

Engine timing, valves 05

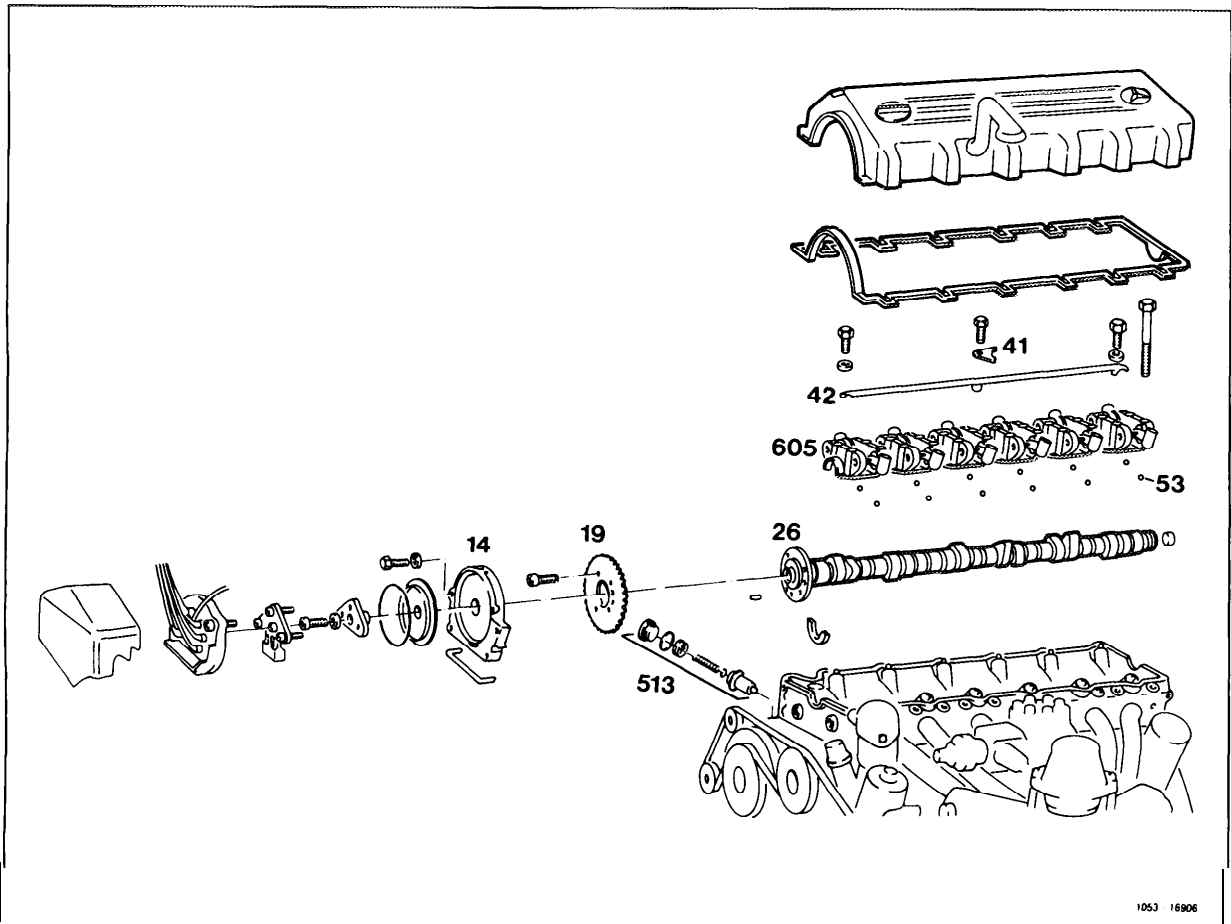


Job No.

Removing, installing camshaft	05 - 220
Removing, installing valve springs	- 250
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05-220 Removing, Installing Camshaft

Job No. of job texts and job values or standard
 texts and flat rates 05-5521, 05-5541
 05-6292 - 05-7050



Piston of No. 1 cylinder	set to TDC (step 1).
Front cover (14) at top	remove, install (01-212).
Chain tensioner (513)	remove, install (05-310).
Camshaft gear (19)	mark relative to camshaft (26), detach, attach. Tightening torque M6 – 11 Nm, M7 – 16 Nm (step 4).
Oil pipe (42)	remove, install. Pay attention to oil spray holes. Install only oil pipe 2nd version with retaining plate (41) (steps 7 and 8).
All rocker arm bearing brackets (605) with rocker arms	remove, install, 21 Nm (step 9).
Ball sockets (53)	take off, insert (step 10).
Cam and rocker arm sliding surfaces	oil.

In the reverse order install.
 Setting of camshaft (26) check (steps 16 and 17).
 Camshaft lubrication when engine running check (step 18).

Permissible test data

		When new	Wear limit
Camshaft bearing \varnothing	Normal size	30.934 – 30.950 mm	—
	Repair size	31.434 – 31.450 mm	—
Permissible variation in concentricity of middle bearing points and of camshaft gear seat when mounted in outer bearing points	Camshaft gear seat	0.025 mm	—
	Bearing point 2, 3, 4	0.030 mm	
Camshaft bearing play	radial	0.050 – 0.091 mm	0.11 mm
	axial	0.030 – 0.110 mm	0.15 mm
Scleroscopic hardness of cams		70 – 82	63

Timing in °CA at 2 mm valve lift

Code number of camshaft stamped on front of camshaft flange	Inlet valve		Exhaust valve	
	opens after TDC	closes after BDC	opens before BDC	closes before TDC
18, 36 ²⁾ 19 ¹⁾ , 37 ¹⁾²⁾	11.5" (12")	17.0"	18.5"	13.5"
22 ³⁾ , 42 ⁴⁾ , 49 ⁵⁾ 23 ¹⁾ , ³⁾ 43 ¹⁾⁴⁾ , 50 ¹⁾⁵⁾	11.5" (12°)	19.5"	21.5"	13.5"
20 Belgium 115 kW (power-reduced) 21 ¹⁾	16° (16.5")	0.5"	19.0"	14.5"
30 ³⁾ , 44 ⁴⁾ , 56 ⁵⁾ 31 ¹⁾³⁾ , 45 ¹⁾⁴⁾ , 57 ¹⁾⁵⁾	6.5" (7°)	14.0"	26.5"	18.5"
53 ⁶⁾ 54 ¹⁾⁴⁾	16.5" (17")	24"	21.5"	13.5"

1) Repair camshaft with 0.5 mm larger bearing diameter.

