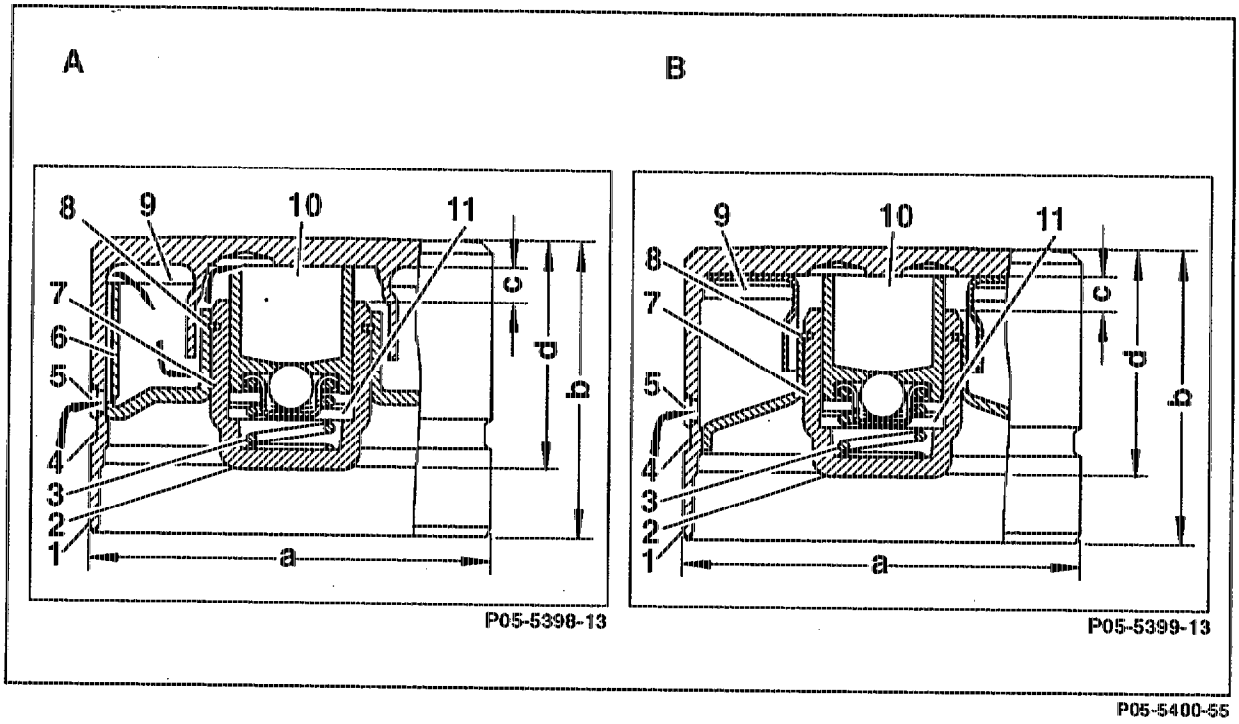
05–2110 Examining and replacing hydraulic valve clearance compensating elements (bucket tappets)

Operation no. of operation texts and work units or standard texts and flat rates
05–2010–2500



A. Bucket tappet 1st version

a	34.965 – 34.975 mm
b	25.5 – 26.5 mm
c	(stroke) = min. 2.04 mm
d	(piston extended) = 20.1 mm
	Weight 82 g

B. Bucket tappet 2nd version

a	34.965 – 34.975 mm
b	25.5 – 26.5 mm
c	(stroke) = min. 2.04 mm
d	(piston extended) = 20.1 mm
	Weight 64 g

Examining

Cylinder head cover	remove, install (01–0500).
Cam at relevant bucket tappet	position to base circle (lobe of cam must face up).
Bucket tappet	press with suitable tool (not steel tool).
If one bucket tappet can be pressed more easily in comparison to the others	replace this bucket tappet.

Replacing

Relevant camshaft	remove, install (05–2200).
Bucket tappet of respective cylinder	pull up with rubber suction cup and remove.
	⚠ Install the first version of bucket tappet only together with double valve springs. Do not use magnets as minute iron particles collect at the magnetised contact surfaces of the bucket tappet and cause damage to the buckets and cams. The bucket tappets must be re-installed at the same point. The contact surface must not have any pitting caused by the cam lobe so that the rotational movement of the bucket tappet is not obstructed.
Basic bore	perform visual inspection.

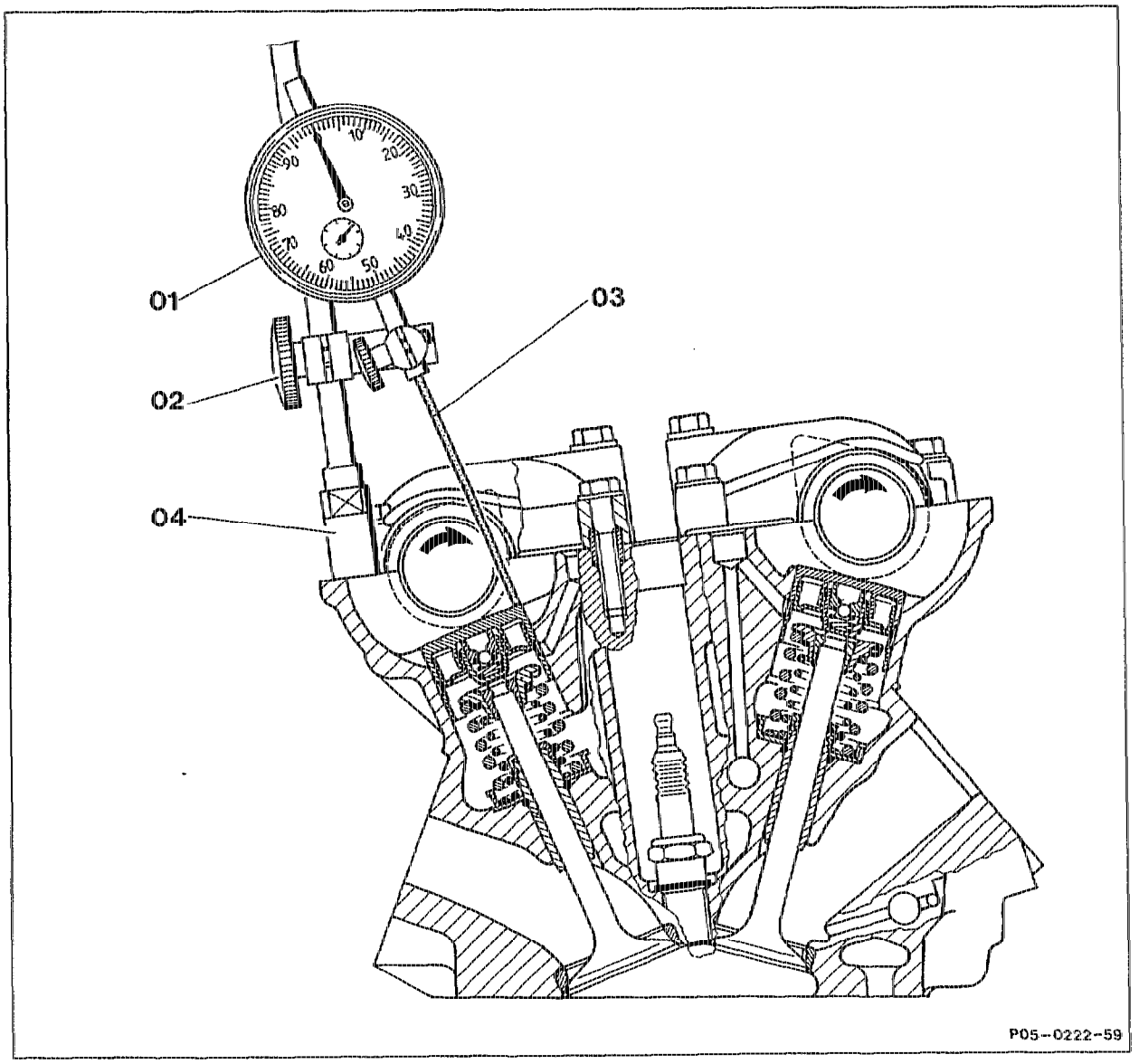
Commercially available tool

30 mm dia. rubber suction cup	e. g. Hazet, no. 735-2

05–2150 Checking timing of camshafts

Preceding work:
Cylinder head covers removed (01–0500).

Operation no. of operation texts and work units or standard texts and flat rates
05–6010, 6020



Camshaft code numbers . . . . . check (step 1).

Checking timing of inlet camshafts

Position inlet camshaft of cylinder No. 1 or No. 6 so that only the base circles are resting against the bucket tappets (step 2).

Dial gauge holder (02) . . . . . install with threaded sleeve (04) at cylinder 1 or 6, special tool 363 589 02 21 00 (step 3).

Dial gauge (01) . . . . . install in dial gauge holder (02) with tracer pin (03) on left side of camshafts to be checked (step 4).

Preload of 3 mm and angular position of 90° of tracer pin to bucket tappet . . . . . set (step 5).

Crankshaft . . . . . rotate with wrench socket in direction of rotation of engine, special tool 001 589 65 09 00.

At 2 mm valve lift, the reading on vibration damper must agree with the reading in table "Inlet valve opens".

Testing timing of exhaust camshafts

Position exhaust camshaft of cylinder No. 1 or No. 6 so that only the base circles are resting against the bucket tappets (Step 7).

Dial gauge holder (02) 363 589 02 21 00 with threaded sleeve (04) . . . . . install at cylinder No. 1 or No. 6 (step 8).

Dial gauge (01) with tracer pin (03) . . . . . install at cylinderNo. 1 on left side at cylinder No. 6 on right side of camshaft to be tested.

Preload of 3 mm and angular position of 90° of tracer pin (03) to bucket tappet . . . . . set (step 9).

Crankshaft . . . . . crank with wrench socket 001 589 65 09 00 in direction of rotation of engine.

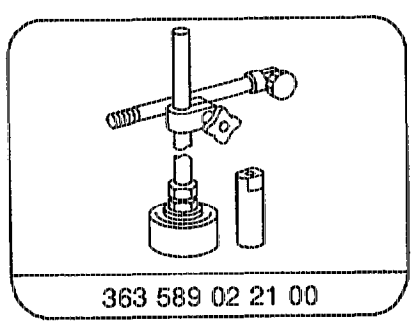
At 2 mm valve lift, the reading on vibration damper must agree with the reading in table "Exhaust valve opens"

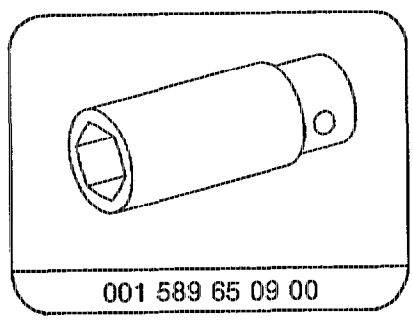
Timing in crank angle degrees (°CA) at 2 mm valve lift[1]) with new timing chain

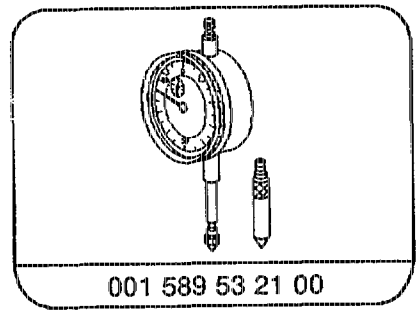
Engine	Code numbers of camshafts[2])				Inlet valve[3])		Exhaust valve	
	Inlet camshaft rt	lt	Exhaust camshaft rt	lt	opens ATDC	closes ABDC	opens BBDC	closes BTDC
119.960	58 59[5])	56 57[5])	62[4]) 63[5])	60[4]) 61[5])	25.0°	35.0°	13.0°	13.0°
119.970 972/974	74 75[5])	72 73[5])	78[5]) 79[5])	76[5]) 77[5])	30.0°	40.0°	13.0°	13.0°
119.971	82 83[5])	80 81[5])	86 87[5])	84 85[5])	30.0°	35.0°	8.0°	13.0°
119.970/ 972/974 [6])/ 980/982	98	96	02	00	33.0°	42.0°	10.0°	11.0°
119.971/ 975 [6]) / 981/985	90	88	94	92	30.0°	–	8.0°	–

1) Permissible variation: ± 2.0 °CA. Perform test only when cam ascending (in direction of rotation of engine).
2) Camshaft code number inscribed on camshaft bearing journal at front.
3) Camshaft adjuster retarded.
4) replaced by 78 or 76, respectively
5) Repair camshaft with 0.5 mm larger bearing diameter
6) as of model year 1993

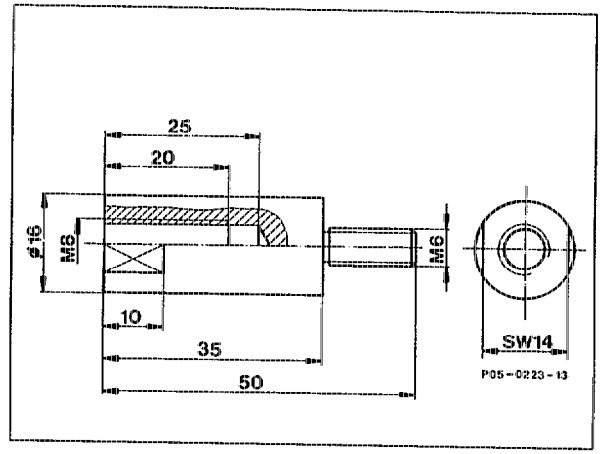
Special tools


363 589 02 21 00


001 589 65 09 00


001 589 53 21 00

Shop-made tool
Threaded sleeve (reduction M8 to M6) for attaching dial gauge holder 363 589 02 21 00 to cylinder head cover sealing surface.

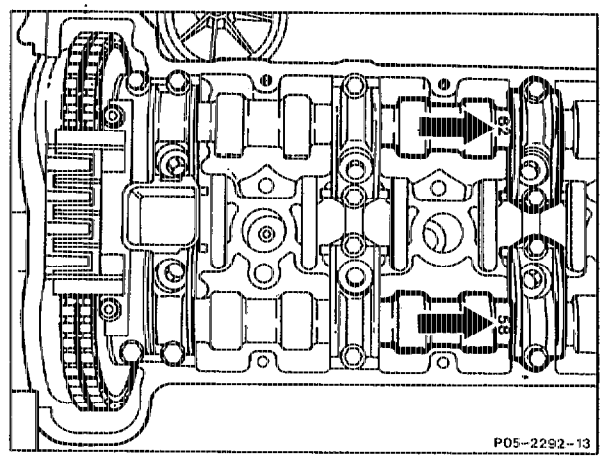


Note
If performing installation work, it is sufficient to check the basic setting of the camshafts (see 05–2230).

The timing is measured with the hydraulic bucket tappets.

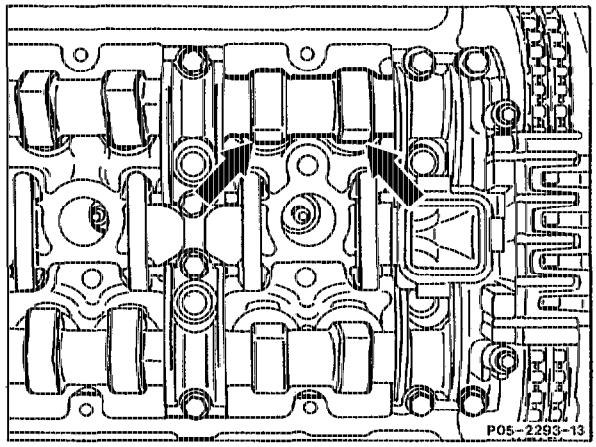
Check "inlet valve opens" at No. 1 and No. 6 cylinder with 2 mm valve lift and camshaft adjuster retarded.
Check "exhaust valve closes" at No. 1 and No. 6 cylinder at 2 mm valve residual lift.

1 Check camshaft code numbers. The camshaft code numbers are inscribed on the 3rd camshaft bearing journal (fitted bearing) (arrows) and stamped on the camshaft flange from behind with coloured ink.

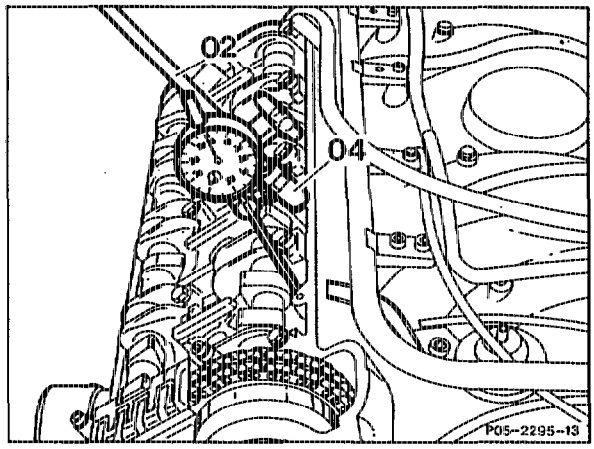


Checking timing of inlet camshafts

2 Rotate crankshaft in direction of rotation of engine until the lobes of the inlet cams to be tested are facing up (arrows) and only the base circles are resting against the bucket tappets.



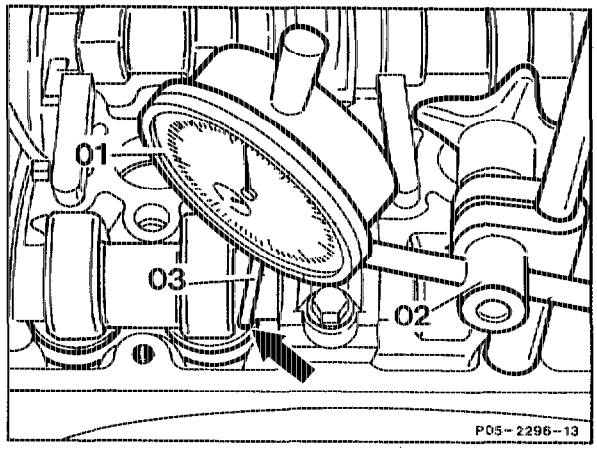
3 Install dial gauge, special tool (02) 363 589 02 21 00 with threaded sleeve (04) at sealing surface of cylinder head cover at the camshaft to be tested.



4 Clamp dial gauge (01) with tracer pin (03) (80 mm) in the dial gauge holder (02) so that the tracer pin (03) is resting vertically on the bucket tappet (arrow) with a preload of 3 mm (small pointer of dial gauge).

Note
Check freedom of movement of tracer pin (03).

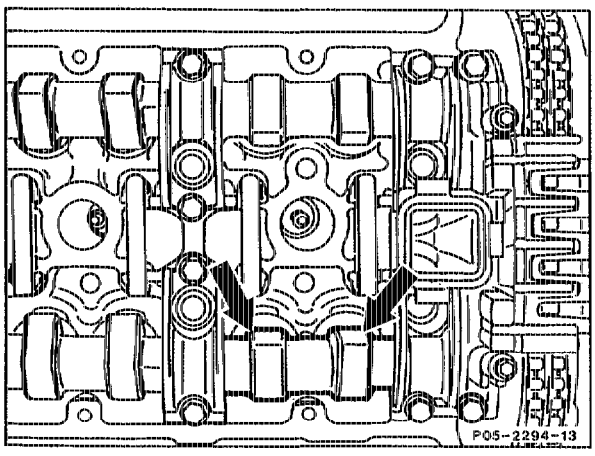
5 Turn scale of dial gauge until large pointer of gauge (01) is at "0".



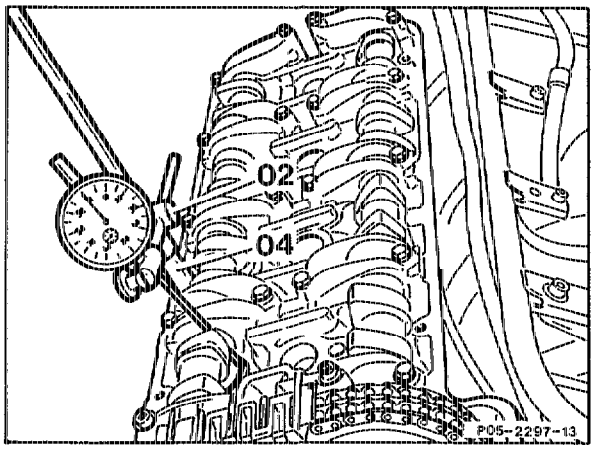
6 Rotate crankshaft in direction of rotation of engine with wrench socket, special tool 001 589 65 09 00 until the dial gauge indicates a valve lift of 2 mm. In this position, the reading obtained at the vibration damper must agree with the reading "inlet valve opens ATDC".

Testing timing of exhaust camshafts

7 Rotate crankshaft in direction of rotation of engine until the lobes of the inlet cams to be tested are facing up (arrows) and only the base circles are resting against the bucket tappets.

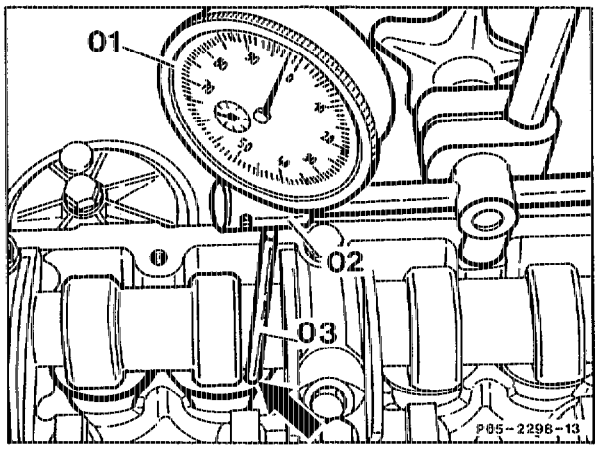


8 Install dial gauge, special tool (02) 363 589 02 21 00 with threaded sleeve (04) at sealing surface of cylinder head cover at the camshaft to be tested.



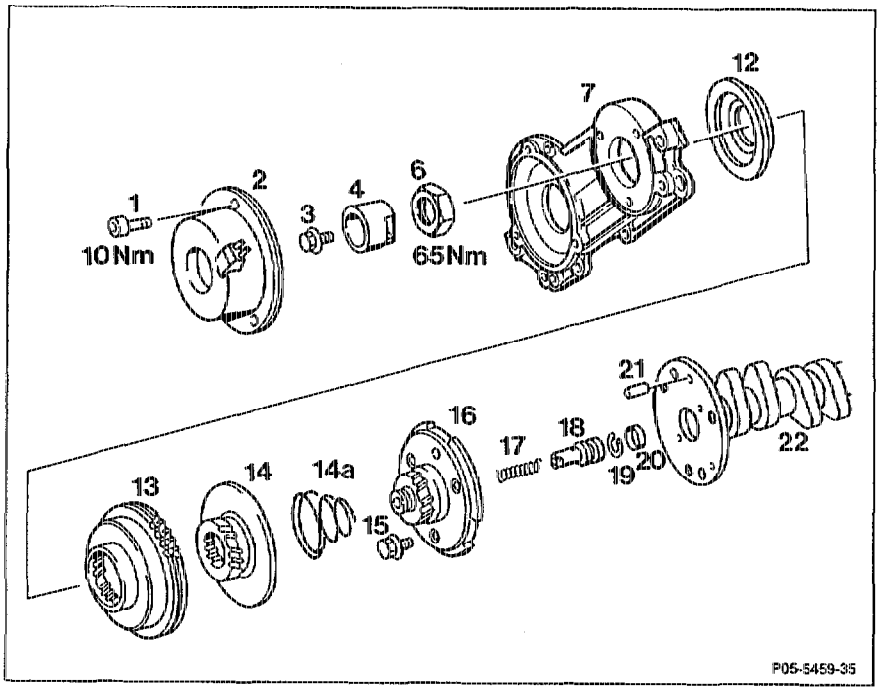
9 Clamp dial gauge (01) with tracer pin (03) (80 mm) in the dial gauge holder (02) so that the tracer pin (03) is resting vertically on the bucket tappet (arrow) with a preload of 3 mm (small pointer of dial gauge).

Note
Check freedom of movement of tracer pin (03). Install tracer pin (03) at No. 6 cylinder on right of camshaft.



10 Turn scale of dial gauge until large pointer of gauge (01) is at "0".

11 Use wrench bit, special tool 001 589 65 09 00, to rotate crankshaft in direction of rotation of engine until dial gauge indicates a valve lift of 2 mm.
In this position, the reading obtained at the vibration damper must agree with the reading "exhaust valve closes BTDC".



Both front covers	remove, install (01–2120).
	Note For left camshaft adjuster remove only left cover, for right camshaft adjuster only right cover.
Piston of cylinder 1	set to 45° before ignition TDC (step 2).
All four camshafts	secure with pins, special tool 111 589 03 15 00 (step 3).
Timing chain with all four camshaft sprockets	mark relative to each other (check marking when installing) (step 4).
Chain tensioner	remove, install (05–3100).
Top guide rails	remove, install (05–3350).
	Note Remove only right guide rail for right camshaft adjuster.
Left exhaust camshaft sprocket	unbolt, bolt on (18 Nm).

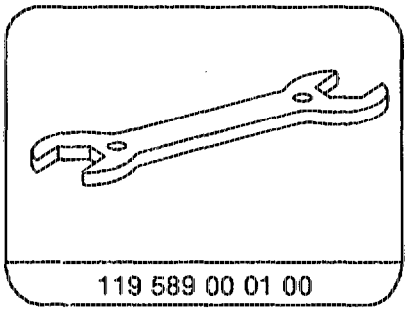
Armature (4), nut (6), cover (12), right camshaft sprocket (13) with adjusting piston (14), conical spring (14a) and flanged shaft (16) . . . . . unbolt, take off, fit on, bolt on (steps 8 and 9).

Note

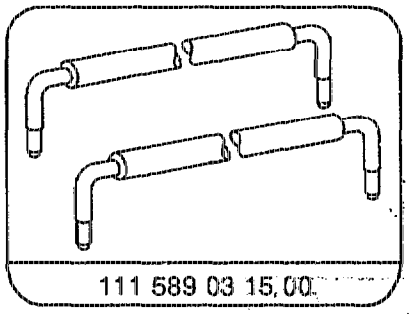
If only the left camshaft adjuster is removed, the right one remains installed.

Armature (4), nut (6), cover (12), left camshaft sprocket (13) with adjusting piston (14), conical spring (14a) and flanged shaft (16) . . . . . take off, unscrew, screw on and fit on (steps 10 to 19).

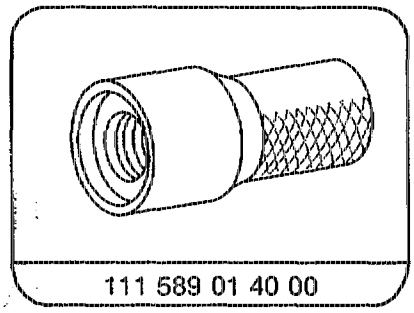
Special tools



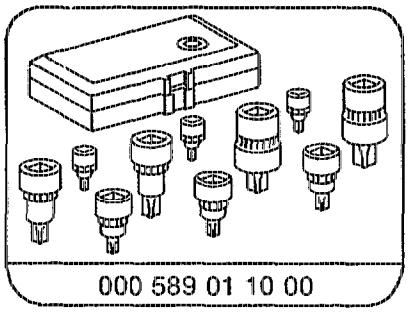
119 589 00 01 00



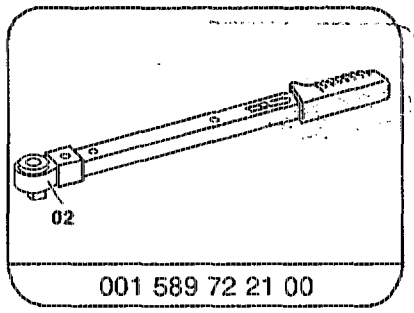
111 589 03 15 00



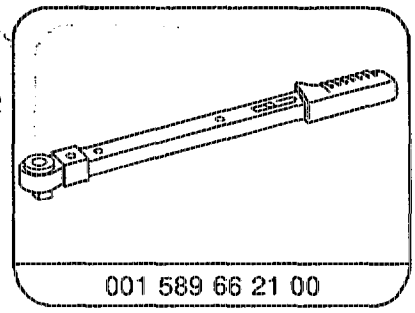
111 589 01 40 00



000 589 01 10 00



001 589 72 21 00

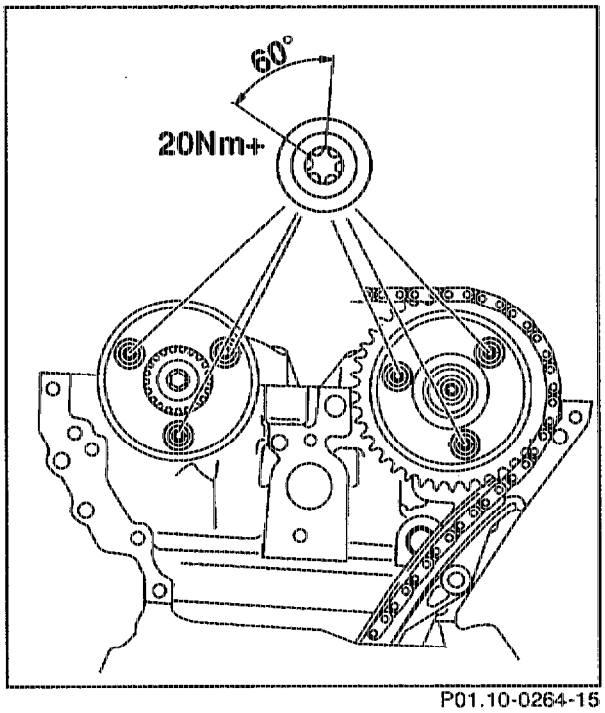


001 589 66 21 00

Tightening torques in Nm and tightening angle

Bolt of armature to control piston	1st version bolt + washer [1]	7
	2nd version collar bolt [2]	
	Initial torque	5
	Angle of rotation	90°
M 20 × 1,5 nut		65
Flange shafts to camshaft Torx T 40	1st version bolt + washer [1]	18
	2nd version collar bolt [2]	
	Initial torque	20
	Angle of rotation	60°

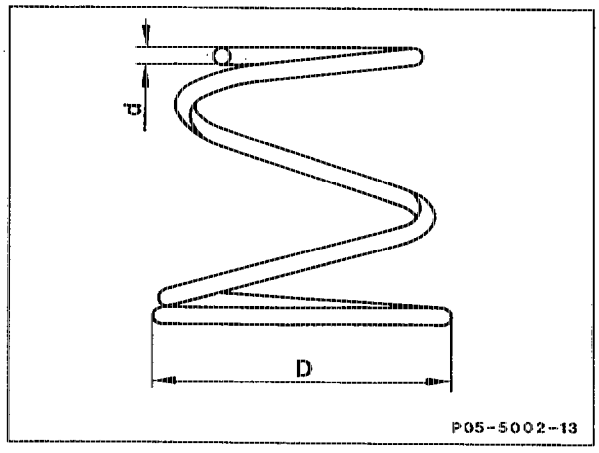
[1] Replace with 2nd version when performing repairs
[2] Use only once



P01.10-0264-15

Note

Conical spring	Size (d)	Size (D)
Engine 119.96	2.1 mm	51.7 mm
Engine 119.97		
1st version [3]	2.1 mm	51.7 mm
2nd version [3]	2.9 mm	53.3 mm
3rd version [4]	3.0 mm	53.3 mm
Engine 119.98	3.0 mm	53.5 mm



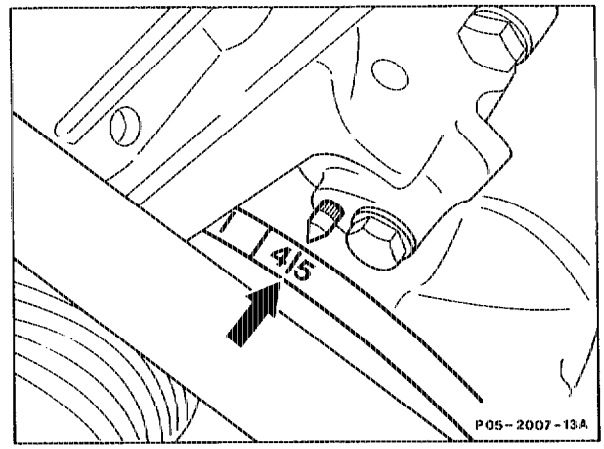
P05-5002-13

[3] On engines 119.97 replace 1st and 2nd version by 3rd version when performing repairs
[4] Standard as of 12/1992

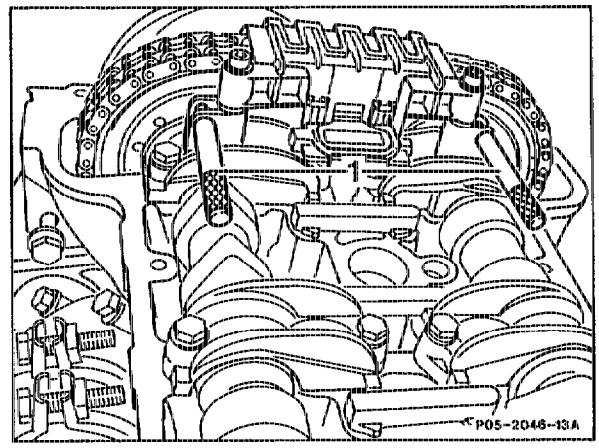
Removal

1 Remove both front covers (01–2120). (Remove only left-hand cover for left-hand camshaft adjuster, right-hand cover for right-hand camshaft adjuster.)

