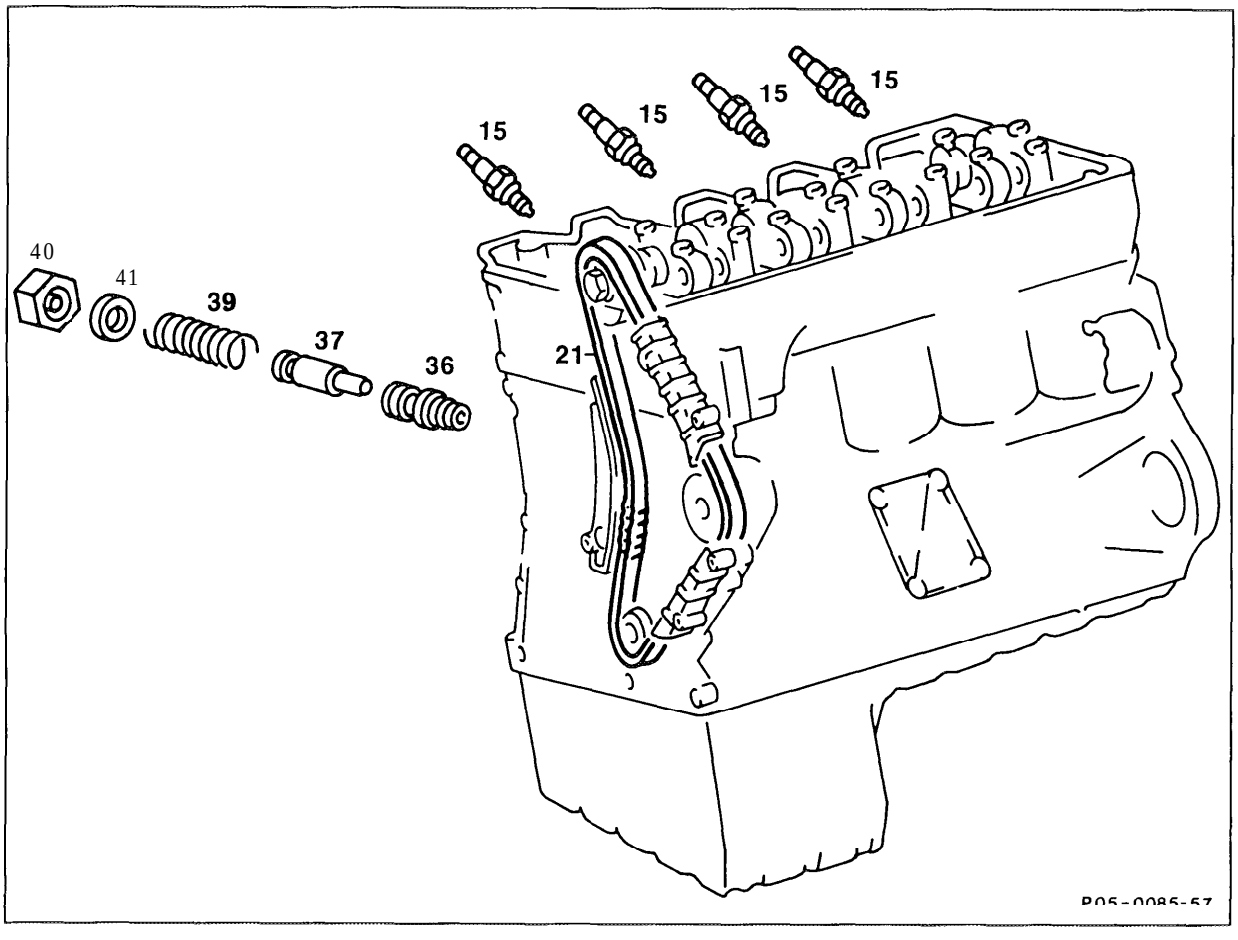
11 Install Poly V- belt (13-342).

12 Check for leaks when engine is running.



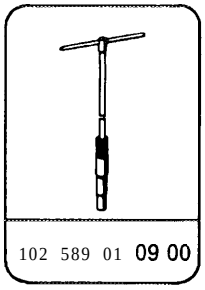
05-320 Replacement of timing chain

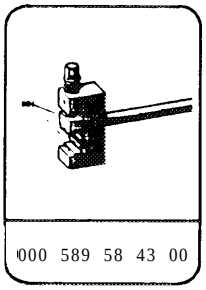
Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-406).

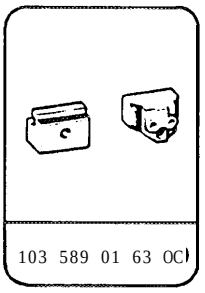


Spark plugs (15)	remove, install (15-318).
Chain tensioner (36 to 41)	remove and install (05-310).
Chain bolt	grind off (Number 3).
New timing chain with old timing chain (21)	connect, pull in (Numbers 4 to 7).
Exterior bracket	press on with riveting tool 000 589 58 43 00, rivet set 103 589 01 63 00 for single roller chain, conversion set 000 589 53 43 for double roller chain (Numbers 8 to 10).
Riveting tool	remove, convert (Number 11).
Connector link bolt	rivet individually (Numbers 12 and 13).

Special tools







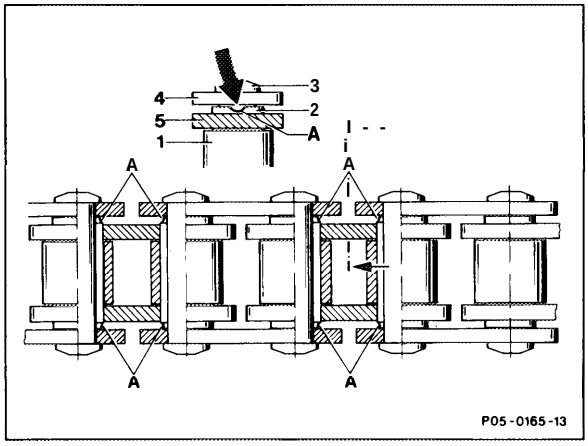
Note

An open timing chain with connector link is supplied for repairs. The sprockets are to be checked for scores and pitting as well as the chain tensioner for perfect function before installing a new timing chain.

Improved timing chains have been installed since November 1985.

Changes:

Sleeves (2) with recesses (notches, arrow and A). Hence improved oil supply to bolts (3) and sleeves (2).



Introduced in production: November 1985 - May 1986

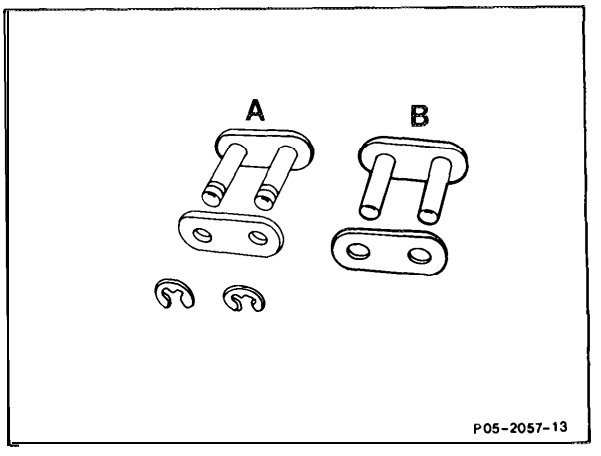
Model	Engine	Engine end number Manual transmission	Engine end number Automatic transmission
201.024 (USA)	102.985	003057-003893	027366-036001

Introduced in production: June 1986

Model	Engine	Engine end No. Manual transmission	Engine end No. Automatic transmission	Vehicle chassis end No.	
				A	F
201.024 (USA)	102.985	003925	036289	312513	Not recorded

Double roller timing chains have been installed since January 1988.

The former connector link with locking devices (A) has been deleted. Only the connector link (B) is still supplied for riveting.



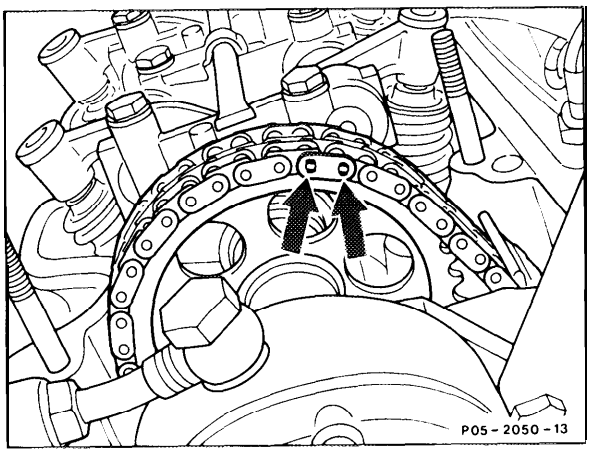
A Former connecting link with locking devices
B Modified connecting link - can be riveted

Replacement

1 Remove, install spark plugs (15018).

2 Remove, install chain tensioner (05-310).

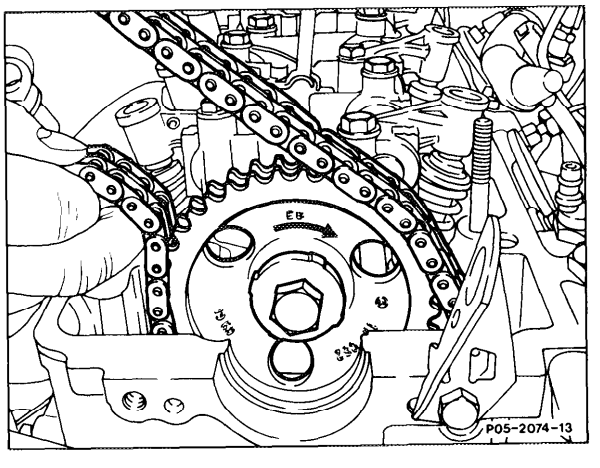
3 Cover the open part of the chain casing with a rag, grind off both chain bolts (arrows) at a double link in the timing chain.



4 Attach new timing chain and the connector link onto the old timing chain. To do this press out ground off double link.

5 Put the new timing chain connected with the old timing chain onto the camshaft timing gear. Rotate crankshaft.

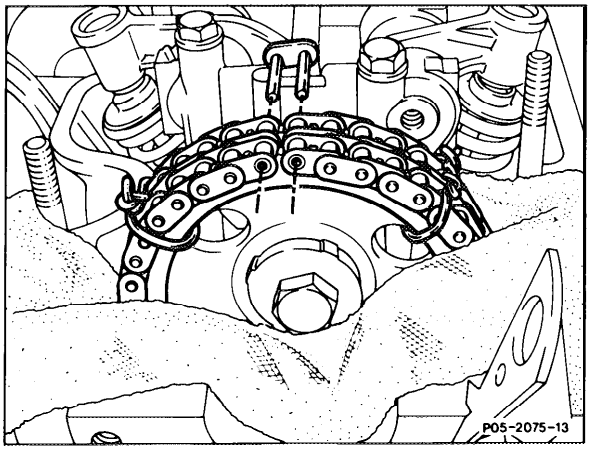
Caution!
The timing chain must remain engaged while rotating the camshaft timing gear.



6 Pull out the released end of the old timing chain evenly, to correspond with drawing on the new timing chain.

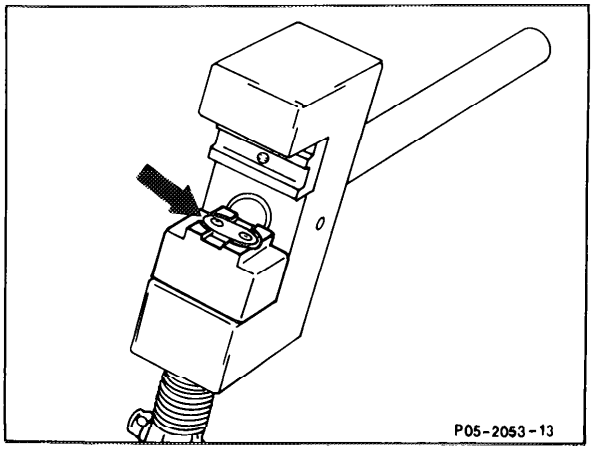
Caution!
The timing chain must remain engaged while turning the camshaft timing gear and crankshaft gear.

7 Secure the ends of the chain to the camshaft timing gear with wire. Detach old timing chain and connect the ends of the new timing chain with the repair connector link.
Note
Connector link must be inserted from behind.

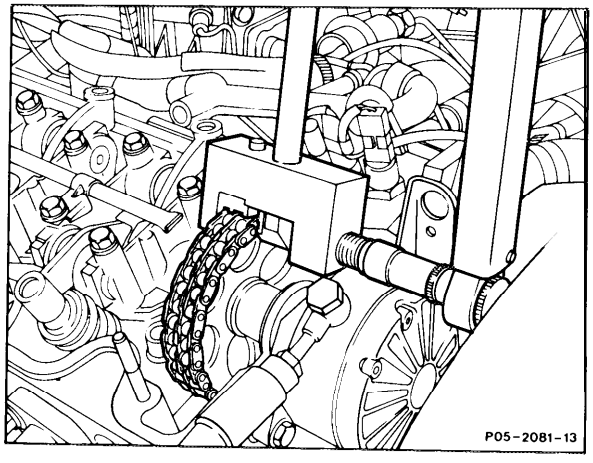


8 Fit riveting set 103 589 01 63 00 to the basic tool 000 589 43 00 corresponding to the timing chain design (single or double roller chain).