2) USA 1986.

3) Installed since May 1986 (M7 thread) for mounting camshaft gear.

4) Camshaft tin-coated, cam 1 mm wider, standard as from October 1986.

5) Chilled cast camshaft, as from February 1989 (follower mounting \varnothing 20 mm).

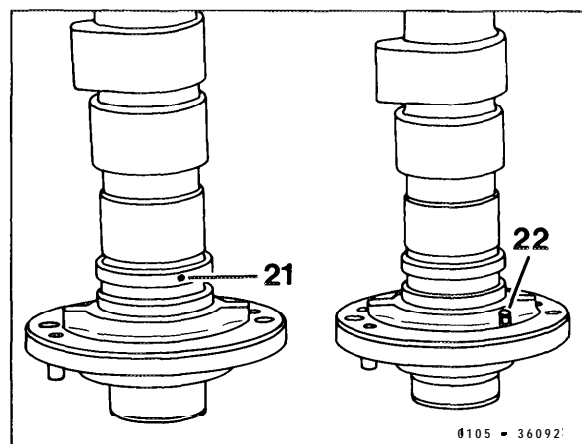
6) 103.984 as from March 1989 (follower mounting \varnothing 20 mm).

Settings for used timing chains in parentheses.

Note

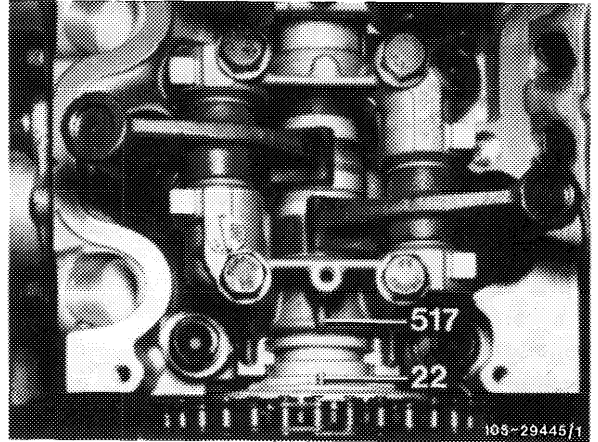
If the camshaft is renewed, the rocker arms must also be renewed.
Inductively hardened camshafts must only be used with hard chrome-plated rocker arms (standard up to February 1989).
Chilled cast camshafts may only be used with rocker arms with carbide metal coating (standard as from March 1989).
If bearing fretting or severe scoring exists, the camshaft bearings can be drilled open by 0.5 mm in the cylinder head or in the rocker arm bearing brackets and a camshaft with oversized bearing journals installed.
After damage to a cam (e. g. worn cams), all the affected timing parts (hydraulic elements, valves, valve springs, valve plates and valve wedges) should be checked for signs of damage.
If individual rocker arm bearing brackets are renewed, all the bearing brackets must be tightened to specification and the camshaft checked to ensure that it moves freely.

A positioning hole (21) is provided in place of the pin (22) as from December 1986.

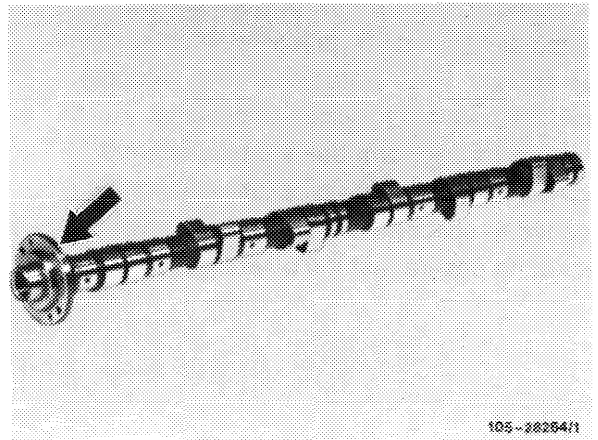


Basic setting

With No. 1 cylinder in TDC position, the pin (22) or the positioning hole (21) in the camshaft flange must be opposite the cast marking (517) on the 1st bearing bracket.

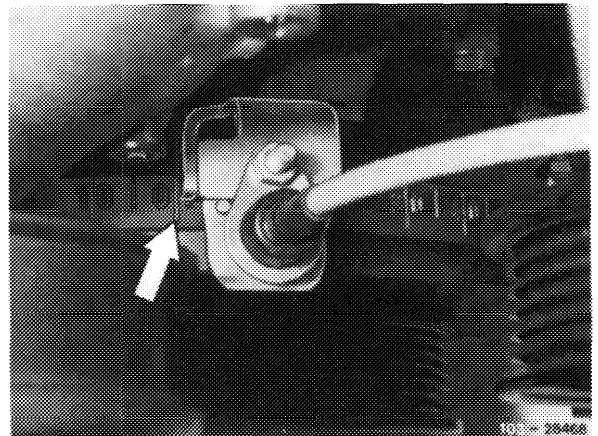


The camshaft code number is stamped in the flange (arrow).



Removal, installation

- 1 Set piston of No. 1 cylinder to TDC (arrow).
- 2 Remove front cover at the top (01-212).
- 3 Remove chain tensioner (05310).



4 Mark position of camshaft gear relative to camshaft. This is done by applying colored marking next to the locating pin (3) on the camshaft gear.

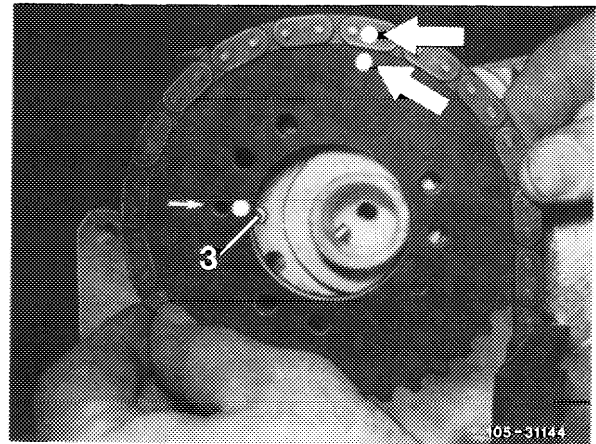
Note

If the camshaft gear is renewed, the colored marking must be applied to the corresponding point on the new camshaft gear.