2 Set piston of No. 1 cylinder to 45° before ignition TDC.

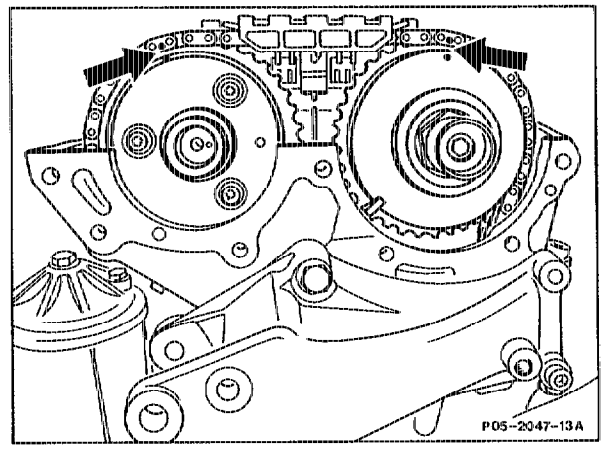


3 Secure all four camshafts with pins (1) 111 589 03 15 00.



4 Mark timing chain with all four camshaft timing gears together (arrows).

Installation Instruction
Fit on the timing chain in the opposite direction of rotation of engine, beginning at the left exhaust camshaft gear. The markings made previously must again agree.

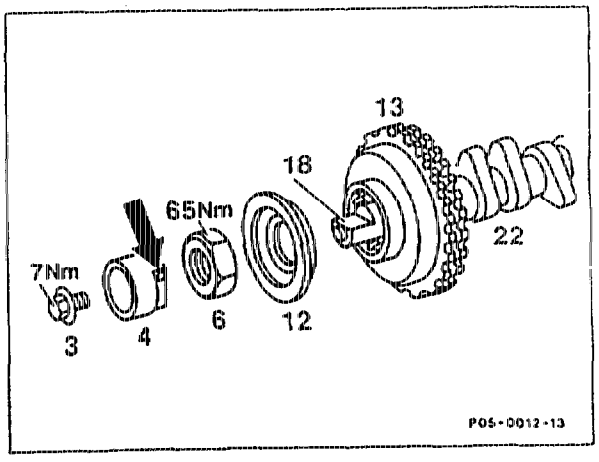


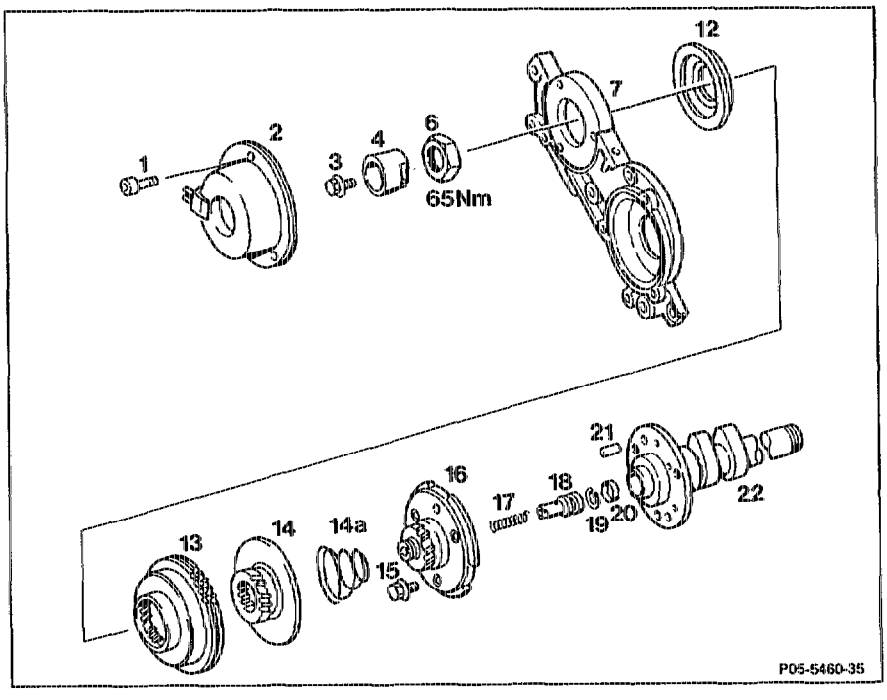
5 Remove chain tensioner (05–3100).

6 Remove top guide rails (05–3350). Remove only right guide rail for right camshaft adjuster.

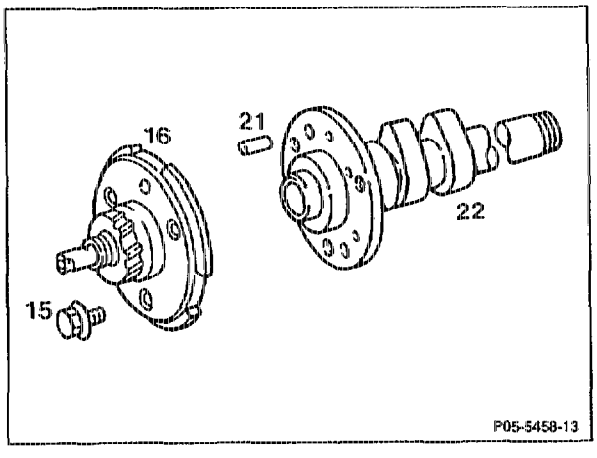
7 Remove right exhaust camshaft sprocket.

8 Unscrew bolt (3) holding armature (4) in position on face (arrow). Pull off armature (4). Tightening torque 7 Nm.





9 Take off nut (6), cover (12), left-hand camshaft gear (13) with adjusting piston (14) and conical spring (14a). Unscrew bolts (15) and take flange shaft off intake camshaft.

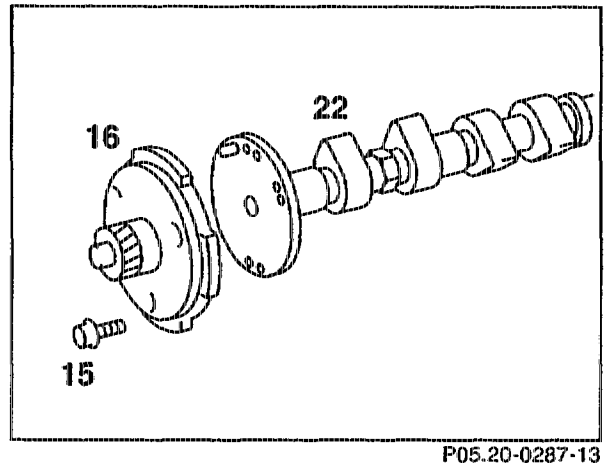


Installing

10 Bolt flange shaft (16) onto inlet camshaft (22); pay attention to dowel pin.

Note

Replace collar bolts (15); use only once.

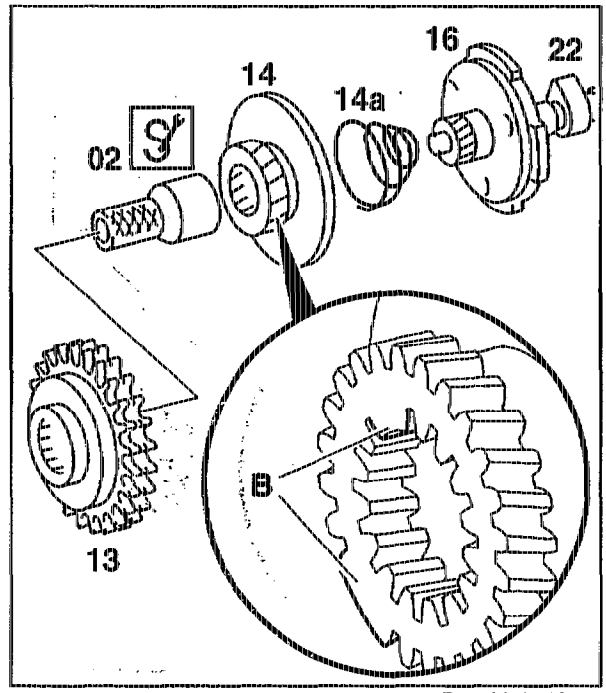


P05.20-0287-13

11 Insert spherical spring (14a) and push adjusting piston (14) onto flange shaft (16) in fixed position (block tooth B).

12 Screw on thrust nut (02), special tool 111 589 01 40 00.

13 Push inlet camshaft sprocket (13) into fixed position (block tooth B) onto splines of adjusting piston (14); hold timing chain up for this step.

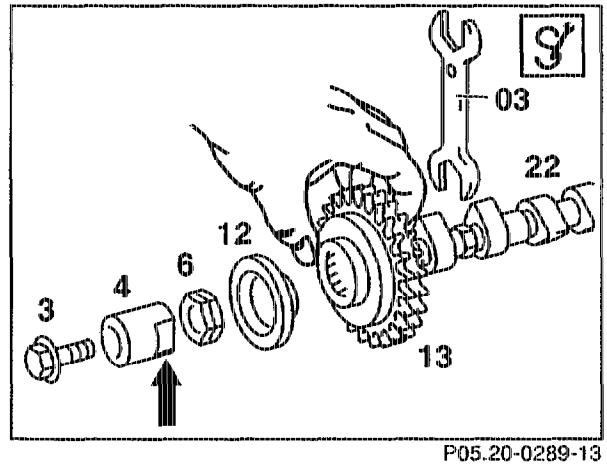


P05.20-0288-15

14 Unscrew thrust nut; hold camshaft adjuster together for this step.

15 Fit on cover (12).

16 Screw on nut (6) with its flat face pointing towards camshaft adjuster (securing slot at front).



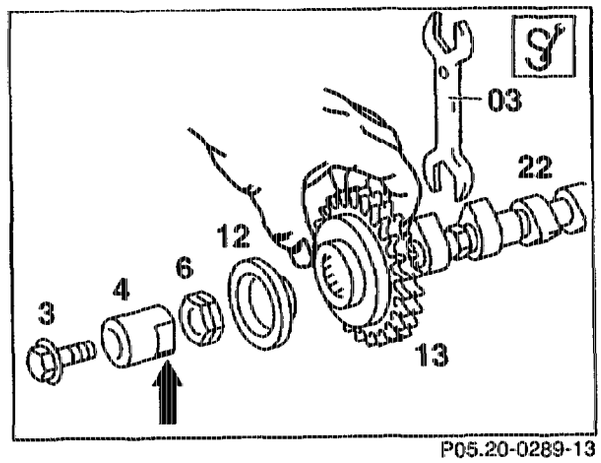
P05.20-0289-13

17 Tighten nut (6); counter-hold camshaft (22) at hexagon with wrench (03), special tool 119 589 00 01 00.

18 Fit on armature (4) in fixed position.

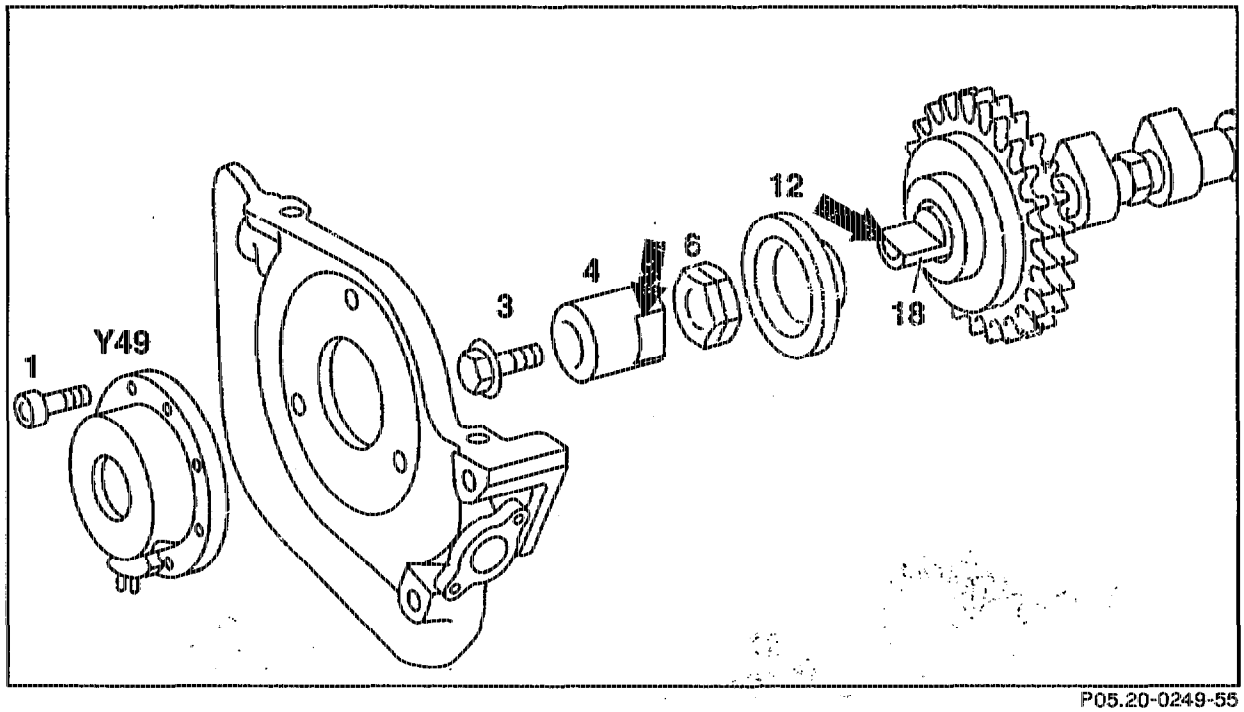
⚠

Pay attention to operation 05-2175.



P05.20-0289-13

05–2175 Armature and solenoid at camshaft adjuster



P05.20-0249-55

Solenoid (Y49)	unbolt, bolt on.
Solenoid (Y49)	coat sealing surface with sealant 002 989 47 20 10.
M6×16 bolts (1)	tighten.
Front cover (7)	remove, install (05-2170).
Armature (4) with M5×11 bolt (3)	unscrew, screw on; counter-hold armature (4) at flats (arrow) for this step; see table for tightening torque; armature (4) can be fitted onto control plunger (18) only in fixed position (arrow).

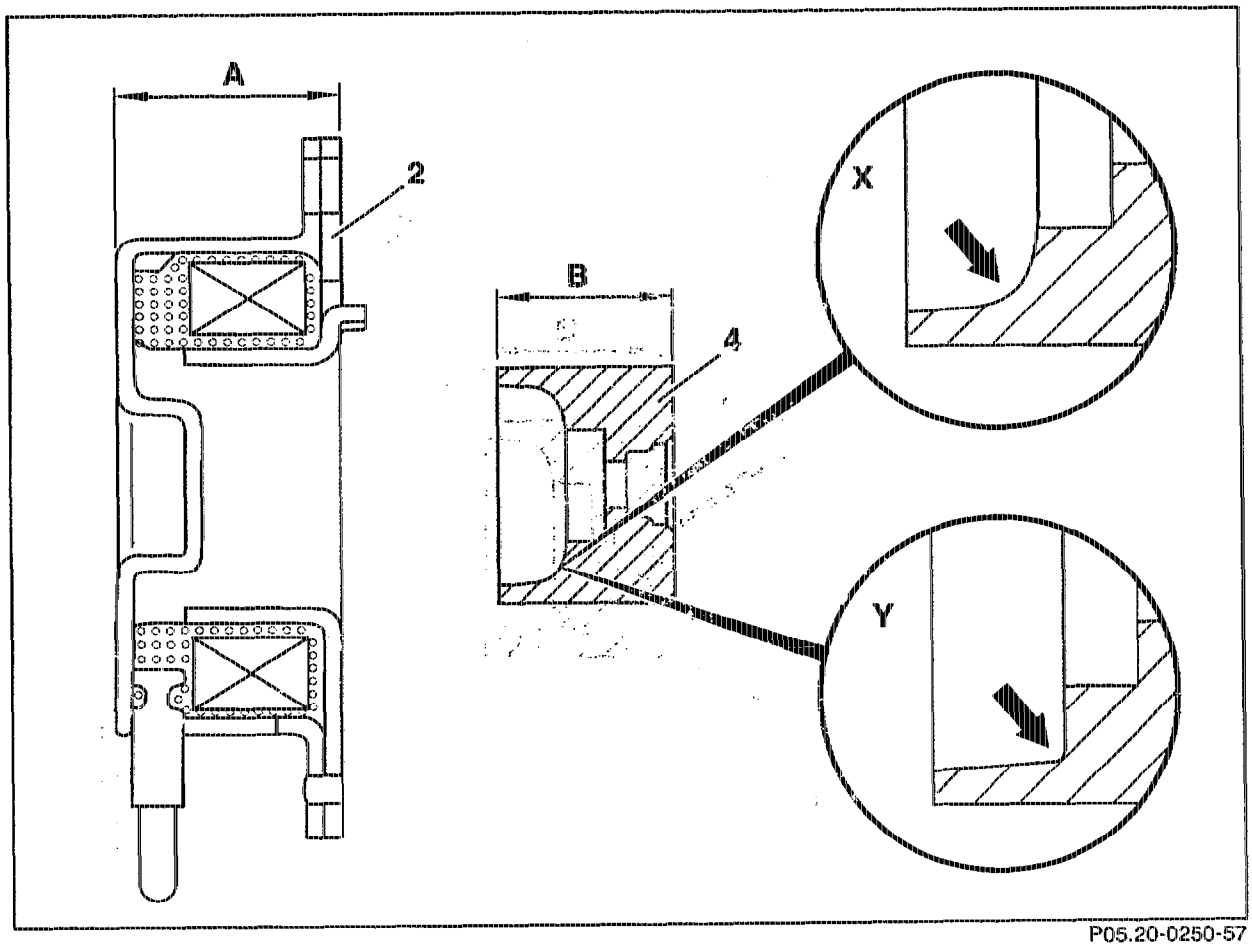
⚠ It is not permitted to re-use the bolt (3).

Note

The armature (4) together with the control plunger (18) must move freely from stop to stop after the nut (6) has been tightened to the specified torque of 65 Nm.

⚠

For operational reasons, the different versions of the armature (4) and of the solenoid (2) must only be installed in the specified combination (see table for matching).



P05.20-0250-57

Matching armature and solenoid

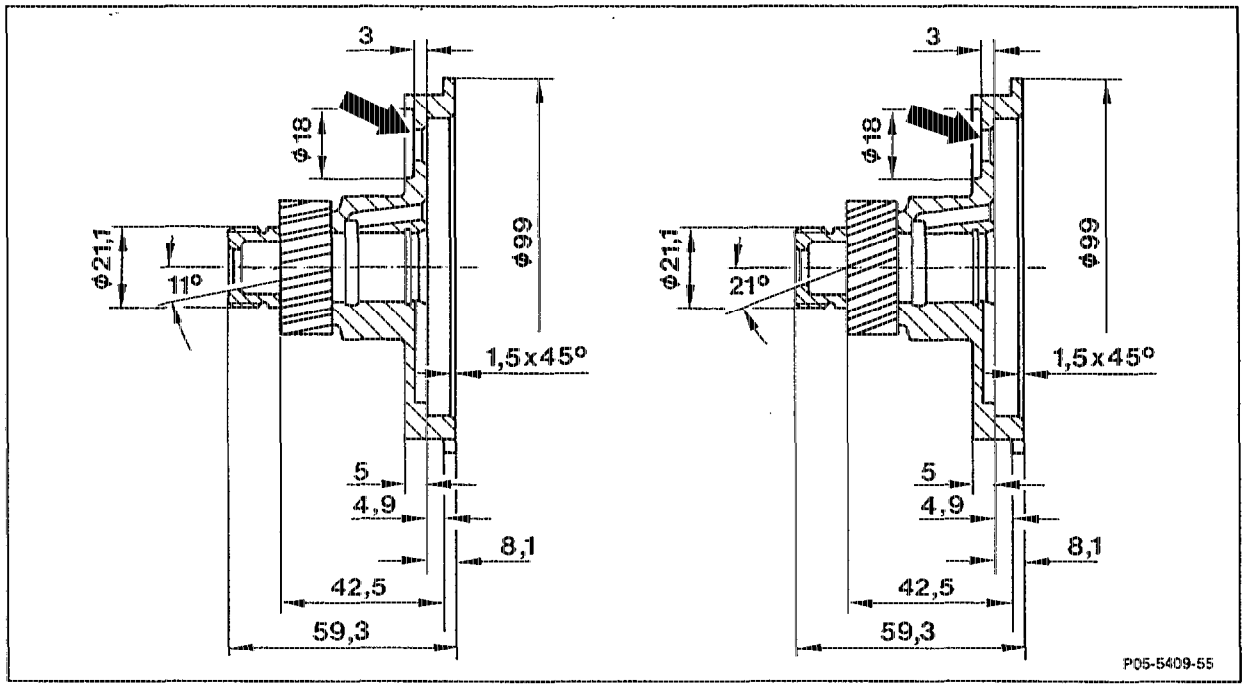
1st version	Part no.	Size A in mm	Size B in mm	Identification
Armature (4)	104 051 04 43	–	21	see arrow X
Solenoid (2)	104 050 01 77	27.1	–	–
2nd version				
Armature (4)	119 051 00 43	–	23	see arrow Y
Solenoid (2)	119 051 00 77	29.1	–	–

Tightening torques in Nm and tightening angle

Bolt of armature to control plunger	1st version [1]) bolt + washer	7
	2nd version [2]) collar bolt Tightening angle	5 + 90°
Bolts of solenoid to front cover		10