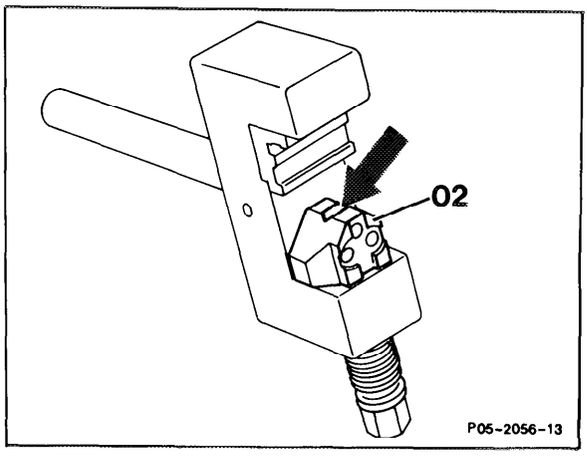
9 Put loosely attached exterior bracket of the connector link in the press tool (arrow).
The exterior bracket is held magnetically.



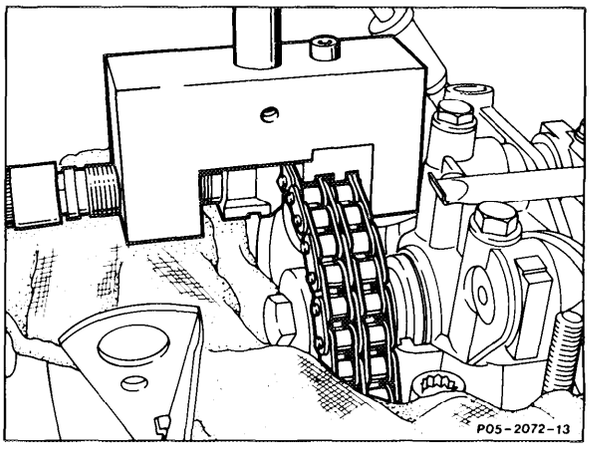
10 Put press tool on the connector link and press on bracket up to the stop.
Note
Put on clip so that both rivet pins engage.



11 Remove assembly tool and turn punch (02) so that the notch (arrow) points forward.

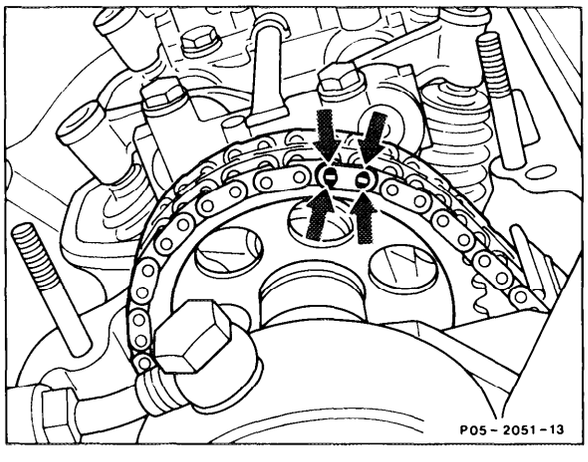


12 Install assembly tool exactly over the center bolt. Rivet bolts of the connector links individually, tightening up spindle to approx. 30 - 35 Nm (reference value).



13 Check riveting (arrows), re-rivet if required.

14 Install chain tensioner (05310).

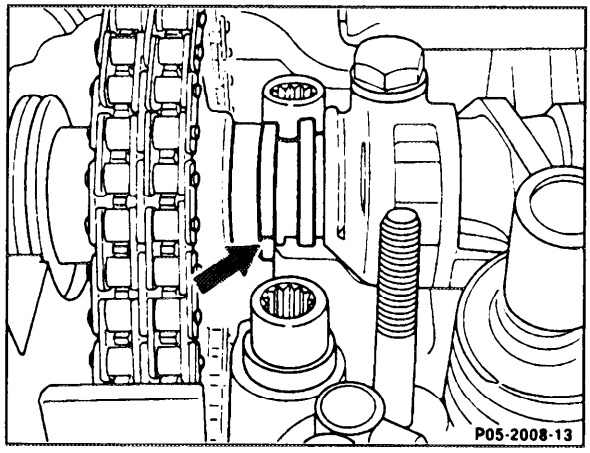


15 Turn crankshaft and check adjustment markings at engine TDC position.

Note

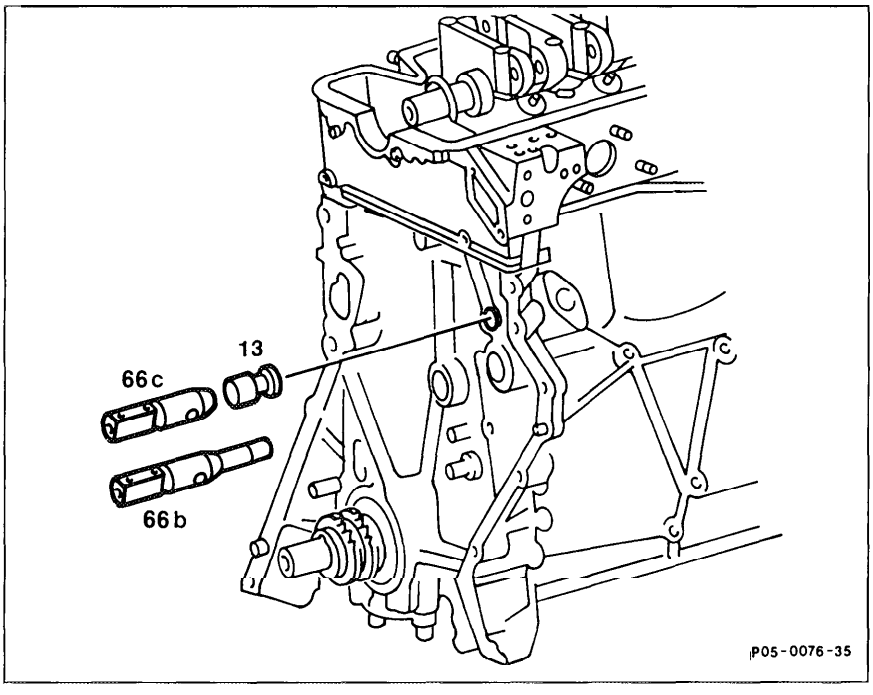
If the adjustment markings do not align, the valve timing settings of the camshaft must be checked (05215).

16 Assembly is completed in the reverse order.



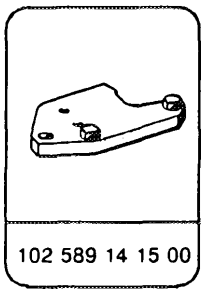
05328 Installation of oil spray nozzle retroactively

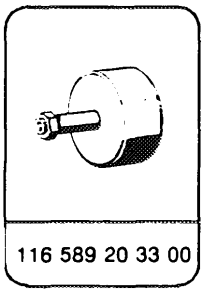
Preceding work:
Timing case cover removed (01-210).
idler gear shaft removed (05-412).

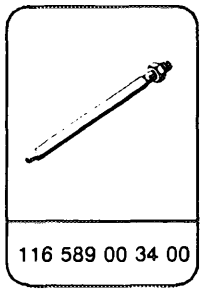


Sealing plug (13)	remove (Numbers 1 and 2).
Joggle plate	Part No. 102 589 14 15 00 bolt up, unbolt (Number 3).
Oil spray nozzle (66b and 66c).	drive home up to stop (Number 4).
Idler gear shaft	install (05-412).
Timing case cover	install (01-210).
On engine	change oil and filter.
When engine is running	check for leaks.

Special tools

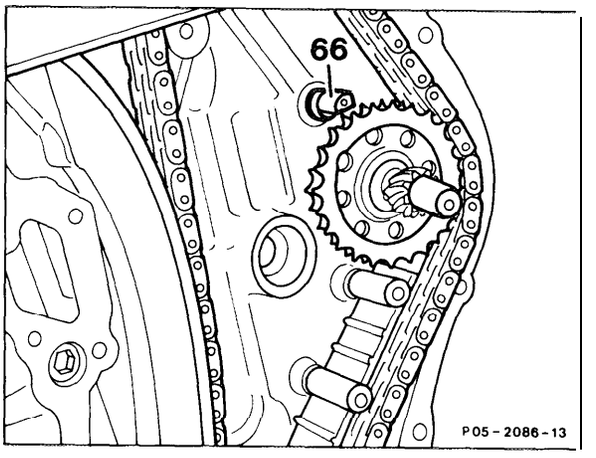

102 589 14 15 00


116 589 20 33 00


116 589 00 34 00

Note

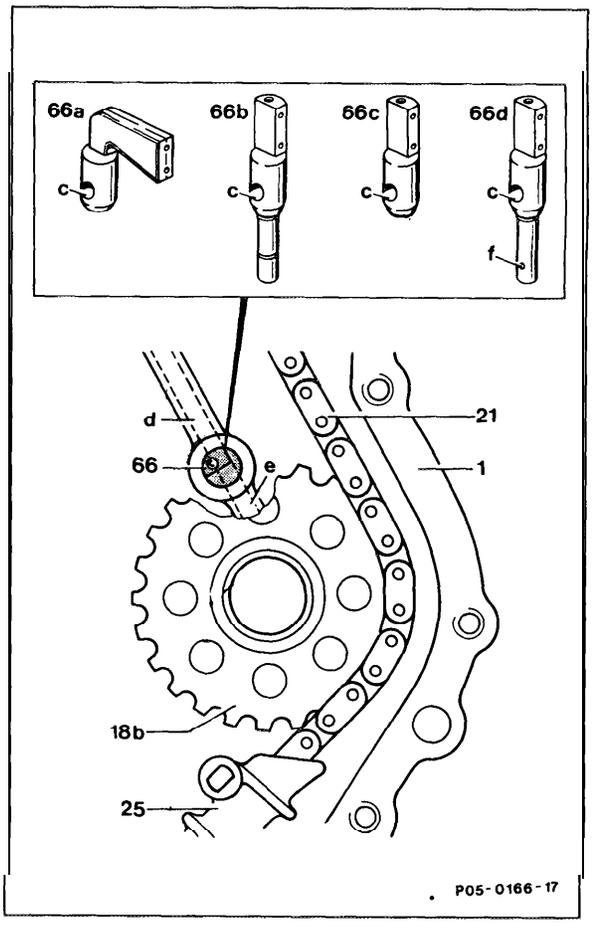
In order to achieve better lubrication of the timing chain, an additional oil spray nozzle (66) has been fitted in the front face of the main oil channel. This oil spray nozzle, can be installed retroactively. The retroactive installation should only be carried out, when for example the timing case cover has already been removed for other work.



Production breakpoint of the various designs

Injection engines

66a 1st design March to April and May 1986
66b 2nd design November 1986 to July 1987
66c 3rd design July 1987



Production breakpoint: March - April 1986
(Injection engines 1st design)

Model	Engine	Engine end No. Man. transm.	Engine end No. Autom. transm.
201.024 (USA)	102.985	003626-003670	**033140-033543**

Production breakpoint: May 1986
(Injection engines 1 st design)

Model	Engine	Engine end No. Man. transm.	Engine end No. Autom. transm.
201.024 (USA)	102.985	00381 **I-003828**	**03521 o-035424**

Production breakpoint: November 1986
(Injection engines 2nd Design)

Model	Engine	Engine end No. Man. transm.	Engine end No. Autom. transm.
201.028	102.985	007099	045782

Production breakpoint: July 1987
(Injection engines 3rd Design)

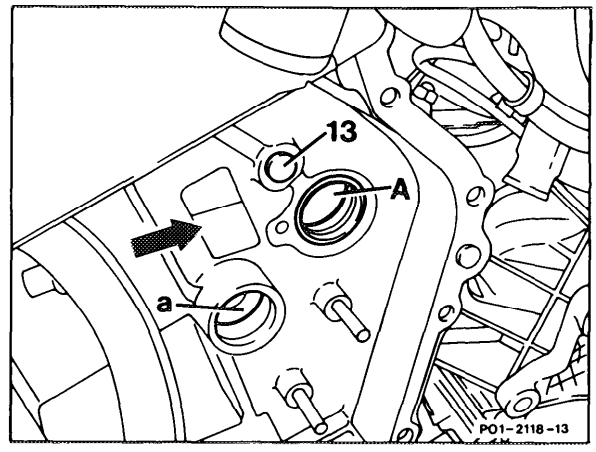
Model	Engine	Engine end No. Man. transm.	Engine end No. Autom. transm.
201.028	102.985	015733	057671

Installation

1 Remove sealing plug (13), to do this drill a core hole (5 mm Ø, 10 mm deep).

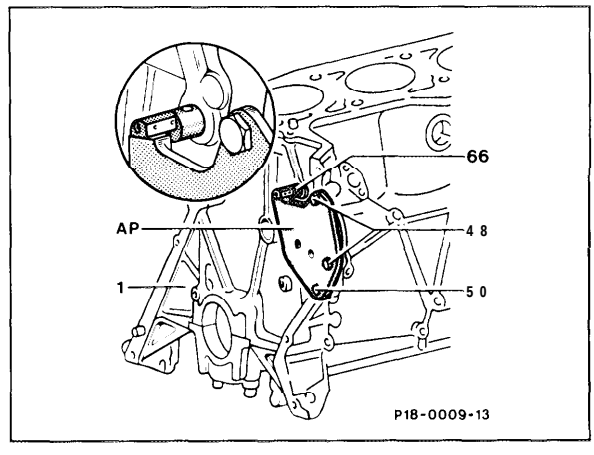
Note

Carefully cover oil channel (a), bearing bore (A) and window (arrow).