The camshaft gear with 3 oblong holes (1st version) should be renewed if performing repairs with the camshaft gear 2nd version with 3 holes 0 6 m m .

The camshaft gear 2nd version can be used when performing repairs in place of the camshaft gear 3rd version with 3 holes \varnothing 7 mm. In this case the 3 holes should be widened from \varnothing 6 mm to \varnothing 7 mm.

The timing can be set by turning or changing the side of the camshaft gear on the camshaft (05215).

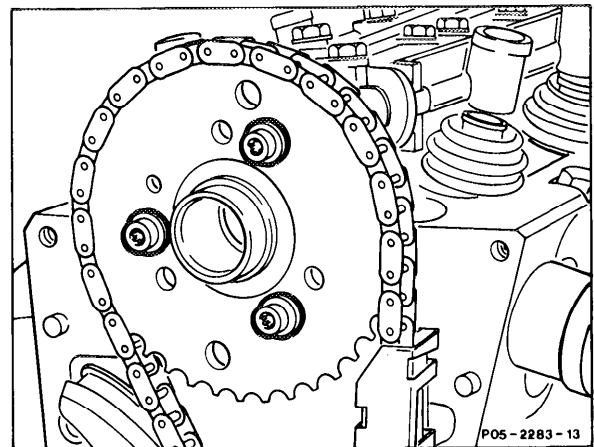


5 Unscrew bolts (16).

Tightening torque:

I-lex. socket bolts	M6 11 Nm
Tom bolts	M7 16Nm

6 Pull off camshaft gear (19) by hand.

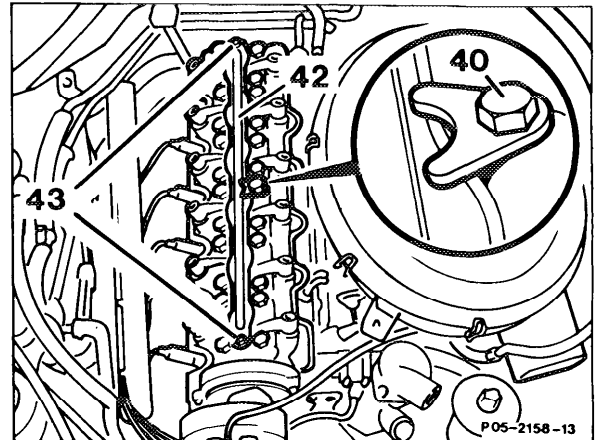


7 Unscrew bolts (40, 43). Take off oil pipe (42).



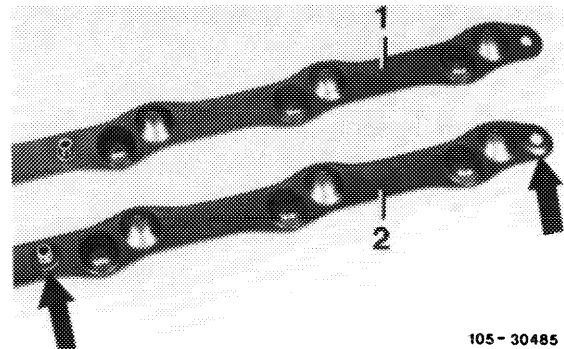
The shaped edge of the oil spray holes on the oil pipe must not be misshaped otherwise this will affect the spray direction.

The oil pipe (42) for lubricating the camshaft is attached additionally with a retaining plate (41) and a bolt (40) without washer on the 3rd rocker arm bearing bracket at the rear hole (inlet manifold side) since October 1986.



8 Check whether 1st or 2nd version of the oil pipe is installed.

The 1st version (1) must be replaced with the 2nd version (2), standard as from October 1986, and bolted on additionally to the 3rd rocker arm bearing bracket with a retaining plate (41).



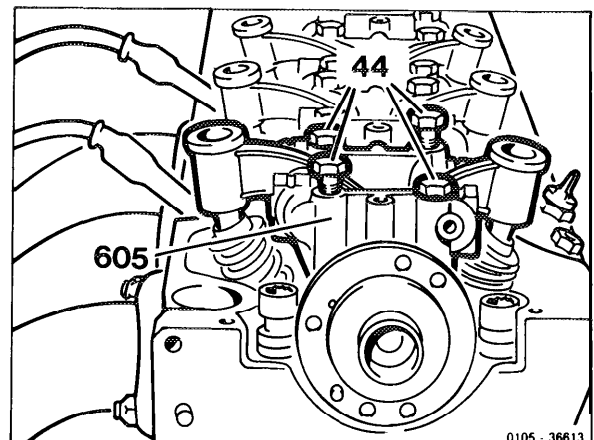
9 Unscrew bolts (44) in such a way that the rocker arm bearing bracket (605) is not tensioned, tightening torque 21 Nm.

Note

The rocker arm bearing brackets must be installed again at the same point and at the same attitude.

Use rocker arm 1st version with 3 mm wide reinforcing rib only with camshafts which are not chill cast.

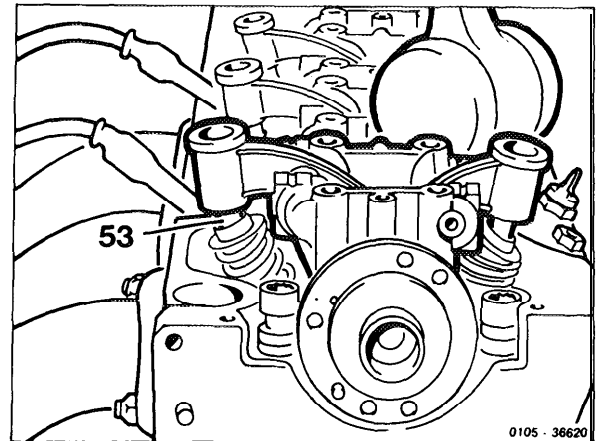
Use rocker arm 2nd version with 1.5 mm wide reinforcing rib only with chilled cast camshaft. The 2nd version of rocker arms have soldered-on carbide metal running surfaces.