[1]) Replace with 2nd version when performing repairs
[2]) Use only once

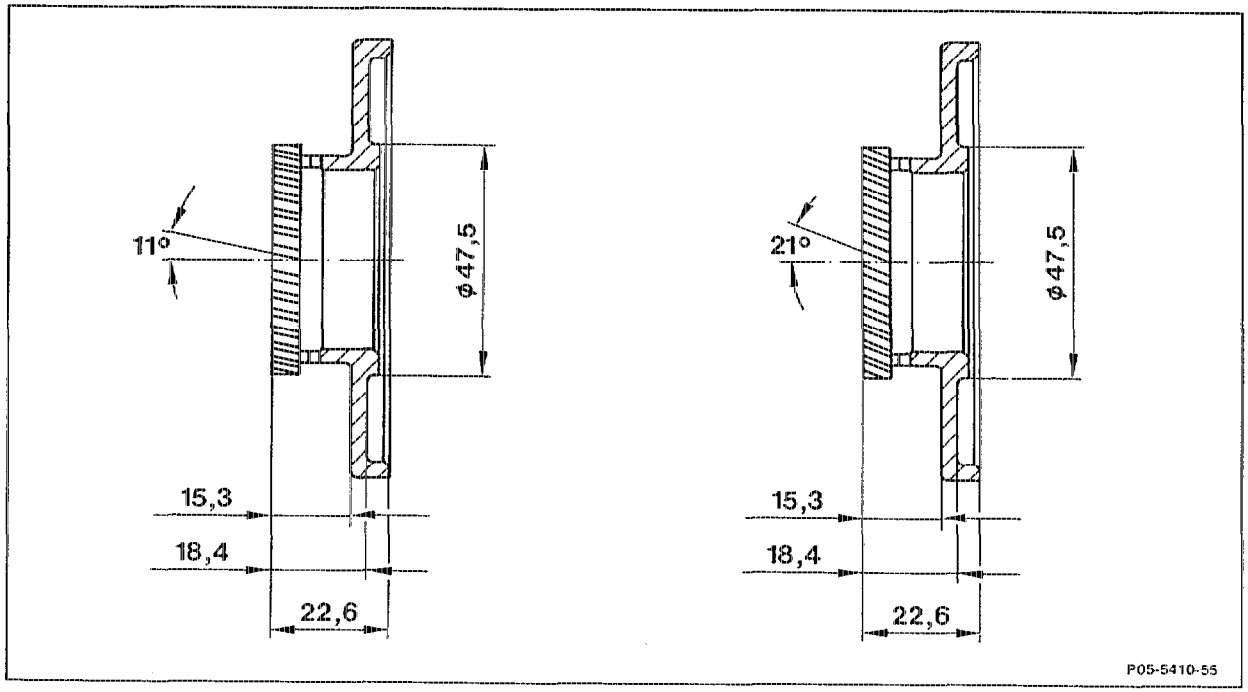
Flanged shaft



Engine 119.96

Engine 119.97

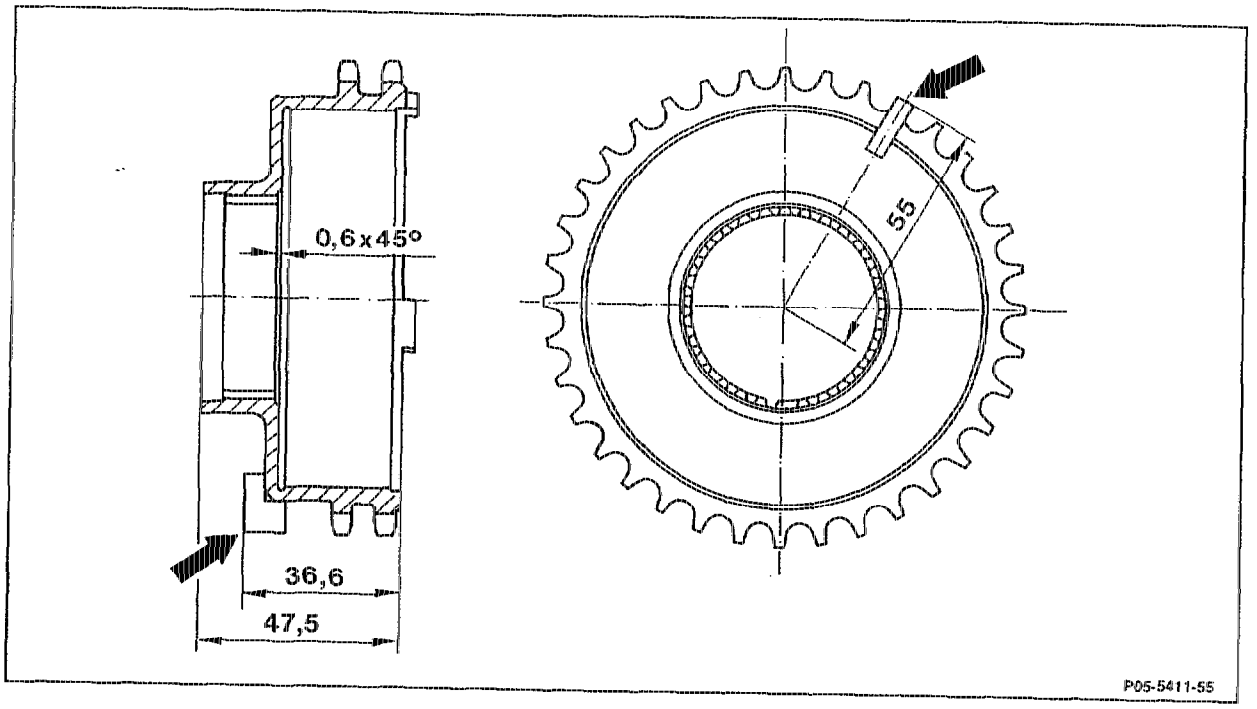
Adjusting piston



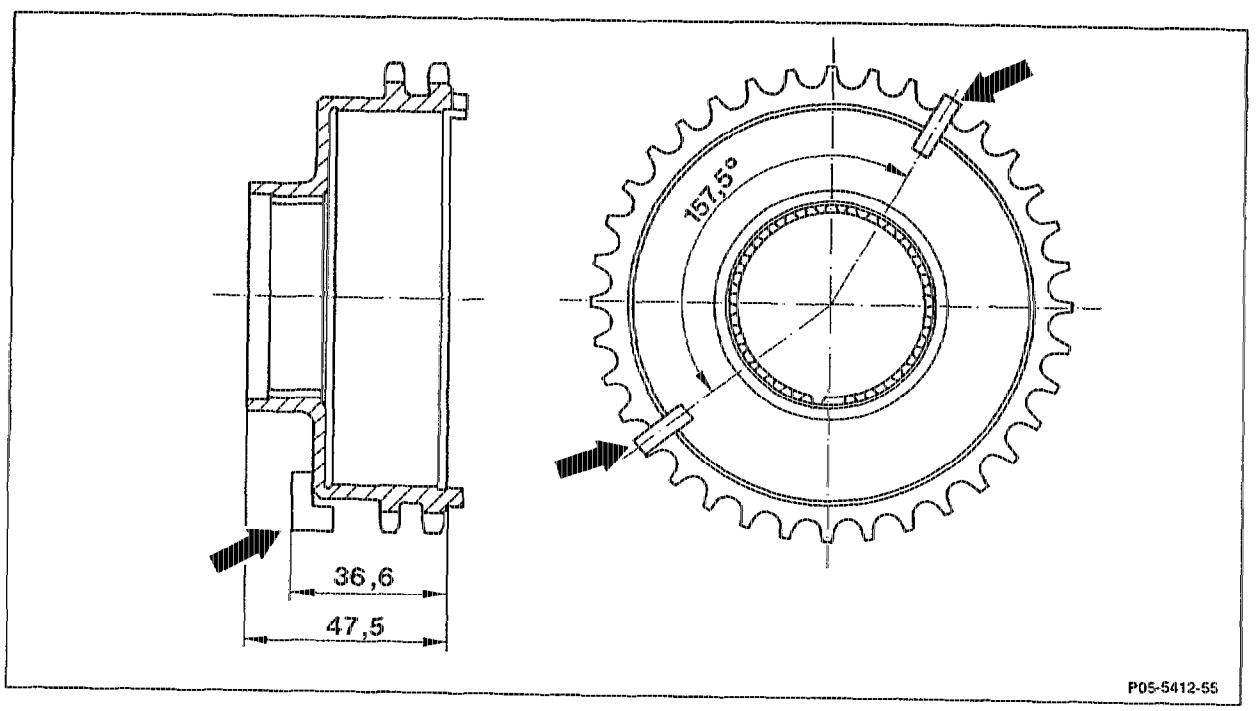
Engine 119.96

Engine 119.97

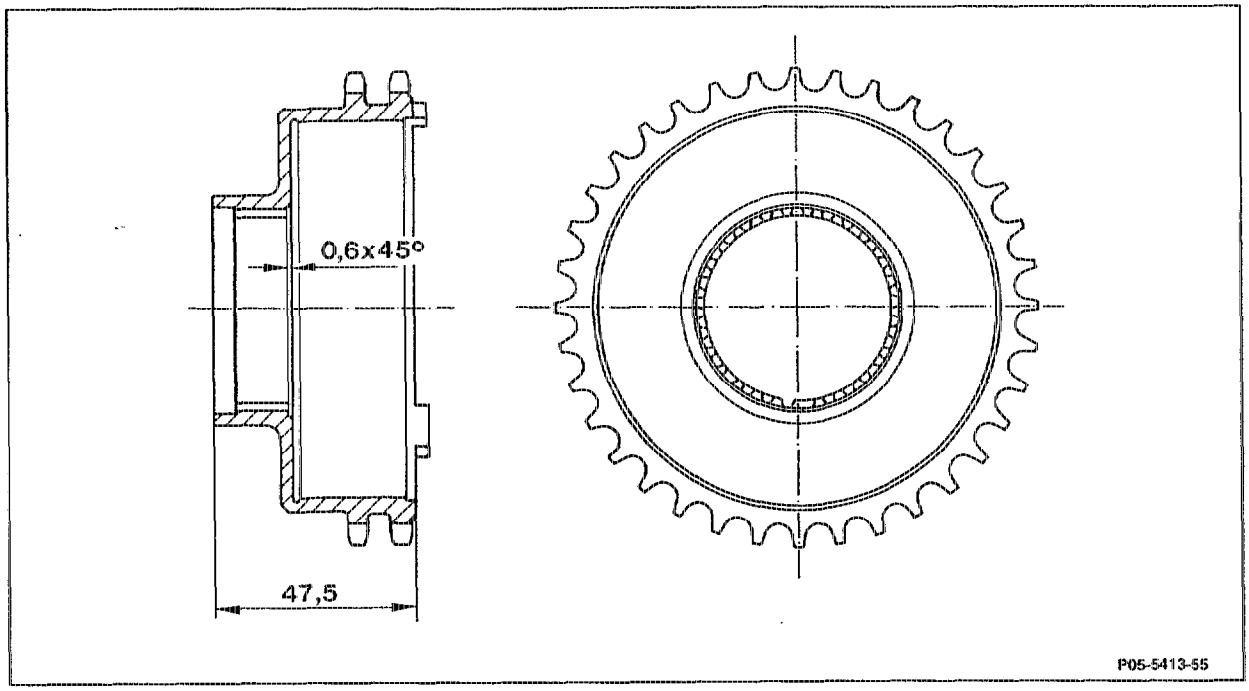
Camshaft sprocket



Engine 119.96 on left and right

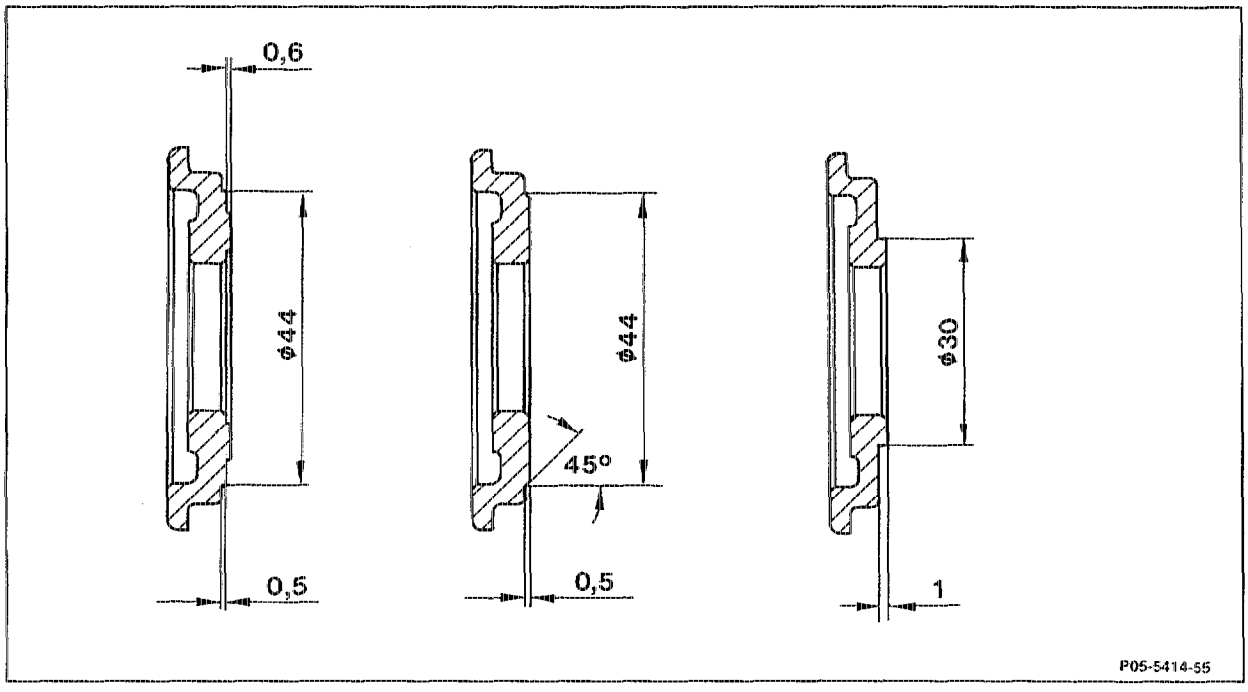


Engine 119.97 on left



Engine 119.97 on right

Cover



Engine 104.98

Engine 104.99
Engine 120

Engine 111
Engine 119
Engine 120

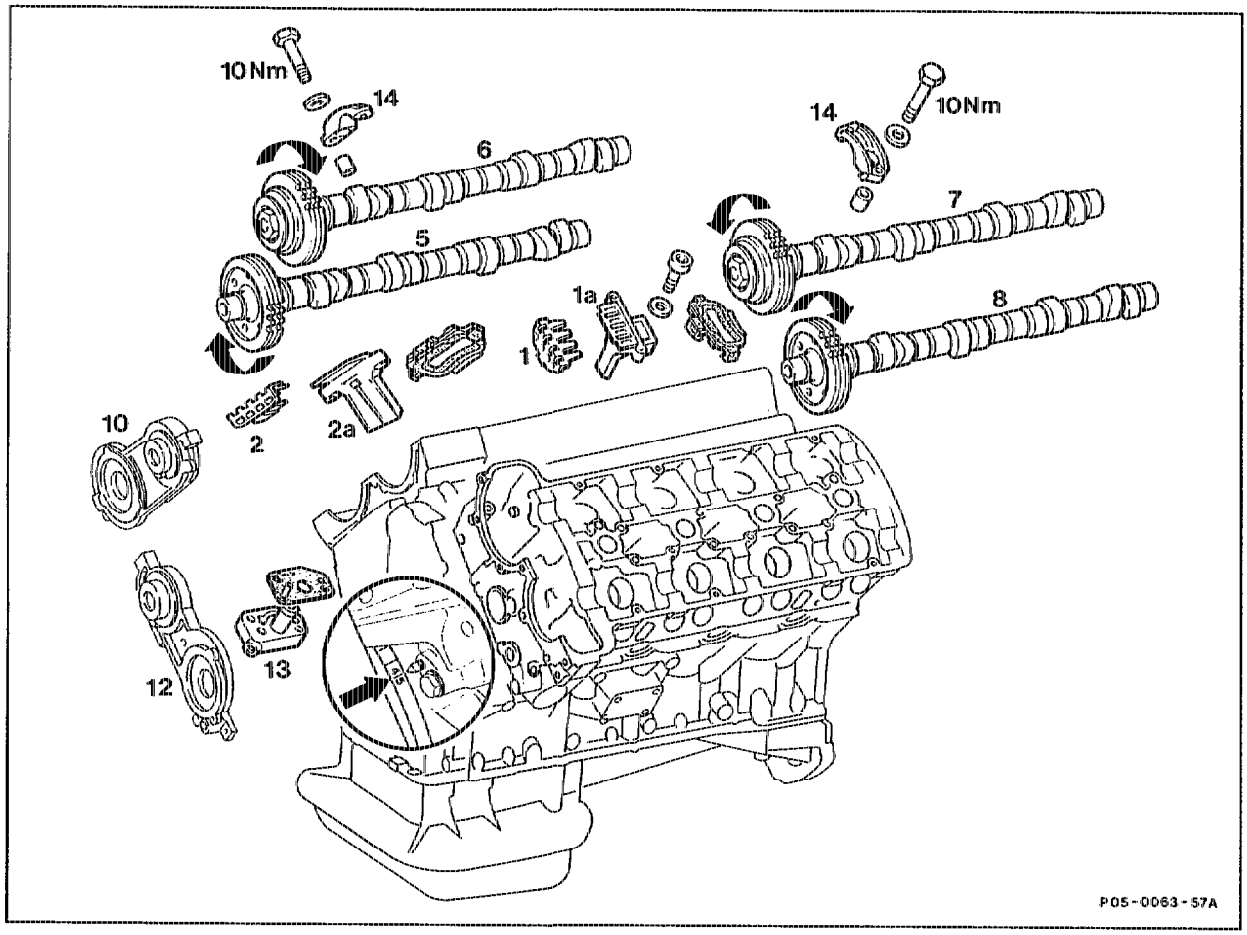
Engine	119.960 lt. and rt.	119.97 left	119.97 right	Difference
Camshaft adjuster [1]	119 050 03 47 war 119 050 01 47	119 050 06 47	119 050 07 47	Part no.
Flanged shaft (chamfer at 3 holes)	119 051 01 84 war 119 050 00 89	119 051 02 84		Oblique angle
Oblique angle	11° 20'	21° 39'		Flanged shaft and adjusting piston
Adjusting piston	119 051 02 37	119 051 04 37		Oblique angle
Oblique angle	11° 20'	21° 39'		Flanged shaft and adjusting piston
Camshaft sprocket [2]	119 050 03 49	119 050 05 49	119 051 09 28	Sensor
Cover	119 051 47 03			Dimensions
Adjusting angle °CA	20	25		--
Sensor at camshaft sprocket	1	2	0	Qty.

1) For repair measures to eliminate knocking noises from the camshaft adjuster in hot countries, camshaft adjusters with 11° 20' inclined angle are supplied for engines 119.97. Part no. right 119 050 10 47 (without sensor), left 119 050 011 47 (2 sensors)

2) The camshaft gear for engines 119.98 has a modified sensor position.

05–2200 Removing and installing camshafts

Operation no. of operation texts and work units or standard texts and flat rates
05–5521, 5541, 6292–7050



Piston of No. 1 cylinder	set to 45° before ignition TDC (arrow), (step 1).
Front covers (10 and 12) at top	remove, install (01–2120).
Camshaft timing gears	mark relative to timing chain (step 3).
Chain tensioner (13)	remove, install (05–3100).
Top slide rails (1, 1a, 2, 2a)	remove, install (05–3350).
Camshaft bearing caps (14)	mark (step 6).
Camshafts (5), (6), (7) and (8)	turn in direction of arrow with wrench (slacken), special tool 119 589 00 01 00 (step 7).

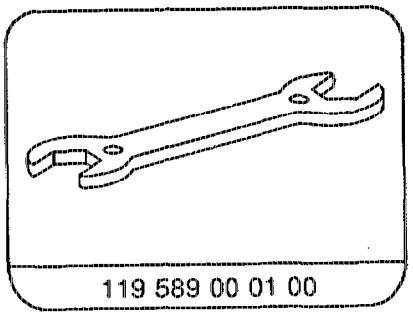
Camshaft bearing caps (14)	unscrew, take off (10 Nm) (steps 8 and 9).
Camshafts with camshaft adjuster and camshaft timing gear	take off, install. Special tool 119 589 00 05 00 (steps 9 to 20).
	⚠ Since 1993 the camshaft bearing caps are no longer fixed in position with dowel sleeves but the bearing caps are centered by means of the bearing points of the camshafts when the securing bolts are tightened to specification.
Basic setting	check (05-2230).

Tightening torques in Nm

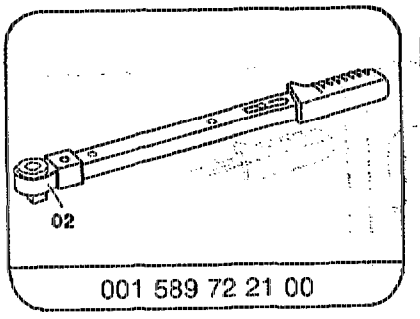
Camshaft bearing cap bolts		12
Camshaft gear to camshaft		18
Flanged shaft to camshaft Torx T40	Initial torque	20
	Tightening angle	60

1) Replace when performing repairs; use only once.

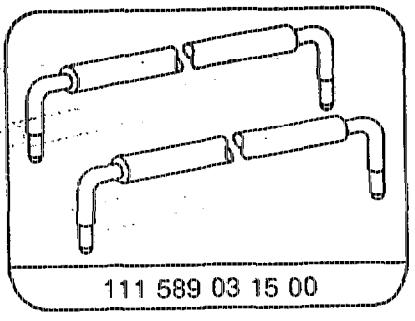
Special tools



119 589 00 01 00



001 589 72 21 00



111 589 03 15 00

Test value

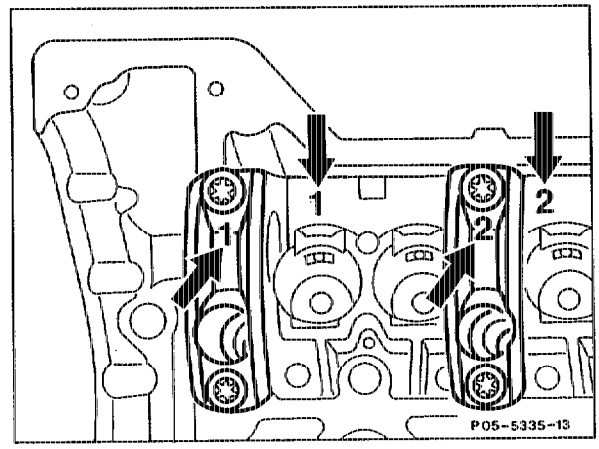
		When new
Camshaft bearing dia. in cylinder head	Standard size	28.000
		28.021
	Repair size	28.500
		28.521
Camshaft bearing dia. at camshaft	Standard size	27.960
		27.947
	Repair size	28.447
		28.460
Permissible variation in concentricity of middle bearing point and of camshaft timing gear seat when mounted in outer bearing points	Camshaft gear seat	0.02
	Bearing points 2, 3, 4	
Camshaft bearing play	Radial	0.053–0.061
	Axial	0.050–0.150

Note

The camshaft bearing caps are numbered consecutively (arrows), beginning at the right exhaust camshaft at the front.

The numbers (arrows) are cast in the cylinder heads.

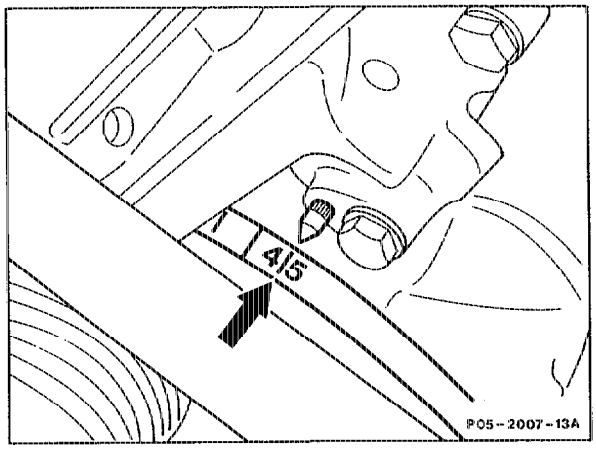
The camshaft bearing caps must be re-installed at the same point.



⚠

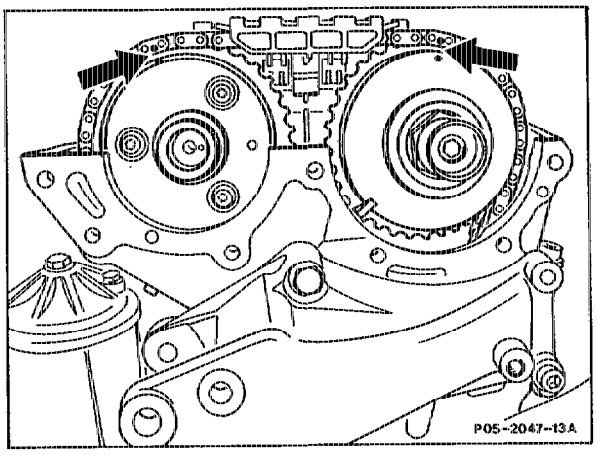
The camshafts are sensitive to fracturing and must not be twisted when removing and installing camshaft bearing caps. If a camshaft is removed, all the others must be secured with fixing pins to prevent them turning.

1 Set piston of No. 1 cylinder to 45° before TDC (arrow).



2 Remove front cover at top (01–2120).

3 Mark position of camshaft timing gears (arrows) relative to timing chain.

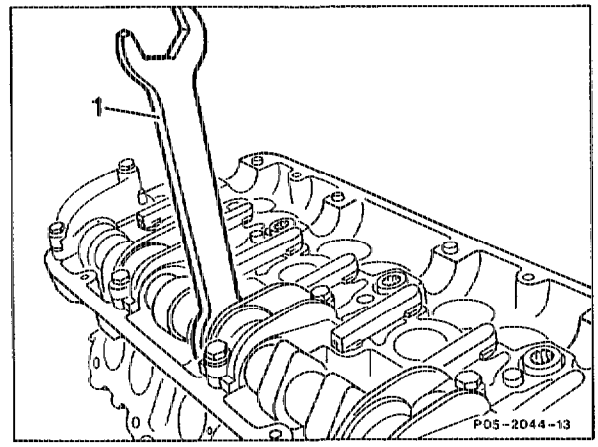


Note
If the camshaft timing gear is removed, the colour marking must be transferred to the corresponding point on the new camshaft timing gear.

4 Remove and install chain tensioner (05–3100).

5 Remove top slide rails (05–3350).

6 Lift timing chain off camshaft sprockets. Rotate camshafts with wrench 119 589 00 01 00 so that only the base circle of the cams is touching the bucket tappets in each case.



Note
The timing chain is secured on the camshaft sprocket to prevent it turning when the timing case cover is installed.

Removal note
Rotate camshafts free of tension: rotate right exhaust camshaft and right inlet camshaft approx. **6 teeth** in direction of rotation of engine.

Rotate left inlet camshaft approx. **10 teeth in opposite** direction of rotation of engine.
Rotate left exhaust camshaft approx. **14 teeth** in direction of rotation of engine.

7 Slacken camshaft bearing caps alternately so as to prevent any one-sided residual stress acting on the camshaft.

8 Take off camshaft bearing caps and camshafts together with camshaft sprockets and camshaft adjusters.

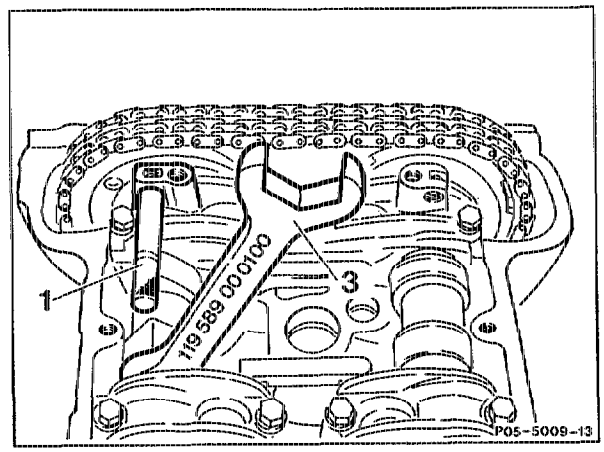
Installing
9 Oil bucket tappets and camshaft bearing points.

10 Insert left inlet and exhaust camshafts with timing chain fitted, free of tension. Pay attention to guide bearing at bearing point 3.

11 Oil bearing caps, install and tighten uniformly to 10 Nm. Camshaft must not be over-tensioned on the one side.

12 Rotate camshaft with wrench (3) 119 589 00 01 00 and check for ease of movement.

13 Rotate left exhaust camshaft into position with wrench (3). Fit timing chain onto the marking affixed previously to the exhaust camshaft sprocket and pin with pin (1), special tool 111 589 03 15 00.

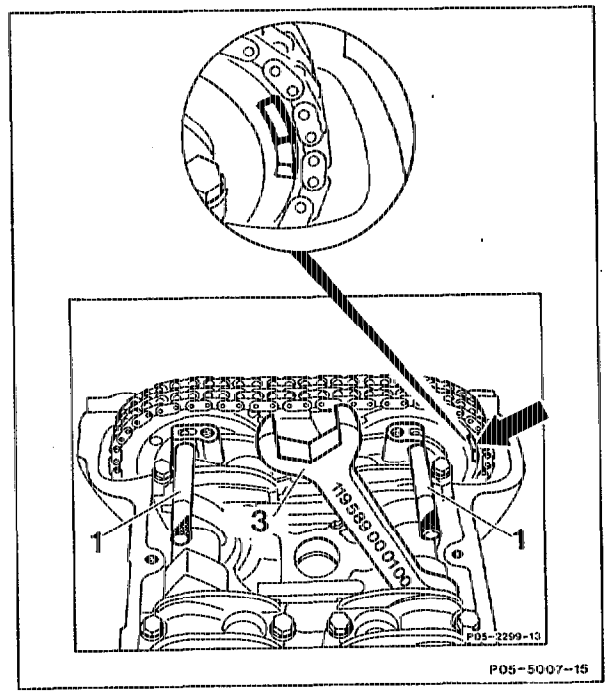


14 Rotate left inlet camshaft into position with wrench (3). Fit timing chain onto the previously affixed marking on the inlet camshaft sprocket and secure with pin (1). Camshafts in "retarded" position (arrow).

15 Insert right inlet and exhaust camshafts free of tension, with timing chain fitted. Pay attention to guide bearing at bearing point 3.

16 Oil bearing caps, install and tighten uniformly to 12 Nm. Camshaft must not be over-tensioned on the one side.

17 Rotate camshafts and check for ease of movement.



18 Rotate right inlet camshaft into position with wrench 119 589 00 01 00. Fit timing chain onto the marking affixed previously to the inlet camshaft sprocket and pin with pin 111 589 03 15 00. Camshafts in "retarded" position (arrow).

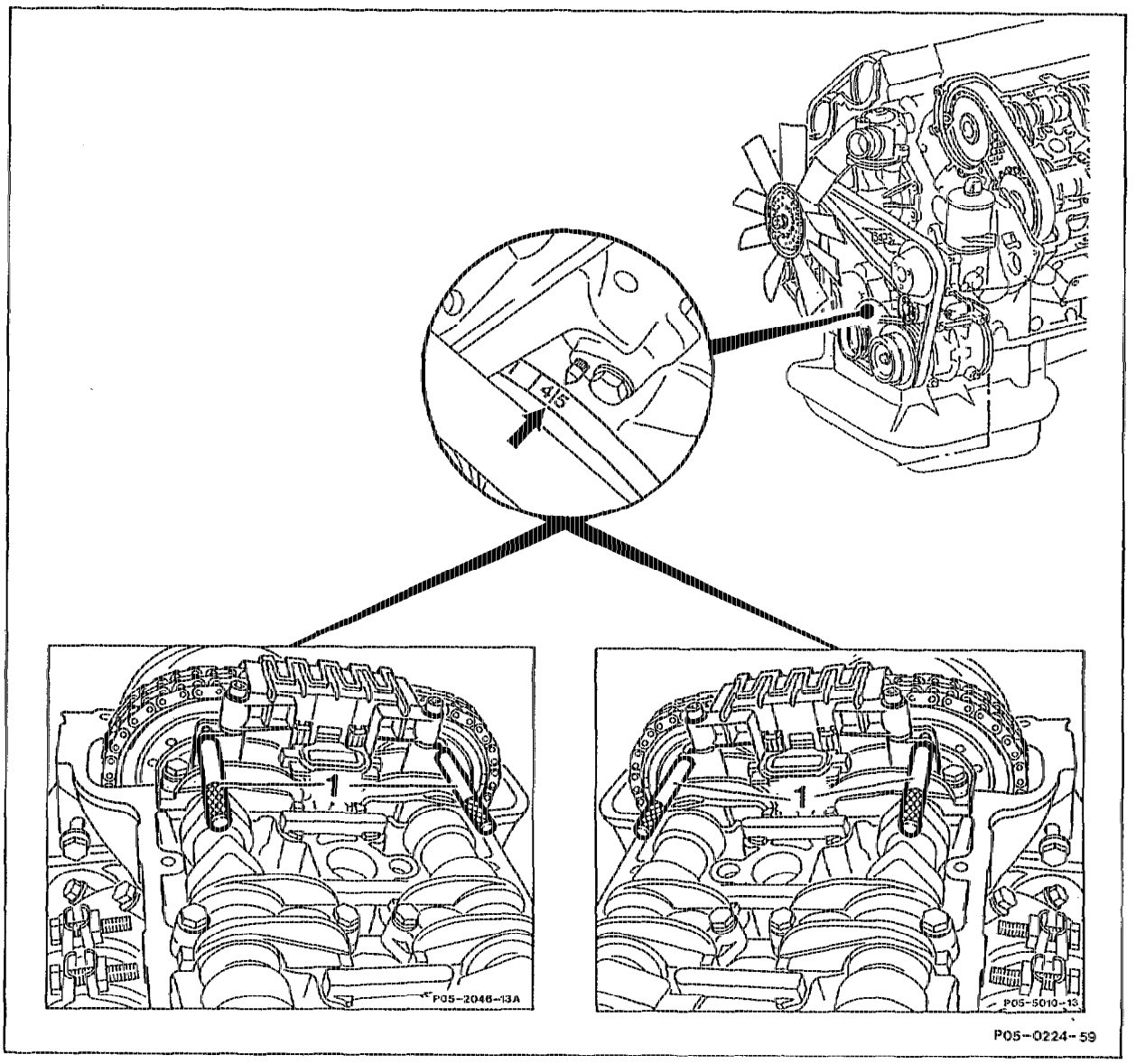
19 Rotate right exhaust camshaft into position with wrench 119 589 00 01 00. Fit timing chain onto the marking affixed previously to the exhaust camshaft sprocket and pin with pin 111 589 03 15 00.

20 Install in reverse order, beginning with step 5.

21 Check basic setting (05-2230).

05–2230 Checking, adjusting basic setting of camshafts

Preceding work:
Cylinder head covers removed (01–0500)



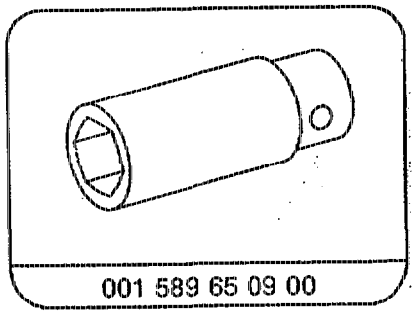
Checking

Engine	rotate to 45° before ignition TDC with socket wrench, special tool 001 589 65 09 00 (step 1).
It must be possible to pin the camshafts with the pins (1)	special tool 111 589 03 15 00 (step 2).

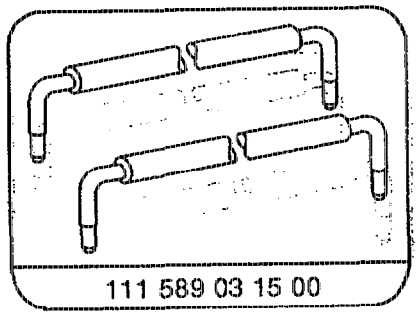
Adjusting (at 45° before TDC)

Guide rails (2)	remove, install (05-3350).
Chain tensioner	remove, install (05-3100).
Camshafts, beginning at right exhaust camshaft	rotate with wrench in direction of rotation of engine, special tool 111 589 01 01 00 (step 5).
Camshafts, beginning at left exhaust camshaft	rotate into position with wrench, special tool 111 589 03 15 00 (step 6).
Timing chain	fit on.
Camshafts	pin with pins (1), beginning at left exhaust camshaft, special tool 111 589 03 15 00 (steps 6 to 9).

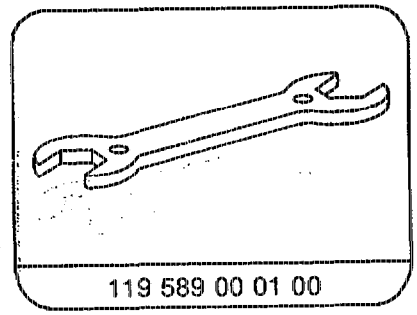
Special tools



001 589 65 09 00



111 589 03 15 00



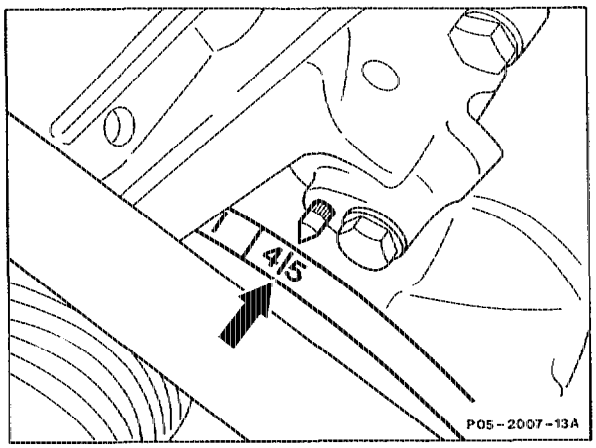
119 589 00 01 00

Note

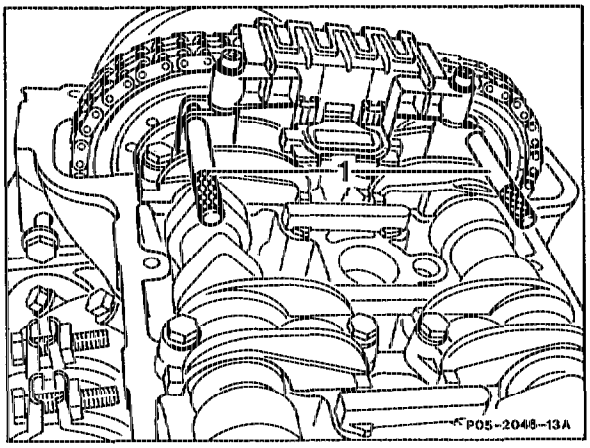
The 45° before TDC marking on the vibration damper is an assembly marking. The camshafts can be rotated in this position with the wrench 119 589 00 01 00 without the valves coming into contact with the piston.

Checking

1 Position engine to 45° before ignition TDC at No. 1 cylinder by cranking engine at crankshaft in direction of rotation of engine using special tool 001 589 65 09 00.



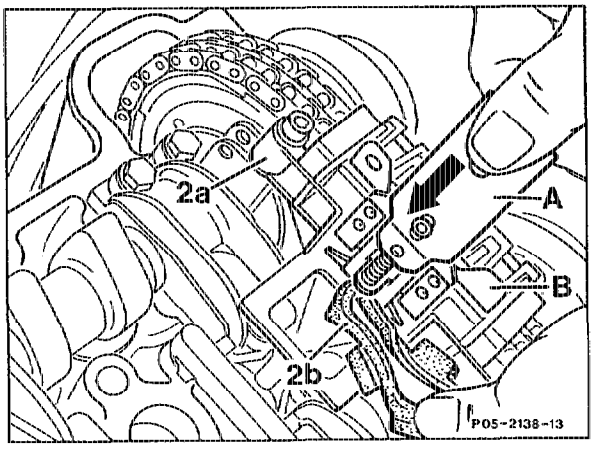
2 It must be possible to pin all 4 camshafts with the pins (1), special tool 111 589 03 15 00, through the 6.5 mm dia. holes in the first camshaft bearing caps.