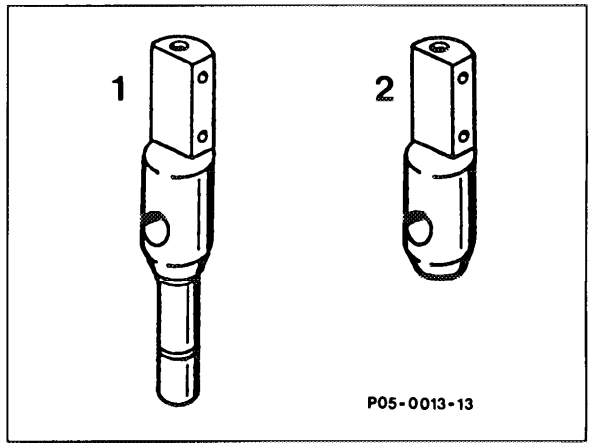
2 Unscrew sealing plug with impact extractor 116 589 20 33 00 and stud 116 589 00 34 00

3 Attach joggle plate (AP) 102 589 14 15 00 with two hexagon bolts M8 x 15 (48).



1 Cylinder crankcase
48 Fixing bolts
50 Straight pin (guide for timing case cover)
66 Oil spray nozzle
AP Joggle plate

4 Select correct oil spray nozzle (carburettor or injection engine) and drive home the cylinder crankcase up to the stop. The correct fitting position of the oil spray nozzle is achieved when this is laid on the joggle plate, as shown in Figure (Number 3).



1 Carburettor engines (non-US)
2 Injection engines

5 Detach joggle plate.

6 Install idler gear shaft (05412).

7 Install timing case cover (01-210).

8 Change engine oil and filter.

9 Check for leaks when engine is running.

Parts required	Part No.
Oil spray nozzle	102 180 09 43 (Carburettor engine) 102 180 08 43 (Injection engine)

Standard Text and flat rates

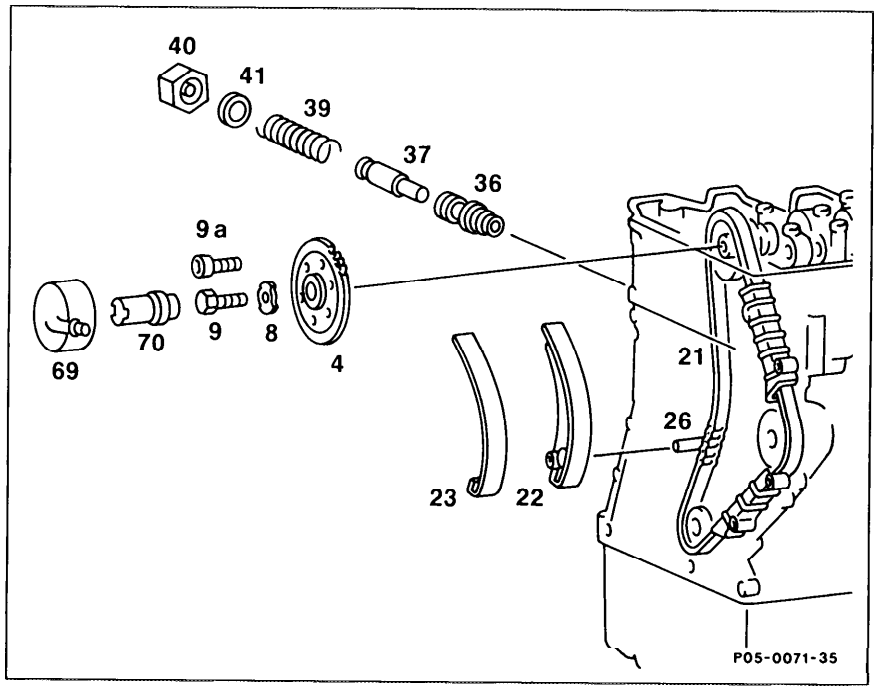
Install oil spray nozzle for timing chain (Idler gear shaft removed)	02-0367/01	Related work, 5 flat rates or 0.4 hours

The operation number is to be placed in front of the book/column number.

EXIT

05-330 Removal and installation of tensioner blade

Preceding work:
Timing case cover removed (01-210).



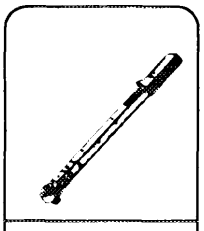
Timing chain (21) and crankshaft gear	mark (Number 1).
Timing chain and camshaft timing gear (4)	mark (Number 2).
Chain tensioner (36 to 41)	remove, install (05310).
Oil pressure pump (69)	unbolt, bolt up, put to one side with lines connected (Number 4).
Camshaft timing gear (4)	unbolt, bolt up, 80 Nm (Number 5).
Tensioner blade (22)	remove from bearing bolt, put on.

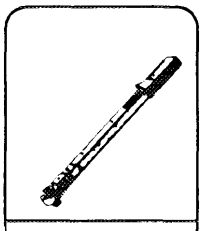
Note

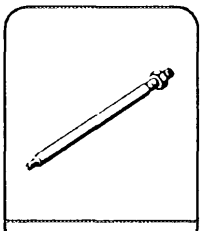
On double roller chain, spot drill bearing pin (26) and drive out with the impact extractor 115 589 12 33 00. Install new tensioner blade with bearing pin (Numbers 7 and 9).

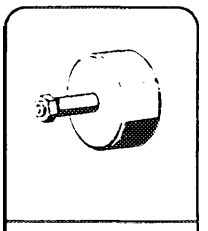
Plastic support (23)	check, possibly renew (Number 8).
Camshaft adjustment	check (Number 11).

Special tools


001 589 66 21 00


001 589 72 21 00

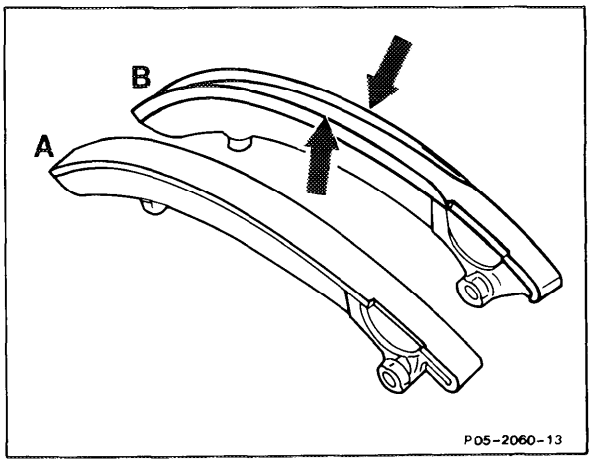

116 589 03 34 00


116 589 20 33 00

Note

In order to achieve better guidance of the timing chain, the plastic support has lateral guide bars (arrows). The plastic support is also fixed differently; in this way the support is prevented from slipping off the tensioner blade.

A Former design
B Current design

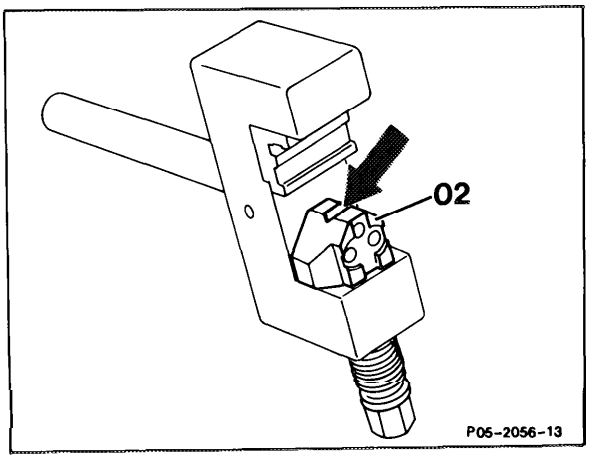


Production breakpoint: August 1986

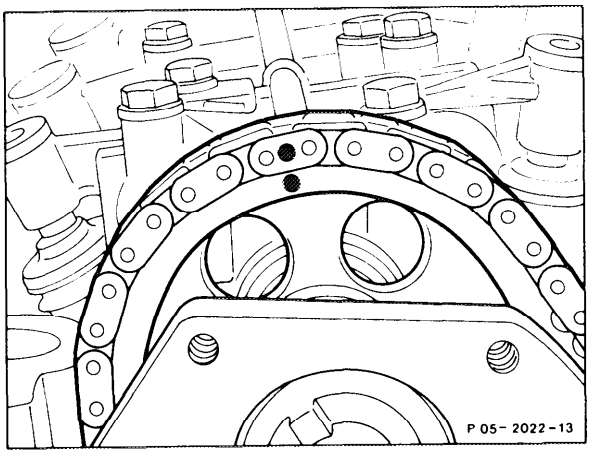
Model	Engine	Engine end No. Man. transmission	Engine end No. Auto. transmission	Vehicle chassis end No.	
				A	F
201.023	102.924	026699	006810	325157	268097
201.024	102.962	102052	051653		268146
201.024 (USA)	102.985	004185	039295		266691

Removal and installation

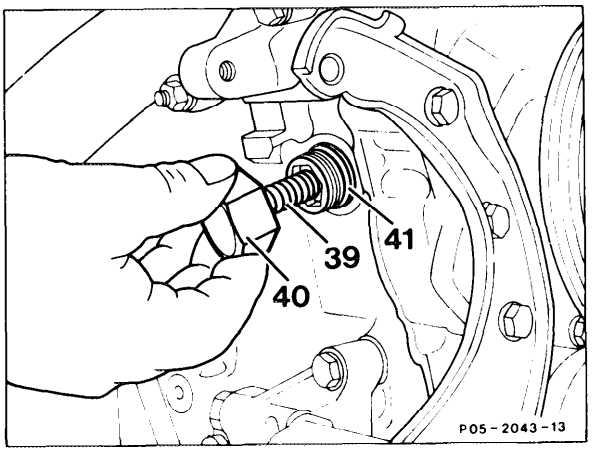
1 Align timing chain and crankshaft gear.



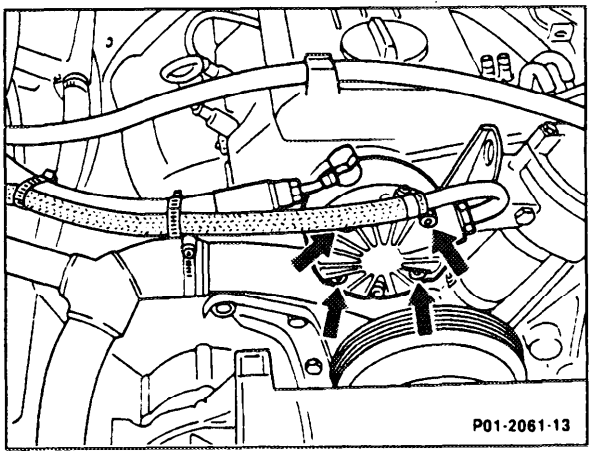
2 Align timing chain and camshaft timing gear.



3 Remove chain tensioner (05-310).



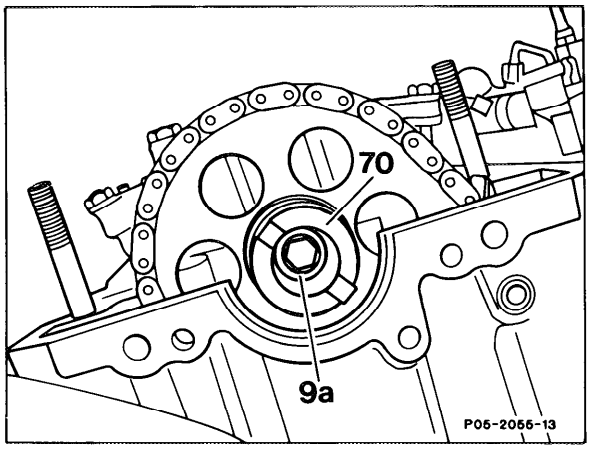
4 Unbolt oil pressure pump with lines connected (arrows) and put to one side.