10 Remove all rocker arm bearing brackets. (Slacken tight rocker arm bearing brackets with light blows from a plastic-headed hammer).



When taking off the rocker arm bearing brackets, the ball sockets (53) may catch on the hydraulic valve clearance compensating elements.



Installation instruction

The ball sockets must be installed again at the same point.

11 Take off ball sockets (53).

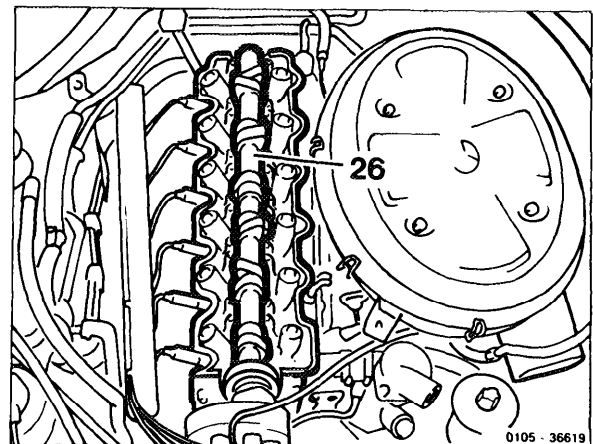
12 Lift out camshaft (26).

Note

When lifting out, pay attention to the thrust washer at the front (axial mounting).

13 Oil camshaft bearing journals.

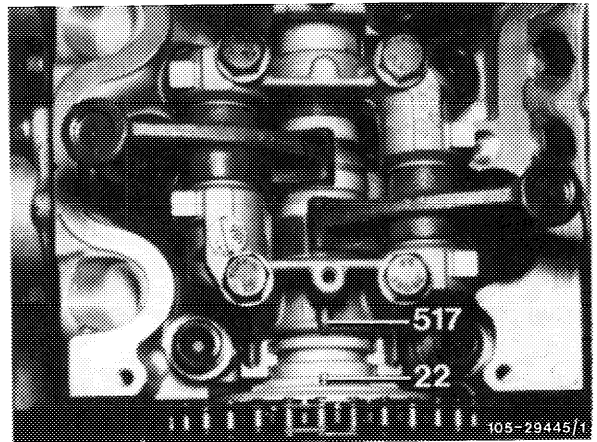
14 With No. 1 cylinder in TDC position, insert camshaft so that the pin (22) or the positioning hole (21) is facing up the way.



15 Oil cam and rocker arm sliding surfaces.

16 Fit on all rocker arm bearing brackets. Screw in all bolts by hand and tighten evenly, tightening torque 21 Nm.

17 Pin (22) or positioning hole on 1st camshaft flange must be aligned with the marking (517) when No. 1 cylinder is in the TDC position.



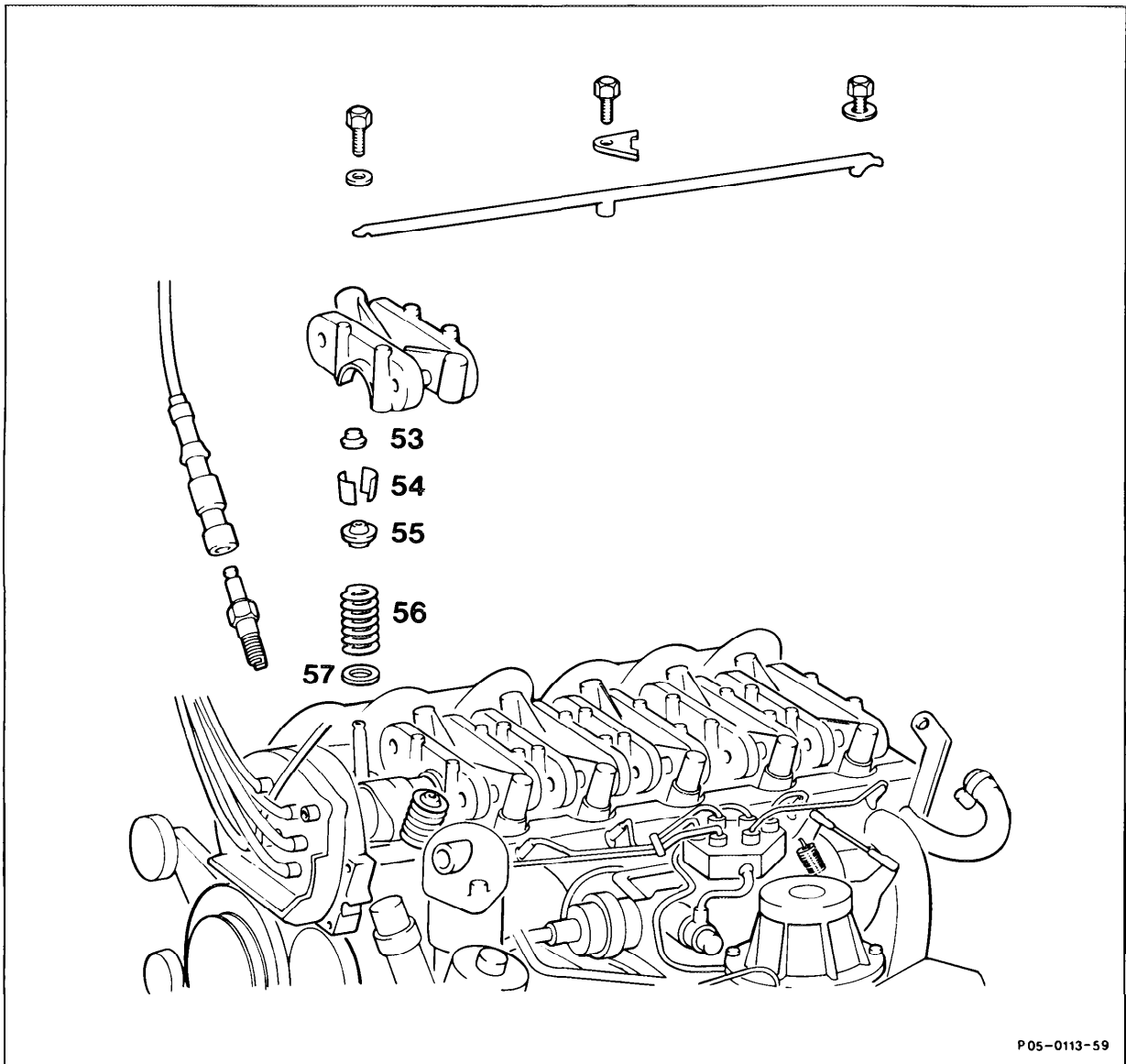
18 Check the oil supply (spray direction) of the camshaft at idling speed.