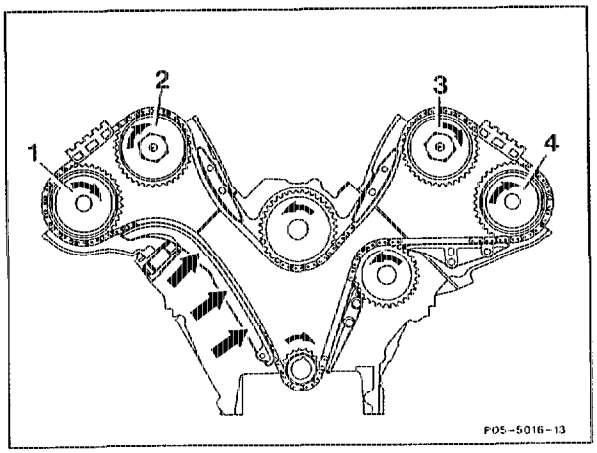
Adjusting (at 45° before TDC)

3 Remove, install top slide rail (2a) (05-3350).

4 Remove, install chain tensioner (05-3100).

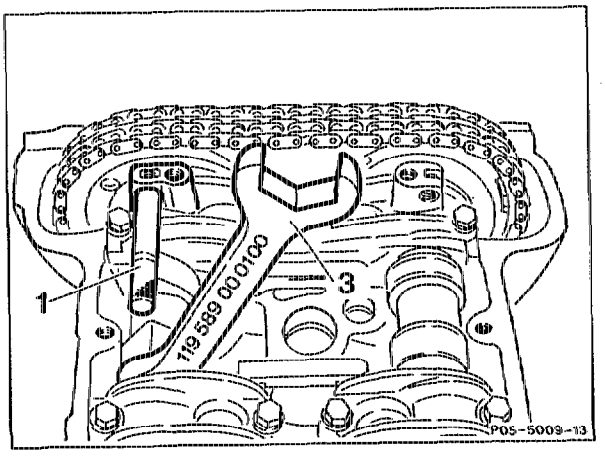


5 Rotate camshafts in direction of rotation of engine with wrench, special tool 119 589 00 01 00, beginning at right exhaust camshaft (1).
To make it possible to start the adjustment at the left-hand exhaust camshaft (4), the slack section (arrows) of the timing chain (at chain tensioner) must be transferred by rotating the camshafts (1, 2, and 3).

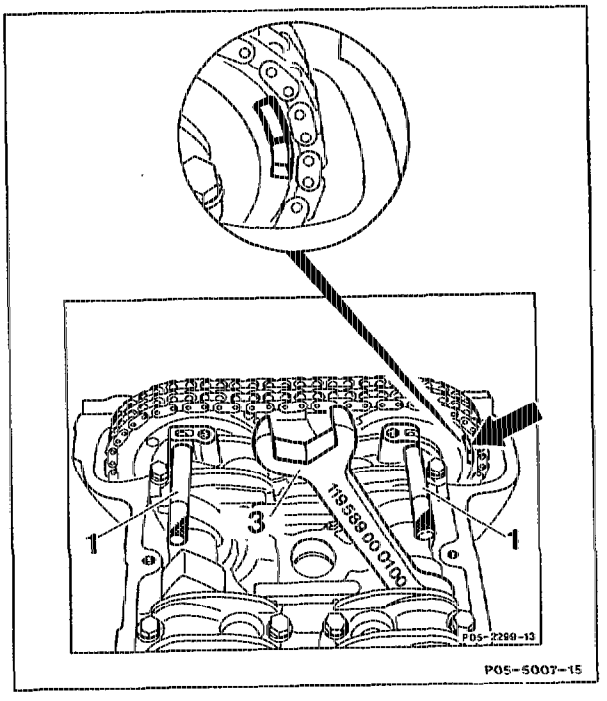


Engine 119.960

6 Rotate left-hand exhaust camshaft into position with wrench (3) 119 589 00 01 00.
Fit timing chain onto exhaust camshaft timing gear and pin with pin (1) 111 589 03 15 00.



7 Rotate left-hand inlet camshaft into position with wrench (3). Fit timing chain onto inlet camshaft timing gear and pin with pin (1).
Camshafts in "retarded" position (arrow).



8 Rotate right-hand inlet camshaft into position with wrench 119 589 00 01 00.
Fit timing chain onto inlet camshaft timing gear and pin with pin 111 589 03 15 00.
Camshafts in "retarded" position (arrow).

9 Rotate right-hand exhaust camshaft into position with wrench 119 589 00 01 00.
Fit timing chain onto exhaust camshaft timing gear and pin with pin 111 589 03 15 00.

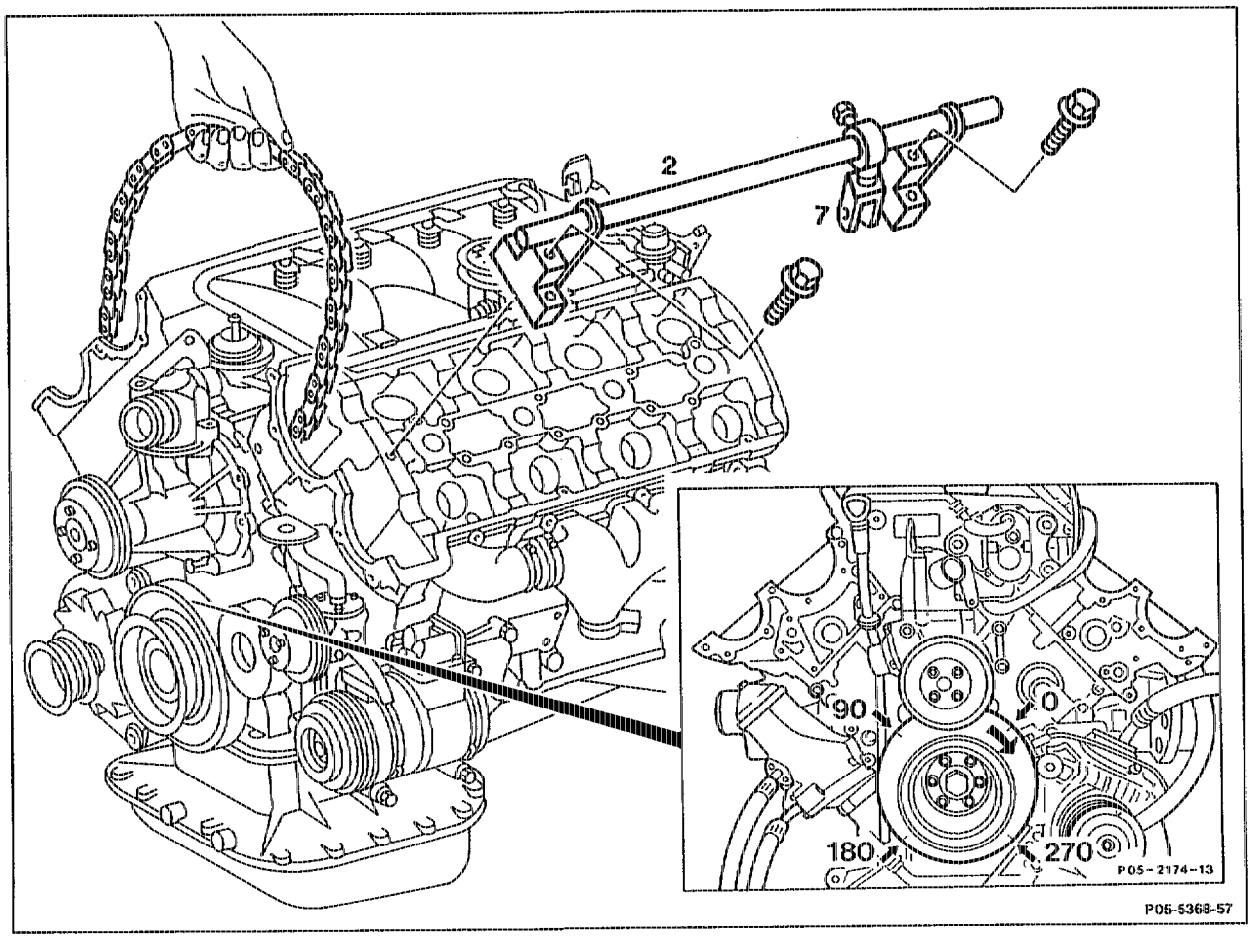
Installation is performed in the reverse order, beginning from step 4.

05–2500 Removing and installing valve springs

Preceding work:
Camshafts removed (05–2200).
Spark plugs removed (15–1031).

Operation no. of operation texts and work units or standard texts and flat rates
05–3500

A. Models 124, 129, 140



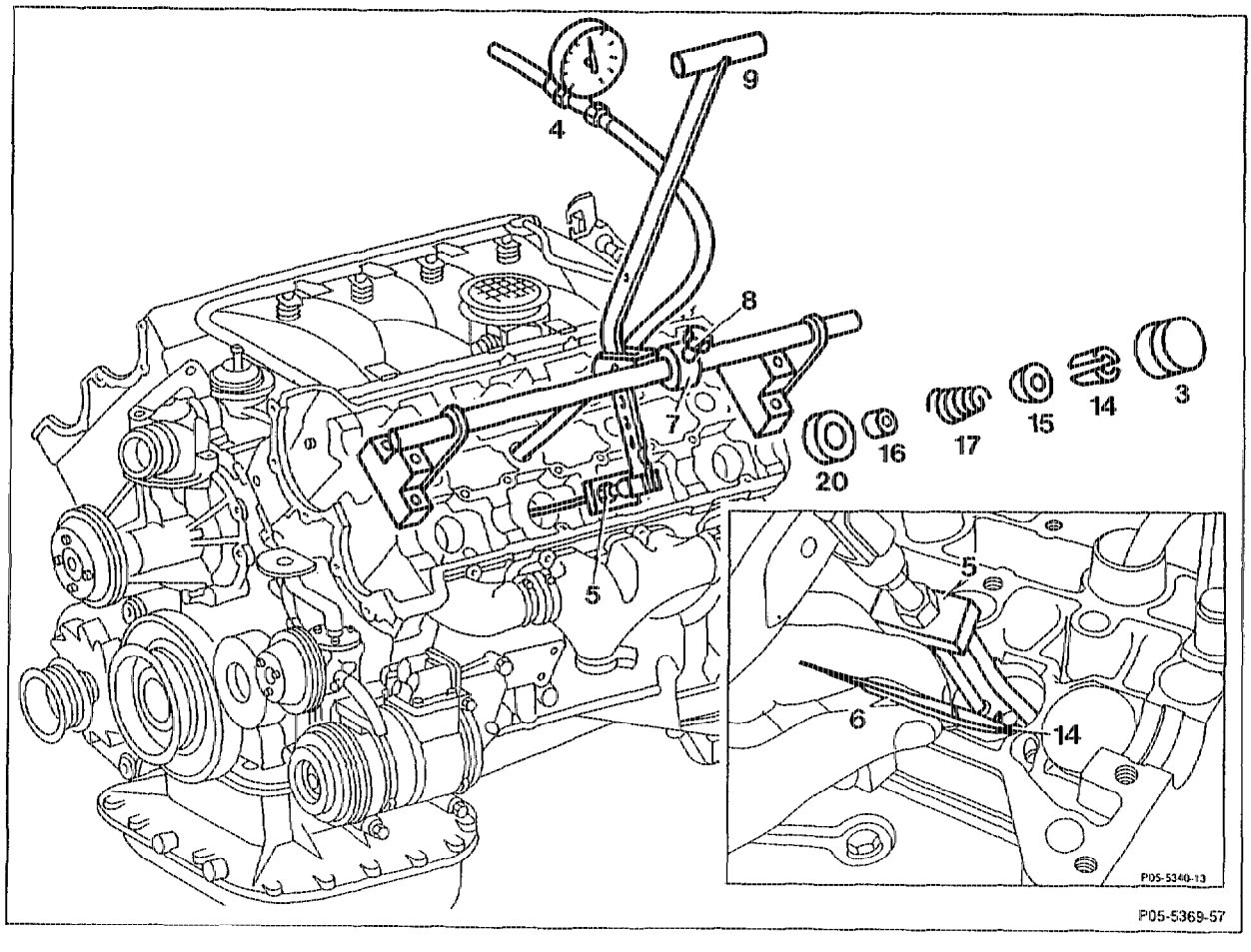
Right cylinder head: engine wiring harness	disconnect, connect.
Supporting bar (2) with slide (7)	attach off-center (facing toward outside of vehicle) to relevant cylinder head, take off, special tool 111 589 01 59 00.
Supporting bar (2)	bolt on with two M7×35 bolts (bolts of camshaft bearing caps), unbolt.

Timing chain . . . . . raise and turn piston of cylinder to be machined with wrench socket to TDC.

⚠

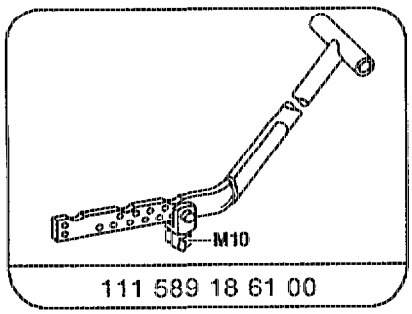
If turning at the crankshaft, ensure that the starting position is restored so that the coloured markings affixed to the timing chain can be re-used for setting the timing of the camshafts. The respective piston is in the TDC position if the marking numbers on the vibration damper, shown in the drawing above, are aligned with the TDC pointer.

Marking number	Piston in TDC
0	1 and 6
90	5 and 3
180	4 and 7
270	8 and 2

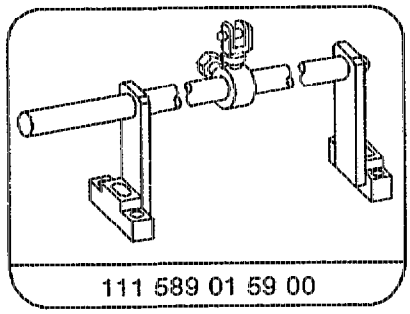


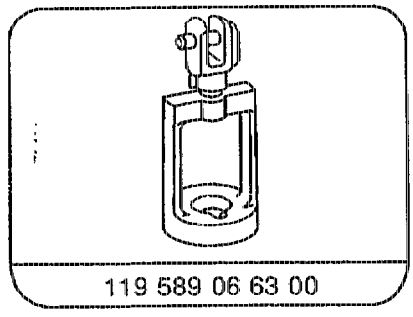
Bucket tappet (3) of relevant cylinder	remove, install (05–2110).
Connection hose (4) of cylinder leak tester	screw into spark plug hole.
Crankshaft	fix in position with retaining lock to prevent it rotating (03–5000).
Compression chamber	pressurise.
Lever presser (9) with thrust piece (5)	insert into slide (7), special tools 111 589 18 61 00 and 119 589 06 63 00.
Thrust piece (5)	attach to valve spring retainer (15) vertically.
Slide (7)	fix in position with bolt (8).
Valve spring (17)	compress.
	⚠ Valves must not touch the piston crown otherwise they will be bent.
Valve collets (14)	remove with tweezers (6) or magnetic finger, install, special tool 116 589 06 63 00.
	Installation note Coat valve spring retainer (15) for fixing valve collets (14) with grease.
Valve spring retainer (15) with valve spring (17)	remove, install.
Valve stem seal (19)	replace (05–2700).
Bottom valve spring retainer (20)	remove and examine for scoring, install.

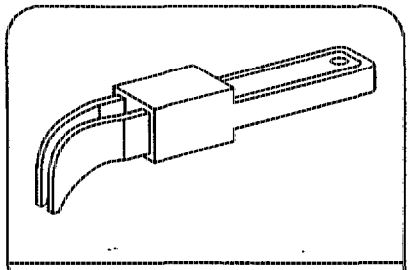
Special tools



111 589 18 61 00


111 589 01 59 00


119 589 06 63 00



116 589 06 63 00

Commercially available tools

Cylinder leak tester	e. g.	Bosch E F A W 210 A Sun, CLT 228
Rubber suction cup ∅ 30 mm	e. g.	Hazet Nr. 735-2
Straight tweezers 160 mm with rounded tips	e. g.	Stahlwille D-42331 Wuppertal 12

Note

Valve springs, upper and lower valve spring retainers with scoring must be replaced. The valve springs of the inlet and exhaust valves are identical.

As of 01/1993 conical-shaped valve springs are installed together with modified valve spring retainers and lighter bucket tappets. The inner valve spring is no longer fitted.

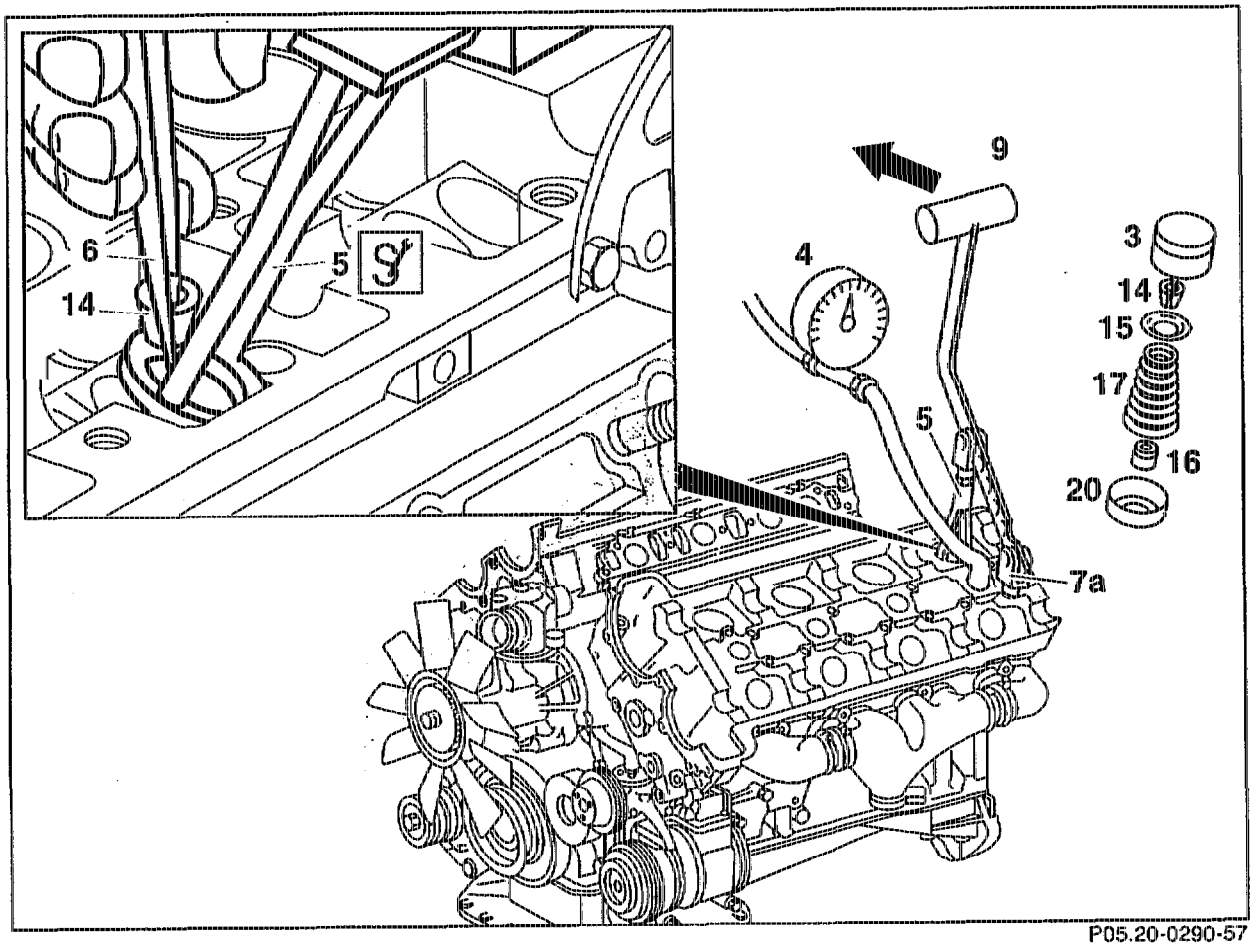
Conical-shaped valve springs

	Valve spring wire dia. (round)	Valve spring wire dia. (oval)
Engine 119.971/975	3.5 mm	–
Engine 119.970/972/974	–	3.4 – 4.2 mm

Preceding work:
Camshafts removed (05–2200).
Spark plugs removed (15–1031).

Operation no. of operation texts and work units or standard texts and flat rates
05–3500

B. Model 210



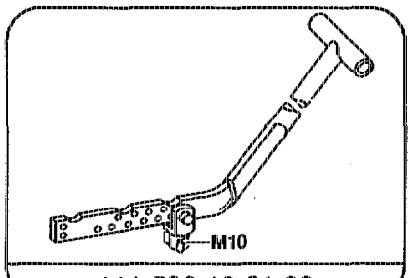
P05.20-0290-57

Lift up timing chain and rotate piston of cylinder to be machined to TDC with wrench bit . . . . . see table for piston in TDC.

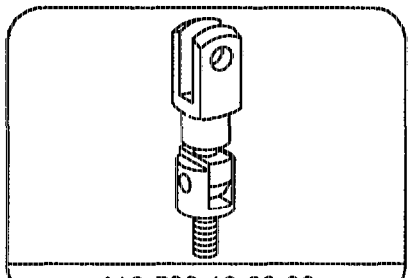
Marking index	Piston in TDC
0	1 and 6
90	5 and 3
180	4 and 7
270	8 and 2

Bucket tappet (3) of the relevant cylinder	remove, install (05–2110).
Connection hose (4) of cylinder leak tester	screw into spark plug hole.
Crankshaft	fix in position with retaining lock to prevent it turning (03–5000).
Compression chamber	pressurize.
Hinged clevis (7a)	insert into appropriate hole of the camshaft bearing cap in cylinder head.
Lever depresser (9)	attach with thrust piece (5) to hinged clevis (7a) in the appropriate hole, special tools 111 589 18 61 00 , 119 589 10 63 00 and 119 589 06 63 00.
Thrust piece (5)	position vertically onto valve spring retainer (15).
Valve spring (17)	compress.
	⚠ The valves must not strike the piston crown otherwise they will be bent.
Valve collets (14)	remove, install with tweezers (6), magnetic finger, special tool 116 589 06 63 00
	Installation note Coat valve spring retainer (15) with grease for fixing the collets (14) in position.
Valve spring retainer (15) together with valve spring (17)	remove, install.
Valve stem seal (19)	replace (05–2700).
Bottom valve spring retainer (20)	remove and inspect for pitting, install.

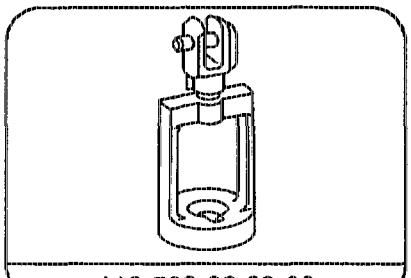
Special tools



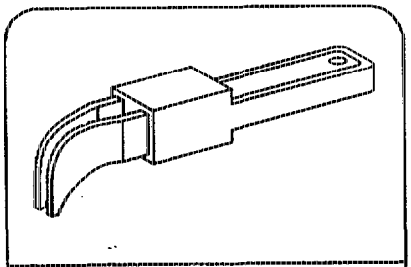
111 589 18 61 00



119 589 10 63 00



119 589 06 63 00



116 589 06 63 00

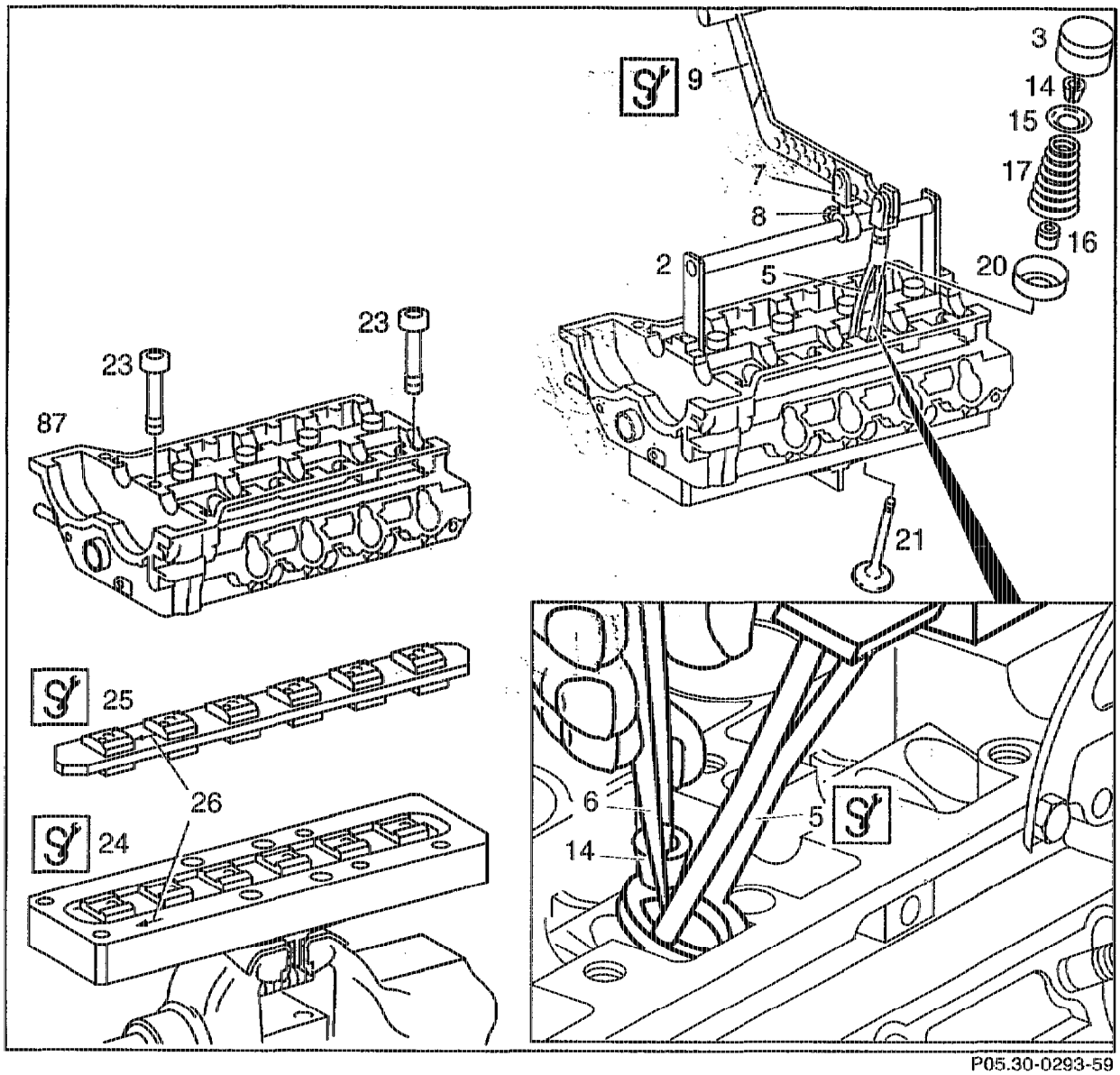
Commercially available tools

Cylinder leak tester	e. g.	Bosch E F A W 210 A Sun, CLT 228
Rubber suction cup ∅ 30 mm	e. g.	Hazet Nr. 735-2
Straight tweezers 160 mm with rounded tips	e. g.	Stahlwille D-42331 Wuppertal 12

05–2550 Removing and installing valves

Preceding work:
Camshafts removed (05-2200).
Cylinder head removed (01-4150).

Operation no. of operation texts and work units or standard texts and flat rates
05–3500



P05.30-0293-59

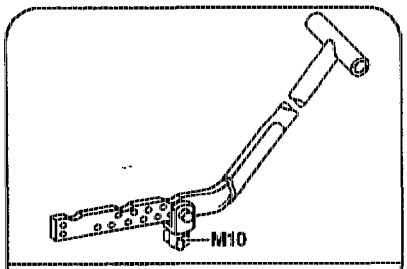
Cylinder head (87) . . . . . place on assembly base (24), special tool 111 589 02 59 00.

Note

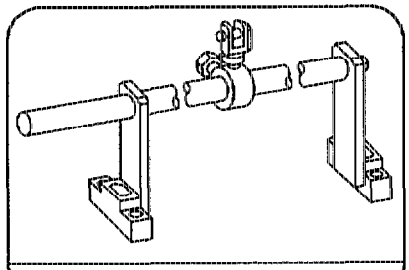
Place insert (25) 111 589 02 59 09 into assembly base (24) with the direction of travel arrow (26) facing forward and with the appropriate side.

Cylinder head (87)	bolt on to assembly base (24). **Note** Bolt cylinder head (87) onto the assembly base (24) with a cyllinder head bolt (23) at the front and rear and with its front end facing toward the direction of travel arrow (26). The cylinder head (87) can be installed with the exhaust manifold.
Supporting bar (2) with slide (7)	fit onto the relevant cylinder head off-centered, take off, special tool 111 589 01 59 00.
Supporting bar (2)	bolt on with two M7×35 bolts (camshaft bearing cap bolts), unbolt.
Bucket tappet (3) of the relevant cylinder	remove, install (05–2110).
Lever depresser (9) with thrust piece (5)	attach to slide (7), special tools 111 589 18 61 00 and 111 589 25 63 00.
Thrust piece (5)	attach vertically to valve spring retainer (15).
Slide (7)	fix in position with bolt (8).
Valve spring (17)	compress.
Valve collets (14)	remove, install with tweezers (6), magnetic finger, special tool 116 589 06 63 00. **Installation note** Coat valve spring retainer (15) with grease in order to fix collets (14) in position.
Valve spring retainer (15) together with valve spring (17)	remove, install.
Valve stem seal (19)	replace (05–2700).
Bottom valve spring retainer (20)	remove and inspect for pitting, install.
Cylinder head (87)	remove from assembly base (24), remove valves (21).