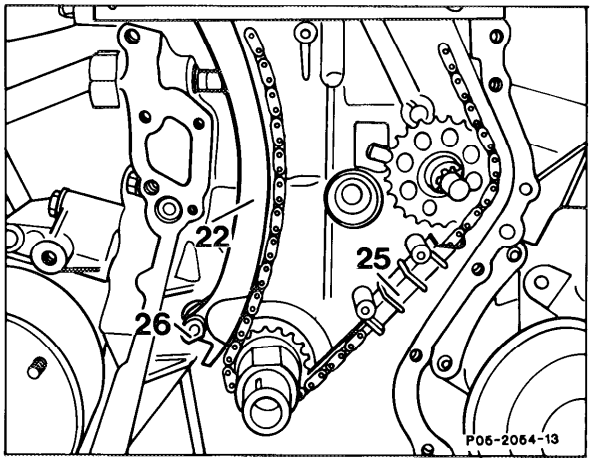
5 Unbolt, bolt up camshaft timing gear, bolt (9a), tightening torque 80 Nm. Note color markings on camshaft timing gear and crankshaft gear.

Note

On vehicles with oil pressure pump remove driving disc sleeve (70).

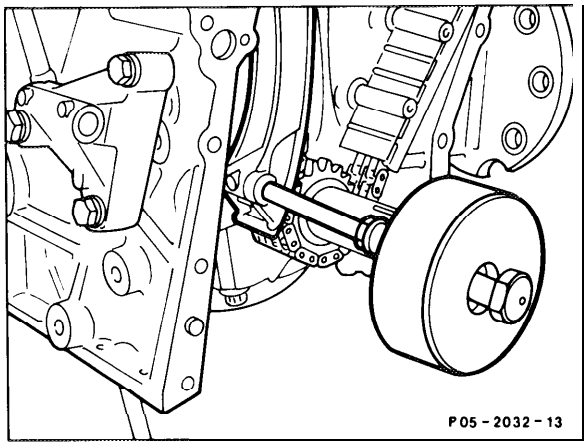


6 Swing tensioner blade (22) for single roller chain inwards and remove from bearing pin (26), install.

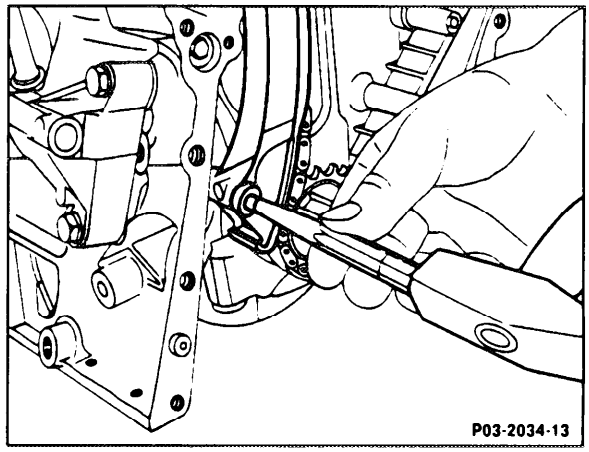


7 On engines with double roller chain, drive out bearing pin (26) of the tensioner blade with the impact extractor 116 589 20 33 00 and extension 116 589 03 34 00. To do this cut an M6 thread approx. 10 mm deep on the bearing pin. Remove tensioner blade.

8 Check plastic support for wear, replace if necessary.



9 Insert new tensioner blade and drive home bearing pin up to stop.

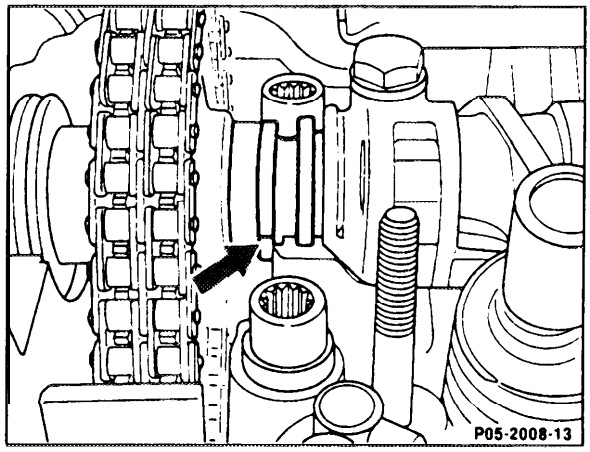


10 Install chain tensioner (05-310).

11 Turn crankshaft and check adjusting marking at TDC position of engine.

12 The installation proceeds in the reverse sequenceas removal.

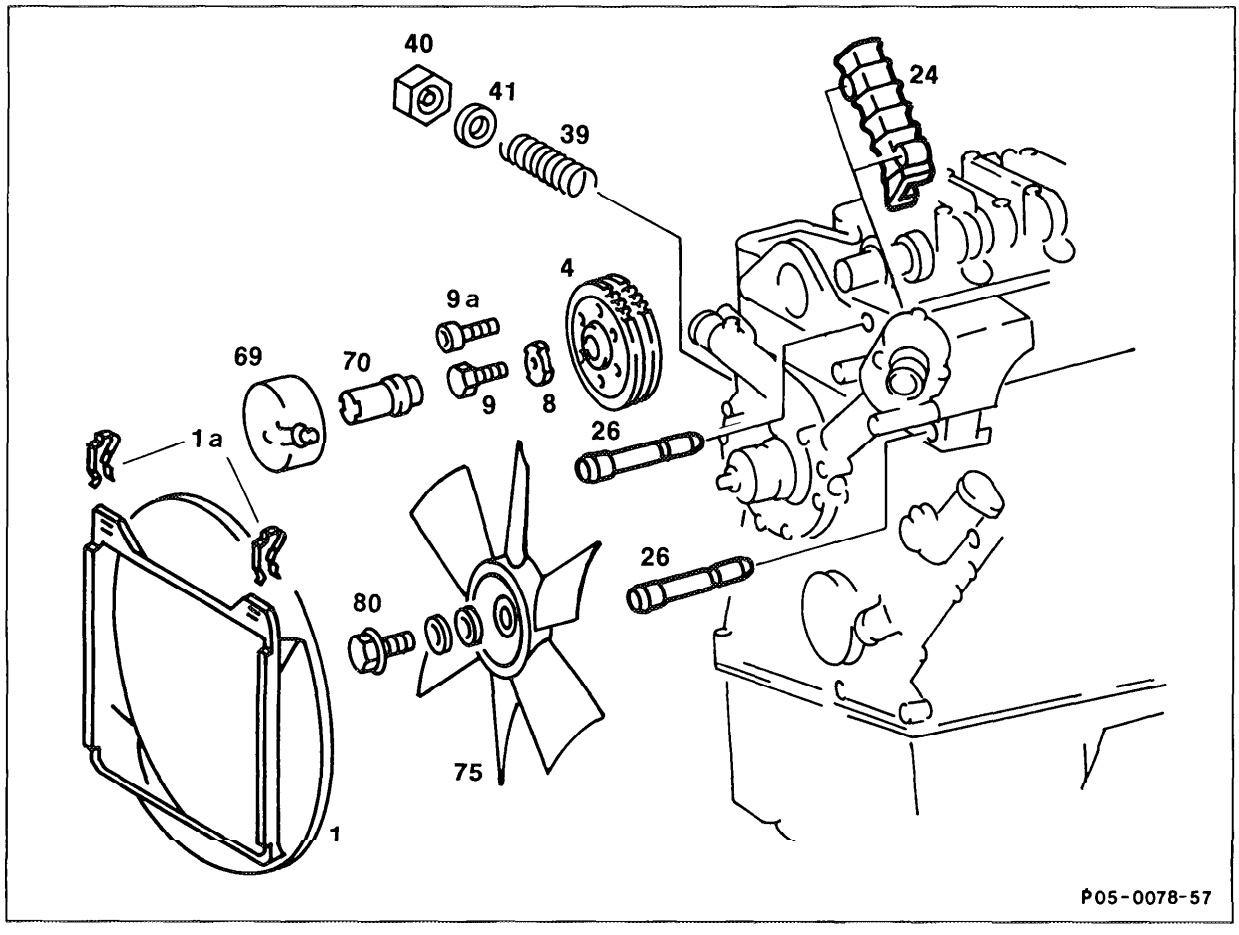
13 Run engine, check for leaks.



05-340 Removal and installation of guide rails

A. Guide rail (24) in cylinder head

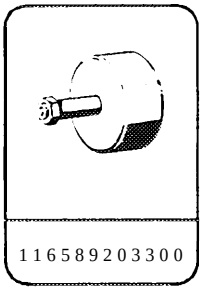
Preceding work:
Air cleaner removed (09-400 and 09-410).
Cylinder head cover removed (01-460).

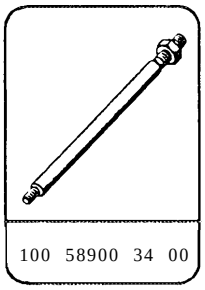


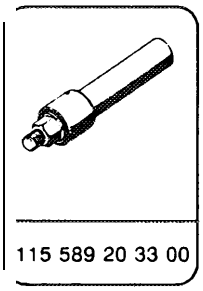
Chain tensioner (39 to 41)	remove, install 70 Nm (Number 1).
Fan shroud (1) and fan (75)	remove, install, bolt (80), 25 Nm (Number 2).
Piston of No. 1 cylinder	position on ignition TDC (Number 3).

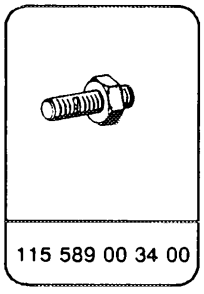
Oil pressure pump (69)	unbolt, bolt up, put to one side with lines connected (Number 4).
Timing chain and camshaft timing gear (4)	align and unbolt, bolt (9 and 9a), 80 Nm (Number 5).
Guide rail bolt (26)	extract, with impact extractor 116 589 20 33 00 and stud 100 589 00 34 00, drive home **Note** Insert guide rail bolt with sealant 001 989 25 20. Note that the fixing nose on the guide rail engages in the guide rail bolt (Numbers 6 and 7).
When engine is running	check for leaks.

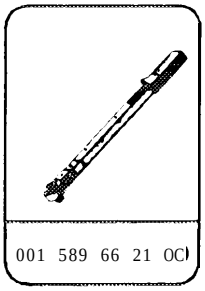
Special tools

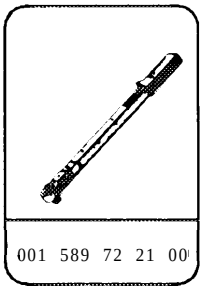






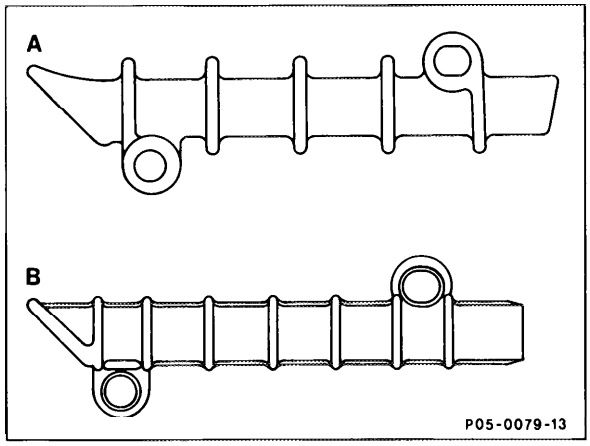






Note

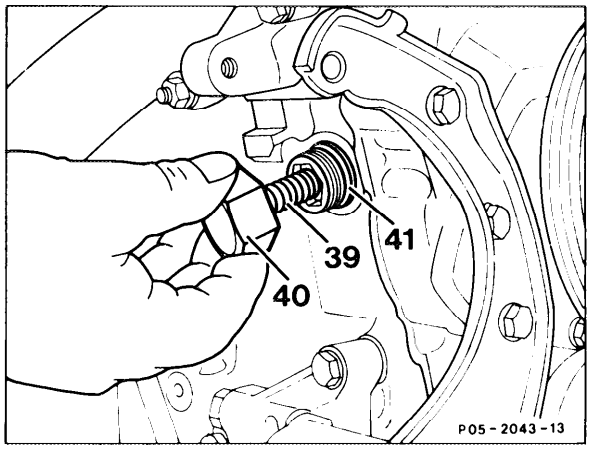
The guide rails have been changed with the introduction of the double roller chain.