Note

If damage to a camshaft has been caused by a lack of oil resulting from a loose oil nozzle return lock without stop collar, an oil nozzle return lock with stop collar must be installed (standard as from December 1986) (18-415).

05-250 Removing, Installing Valve Springs

Job No. of job texts and job values or standard
 texts and flat rates 05-3510

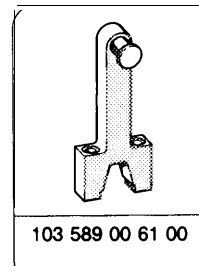
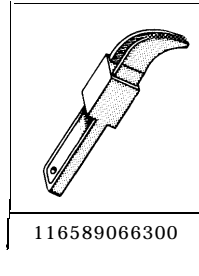
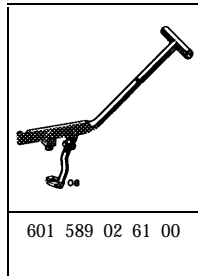
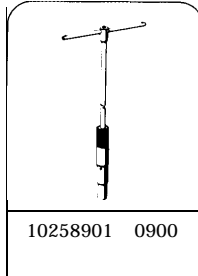


P05-0113-59

- | | |
|---|--|
| Rocker arm bearing bracket of respective cylinder | remove, install. |
| Ball sockets (53) | take off, insert, use magnetic finger 116 589 06 63 00 (step 2). |
| Piston of respective cylinder | set to TDC (step 3). |
| Supporting bracket 103 589 00 61 00 | install (step 4). |
| Respective cylinder | pressurize (steps 5 to 7). |

Valve collet halves (54), valve spring plate at top (55),
 and valve springs (56) remove, install, use lever pusher
 601 589 02 61 00 (steps 8 to 10).

Special tools



Note

Valve springs, top and bottom valve spring plates
 with scoring on the contact surfaces must be
 replaced.

Commercial tool

Cylinder leaktightness tester

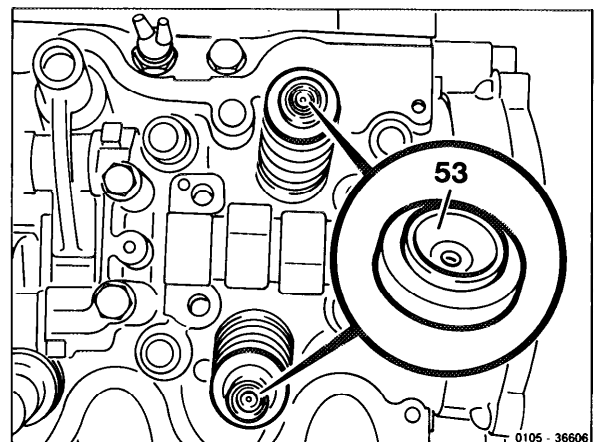
e. g. Bosch, E F A W 210 A
 Sun, CLT 228

Removal, installation

- 1 Remove rocker arm bearing bracket of the
 respective cylinder (05-235).
- 2 Take out ball sockets (53) using magnetic
 finger 116 589 06 63 00.

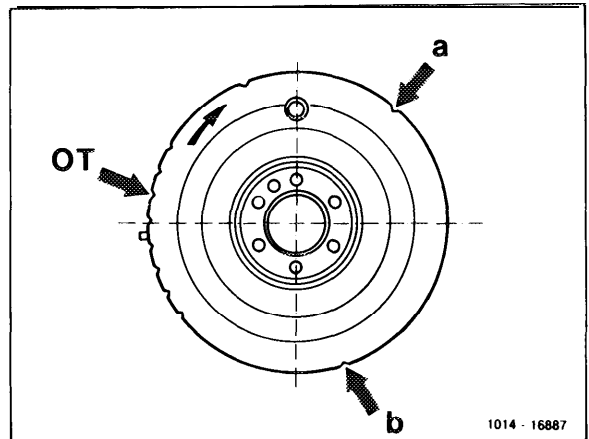
Installation instruction

Ball sockets must be re-installed again at the
 same point.



3 The respective pistons are in ignition TDC position when the marking shown in the drawing opposite (arrows) on the flywheel damper are aligned with the TDC pointer and the cams of the respective cylinder are facing up the way.

Marking	TDC	b = 120	a = 240
Piston in TDC Cylinder	1 and 6	2 and 5	3 and 4



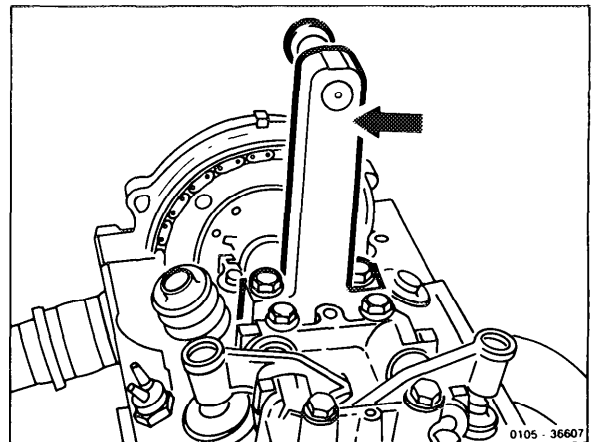
4 Screw supporting bracket (arrow) 103 589 00 61 00 onto cylinder head.

5 Detach spark plug connector of the respective cylinder. Blow out spark plug recesses with compressed air.

6 Unscrew spark plug.

Installation instruction

Tighten spark plugs to 20 Nm.