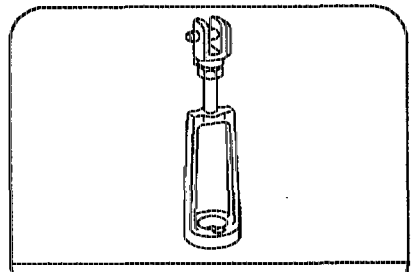
Special tools



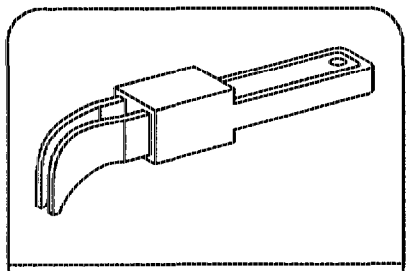
111 589 18 61 00



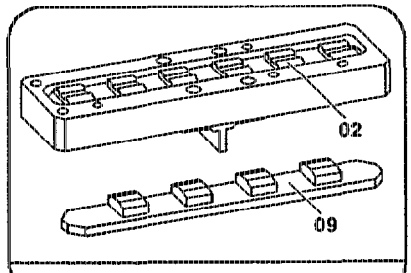
111 589 01 59 00



111 589 25 63 00



116 589 06 63 00



111 589 02 59 00

Commercially available tools

Cylinder leak tester	e.g.	Bosch E F A W 210 A Sun, CLT 228
Rubber suction cup ∅ 30 mm	e.g.	Hazet Nr. 735-2
Straight tweezers 160 mm with rounded tips	e.g.	Stahlwille D-42331 Wuppertal 12

Note

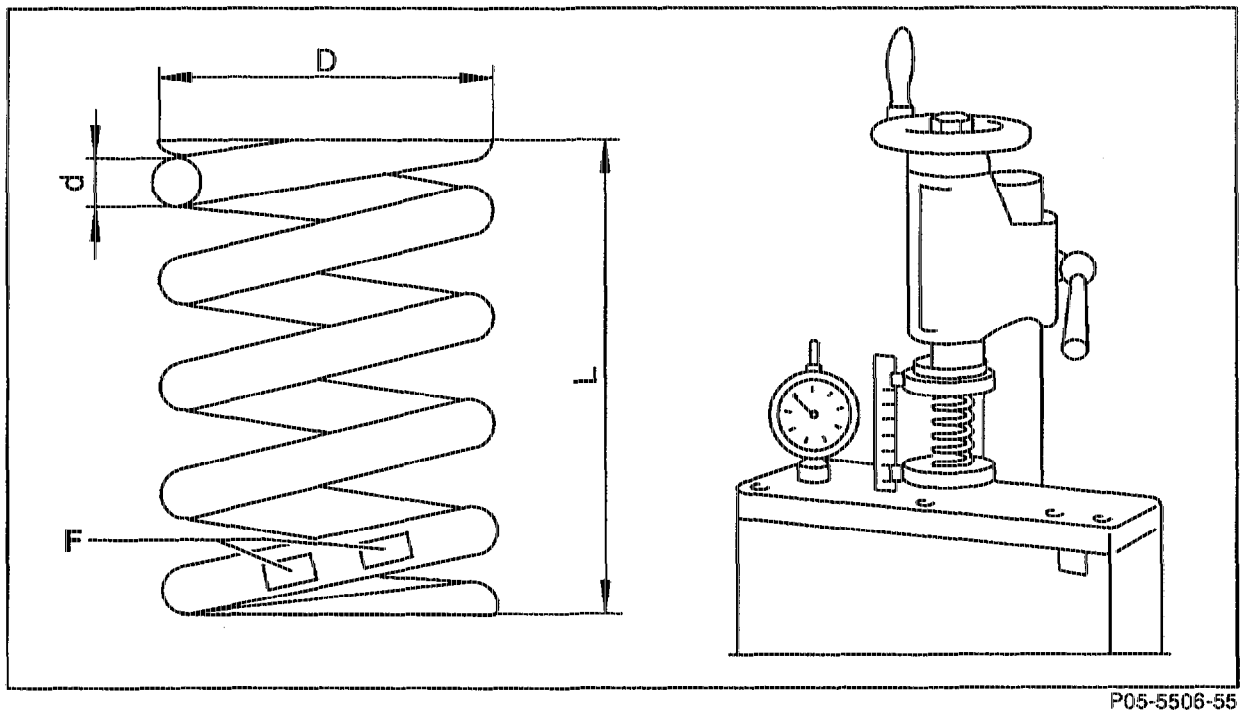
Valve springs, top and bottom valve spring retainers with pitting must be replaced. The valve springs of the inlet and exhaust valves are identical.

As of 01/1993 conical-shaped valve springs have been installed together with modified valve spring retainers and weight-optimized bucket tappets. The inner valve spring is eliminated.

05–2600 Inspecting valve springs

Preceding work:
Valve springs removed (05-2500)

Operation no. of operation texts and work units or standard texts and flat rates



P05-5506-55

Valve springs ..... clean.

⚠

Replace valve springs which are not to dimensional tolerance, are corroded, have surface rust, mechanical damage or worn at the ends.

Color coding on valve springs ..... check, match, see table.

Spring force ..... measure at pretensioned length.
If the valve springs do not achieve the specified spring force, they cause a loss of frictional connection at high engine speeds and should be replaced.

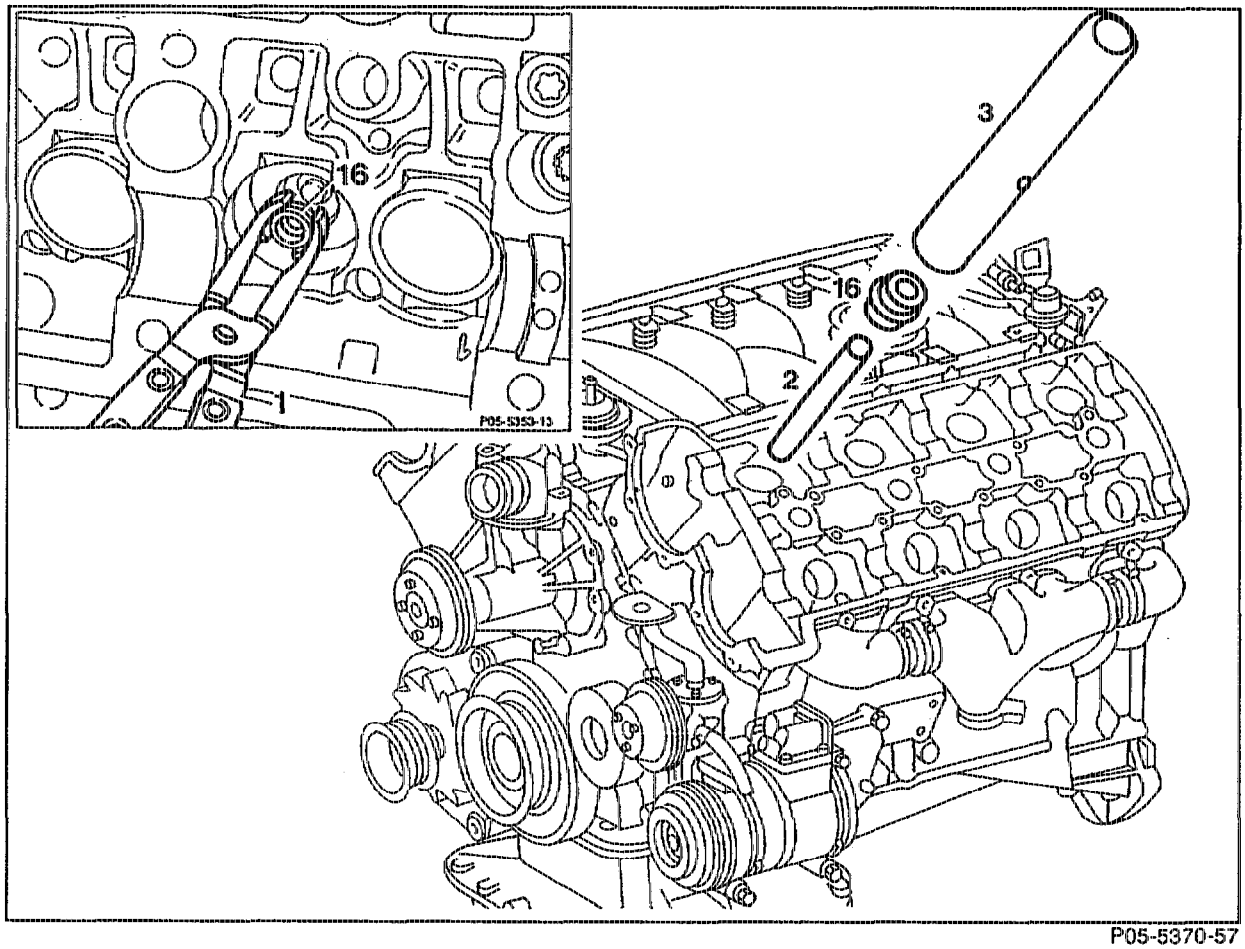
Data for M119

	Valve spring part no.	Color coding (F)	Outer ∅ (D) mm	Wire ∅ (d) mm	Length untensioned (L) mm	Length L1 and L2 initially tensioned spring force in N	
						L1 / N	L2 / N
1st version cylindrical-shaped	119 053 01 20 (outer)	yellow/blue	29.6	3.9	40	33 / 225	23 / 575
1st version cylindrical-shaped	119 053 01 22 (inner)	yellow/blue	20.7	2.4	41.6	30 / 100	20 / 205
2nd version conical-shaped	119 053 02 20	purple or yellow/blue	24.42 30.22	oval	40.8	33 / 250	23.5 / 630
2nd version conical-shaped	119 053 08 20	purple/ blue	23.40 29.20	3.7	40.1	33 / 250	24.1 / 600
2nd version conical-shaped	119 053 04 20	purple or yellow/red	23.76 29.56	oval	41.9	33 / 210	24.5 / 465
2nd version conical-shaped	119 053 09 20	yellow/ green	23.00 28.80	3.5	41.7	33 / 220	24.5 / 475
2nd version conical-shaped	119 053 07 20	purple/ white	22.80 28.60	3.4	41.9	33 / 210	24.5 / 465

05–2700 Replacing valve stem seals

Preceding work:
Valve springs removed (05–2500).

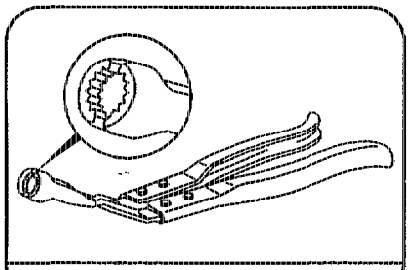
Operation no. of operation texts and work units or standard texts and flat rates
05–3510



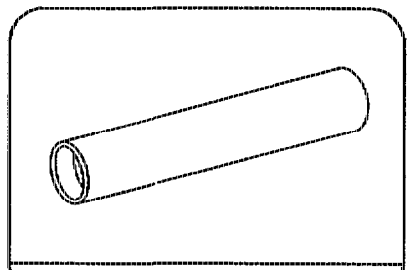
P05-5370-57

Valve stem seals (16)	remove with pliers (1) 104 589 00 37 00.
Valve stems	debur, if necessary.
Protective sleeve (2)	fit onto valve stem, remove.
Valve stem seals (16)	oil.
Valve stem seals (16)	press on by hand with the assembly drift (3). Assembly drift 104 589 01 43 00 (dia. 8 and 9 mm) Assembly drift 119 589 00 43 00 (dia. 7 mm)

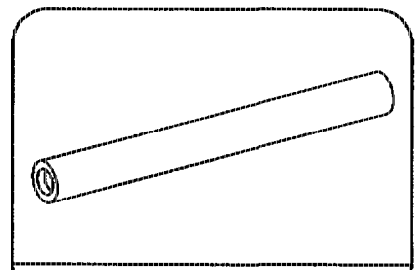
Special tools



606 589 00 37 00



104 589 01 43 00



119 589 00 43 00

Note
Valve stems and assembly sleeves are supplied as a repair kit.

Valve guides which are worn at the retaining groove for the valve stem seals and valves with damaged valve ends or valve stem must be replaced.
Valve stem seals with bent metal shell must be replaced.

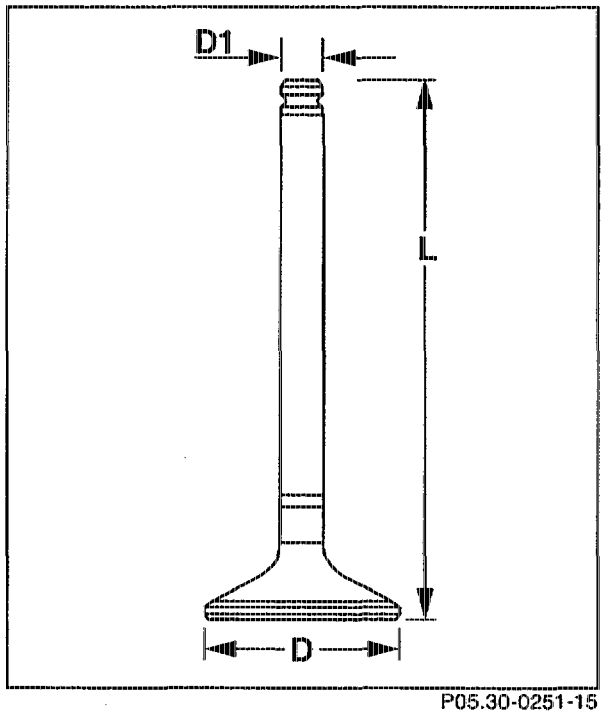
Distinguishing features of valve stem seals

Engine	Engine No.	Identification Part No.	Valve stem dia. Inlet	Exhaust	Assembly drift (special tool)
119.96 (1st version)	up to 011 930	104 053 02 58 104 053 01 58	8 mm –	– 9 mm	104 589 01 43 00
119.96 (2nd version)	as of 011 931	000 053 42 58 or 000 053 43 58	7 mm	7 mm	119 589 00 43 00
119.97	as of start of series production				

05–2800 Inspecting and machining valves

Preceding work:
Cylinder head removed (01–4150).
Valve springs removed (05–2500).
Valves removed

Operation no. of operation texts and work units or standard texts and flat rates 05–4201



P05.30-0251-15

Valves	clean, inspect visually.
Valve stem	inspect for runout (max. 0.03 mm).
Valve seat	inspect for runout (max. 0.05 mm), grind.
Dimensions and angle	inspect (table).

Data

Engine		up to 119.960 12 011 930		as of 119.960 12 011 931	
		Inlet valve	Exh. valve	Inlet valve	Exh. valve
Valve disc Ø (D)		37.90 38.10	32.90 33.10	37.90 38.10	32.90 33.10
Height (h) of valve disc	when new	1.15–1.45	1.55–1.65	1.15–1.45	1.4–1.7
	limit val.	1.05	1.3	1.05	1.3
Setting angle (α) for machining valve		45° + 15'	45° + 15'	45° + 15'	45° + 15'
Valve stem Ø (D 1)		7.970 7.955	8.960 8.938	6.975 6.960	6.970 6.950
Sodium filling		without	with	without	with
Valve length (L)		95.8	102.6	95.8	102.6
Width of valve seat		min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0
Maximum permissible runout at valve stem and valve seat		0.05	0.05	0.05	0.05
Grooves for wedges on stem		1	1	3	3

Daten

Engine		up to 119.970 12 049 738 up to 119.972 12 010 751 up to 119.974 12 009 281		as of 119.970 12 049 739 as of 119.972 12 010 752 as of 119.974 12 009 282	
		Inlet valve	Exh. valve	Inlet valve	Exh. valve
Valve disc Ø (D)		37.90 38.10	32.90 33.10	37.90 38.10	32.90 33.10
Height (h) of valve disc	when new	1.15–1.45	1.4–1.7	1.05–1.35	1.4–1.7
	limit val.	1.05	1.3	0.95	1.3
Setting angle (α) for machining valve		45° + 15'	45° + 15'	45° + 15'	45° + 15'
Valve stem Ø (D 1)		6.975 6.960	6.970 6.950	6.970 6.950	6.970 6.950
Sodium filling		without	with	without	with
Valve length (L)		95.8	102.6	95.7	102.6
Width of valve seat		min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0
Maximum permissible runout at valve stem and valve seat		0.05	0.05	0.05	0.05
Grooves for wedges on stem		3	3	1	1

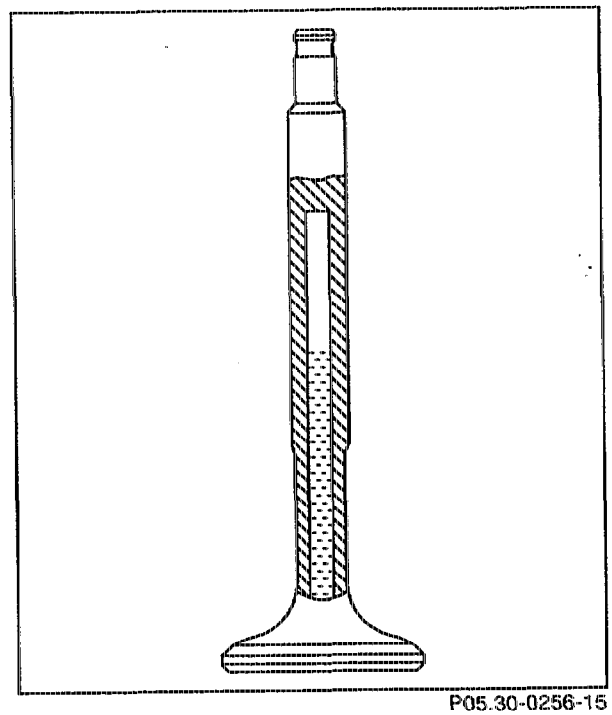
Data

Engine		up to 119.971 12 023 158 up to 119.975 12 018 412		as of 119.971 12 023 159 as of 119.975 12 018 413 as of 119.98 start of prod.	
		Inlet valve	Exh. valve	Inlet valve	Exh. valve
Valve disc Ø (D)		34.90 35.10	32.90 33.10	34.90 35.10	32.90 33.10
Height (h) of valve disc	when new	1.15–1.45	1.4–1.7	1.05–1.35	1.4–1.7
	limit val.	1.05	1.3	0.95	1.3
Setting angle (α) for machining valve		45° + 15'	45° + 15'	45° + 15'	45° + 15'
Valve stem Ø (D 1)		6.975 6.960	6.970 6.950	6.970 6.950	6.970 6.950
Sodium filling		wihtout	with	wihtout	with
Valve length (L)		95.8	102.6	95.8	102.6
Width of valve seat		min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0	min. 1.4 max. 2.0
Maximum permissible runout at valve stem and valve seat		0.05	0.05	0.05	0.05
Grooves for wedges on stem		3	3	1	1

Note
The stem of the exhaust valve is filled with sodium.

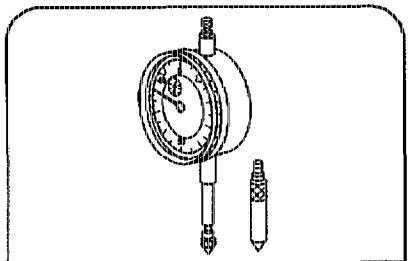
⚠
Unusable valves filled with sodium should be neutralized before scrapping. They should therefore be gathered by the relevant workshop sector foreman and returned to:

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


P05.30-0256-15

Exhaust valve

Special tools


001 589 53 21 00

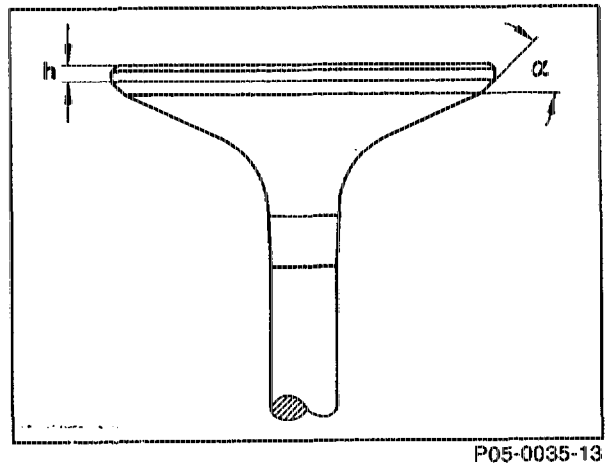
Commercially available tools and testers

Designation	e. g. make	Order no.
Valve cone grinding machine or valve cone turning tool	Hunger, D–81375 München Gräflingerstr. 146	Type VKM 1 A Order no. 231 00 001

Inspecting and machining

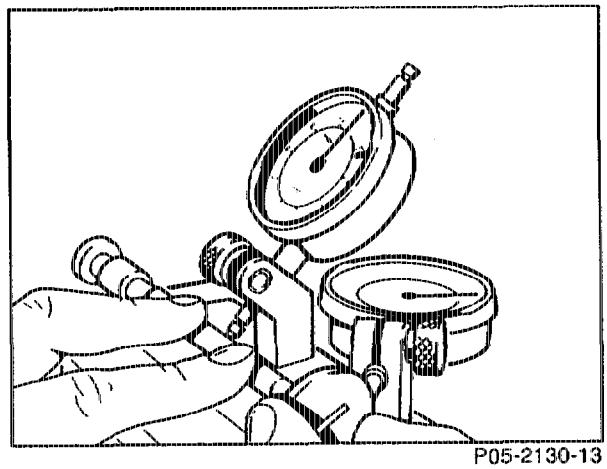
1 Clean valves and conduct a visual inspection.

Valves with scorched valve disc, insufficient height (h) of valve disc or with worn or scored valve stem should be replaced.



P05-0035-13

2 Measure runout at valve stem. If a runout of more than 0.03 mm is measured, replace valve.

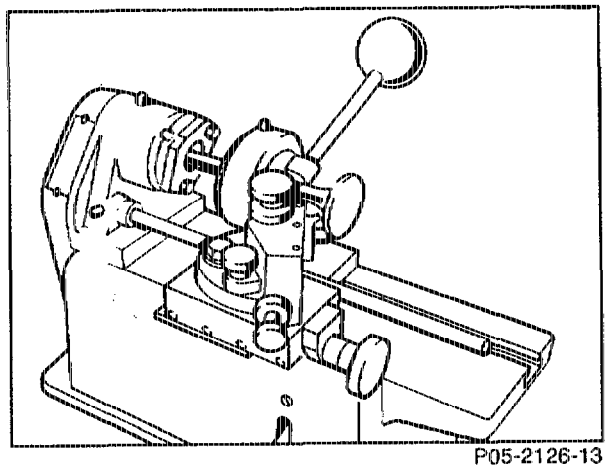

P05-2130-13

3 Machine valve seat.

Pay attention to operating instructions of machining equipment and setting angle (α) 45° + 15'.

⚠

If conducting facing work on cylinder head and re-setting of valve seats, always replace valves. The valve seats of valves as of model designation M119.98 must not be remachined; these should be replaced when performing repairs.

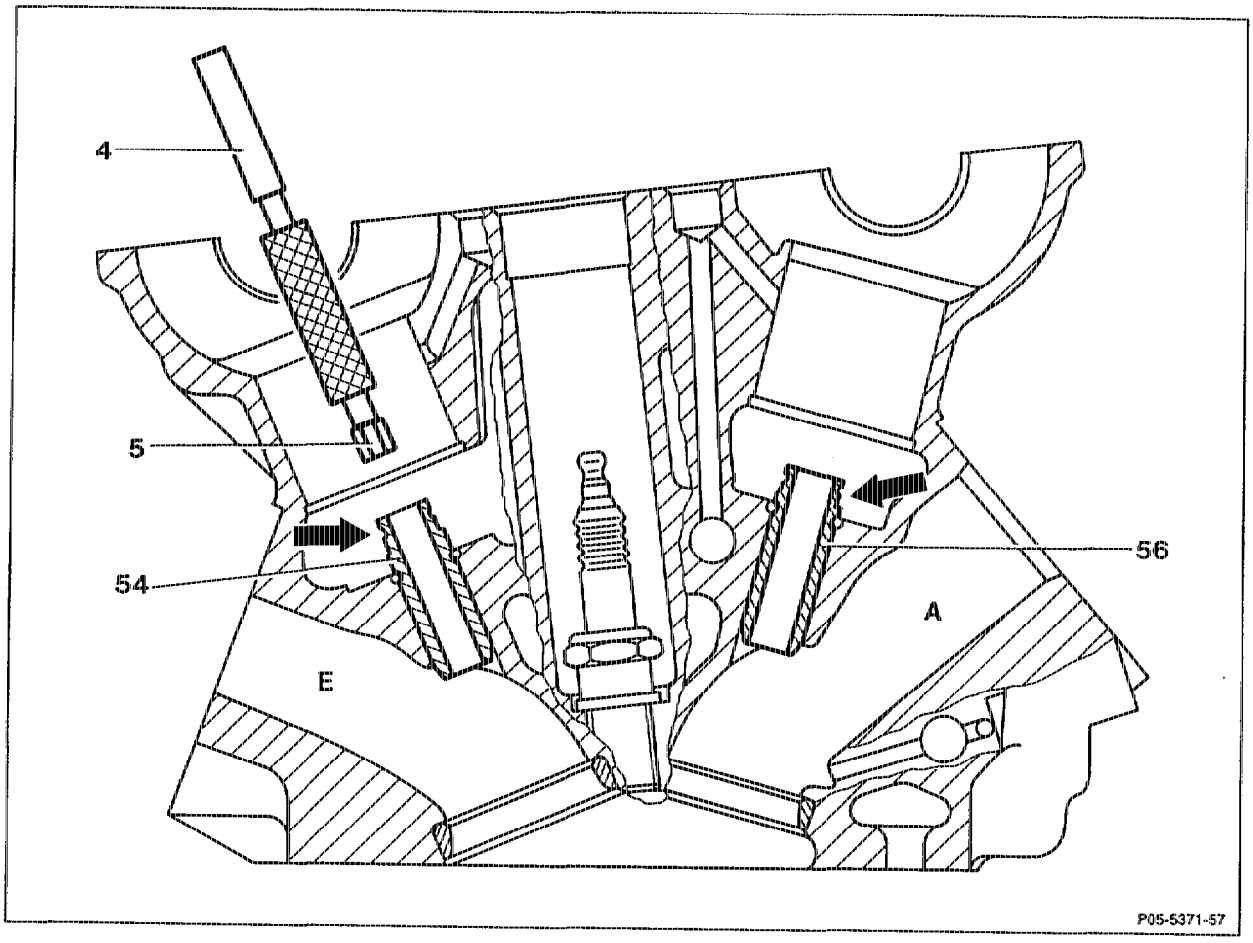

P05-2126-13

4 Measure runout at valve seat and height (h) of the valve disc.

If the runout is greater than 0.05 mm or the height (h) is less than the specification in the table, replace the valve.

05–2845 Checking valve guides

Preceding work:
Cylinder head removed.
Valves removed.



Left cylinder head, engine 119.960

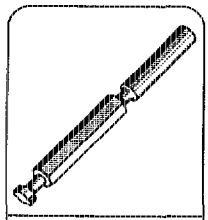
Inlet, exhaust valve guide (54) and (56) in longitudinal and transverse direction . . . . . check with gauging drift (4).

Gauging drift 102 589 00 23 00 inlet valve guide dia. 8 mm.
Gauging drift 117 589 03 23 00 exhaust valve guide dia. 9 mm.
Gauging drift 102 589 01 23 00 inlet, exhaust valve guide dia. 7 mm.

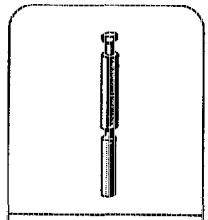
When performing this step, check whether the "no go" stud (5) with the wear limit (+220) can be inserted into the valve guides (54) and (56) over its entire length (5 mm). If the gauging drift (5) can be inserted over its entire length, replace valve guide (05–2850).

Retaining groove (arrows) of valve stem seal on valve guides (54) and (56)	. . . . .	check. If the retaining groove is worn (arrows) with result that the valve stem seal is no longer tightly seated, replace valve guide (05–2850).

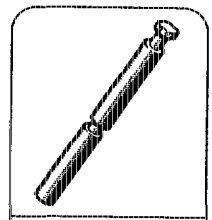
Special tools



102 589 00 23 00
05



117 589 03 23 00
05

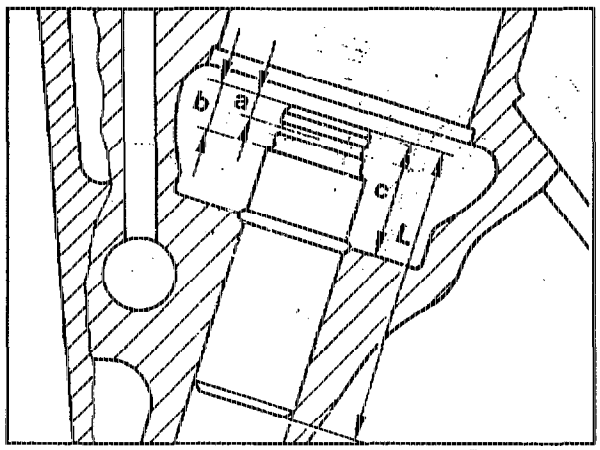


102 589 01 23 00
05

Note
Engine 119.96: as of engine end no. 011931 inlet and exhaust valve guides with ID 7 mm have been fitted.
Engine 119.97: as of start of production inlet and exhaust valve guides with ID 7 mm have been fitted.

Preceding work:
Valve guides checked (05–2845).

A. Engine 119.960/97 with nonferrous metal valve guides



P05-5372-13

Valve guides and basic bores
Engine 119.960 [1)]

	Standard size	Standard size I	Repair size I
Basic bore in cylinder head	13.50 – 13.51	13.53	13.70
Valve guide OD and colour code	13.52 – 13.53	13.52 – 13.53 grey – green 13.54 – 13.55 grey – brown	13.71 – 13.72 red
Overlap		0.012 – 0.031	
	Inlet		Exhaust
Valve guide [1)] ID	8.000 – 8.015		9.000 – 9.015
Length l	35.5		37.9
Dimension a	2.7 – 2.9		2.7 – 2.9
b	5.4 – 5.6		5.4 – 5.6
c	10.8 – 11.2		8.2 – 8.6

[1)] Valve guides with ID inlet 8 mm and exhaust 9 mm up to engine end no. 119.960 12 011 930

Valve guides and basic bores

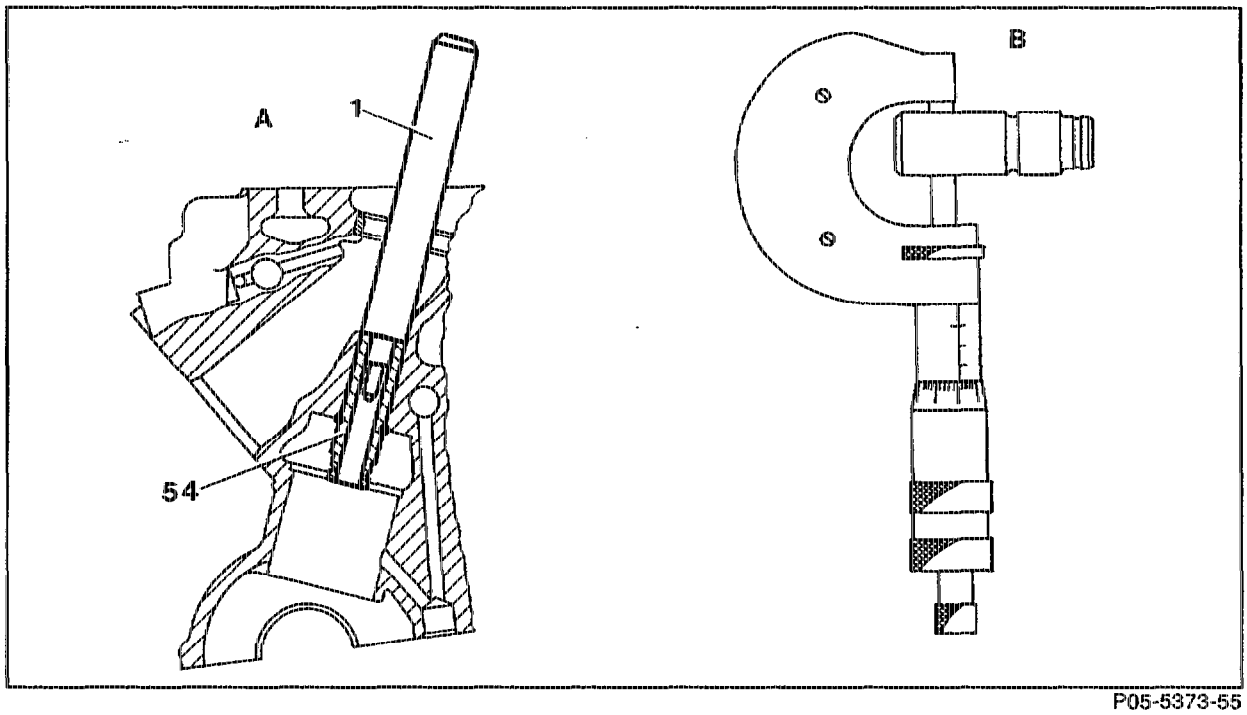
Engine 119.960 [2)]

Engine 119.97 [2)]

		Standard size	Standard size I	Repair size I
Basic bore in cylinder head		13.50 – 13.51	13.53	13.70
Valve guide OD and colour code		13.52 – 13.53	13.52 – 13.53 grey – green 13.54 – 13.55 grey – brown	13.71 – 13.72 red
Overlap			0.012 – 0.031	
		Inlet		Exhaust
Valve guide [2)] ID		7.000 – 7.015		7.000 – 7.015
Length	l	35.5		40.5
Dimension	a	2.7 – 2.9		2.7 – 2.9
	b	5.4 – 5.6		5.4 – 5.6
	c	10.8 – 11.2		10.8 – 11.2

[2)] Valve guide with ID 7 mm, as of engine end no. 119.960 12 011 931 up to 119.960 12 035 320
119.970 12 021 286
119.971 12 010 034
119.974 12 004 781
119.975 12 004 281

Knocking out valve guide

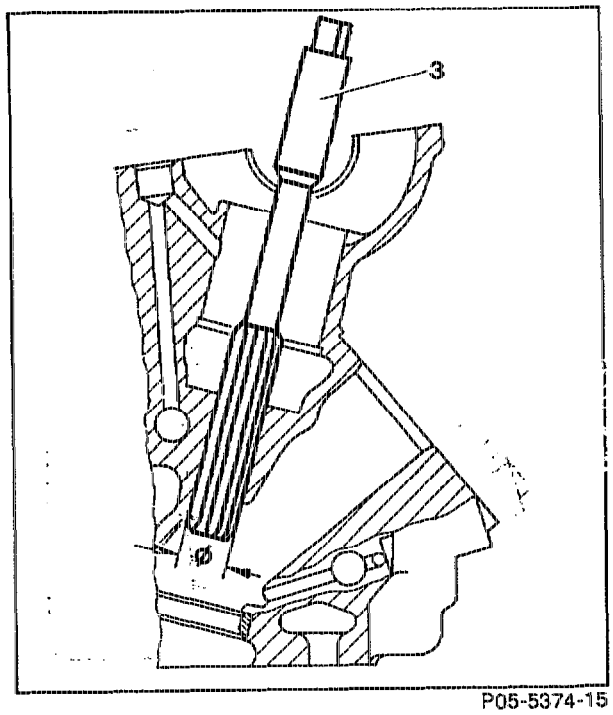


P05-5373-55

A Knock out valve guide
B Measure valve guide OD

Valve guide (54)	knock out with drift (1) from combustion chamber side. Removal drift 103 589 03 15 inlet dia. 8 mm Removal drift 103 589 02 15 inlet, exhaust dia. 7 mm and 9 mm with basic bore 13.5 mm
Measuring valve guide	
OD	measure with micrometer. Determine which valve guide is installed. Match up next larger valve guide, see table.
Basic bore in cylinder head	ream to standard size I or to repair size I depending on matched valve guide.