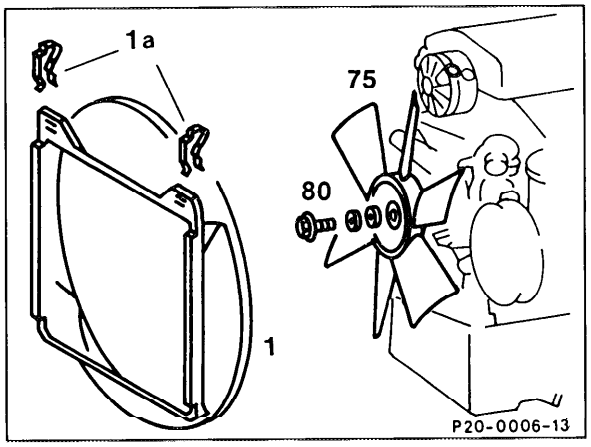
A Guide rail for single roller chain
B Guide rail for double roller chain

Removal and installation

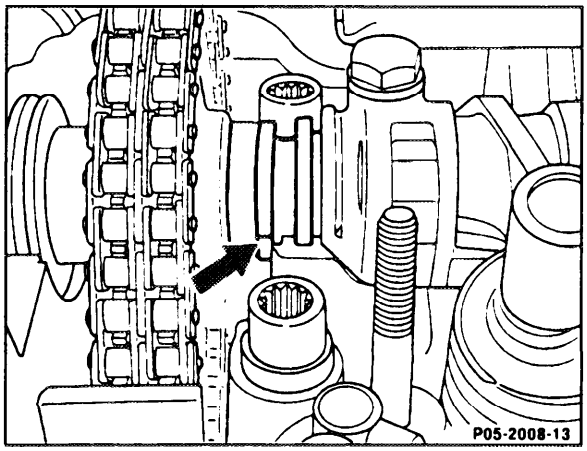
1 Removal and installation of chain tensioner (05310). Tightening torque of hexagon cap nut (40) 70 Nm.



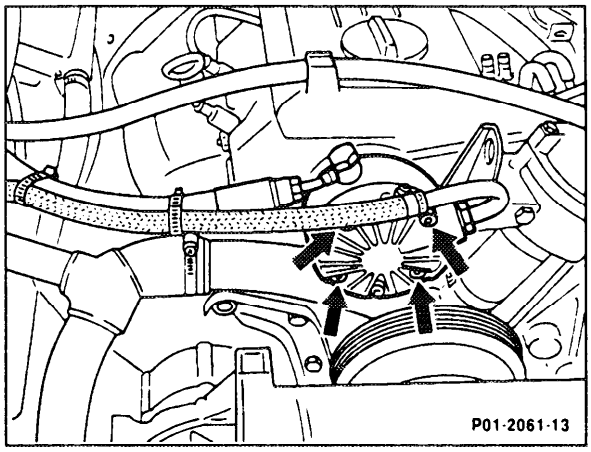
2 Remove fan shroud (1) and fan (75). Tightening torque of bolt (80) 25 Nm.



3 Position piston of No. 1 cylinder on ignition TDC.



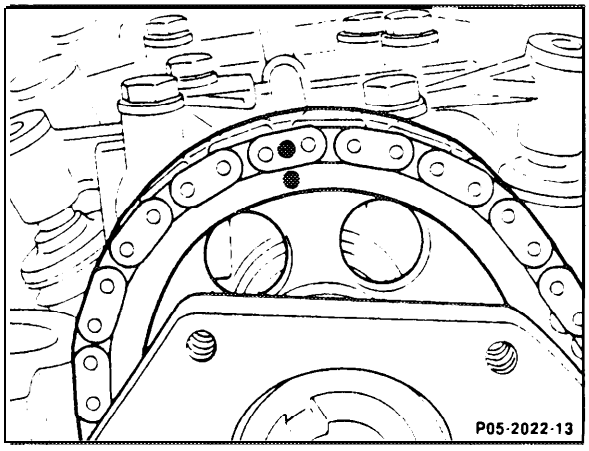
4 Unbolt oil pressure pump with lines connected (arrows) and set to one side.



5 Align timing chain and camshaft timing gear. Unbolt camshaft timing gear and remove sprocket.

Note

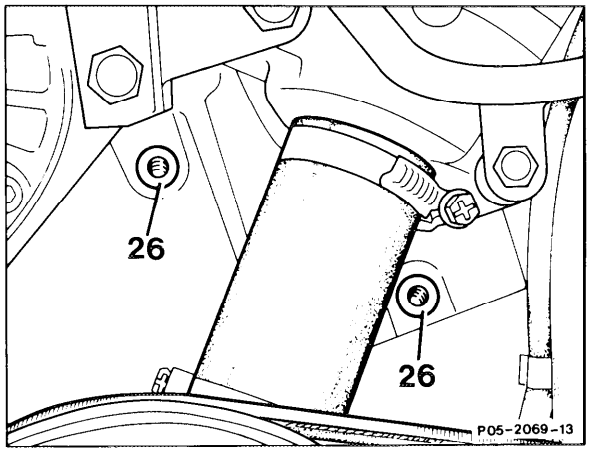
When installing the sprocket note color markings. Tightening torque of set bolt 80 Nm.

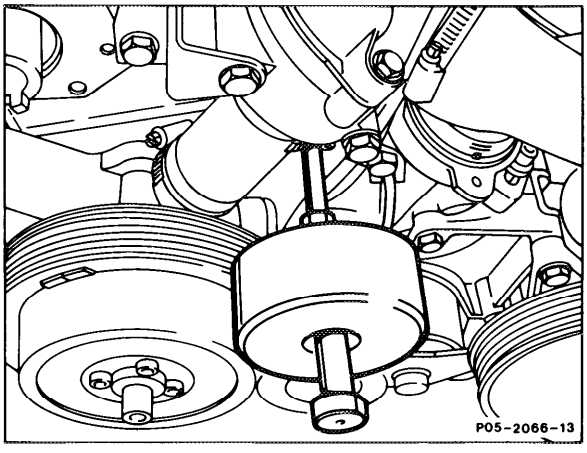


6 Withdraw both guide rail bolts (26) with impact extractor 116 589 20 33 00 and stud 100 589 00 34 00.

Note

If the guide rail bolts are too tight, the extractor 115 589 20 33 00 with stud 115 589 00 34 00 can also be used.





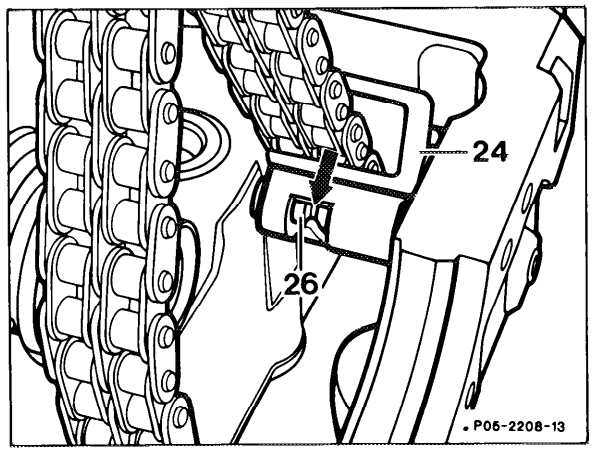
Impact extractor in place

7 Install guide rail (24) so that the locating lug (arrow) engages in the groove of the upper guide rail bolt.

Note

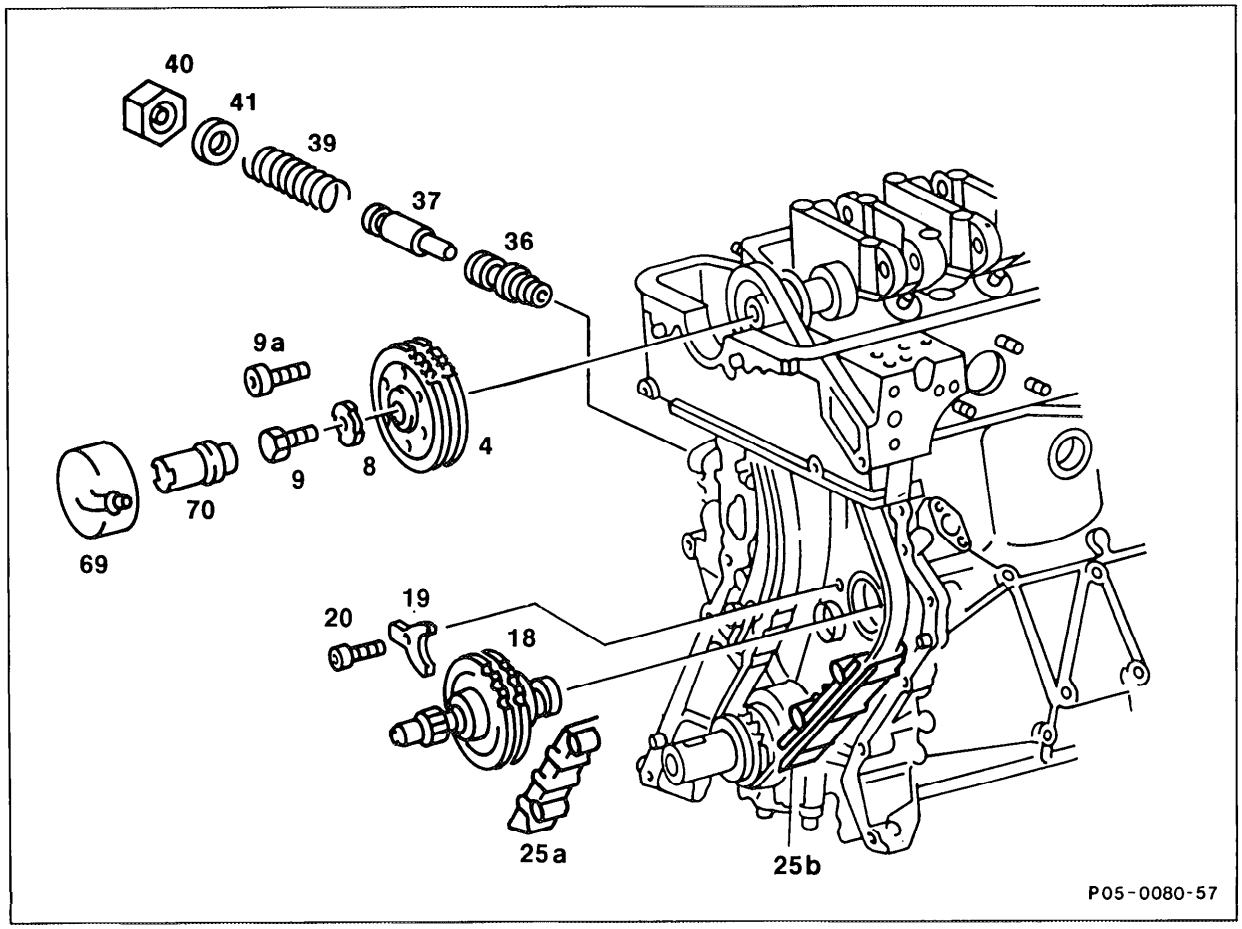
Apply sealant 001 989 25 20 at collar of guide rail bolts.

8 Check for leaks when engine is running.



B. Guide rail in cylinder crankcase

Preceding work:
Timing case cover removed (01-210).



a. With single roller chain

Guide rail (25a, single roller chain)	remove, put on (Number 1).

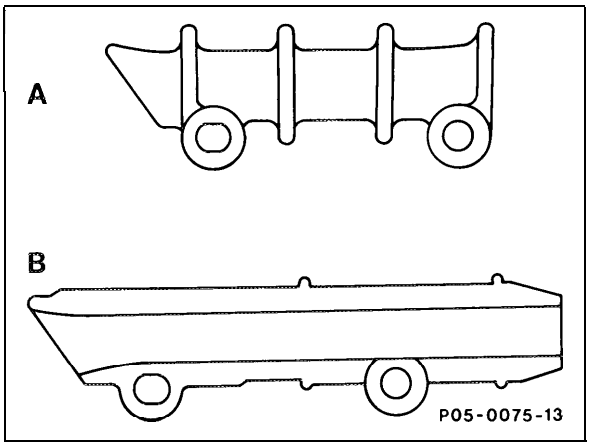
b. With double roller chain

Piston of No. 1 cylinder	position on ignition TDC (Number 2).
Oil pressure pump (69)	unbolt, bolt up, put to one side with lines connected (Number 3).
Chain tensioner	remove, install (05310).

Timing chain and camshaft timing gear (4)	align and unbolt, (9 and 9a), 80 Nm (Number 5).
Timing chain and crankshaft gear	align (Number 6).
Bolt (20)	unscrew, remove clip (19) and idler gear shaft (18) (Numbers 7 and 8).
Timing chain with crankshaft gear	pull forward as far as possible, remove and fit guide rail (25b) (Number 9).
	Note When pushing back the crankshaft gear, and the timing chain, note the positioning pin in the camshaft flange and alignment of timing chain to tension lever.
Idler gear shaft (18)	install, bolt (20), 5 Nm (Number 10).
Further installation	in reverse sequence.
When engine is running	check for leaks.

Special tool

Note
The guide rails have changed with the introduction of the double roller chain.