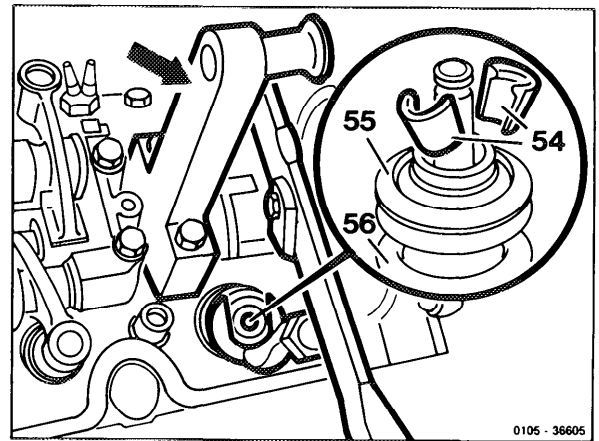
7 Screw connection hose of cylinder leaktightness tester into the spark plug hole and pressurize compression chamber (approx. 5 bar).

8 Attach lever presser 601 589 02 61 00 to the supporting bracket (arrow) and place against valve spring plate (55).

Detach the valve collet halves (54) with light blows to the valve spring plate (55).

9 Compress valve spring and remove valve collet halves (54) with magnetic finger 116 589 06 63 00.

10 Take out valve spring plate (55), valve spring (56).



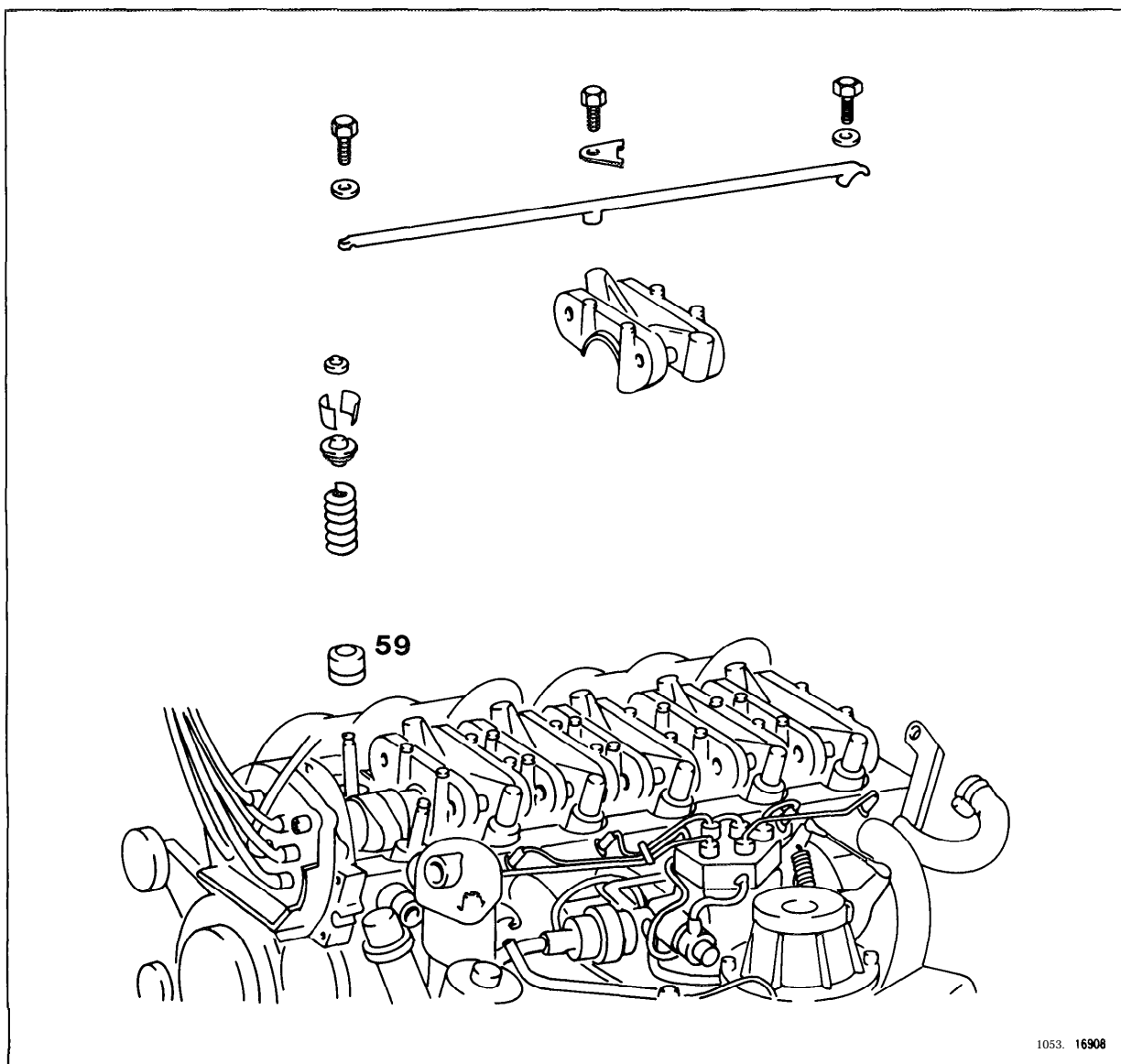
Note

The valve spring plates and valve springs of the exhaust and inlet valves are identical.

Install in the reverse order.

05-270 Renewing Valve Stem Seals

Job No. of job texts and job values or standard
 texts and flat rates 05-3510



1053. 16908

- | | |
|-----------------------------|---------------------------|
| Valve springs | remove, install (05-250). |
| Valve stem seals (59) | remove, install. |
| Valve stem | deburr, if necessary. |

Valve stem
seal
identification

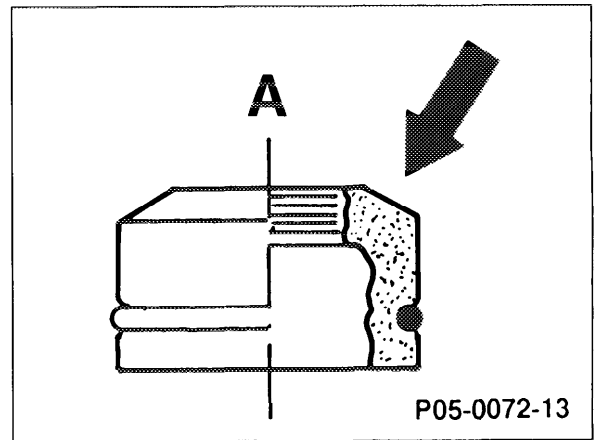
Part No.