Standard size II
(Ream basic bore with reamer)



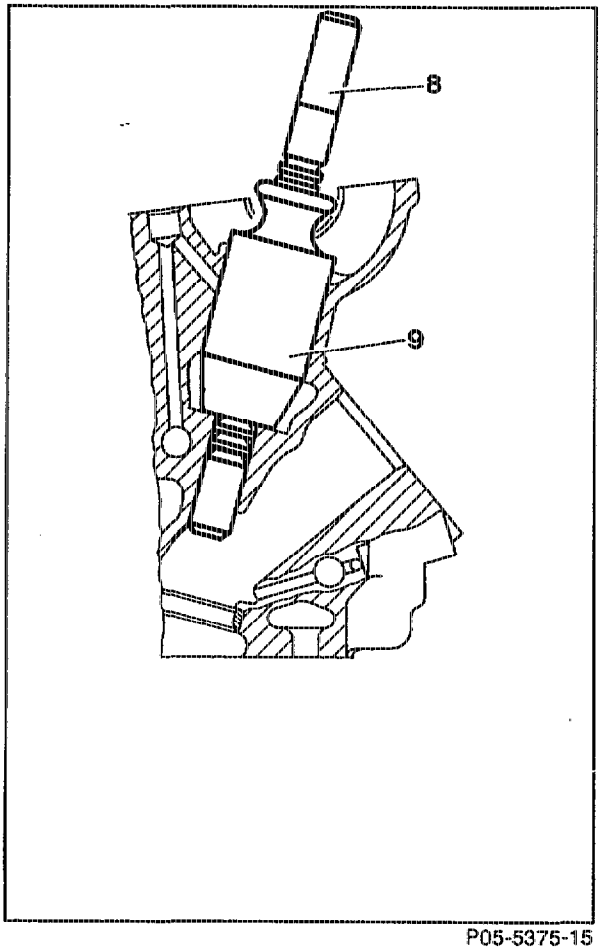
P05-5374-15

Basic bore ..... ream through with reamer (3).

Use reamer 104 589 00 53 00 for basic bore of 13.53 mm.

Note
Lubricate with petroleum. Ream with only a slight pressure and do not twist reamer (3). Clean blades of reamer before each reaming operation.

Repair size I
(Ream basic bore with broaching tool)

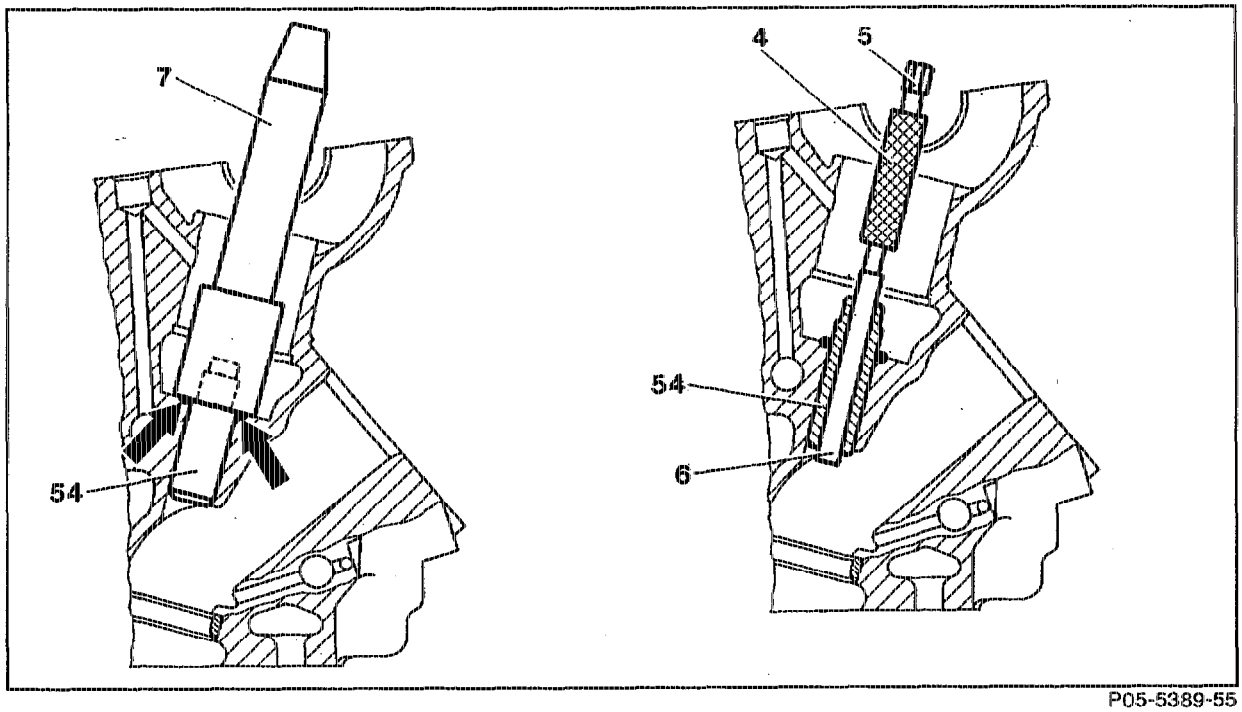


P05-5375-15

Blades of broaching tool (8)	clean with compressed air or plastic brush before each broaching operation.
Guide sleeve (9) and broaching tool (8)	insert into bucket tappet basic bore. Use guide sleeve 104 589 01 63 00 and broaching tool 104 589 01 53 00 for basic bore 13.7 mm.
Broaching tool (8)	press through.

Note
Lubricate with petroleum. Clean broaching tool (8) with compressed air after each broaching operation.

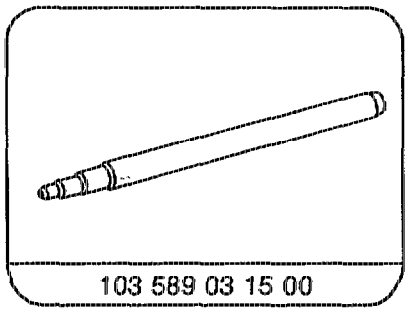
Inserting valve guide, checking ID



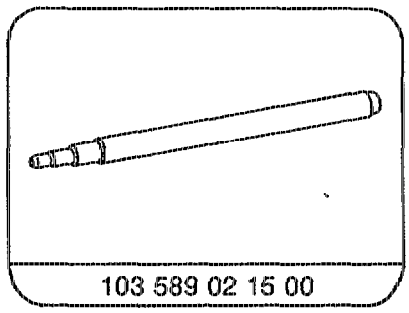
P05-5389-55

Valve guide (54)	supercool in liquid nitrogen (about 3 minutes).
If no liquid nitrogen is available	heat cylinder head in water bath to approx. 80 °C.
Valve guide (54)	knock in as far as stop (arrows) with insertion drift (7). Insertion drift 104 589 00 15 00 inlet Ø 8 mm. Insertion drift 104 589 01 15 00 exhaust Ø 9 mm. Insertion drift 119 589 02 15 00 inlet, exhaust Ø 7 mm.
Valve guide (54)	check if tightly seated if cylinder cool.
ID of valve guide (54)	check with gauging drift (4). Gauging drift 102 589 00 23 00 inlet dia. 8 mm. Gauging drift 117 589 03 23 00 exhaust dia. 9 mm. Gauging drift 102 589 01 23 00 inlet, exhaust dia. 7mm.
Go side (6) of gauging drift (4)	must be possible to insert fully.
ID	ream with reamer, if necessary. Reamer 000 589 21 53 00 inlet dia. 8 mm. Reamer 000 589 10 53 00 exhaust dia. 9 mm. Reamer 102 589 01 53 00 inlet, exhaust dia. 7 mm.

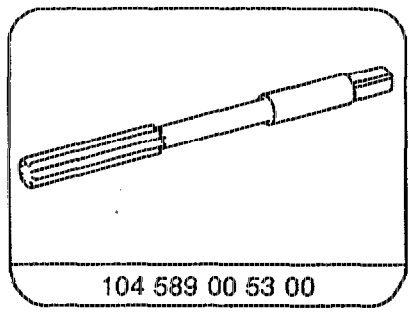
Special tools



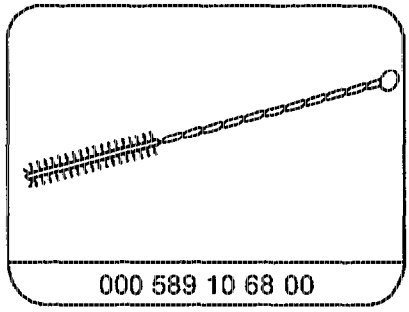
103 589 03 15 00



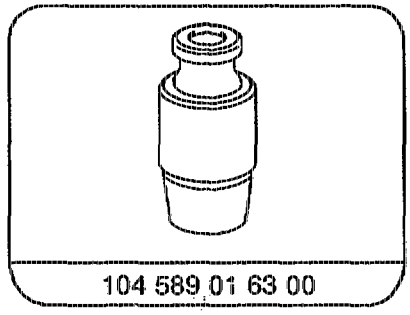
103 589 02 15 00



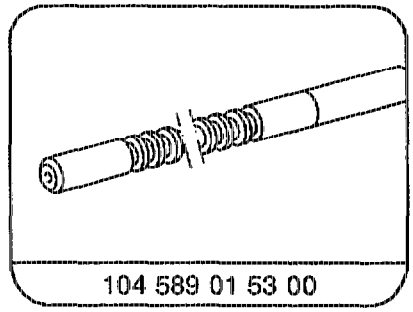
104 589 00 53 00



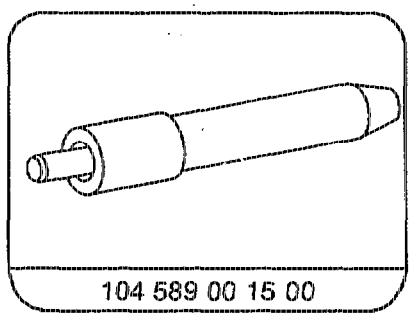
000 589 10 68 00



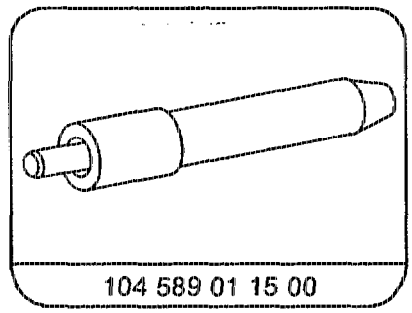
104 589 01 63 00



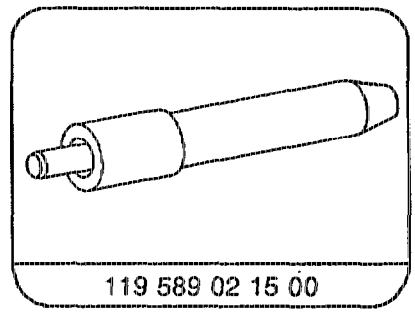
104 589 01 53 00



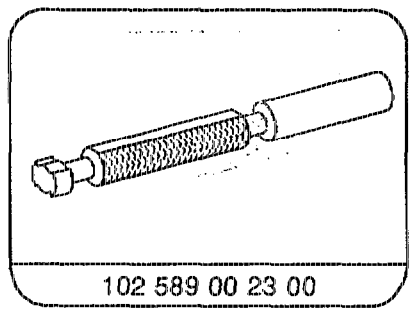
104 589 00 15 00



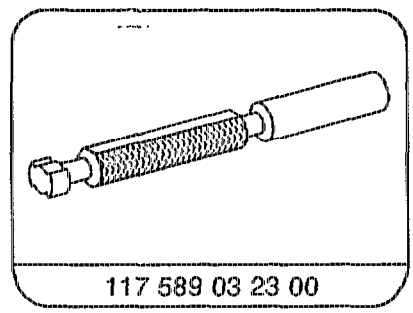
104 589 01 15 00



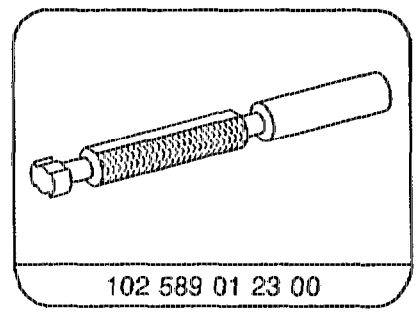
119 589 02 15 00



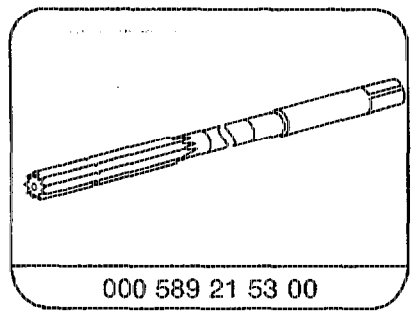
102 589 00 23 00



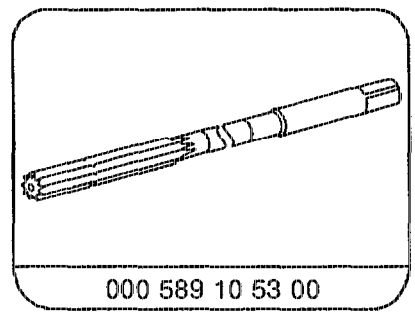
117 589 03 23 00



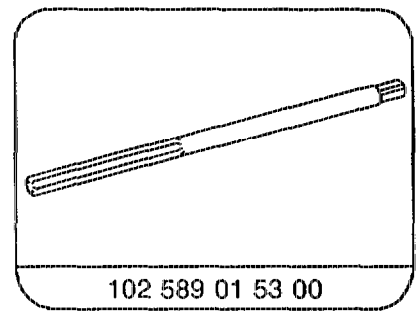
102 589 01 23 00



000 589 21 53 00

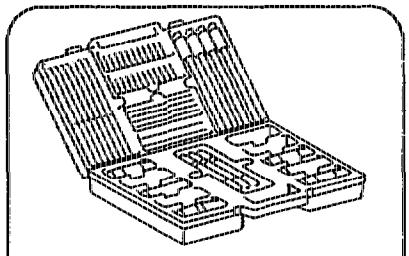


000 589 10 53 00

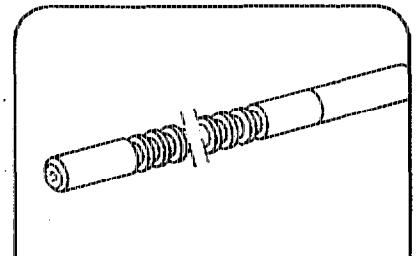


102 589 01 53 00

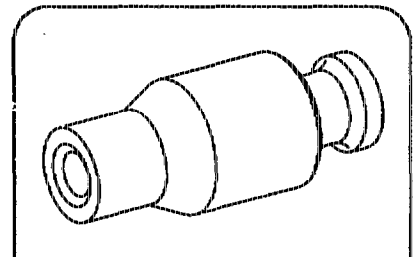
Special tools



103 589 01 98 00



119 589 01 53 00

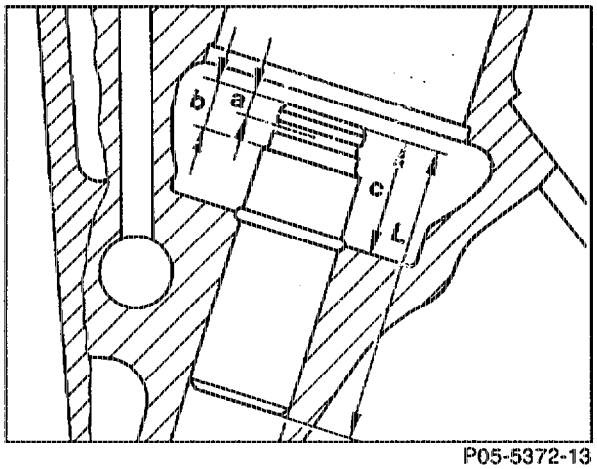


119 589 05 63 00

Commercially available tools

Cylinder head tensioning device	e.g. Hunger D-8000 München 70 Order no. 221.60.000
Micrometer 0.25 mm	

B. Engines119.960/97/98 with sintered metal valve guides

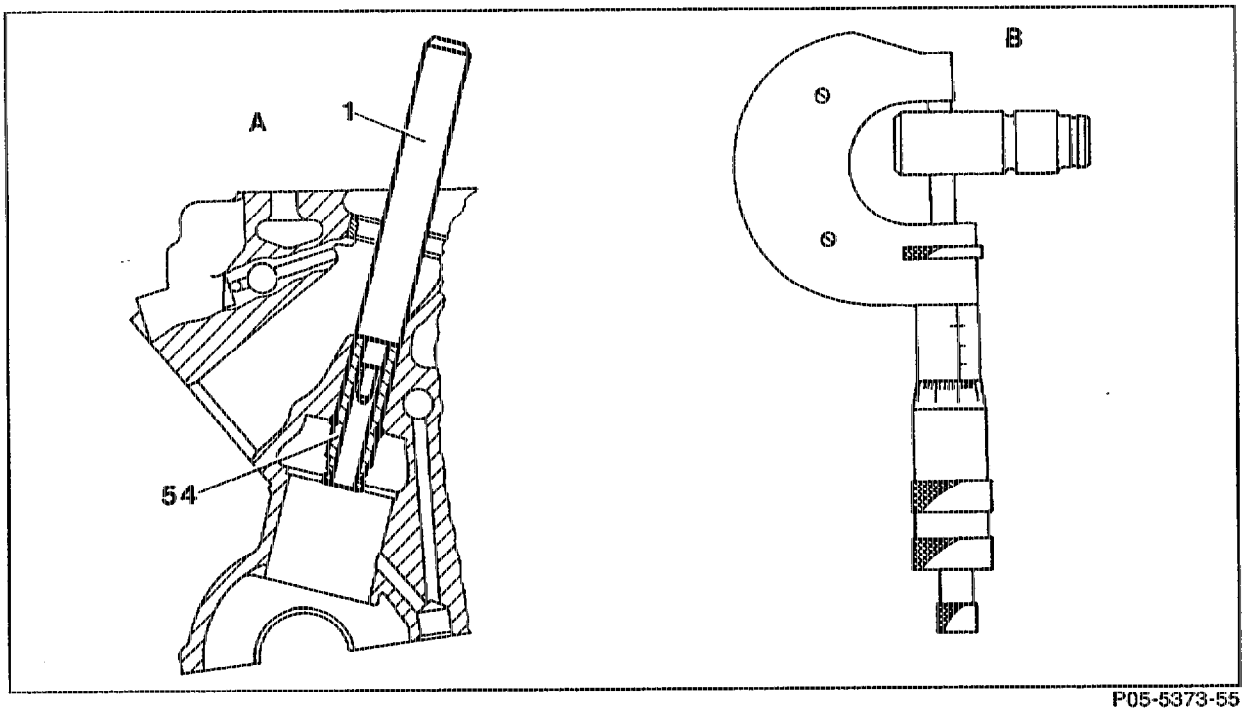


P05-5372-13

Valve guides [1] and basic bores

	Standard size	Standard size I	Repair size I
Basic bore in cylinder head	12.50 – 12.51	12.53	12.70
Valve guide OD and colour code	12.54 – 12.55	12.56 – 12.57 grey	12.74 – 12.75 red
Overlap	0.029 – 0.051		
	Inlet / Exhaust		
Valve guide ID	7.000 – 7.015		
Length l	37.5		
Dimension a	–		
b	5.4 – 5.6		
c	10.2 – 10.4		

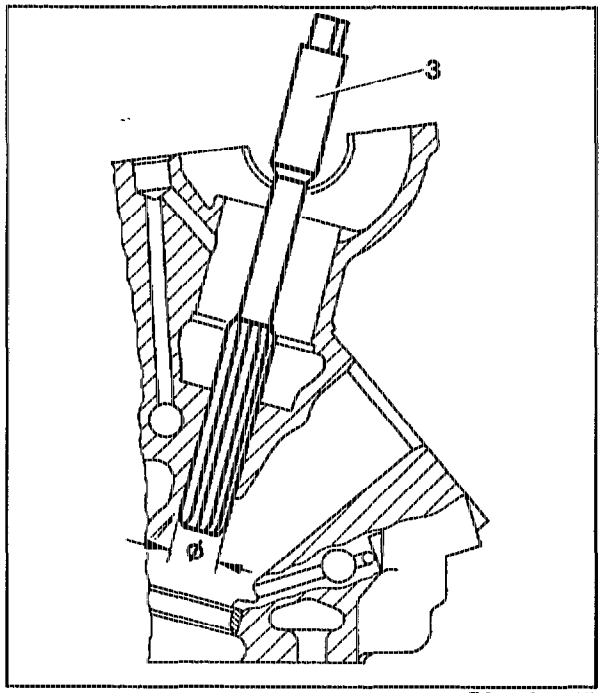
[1] Sintered metal valve guides, without circlip and groove, as of engine no. 119.960 12 035 331
119.970 12 021 287
119.971 12 010 035
119.972 as of start of production
119.974 12 004 782
119.975 12 004 282
119.98 as of start of production



P05-5373-55

Valve guide (54)	knock out with drift (1) from combustion chamber side. Removal drift 111 589 02 15 00 inlet, exhaust Ø 7 mm with basic bore of 12.5 mm.
Measuring valve guide	
OD	measure with micrometer. Determine which valve guide is installed. Match up next larger valve guide, see table.
Basic bore in cylinder head	ream to standard size I according to matched valve guide.
or	broach repair size I.

Standard size I
(Ream basic bore with reamer)

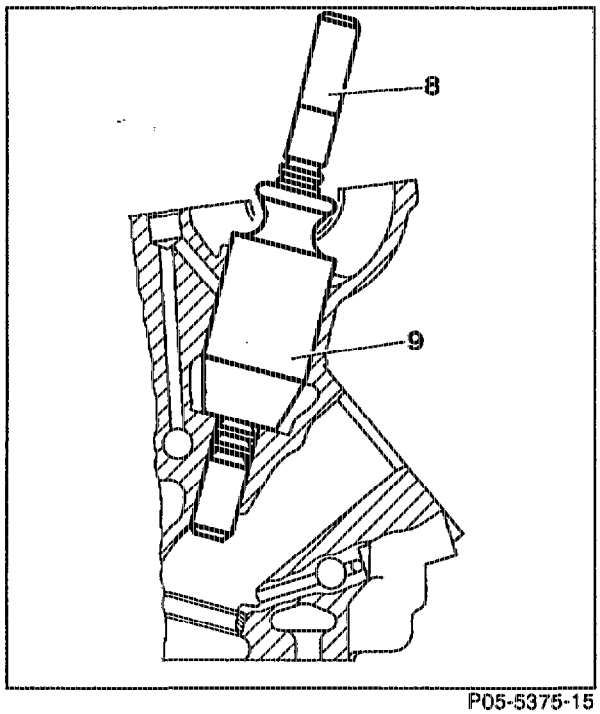


P05-5374-15

Basic bore ..... ream through with reamer (3).
Use reamer 119 589 00 53 00 for basic bore of 12.53 mm.

Note
Lubricate with petroleum. Ream with only a slight pressure and do not twist reamer (3). Clean blades of reamer before each reaming operation.

Repair size I
(Ream basic bore with broaching tool)

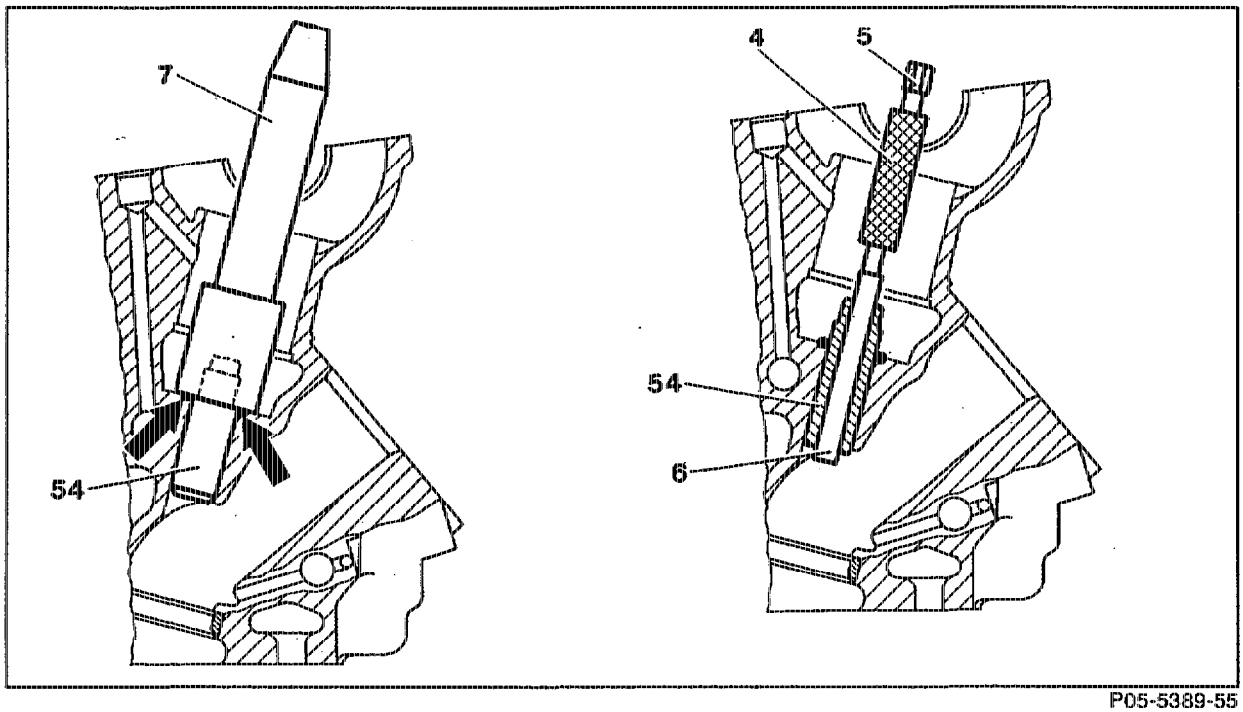


P05-5375-15

Blades of broaching tool (8)	clean with compressed air or plastic brush before each broaching operation.
Guide sleeve (9) and broaching tool (8)	insert into bucket tappet basic bore. Use guide sleeve 119 589 05 63 00 and broaching tool 119 589 01 53 00 for basic bore 12.7 mm.
Broaching tool (8)	press through.

Note
Lubricate with petroleum. Clean broaching tool (8) with compressed air after each broaching operation.

Inserting valve guide, checking ID



P05-5389-55

Valve guide (54)	moisten on outside with oil.
	Note It is not necessary to heat the cylinder head or to cool the valve guide (54).
Valve guide (54)	knock in as far as stop (arrows) with insertion drift (7).
	Insertion drift 606 589 02 15 00 inlet, exhaust Ø 7 mm.
	Note The circlip is not fitted to the sintered metal valve guides. The insertion depth is fixed by the insertion drift.
Installation depth (c) of valve guide (54)	check, correct if necessary.
Valve guide (54)	clean.
	Cylinder brush 000 589 10 68 00
Valve guide (54)	check to ensure tight.
ID of valve guide (54)	check with inspection drift (4).
	Inspection drift 102 589 01 23 00 inlet, exhaust Ø 7mm.

Go side (6) of gauging drift (4)	must be possible to insert fully.

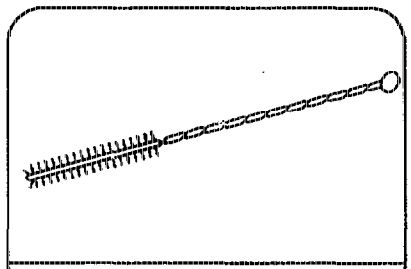
⚠

If it is not possible to insert the gauge, the valve guide should be replaced as the material of the sintered metal versions is too hard for reaming.