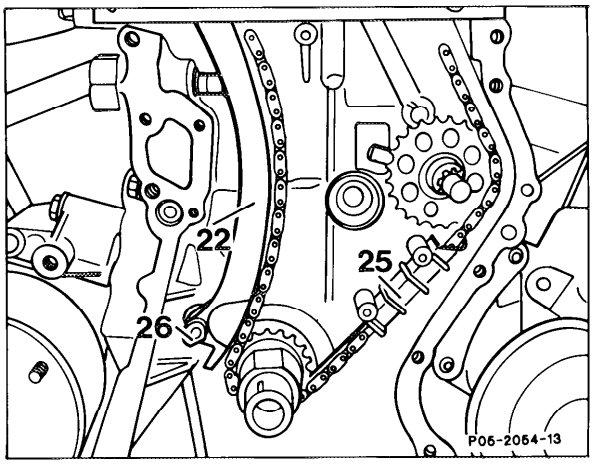


A Guide rail for single roller chain
B Guide rail for double roller chain

Removal and installation

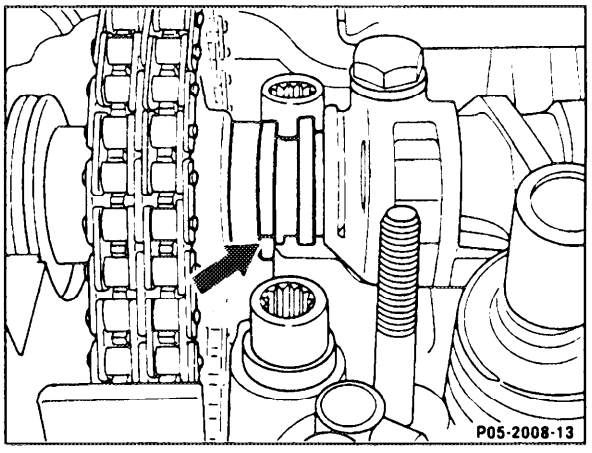
a. With single roller chain

1 Pull off guide rail (25), install.

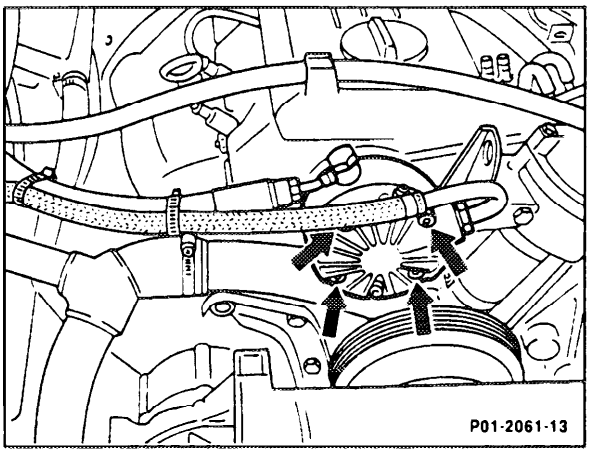


b. With double roller chain

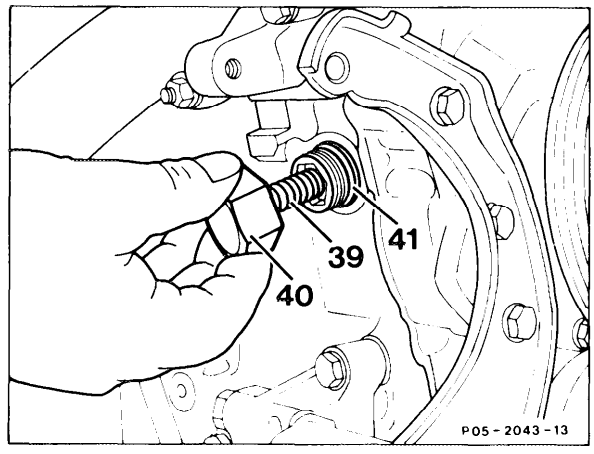
2 Position piston of No. 1 cylinder on ignition TDC.



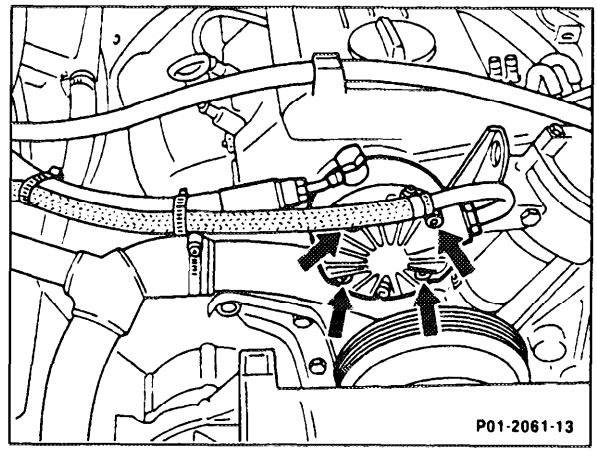
3 Unbolt, bolt up oil pressure pump (arrows) and put to one side with lines connected.



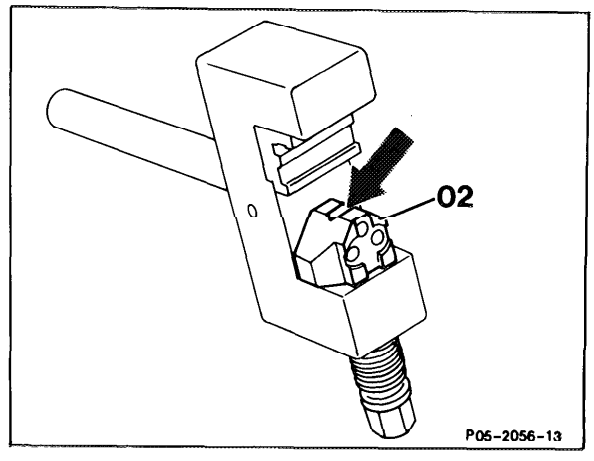
4 Remove chain tensioner (05-310).



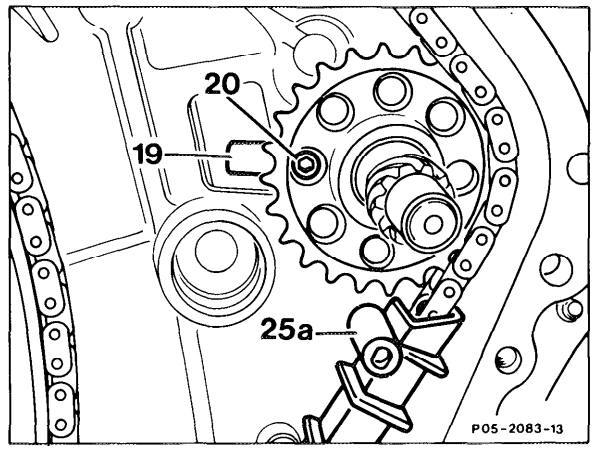
5 Align timing chain and camshaft timing gear and unbolt camshaft timing gear. Put timing chain in timing case.



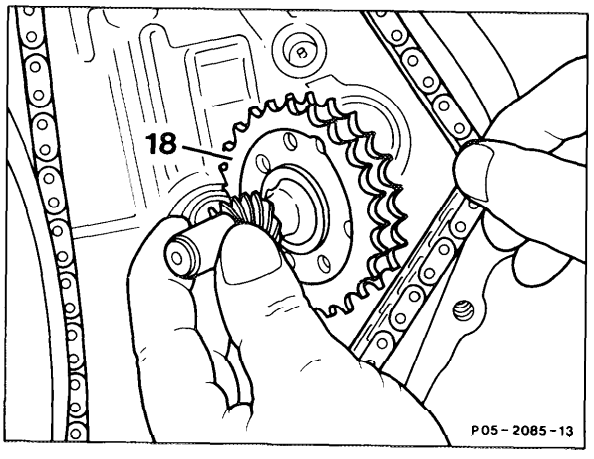
6 Align timing chain and crankshaft gear.



7 Unscrew bolt (20) and remove retaining clip (19).



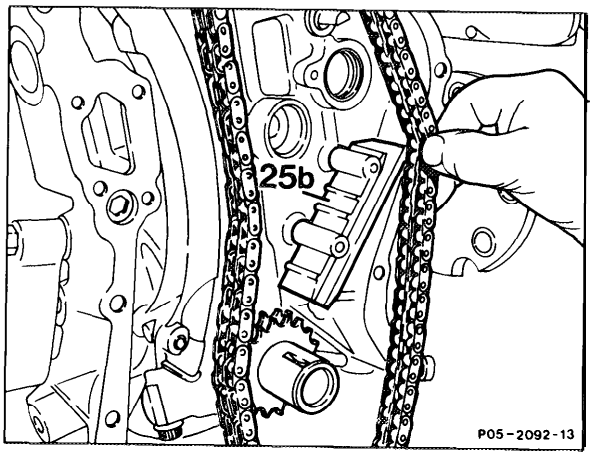
8 **Pull** out idler gear shaft (18) and remove timing chain.



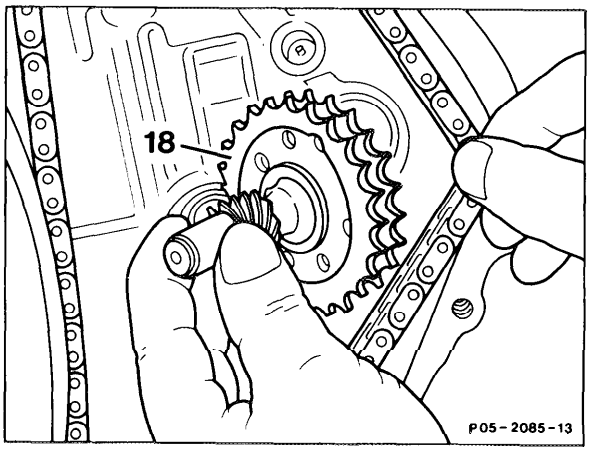
9 Remove, install, pull timing chain and crankshaft gear forward as far as possible and remove guide rail (25b). Put on timing chain and push back crankshaft gear together with timing chain.

Note

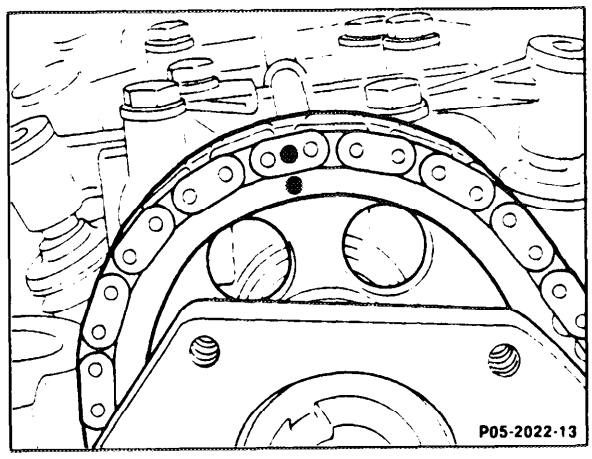
When pushing back the crankshaft gear, note the positioning pin in the camshaft timing gear flange and the color marking.



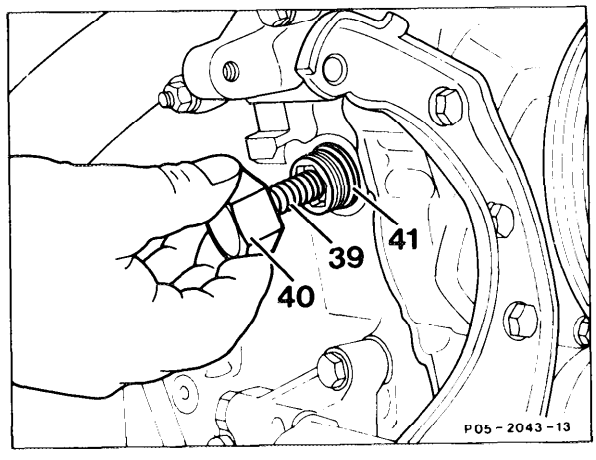
10 Install idler gear shaft, tightening torque of the hexagonal socket screw (20) 5 Nm (reference value).



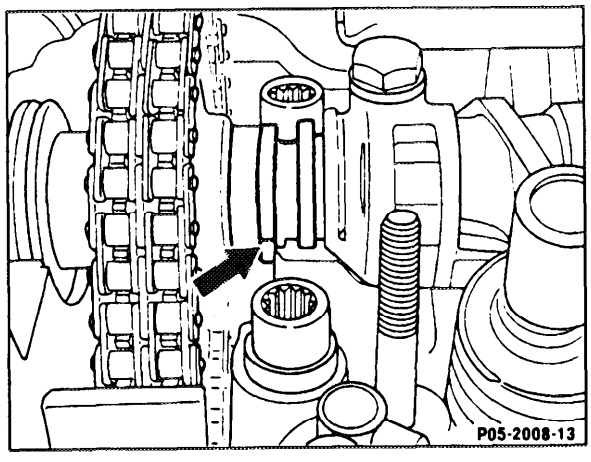
11 Install timing chain and camshaft timing gear, note marking. Tightening torque of camshaft timing gear set bolt 80 Nm.