Color

Repair kit
Exhaust

102 053 03 58 bright zinc-
coated
(yellow)

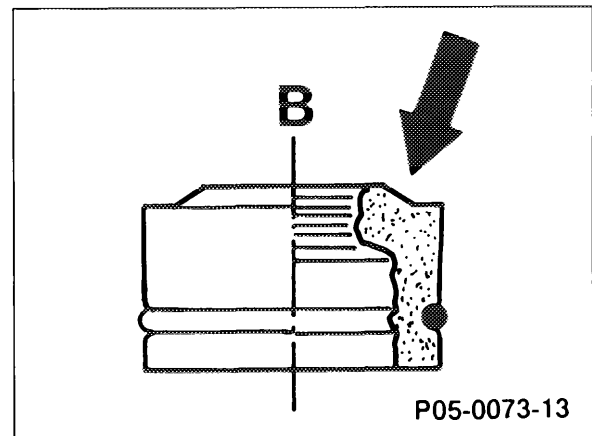
0 9 m m



Repair kit
Inlet

103 053 16 58 phosphatized
(black)

0 8 m m



Note

Exhaust and inlet valve stem seals and assembly sleeves are supplied as a repair kit.

The assembly sleeves must be used to prevent the valve stem seals from being damaged.

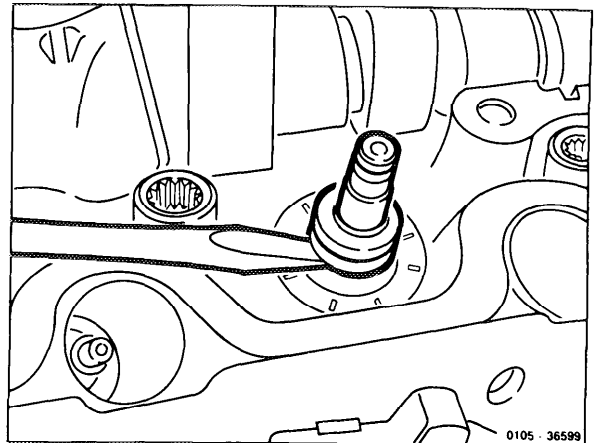
Valve guides which are worn at the retaining slot for the valve stem seals and valves with damaged valve ends or valve stem must be renewed.

Renewal

- 1 Remove valve springs (05250).
- 2 Use a screwdriver to press off valve stem seal or pull off with pliers.



Do not damage cylinder head, valve stem and valve guide.



- 3 Fit assembly sleeve onto the valve stem on the inlet valve.
- 4 Oil valve stem seal and press on by hand.

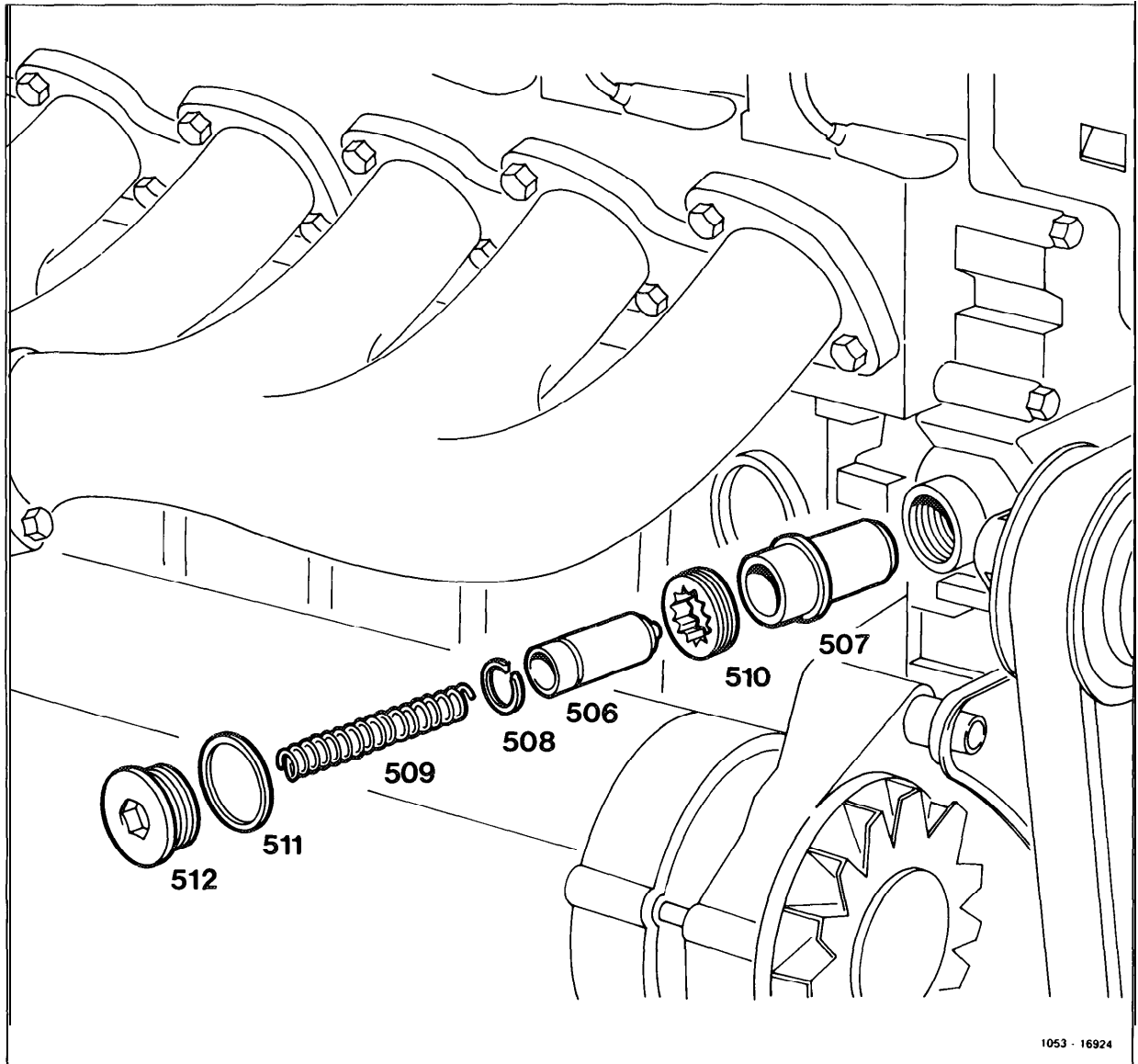


Pay attention to matching of different valve stem seals as shown in table.