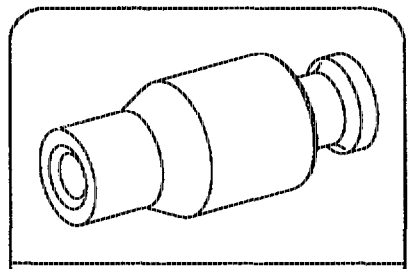
Commercially available tools

Cylinder head clamping device	e. g.	Hunger D-8000 München 70 Order no. 221.60.000
Micrometer 0.25 mm		

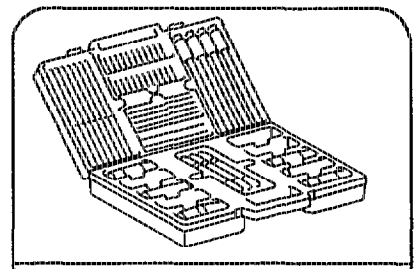
Special tools



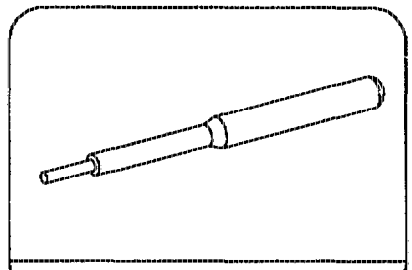
000 589 10 68 00



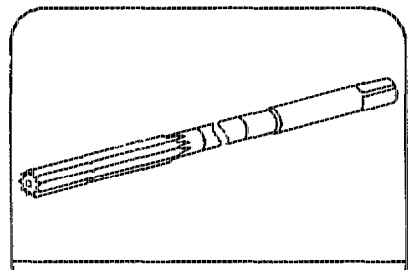
119 589 05 63 00



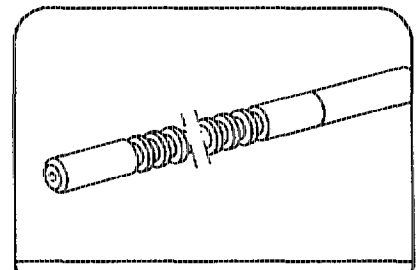
103 589 01 96 00



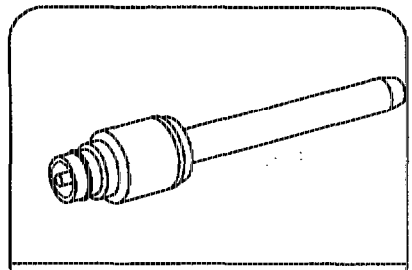
111 589 02 15 00



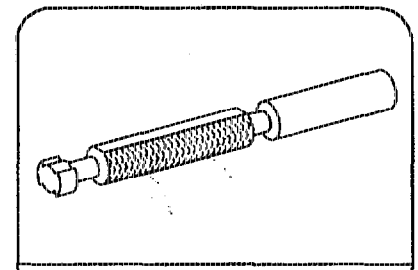
119 589 00 53 00



119 589 01 53 00



606 589 02 15 00

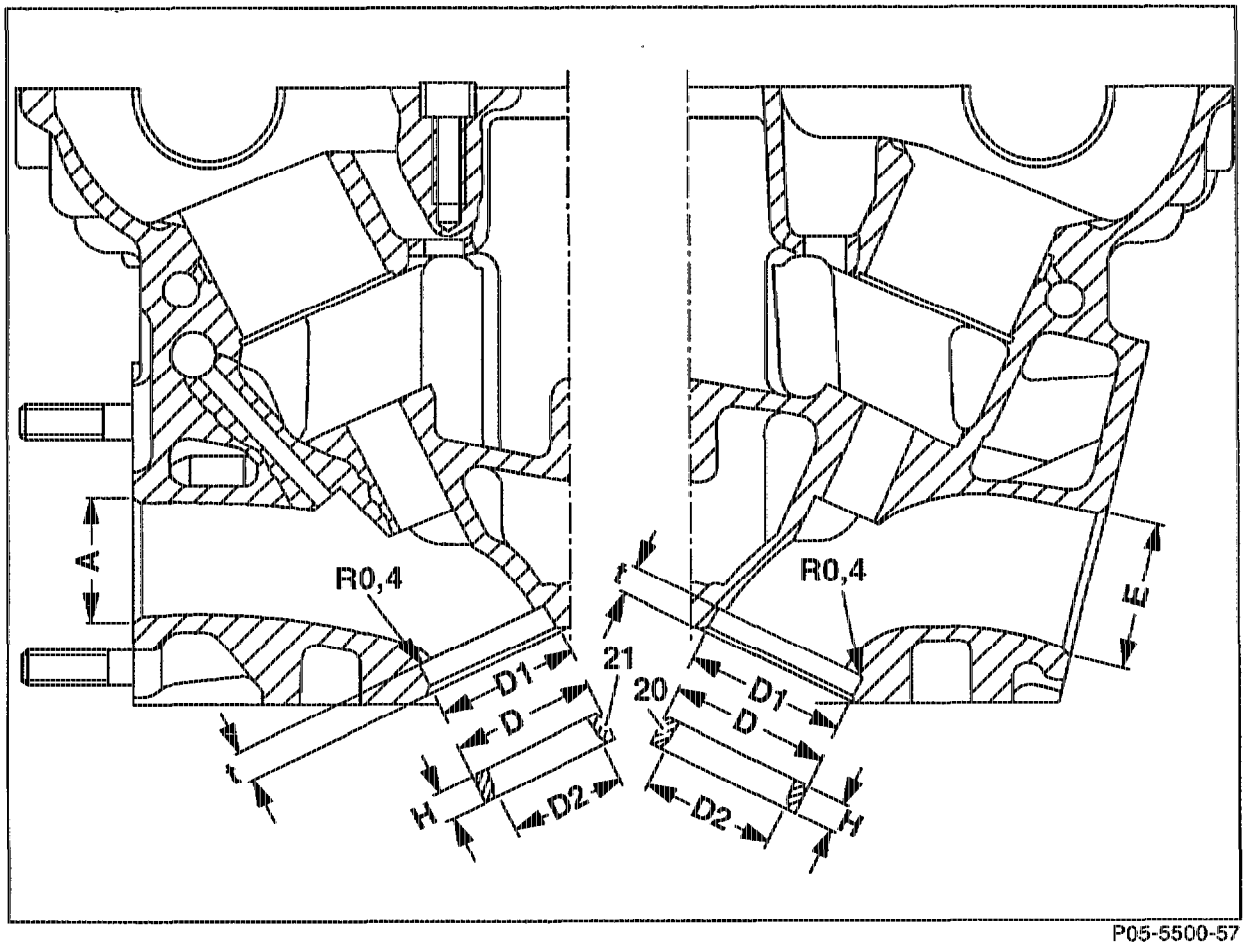


102 589 01 23 00

05–2900 Replacing valve seat rings

Preceding work:
Valve guides inspected (05–2845)

Operation no. of operation texts and work units or standard texts and flat rates



P05-5500-57

Valve seat rings (20 and 21)	turn out with ring seat turning tool.
Operating instructions of tool manufacturer	note.
Basic bore diameter (D1)	measure with internal measuring instrument.
Valve seat rings (standard size or repair size)	select according to overlap.
If repair size	machine basic bore.
If repair size	seat ring bore matching valve seat ring, pay attention to overlap.
Valve seat ring	cool with liquid nitrogen and insert with a suitable drift.
Valve seats	machine (05-2910).

Engine		119.960/970/972/974	
Bore of valve seat ring		Inlet	Exhaust
D1	Standard size cylinder head	39 H6	34 H6
D	Standard size valve seat ring	39.1 to 39.09	34.1 to 34.09
Repair size			
D1	Repair size cylinder head	40.2 H6	35 .2 H6
D	Repair size valve seat ring	40.3	35.3
t		7.8 to 7.9	
D2		38.47	25.6

Engine		119.971/975/980/981/982/985	
Bore of valve seat ring		Inlet	Exhaust
D1	Standard size cylinder head	36 H6	34 H6
D	Standard size valve seat ring	36.1 to 36.09	34.1 to 34.09
Repair size			
D1	Repair size cylinder head	37.2 H6	35 .2 H6
D	Repair size valve seat ring	37.3	35.3
t		7.8 to 7.9	
D2		35.47	33.47

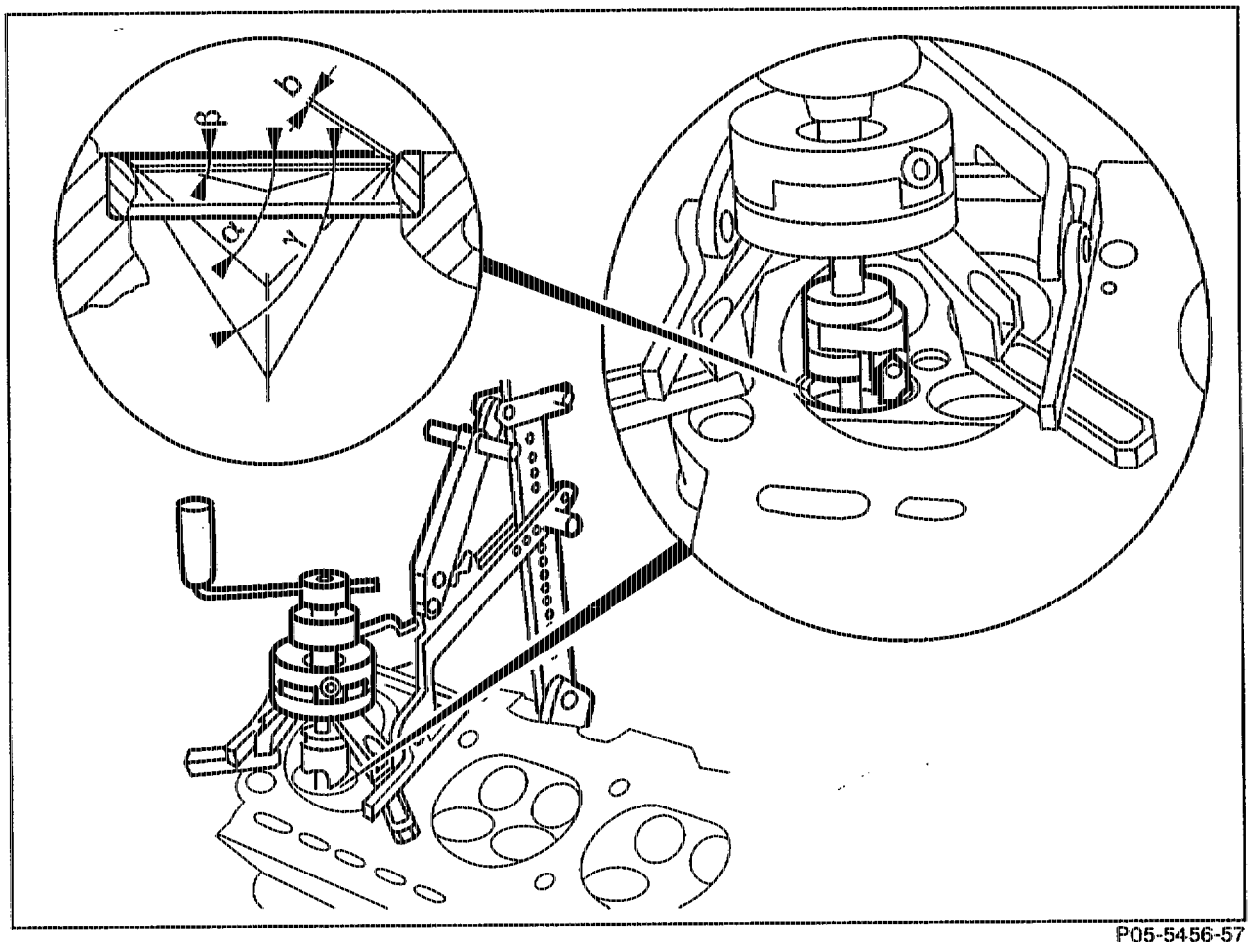
Commercially available tools

Cylinder head clamping device	e. g.	Hunger 81375 München Order no. 221.60.000
Ring seat turning tool	e. g.	Hunger 81375 München Size 2, order no. 220.03.110
Valve seat turning tool (size 2)	e. g.	Hunger 81375 München Type VDSN 1/45/30 Order no. 236.03.308
Test kit for valve seats	e. g.	Hunger 81375 München Order no. 216.93.300
Internal measuring instrument (range 35 – 100 mm)	e. g.	Mahr, 73730 Esslingen Order no. 844 N
External micrometer (range 25 – 50 mm)	e. g.	Mahr, 73730 Esslingen Order no. 40 S H

05–2910 Machining valve seat rings

Preceding work:
Valve guides inspected (05–2845)

Operation no. of operation texts and work units or standard texts and flat rates



P05-5456-57

Valve seats	machine.
	Note Pay attention to operating instructions of tool manufacturer. Use *SERDI* form turning tool no. 41196. Use Hunger turning tool no. 23m or 24m.
Reference size (T) between valve stem end and base of camshaft bearing	measure (see Inspecting, facing cylinder head contact surface 01-4180). ⚠ If size "T" is not achieved, no further correct valve clearance compensation exists. In this case, the valve seat or the cylinder head should be replaced.
Dimensions	maintain according to table.
Leaktightness with valve installed	check.

Valve seat width (b) . . . . . measure.

Note
If necessary, correct valve seat width (b) with correction tools 23m and 24m (Hunger) (angles α and β).

Valves . . . . . insert and measure clearance from valve stem end to base of camshaft bearing (T), see (01–4180).

⚠
The valves should always be replaced when performing facing work on cylinder head and re-setting the valve seats.

Data		Inlet, exhaust valve
Valve seat width (b)	Inlet	0.80 – 1.10 mm
Valve seat width (b)	Exhaust	1.00 – 1.20 mm
Valve seat angle (α)		45°
Top correction angle (β)		30°
Bottom correction angle (γ)		60°
Permissible concentricity of valve seat		0.03 mm

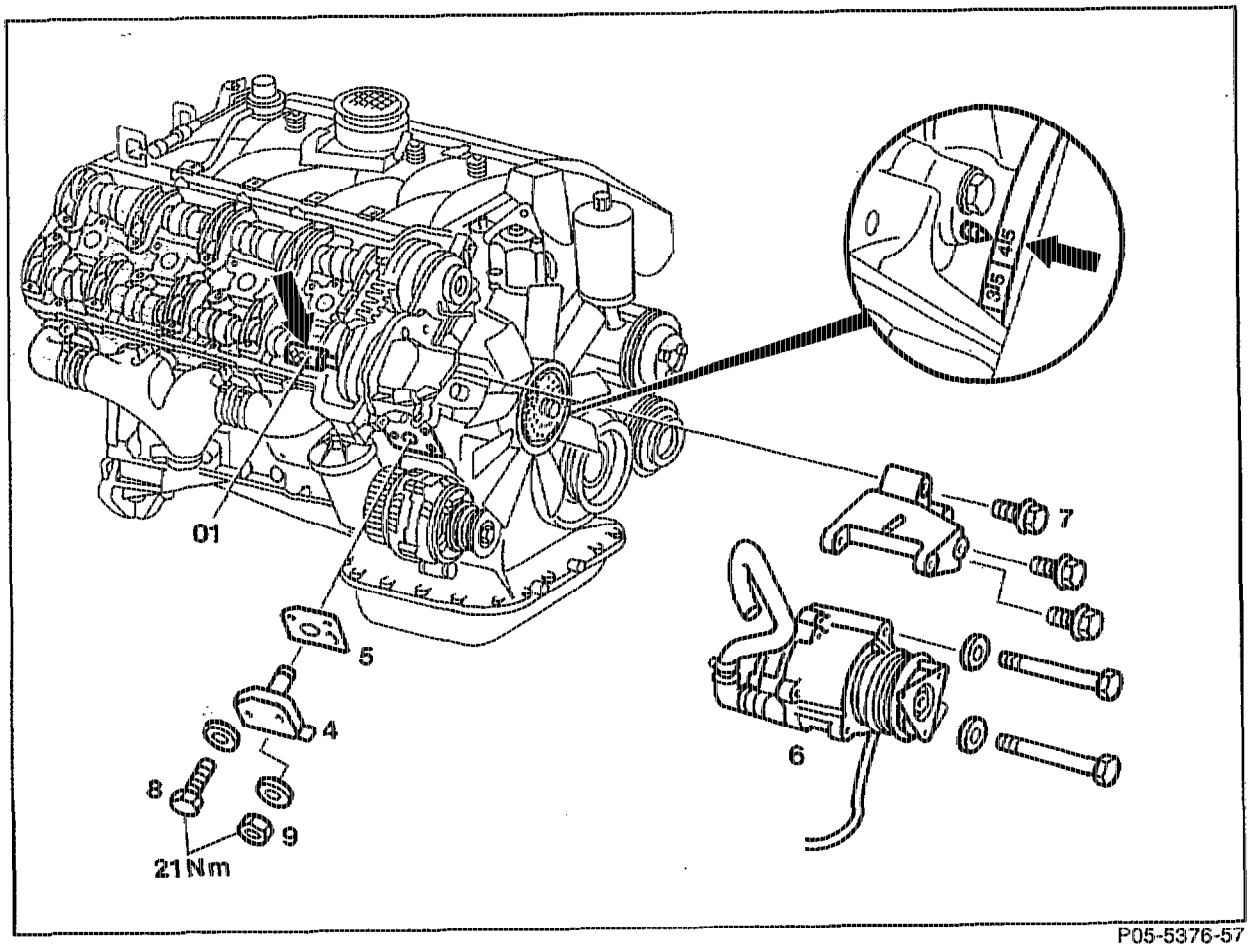
Commercially available tools

Valve seat turning tool	e. g.	*SERDI* GmbH Bregenzstr. 69 88131 Lindau
Form turning tool	e. g.	*SERDI* GmbH Bregenzstr. 69 88131 Lindau Order no. 41196
Cylinder head clamping device	e. g.	Hunger 81375 München 70 Order no. 221.60.000
Valve seat turning tool	e. g.	Hunger 81375 München 70 Type VSDN 1/45/30 Order no. 236.03.308
Test kit for valve seats	e. g.	Hunger 81375 München 70 Order no. 216.93.300
Turning tools for valve seat and correction angle (β) and (γ) 23m 24m	e. g.	Hunger 81375 München 70 Order no. 216.64.235 Order no. 216.62.170

05–3100 Removing and installing chain tensioner

Preceding work:
Right cylinder head cover removed (01–0500).

Operation no. of operation texts and work units or standard texts and flat rates
05–7800, 7801



P05-5376-57

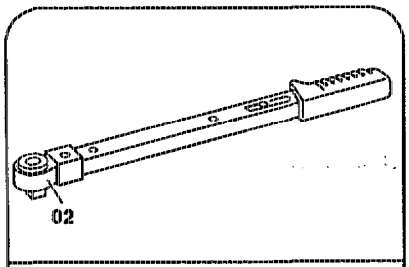
Model 210: air cleaner housing	remove, install.
Piston of cylinder 1	position to 45° before ignition TDC (arrow).
Right outlet camshaft	fix in position with pin (01) (arrow) so that the exhaust camshaft does not jump across when timing chain relieved. Special tool 111 589 03 15 00.
With mechanical secondary air injection:	slacken poly V-belt and take off from air pump (6) or model 129 with engine 119.960, from generator, fit on (13–3420).
Model 129 with engine119.960: generator	unbolt, bolt on (15–510).

With mechanical secondary air injection:	unbolt air pump (6) and place to the side with piping connected.
Models 124, 140 with mechanical secondary air injection:	unbolt bracket (7) of air pump or generator, bolt on (25 Nm).
Model 210 with electric secondary air injection: . .	remove electric air pump together with bracket, install.
	Note Unbolt guide pulley and EGR valve at bracket for this step.
Bolt (8) and nut (9)	slacken, tighten evenly (25 Nm).
	⚠ Engine oil which flows out must not get into the generator. Chain tensioner (4) must not be tilted.
Chain tensioner (4) together with gasket (5)	remove, fit on.
Gasket (5)	replace.
Engine	run and check for leaks.

Tightening torques in Nm

Bolt and nut of chain tensioner M8	25
Bolts of air pump bracket	25
Guide pulley to air pump bracket (with electric secondary air injection)	30

Special tools



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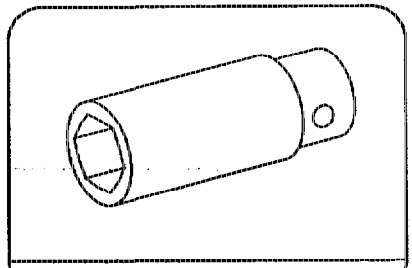

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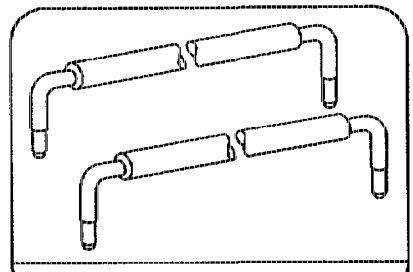
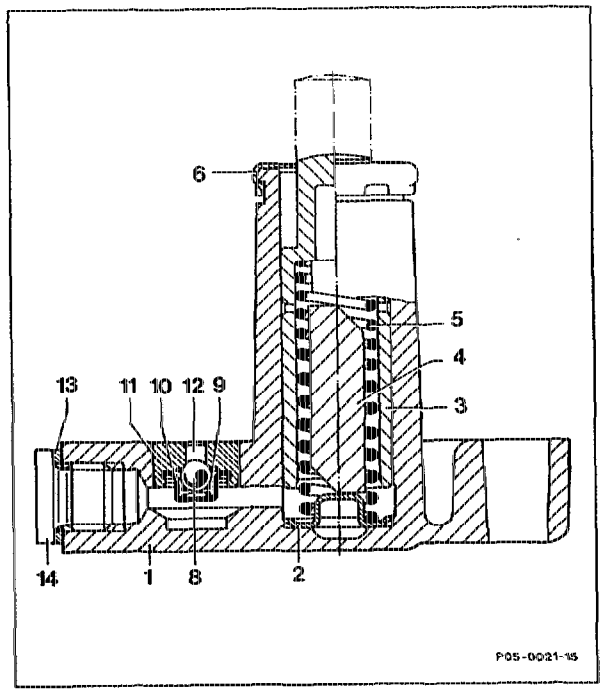


111 589 03 15 00

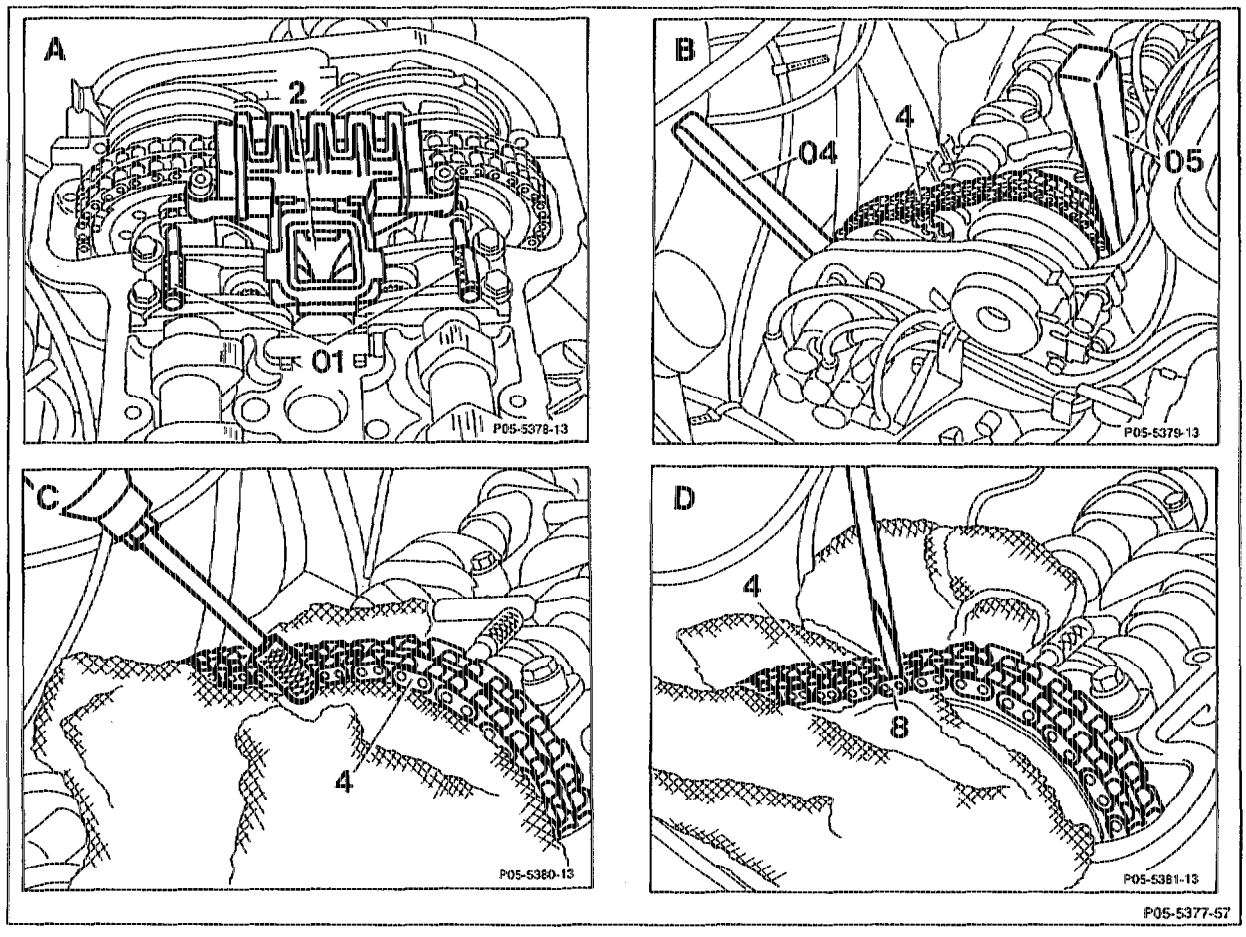


1 Housing
2 Dished washer
3 Thrust pin
4 Filler pin
5 Compression spring
6 Cap
7 Compression spring
8 4 mm ball
9 Compression spring
10 Ball guide
11 Ball seat ring
12 Pressurised oil feed
13 M10×14 seal
14 M10×1 screwplug

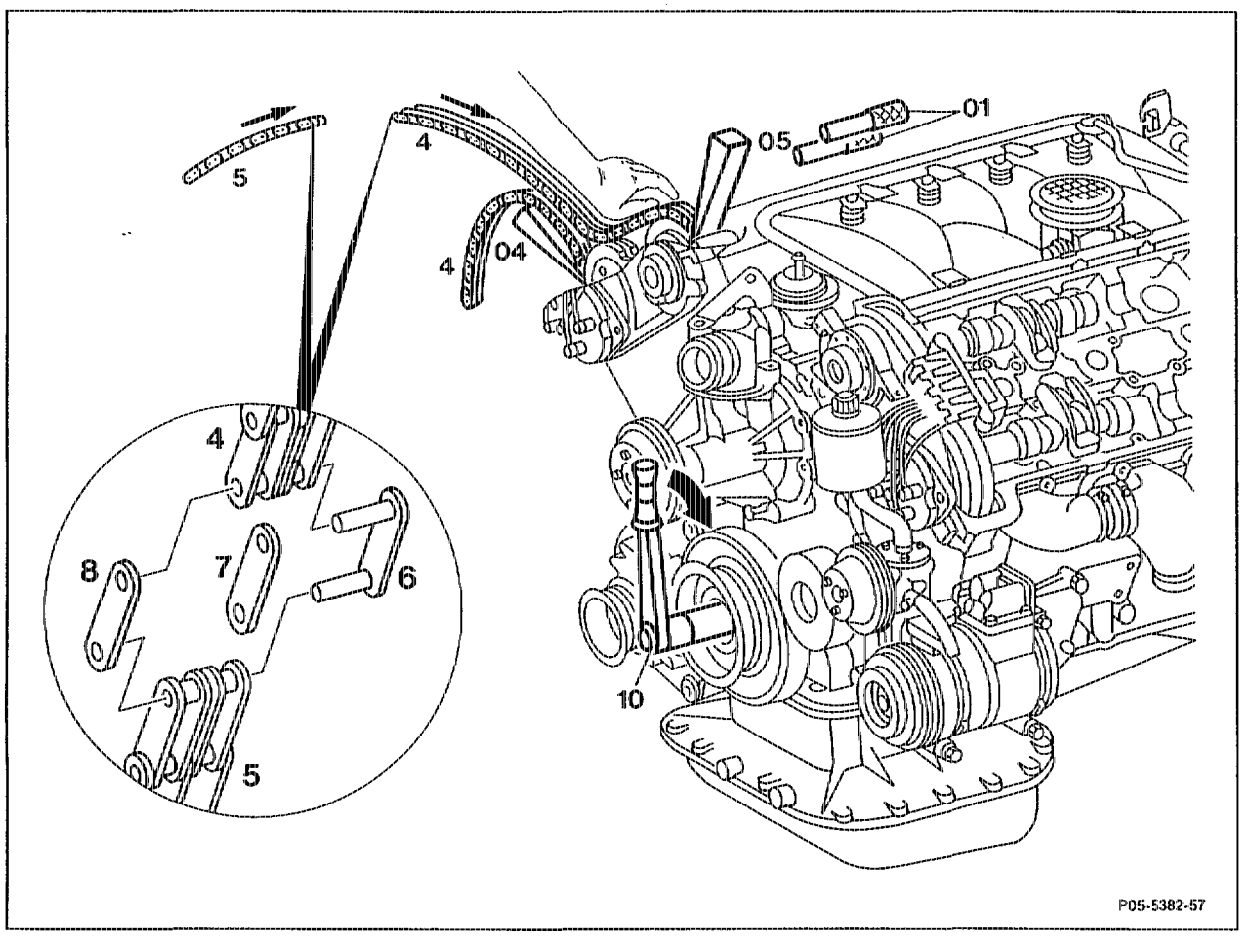
05–3200 Replacing and riveting timing chain

Preceding work:
Cylinder head covers removed (01–0500).
Viscous fan clutch removed (20–3120).
Spark plugs removed (15–1031).

Operation no. of operation texts and work units or standard texts and flat rates
05–7601

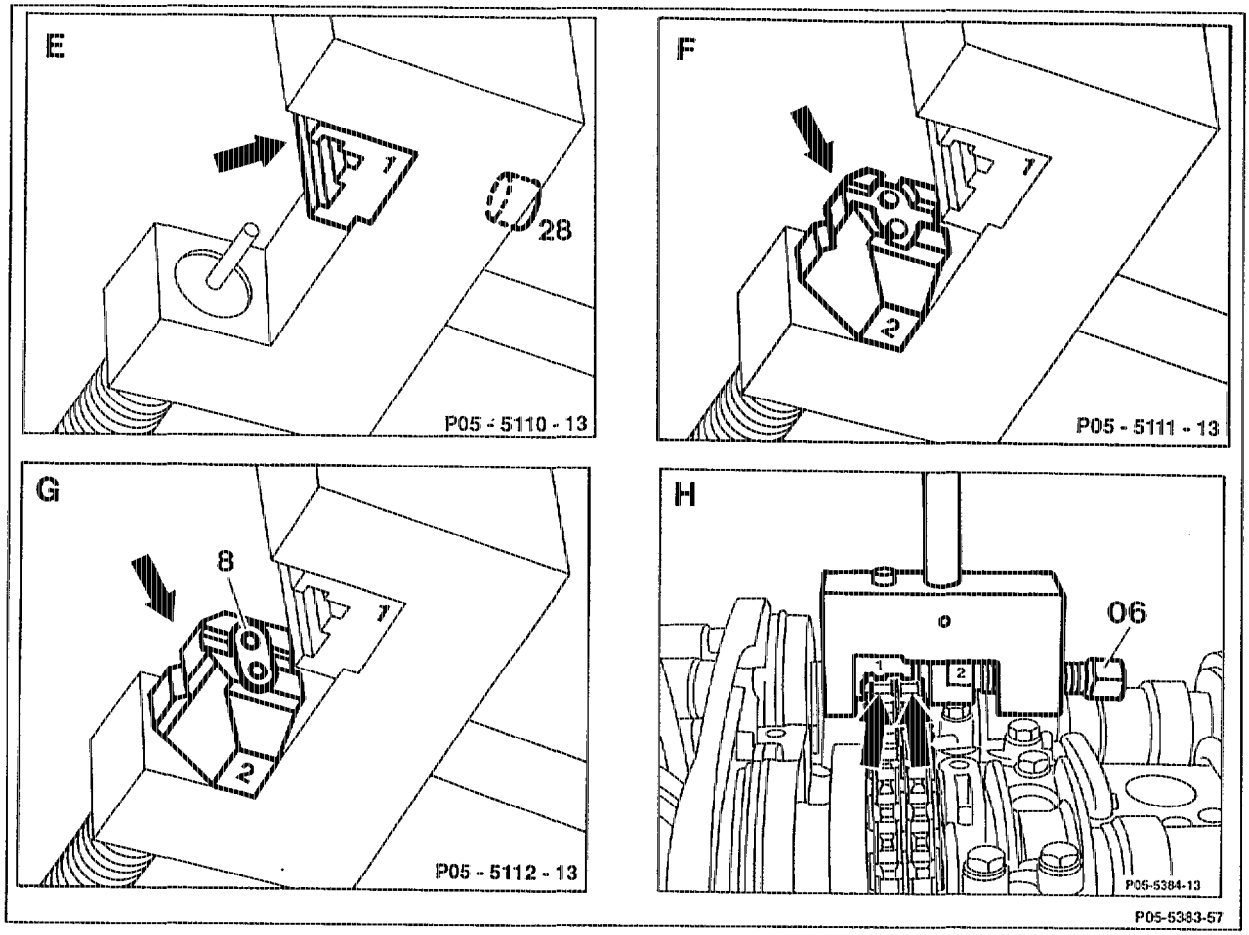


Piston of cylinder 1	set to 45° before ignition TDC.
Right cylinder head: inlet, exhaust camshafts	fix with pins (01) (Fig. A), special tool 111 589 01 15 00.
Chain tensioner	remove (05–3100).
Right guide rail (2) at top	remove, install (05–3350) (Fig. A).
Timing chain to camshaft sprockets	lock with wedges (04) and (05) at right cylinder head (Fig. B), special tool 110 589 03 59 00.
Chain housing	cover over with clean cloth.
Chain pin of timing chain (4) between inlet and exhaust camshaft sprockets	grind open (Fig. C).
Plate (8) of timing chain (4)	prise off with a screwdriver (Fig. D).
Ground-open double link	push out.