12 Install chain tensioner (05-310). Tightening torque of sealing plug (40), 70 Nm.



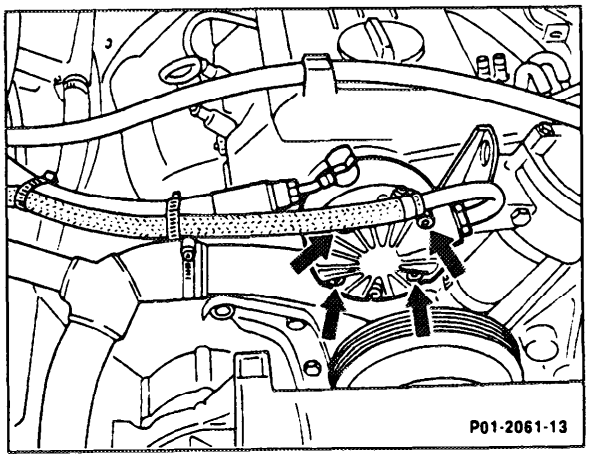
13 Check adjustment marking of camshaft (arrow) at ignition TDC position of engine, correct if necessary.



14 Install oil pressure pump, in so doing note driving disc.

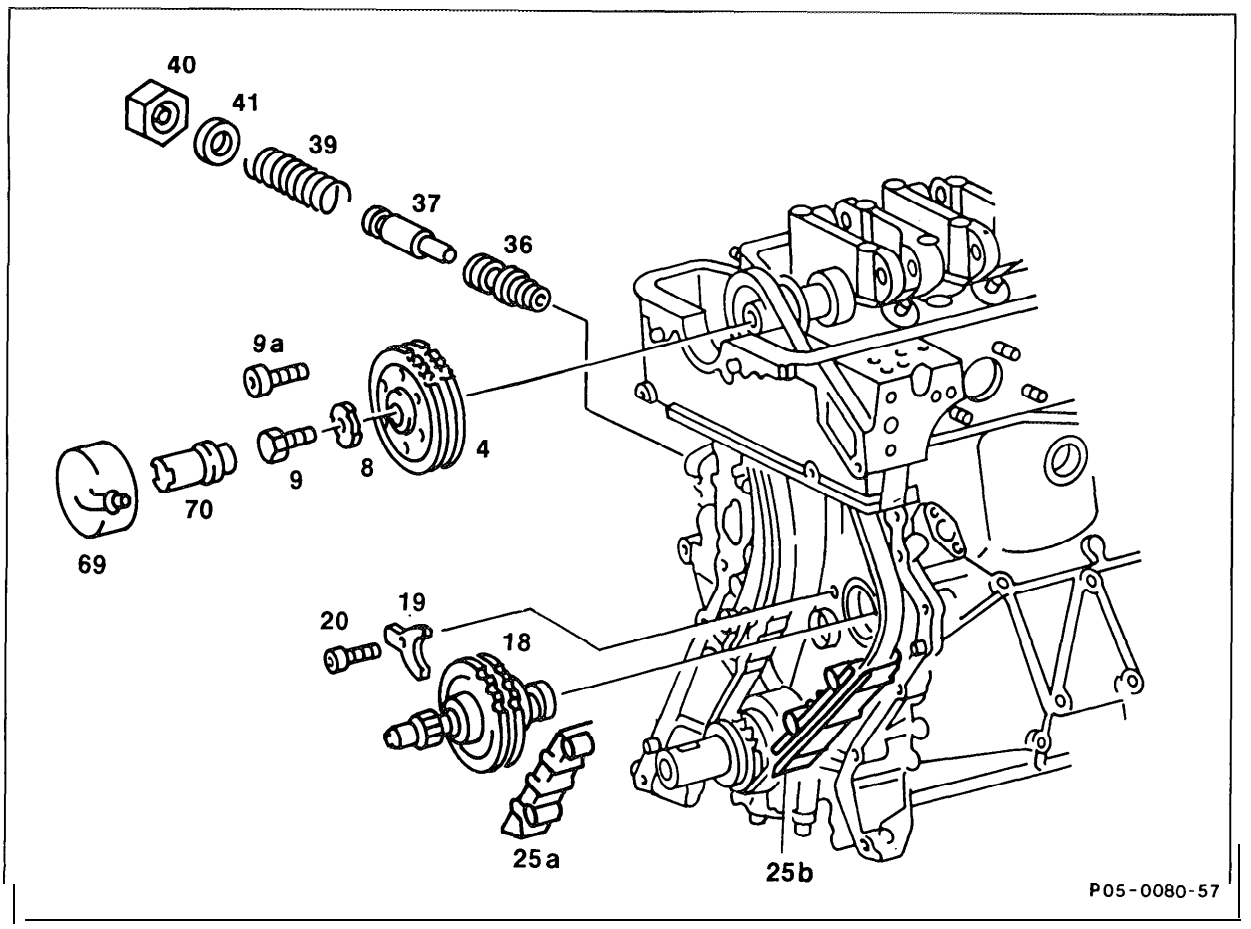
15 The installation is the reverse of removal.

16 Check for leaks when engine is running.



05-412 Removal and installation of idler gear shaft

Preceding work:
Timing case cover removed (01-210).
Fuel pump removed (07.2-212, only carburettor engines).



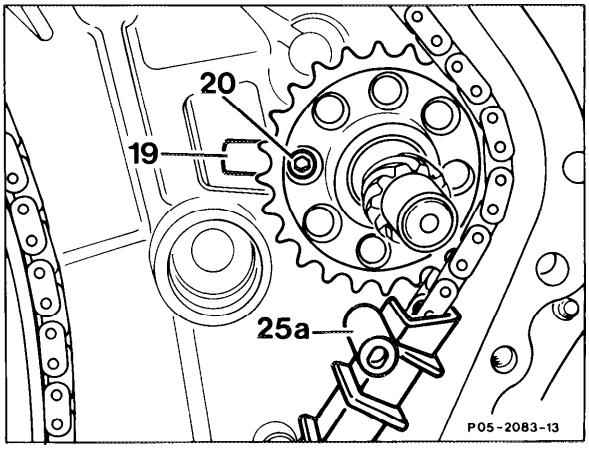
Chain tensioner (36 to 41)	remove, install (05-310).
Oil pressure pump (69)	unbolt, bolt up, set to one side with lines connected (Number 2).
Camshaft timing gear (4)	align with timing chain (Number 3).
Crankshaft gear	align with timing chain (Number 4).
Bolt (9 and 9a)	unbolt, bolt up and remove camshaft timing gear, 80 Nm. Note marking (Number 5).
Guide rail (25a)	remove, install (only on single roller chain, Number 6).

Hexagon socket bolt (20)	unbolt, bolt up, 5 Nm. Remove, install retaining clip (19) (Number 7).
Idler gear shaft (18)	withdraw from rear bearing and remove from timing chain, insert (Numbers 8 and 9).
When engine is running	check for leaks.

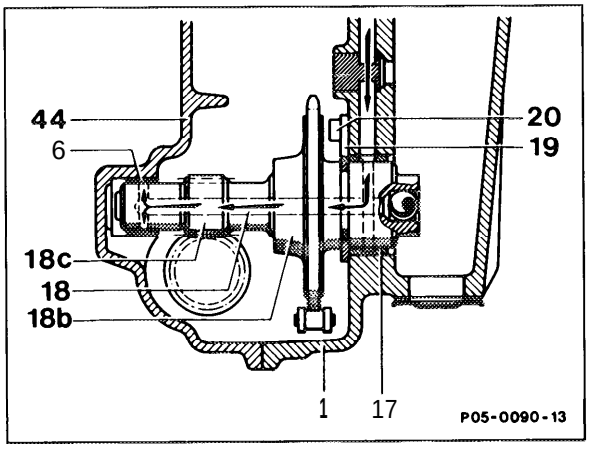
Special tool

Note

The idler gear (18b) is pressed on the idler gear shaft (18) supported on bearings in timing case cover and cylinder crankcase. It is fixed axially by a retaining clip (19) bolted on the cylinder crankcase, which engages in a groove on the idler gear shaft. The teeth for driving the ignition distributor (18c) are located behind the front bearing position.



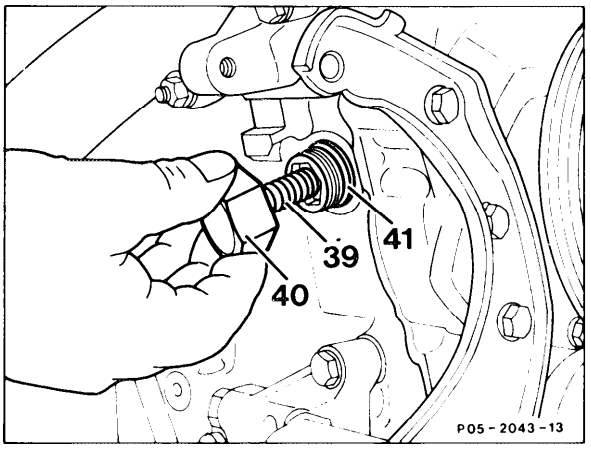
Arrangement of idler gear shaft
Engines 102.985



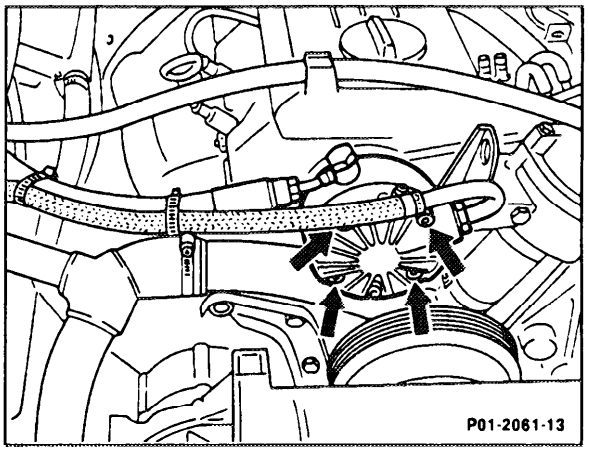
1 Cylinder crankcase
6 Bearing bush in timing case cover
17 Bearing bush in cylinder crankcase
18 Idler gear shaft
18b Idler gear
18c Teeth for ignition distributor drive
19 Retaining clip
20 Bolt M5 × 18 mm
44 Timing case cover

Removal and installation

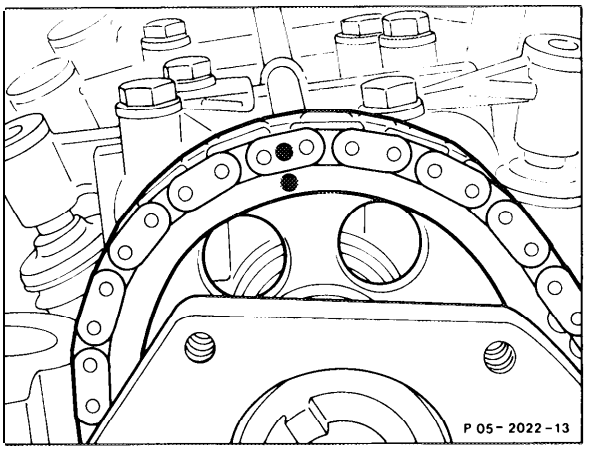
1 Remove chain tensioner (05-310).



2 Unbolt, bolt up oil pressure pump (arrows) and put to one side with lines connected.

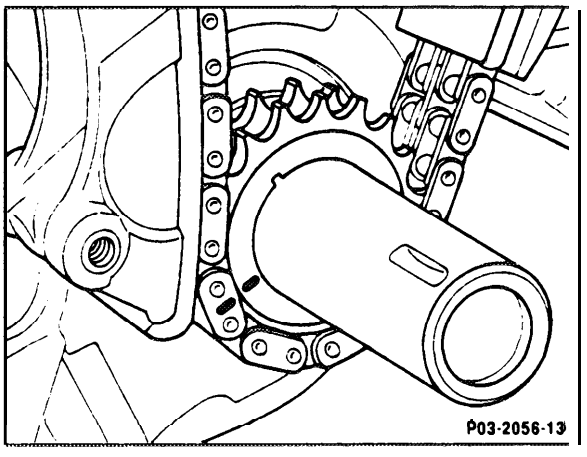


3 Align camshaft timing gear and timing chain.



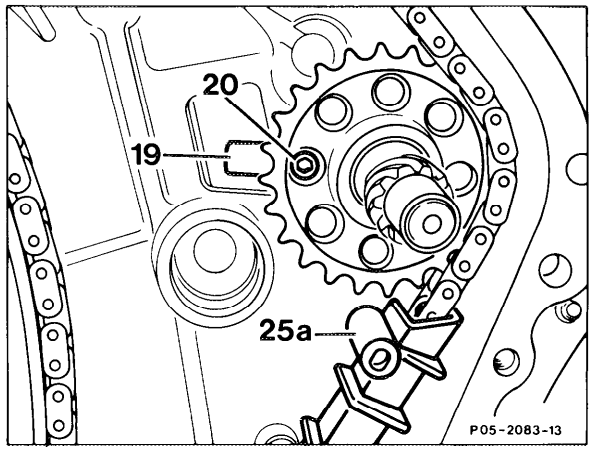
4 Align crankshaft gear and timing chain.