New timing chain (5)	connect to old timing chain (4) with riveted link (6) and middle plate (7) (thickness 1.6 mm) and ground open outer plate (8).
Pins (01)	remove.
Wedge (5) at inlet camshaft	remove, holding timing chain meshed at inlet and exhaust camshaft sprockets by hand when performing this step.
Wedge (04) at exhaust camshaft sprocket	slacken slightly.
Crankshaft	rotate in direction of rotation of engine with wrench socket (10); hold timing chain (4) or (5) meshed at inlet and exhaust camshaft sprockets when performing this step.
	⚠ Ensure that timing chain (4) or (5) does not jump off when turned.
New timing chain (5)	pull in.
End (4) of timing chain which has become free	pull out of chain housing.
Crankshaft	rotate sufficiently until the ends of the new timing chain (5) can be connected with the riveted link.

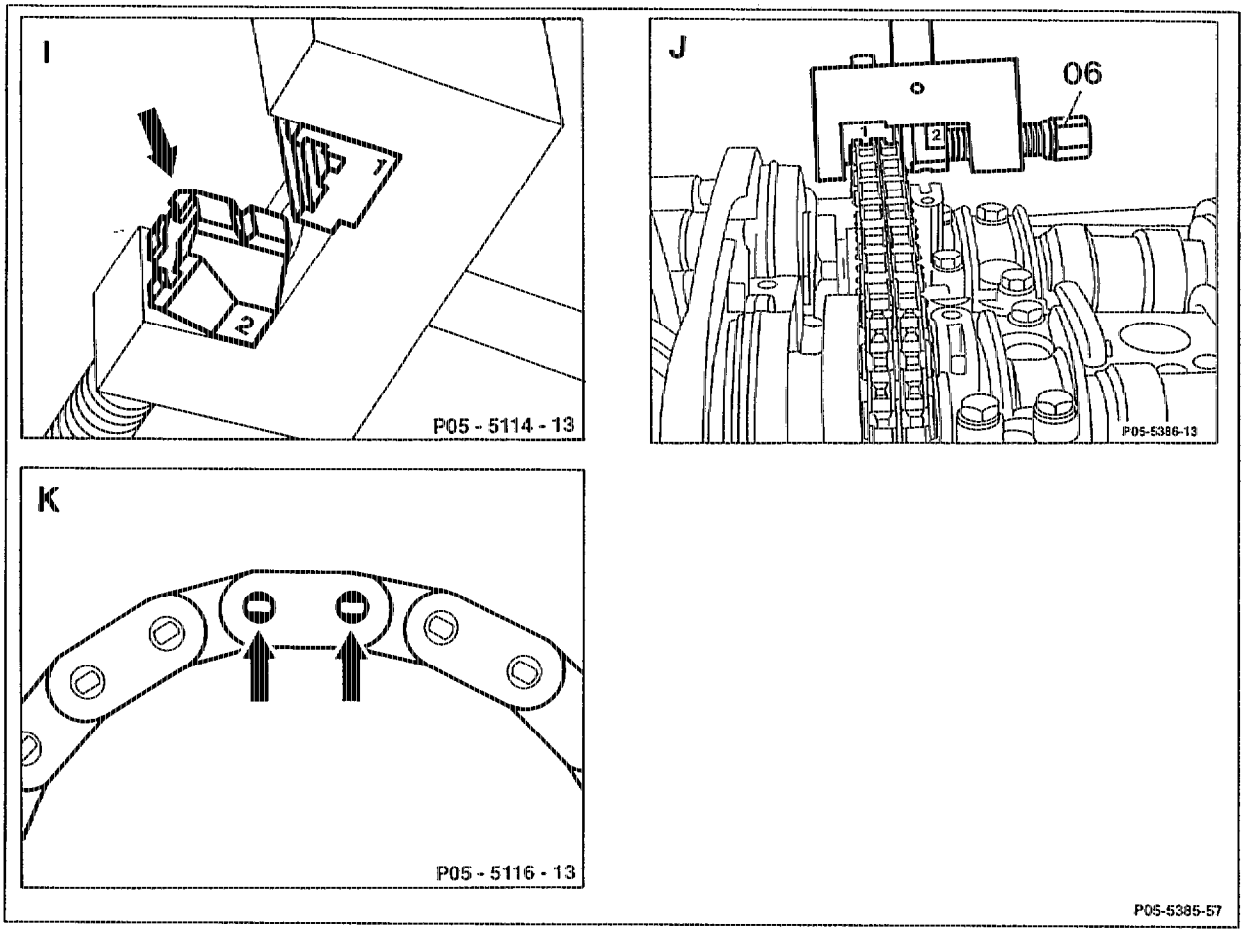
Timing chain to camshaft sprockets	fix with wedges (04) and (05).
New timing chain (5)	connect with link (6) and center plate (7).



Jaws for duplex roller chain with number 1	insert into fitting tool and screw on with screw (28) (Fig. E).
Moving thrust piece (arrow) for simplex roller chain with number 2	insert into fitting tool (Fig. F).
Outer plate (8) (thickness 1.2mm)	insert into moving thrust piece (Fig. G).
Webs (arrows)	fit onto roller at riveted link.
Spindle (06)	screw in until tight resistance.

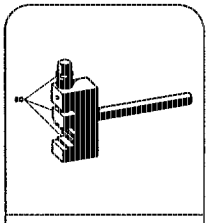
Note
When screwing in, ensure that the pins of the riveted link are inserted into the holes of the outer plate (8).

Insertion tool	remove.



Moving thrust piece (arrow) with number 2	turn over (riveted section) (Fig. I).
Fitting tool	position exactly over center of pin (Fig. J).
Spindle (06)	tighten to 30 Nm (Fig. J).
Pins of riveted link (6)	rivet individuallly (Fig. J).
Riveting (arrows)	examine, re-rivet if necessary (Fig. K).
Basic position of camshafts	set (05–2240).
Chain tensioner	install (05–3100).
Basic position of camshafts	check (05–2230).

Special tools



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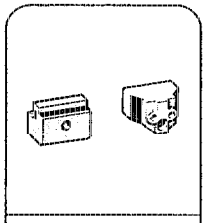
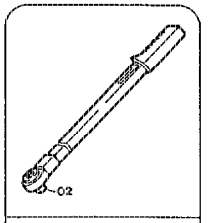


103 589 01 63 00
05



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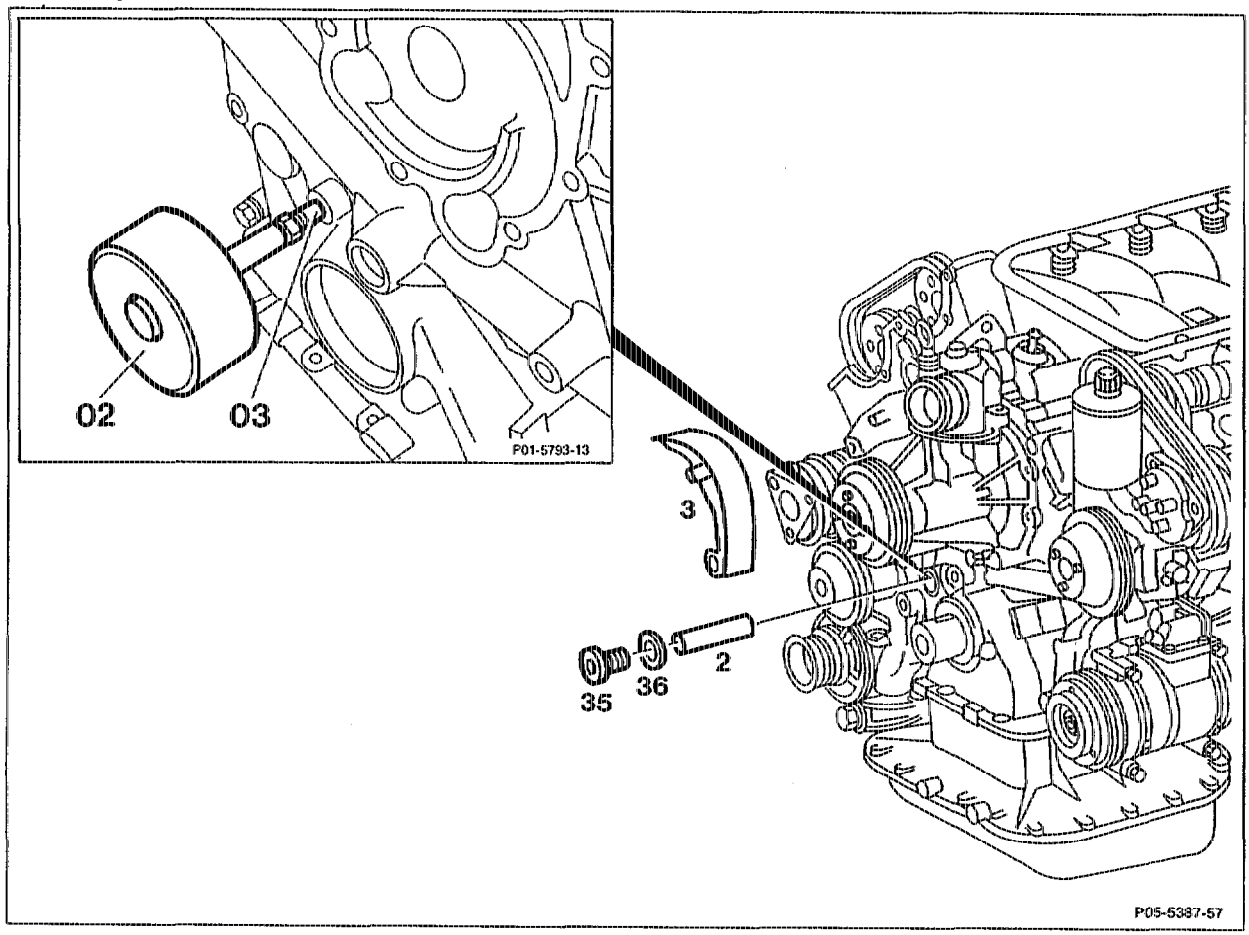
05–3300 Removing and installing tensioning rail

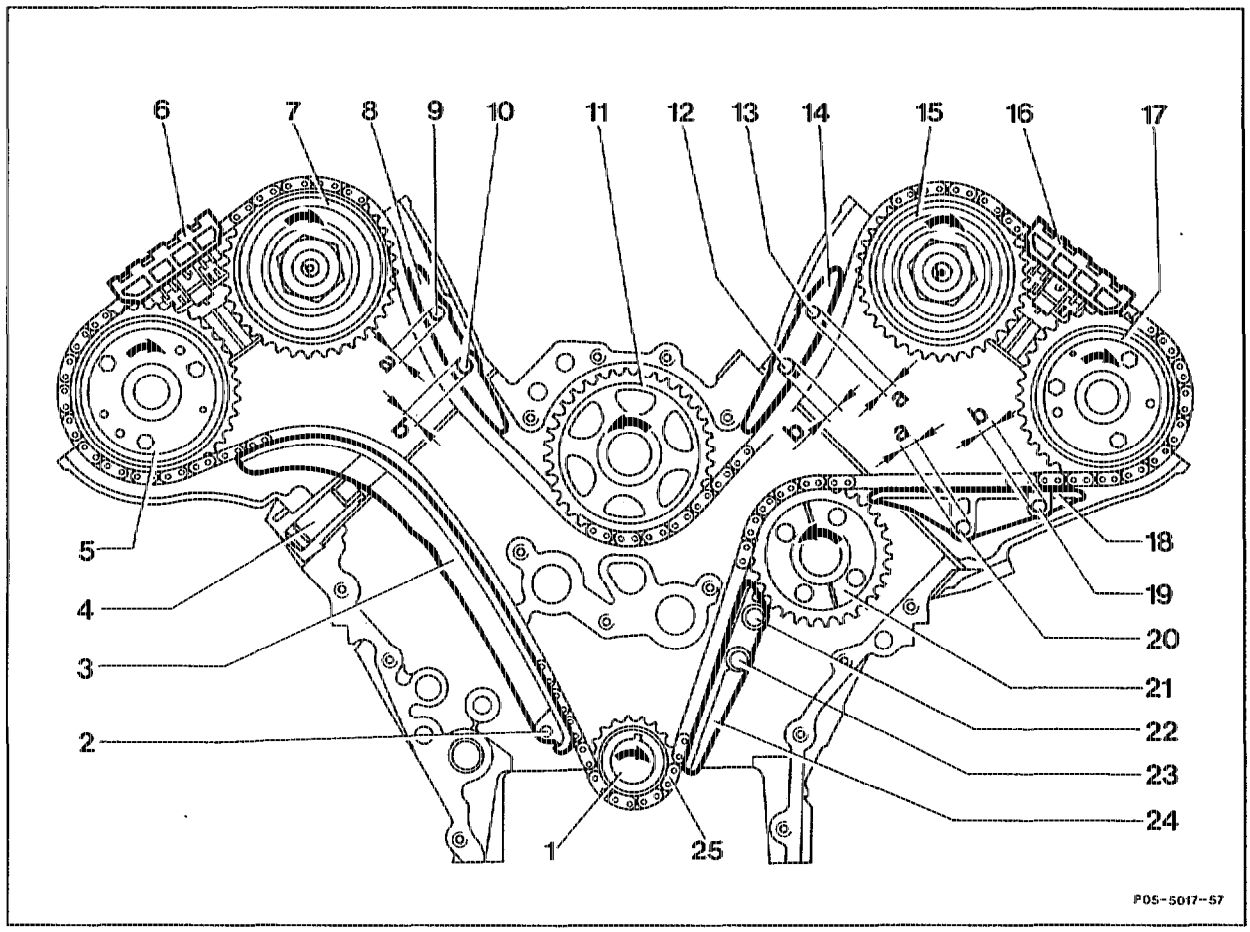
Preceding work:
Right camshaft adjuster removed (05–2170).
Belt pulley/vibration damper removed (03–3420).

Operation no. of operation texts and work units or standard texts and flat rates
05–8126

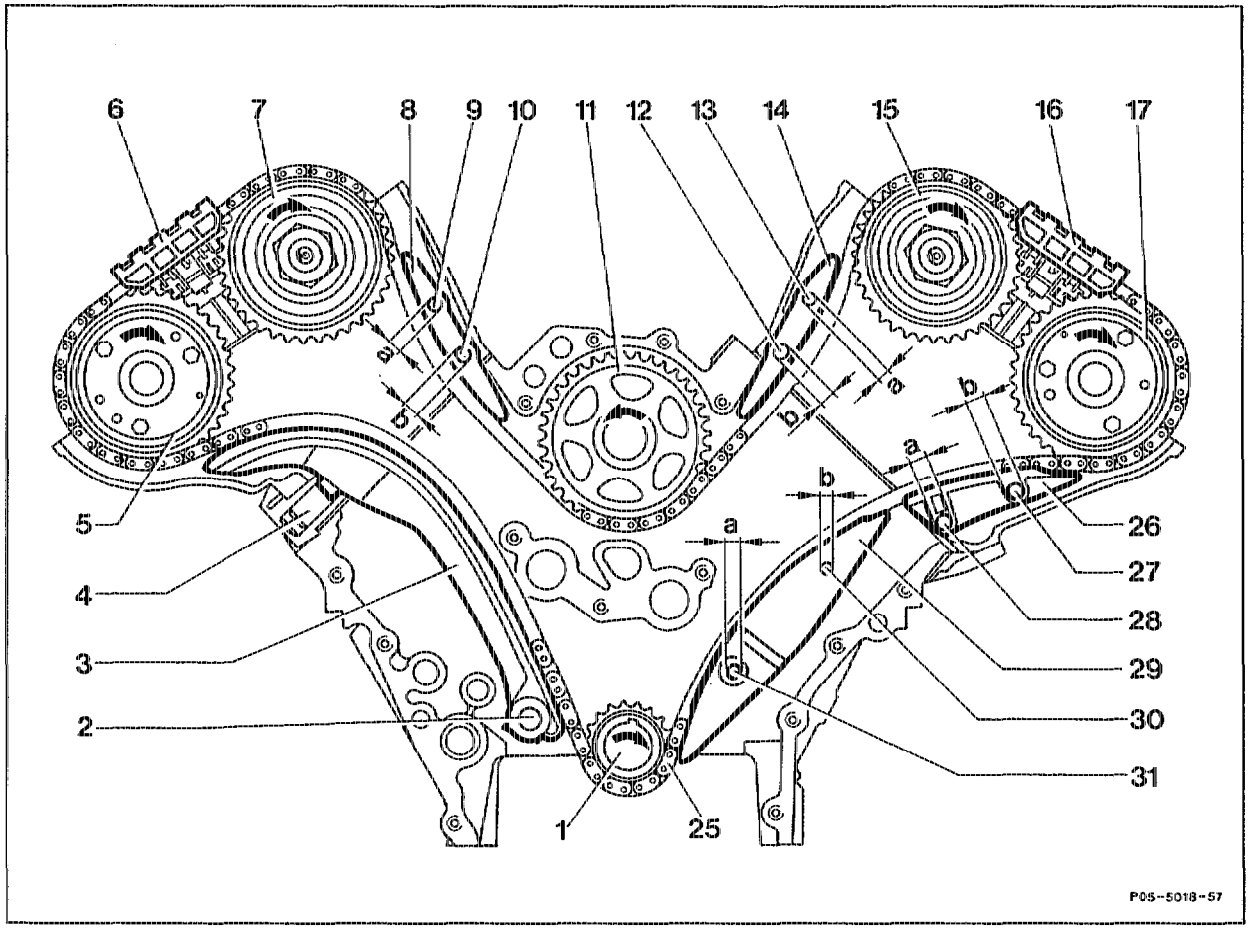


Screwplug (35) with seal (36)	unscrew, screw on (10 Nm).
	Installation note Replace seal (36) according to condition.
Tensioning rail pin (2)	pull off with impact extractor (02) and threaded insert (03), special tools 116 589 20 33 00 and 116 589 02 34 00.
Tensioning rail (3)	pull out of chain housing, insert.
Tensioning rail pin (2)	push in.
	Note Insertion size: pin to sealing ring contact (timing case cover), maintain 10 mm.

A. Engine 119.96



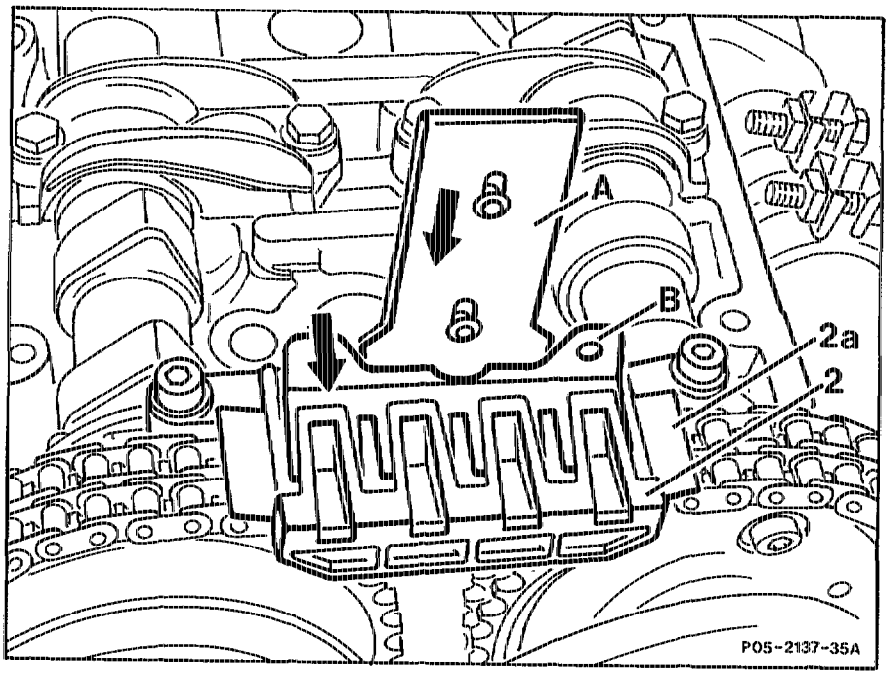
1	Crankshaft timing gear	14	Slide rail, inside left of cylinder head a = 8.1 mm b = 9 mm
2	Bearing pin dia. 12 mm		
3	Tensioning rail		
4	Chain tensioner	15	Inlet camshaft timing gear
5	Exhaust camshaft timing gear	16	Top slide rail
6	Top slide rail	17	Exhaust camshaft timing gear
7	Inlet camshaft timing gear	18	Slide rail, outside left cylinder head a = 8.1 mm b = 9 mm
8	Slide rail, inside right of cylinder head a = 8.1 mm b = 9 mm		
		19	Slide rail pin
9	Slide rail pin	20	Slide rail pin
10	Slide rail pin	21	Idler gear
11	Guide pulley	22	Bearing pin bolted
12	Slide rail pin	23	Bearing pin bolted
13	Slide rail pin	24	Slide rail, crankcase
		25	Timing chain, 228 double links



1	Crankshaft timing gear
2	Bearing pin
3	Tensioning rail
4	Chain tensioner
5	Exhaust camshaft timing gear
6	Top slide rail
7	Inlet camshaft timing gear
8	Slide rail, right of cylinder head a = 8.1 mm b = 9 mm
9	Slide rail pin
10	Slide rail pin
11	Guide pulley
12	Slide rail pin
13	Slide rail pin
14	Slide rail, inside left of cylinder head a = 8.1 mm b = 9 mm
15	Inlet camshaft timing gear
16	Top slide rail
17	Exhaust camshaft timing gear
25	Timing chain, 216 double links
26	Slide rail, outside left of cylinder head a = 8.1 mm b = 9 mm
27	Slide rail pin
28	Slide rail pin
29	Slide rail, crankcase a = 8.1 mm b = 9 mm
30	Bearing pin bolted
31	Bearing pin bolted

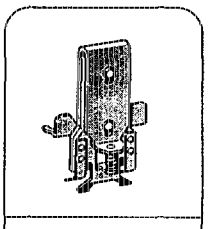
05-3350 Removing and installing guide rails at top of cylinder head

Preceding work:
Valve covers removed (01-0500).



Release device (B)	insert into top detents, special tool 119 589 01 63 03 (step 1).
Pusher (A)	fit onto the rail, special tool 119 589 01 63 00 (steps 2 to 3).
Pusher (A)	push down (step 4).
Front part of guide rail (2)	take off.
Guide rail (2a) with rubber gasket	unbolt, bolt on (9 Nm).

Special tools



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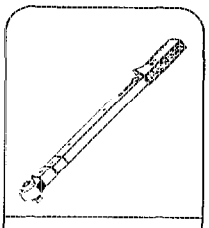
05



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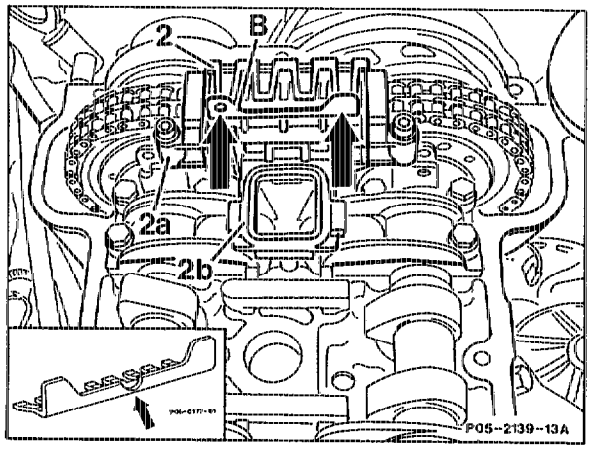
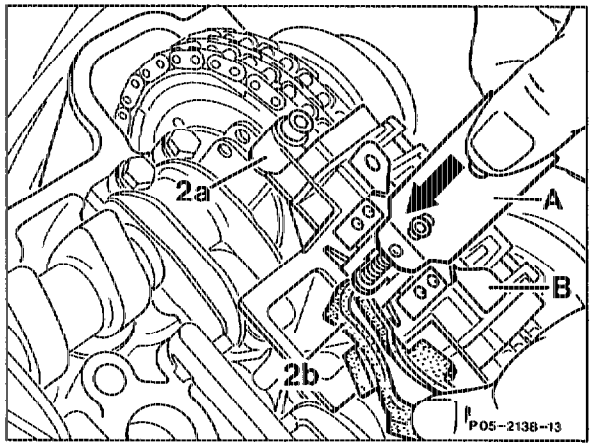
Removing, installing

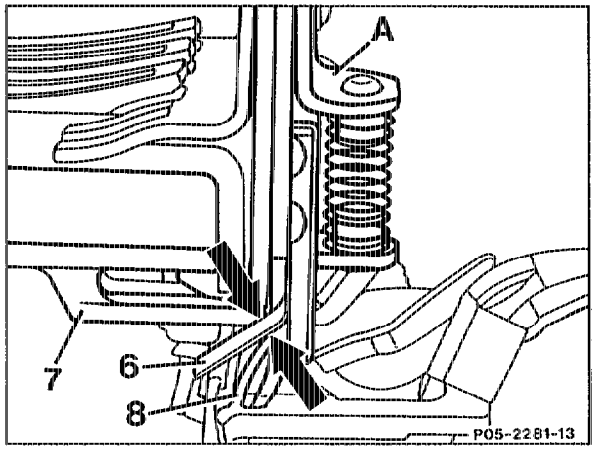
1 Release top detent of rail by inserting the release tool (B) in direction of arrow between bottom part of slide rail (2a) and top part (2).



2 Raise rubber gasket (2b) so that pusher (A) can be inserted at the slide rail (2a).



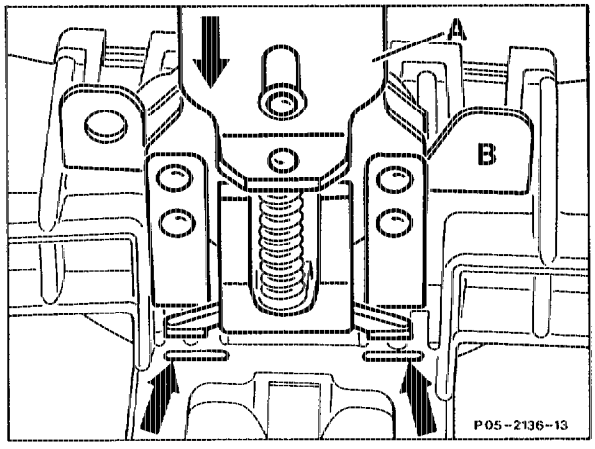
3 Guide the metal tabs (6) of the pusher (A) through between the bottom detent (7) and the locking tabs (8) (arrows).



4 Introduce pusher (A) into the slots (arrows) of the rail and press down vertically at the handle until front part of slide rail can be removed.

Intallation instruction
Ensure engaging points are correctly positioned.

5 Unscrew bottom part of slide rail (2a), tightening torque 9 Nm.

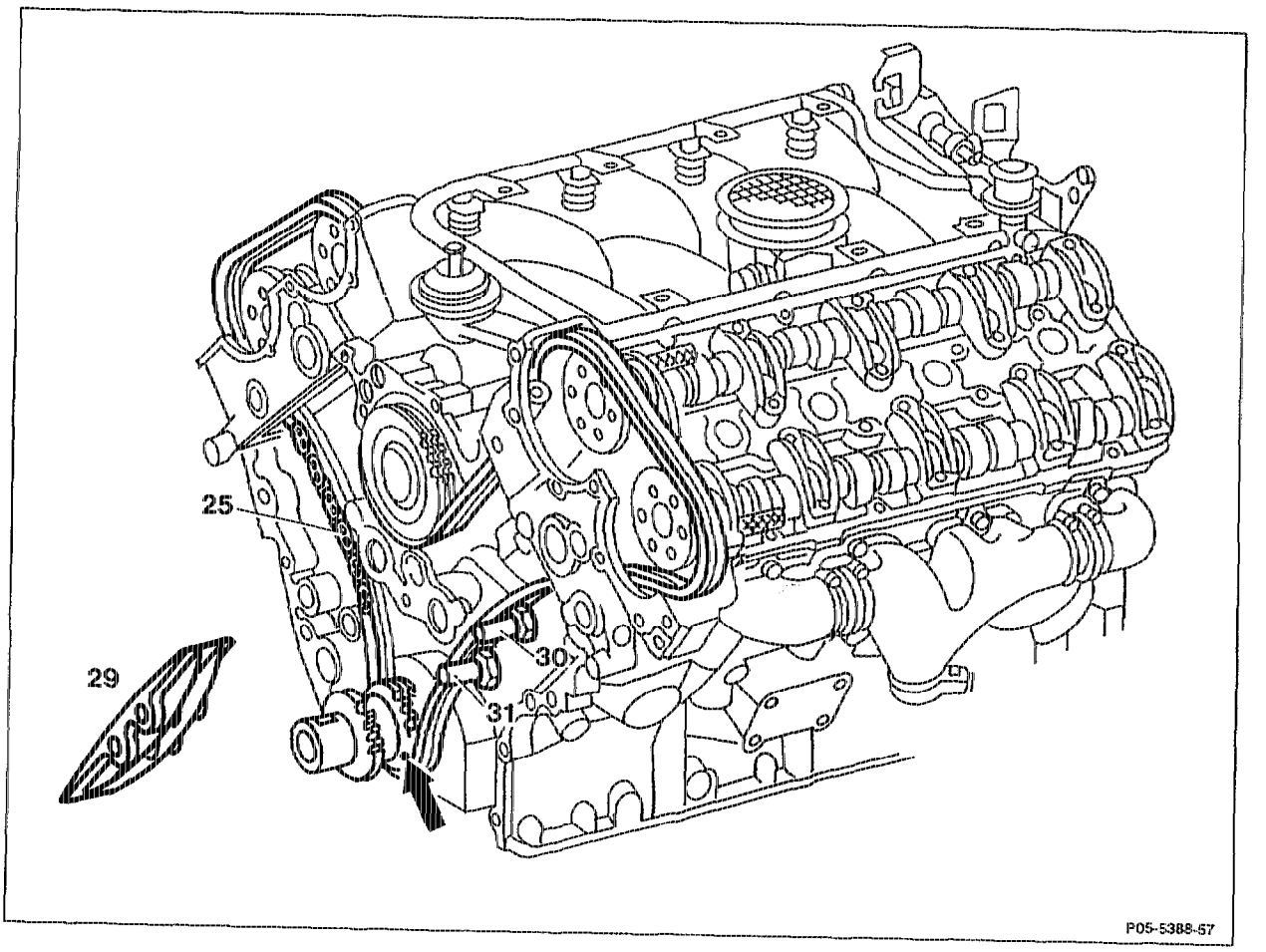


05–3400 Removing and installing guide rail in crankcase

Preceding work:
Timing case cover removed (01–2100).

Operation no. of operation texts and work units or standard texts and flat rates
05–8424

Engine 119.97



Crankshaft sprocket (1)	mark relative to timing chain (25) with coloured marking (arrow).
Guide rail (29)	pull off from bearing pin (30) and (31).
Guide rail (29)	install, pay attention to coloured markings; check basic position of camshaft if necessary (05–2230).