5 Unbolt camshaft timing gear and remove, put timing chain in timing case.



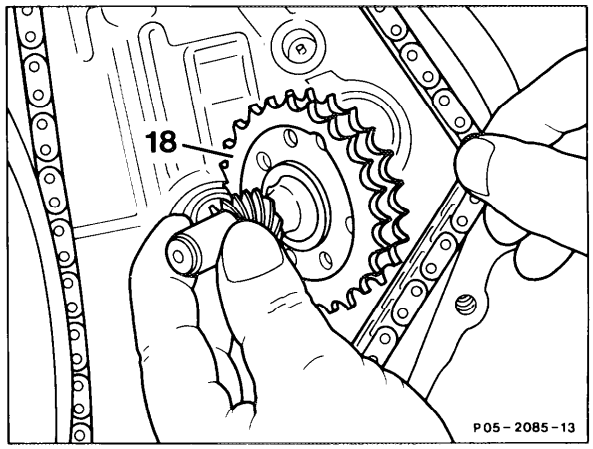
6 Remove guide rail (25a) (only on single roller chain).

7 Unbolt hexagon socket bolt (20) and remove retaining clip (19).



8 Remove idler gear shaft (18), install, in so doing raise timing chain somewhat.

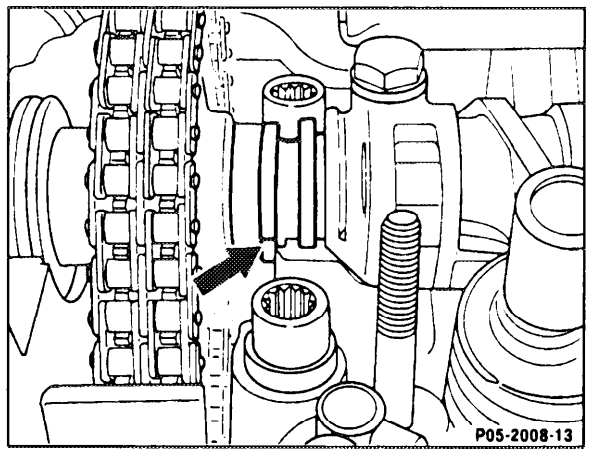
9 Install retaining clip (19) and secure with bolt (20), tightening torque 5 Nm (reference value).



10 Install guide rail (25a).

11 Assemble camshaft timing gear, at the same time noting colored markings, tightening torque 80 Nm.

12 Check adjustment marking of the camshaft (arrow) at ignition TDC position of engine, correct if necessary.



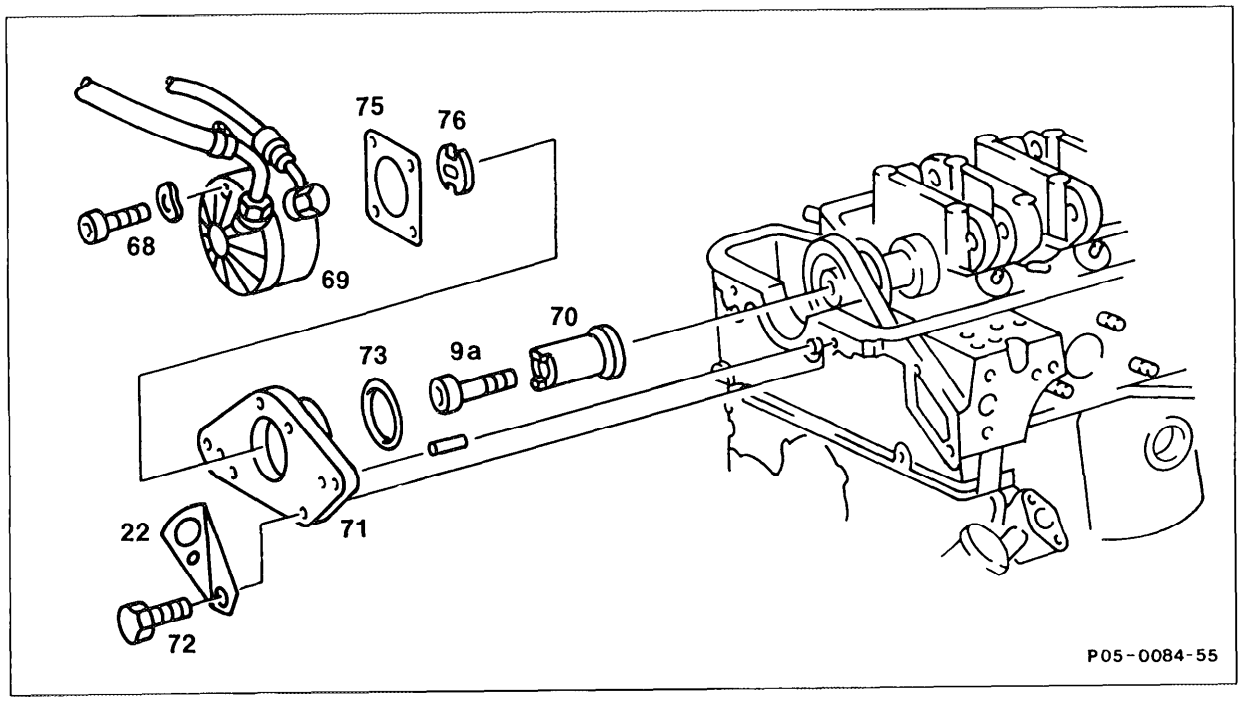
13 Install chain tensioner (05310).

14 The installation is the reverse of removal.

15 Check for leaks when engine is running.

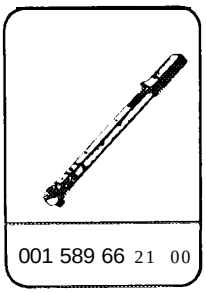
05-437 Removal and installation of oil pressure pump drive

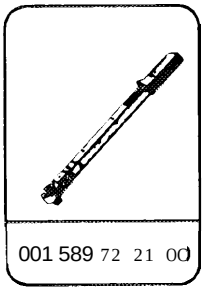
Preceding work:
Cylinder head cover removed (01-406).



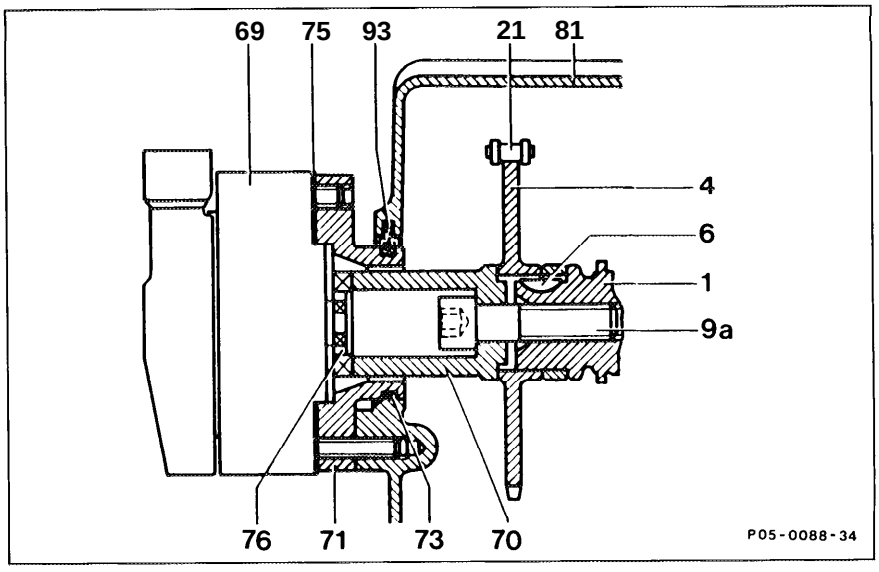
Set bolts (68)	unbolt, bolt up, 15 Nm (Numbers 1 and 2).
Oil pressure pump (69)	remove together with driving disc (76). On Model 201 set oil pressure pump with lines connected to one side.
Gasket (75)	renew.
Driving disc (76)	remove, install.
Flange (71)	unbolt, bolt up, with attachment eye (22), 25 Nm (Number 4).
O-Ring (73)	replace.
Hexagon socket bolt (9a)	unbolt, bolt up, 80 Nm. Remove, install driving disc sleeve (70) (Number 5).

Special tools



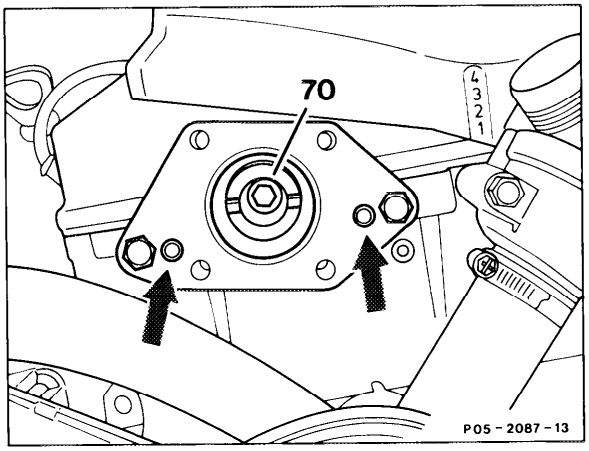


1 Camshaft
4 Camshaft timing gear
6 Woodruff key
9a Hexagon socket bolt
21 Timing chain
69 Oil pressure pump
70 Driving disc sleeve
71 Flange
73 O-Ring
75 Gasket
76 Driving disc
81 Cylinder head cover
93 Cylinder head cover gasket



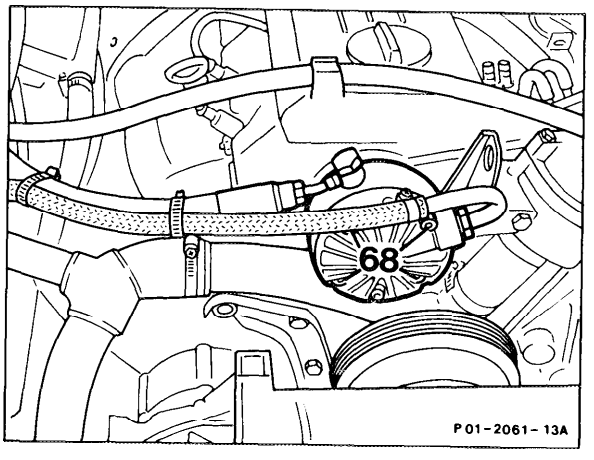
Note

The oil pressure pump (69) is driven directly by the camshaft **(1)** via the driving disc sleeve **(70)** and the driving disc (76) and is attached to the cylinder head by a flange **(71).** The fitting position of the flange on the cylinder head is fixed by two straight pins (arrows). The camshaft timing gear (4) is attached to the camshaft with the driving disc sleeve (70) and the hexagon socket screw **(9a).** The O-Ring (73) on the flange **(71)** seals the front semicircular bore in the cylinder head and in the cylinder head cover (81).



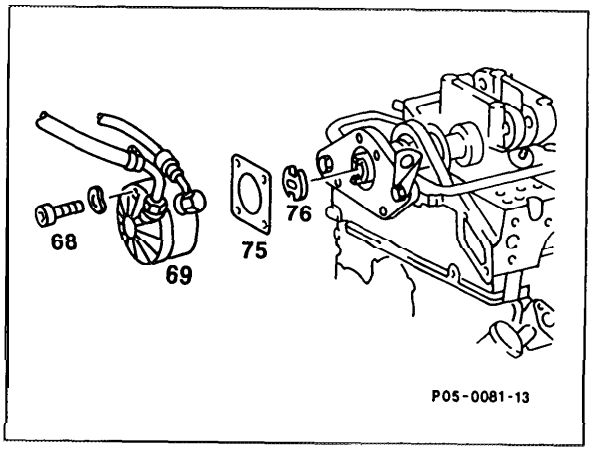
Removal and installation

1 On Model 201 remove bolts (68), remove oil pressure pump and set to one side with lines connected.

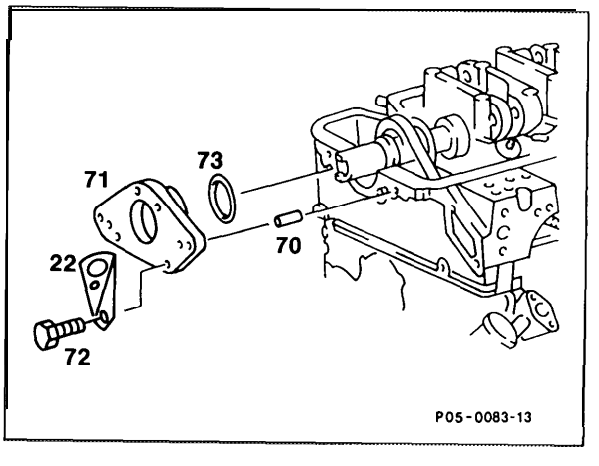


Model 201

2 Remove, install driver (76). Replace gasket (75).



3 Unbolt, bolt up flange (71) together with the attachment eye (22), renew O-Ring (73). Tightening torque of bolts (72) 25 Nm. Note both dowels (70).



4 Unscrew hexagon socket bolt (9a) and remove, insert driver sleeve (70), tightening torque 80 Nm.