Install in the reverse order.

05-310 Removing, Installing Chain Tensioner

Job No. of job texts and job values or standard
 texts and flat rates 05-7800, 05-7801

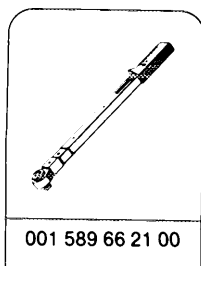


1053 - 16924

- | | |
|---|---|
| Hood | raise to vertical position (01-008). |
| Screw plug (512) with seal (511) and compression spring (509) | unscrew, take out (step 1). |
| Threaded ring (510) | unscrew (step 2). |
| Chain tensioner housing (507) with pressure pin (506) | withdraw (step 3). |
| Pressure pin (506) with detent spring (508) | press out of chain tensioner housing (507) in direction of pressure (step 4). |

Chain tensioner housing (507) into mounting hole	insert (step 5).
Threaded ring (510)	screw in, tighten, 30 Nm (step 6).
Pressure pin (506) with detent spring (508) and compression spring (509)	insert (step 7).
Screw plug (512) with seal (511)	screw in, tighten, 50 Nm (step 8).
Leaktightness	check.

Special tool



Commercial tools

Pin wrench insert
17 mm, 1/2" square

e. g. Hazet,
D-5630 Wemscheid
Order No. **985/17**

Pin wrench insert
12 mm, 1/2" square

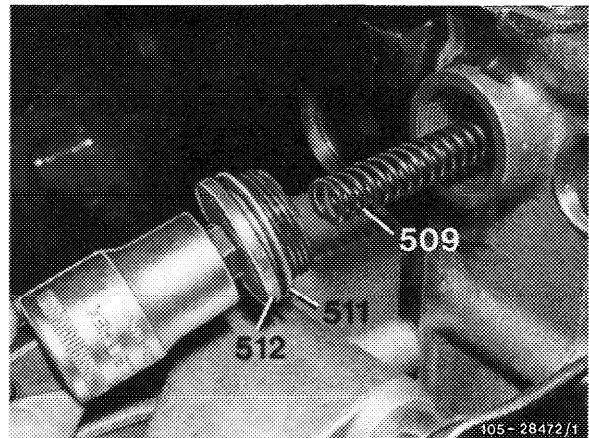
e. g. Hazet,
D-5630 Wemscheid
Order No. **985/12**

Removal, installation

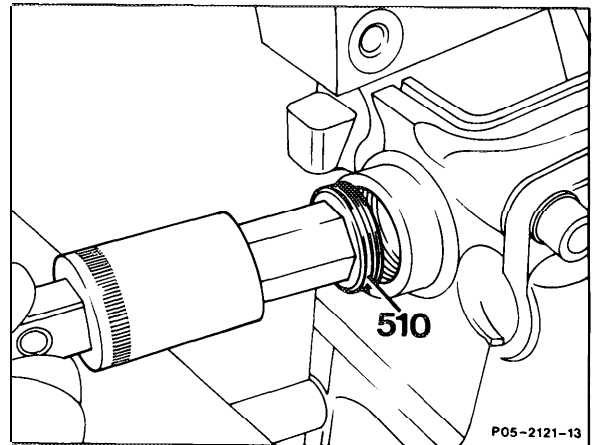
- 1 Unscrew plug (512) with seal (511).
Take out compression spring (509).



The screw plug is pressurized by the compression spring.



2 Unscrew threaded ring (510).

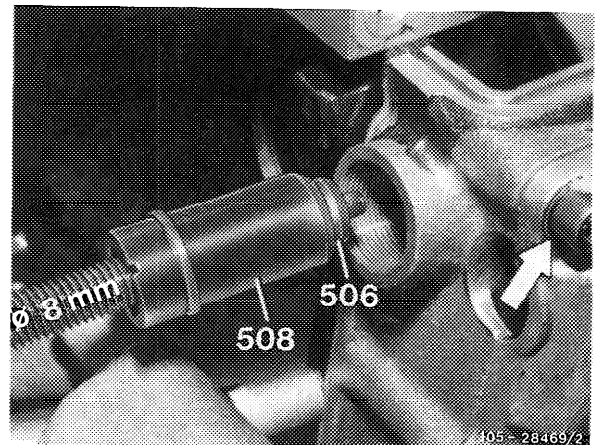


3 Withdraw chain tensioner with the aid of an M8 bolt.

The M8 bolt cannot be screwed in but should only be angled.

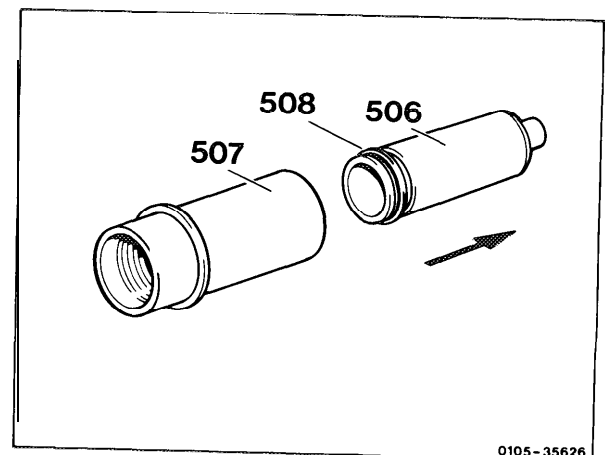
If it is not possible to withdraw the chain tensioner, slacken hex. socket bolt (arrow).

With the cylinder head cover removed, press with the handle of a hammer on the tensioning rail.

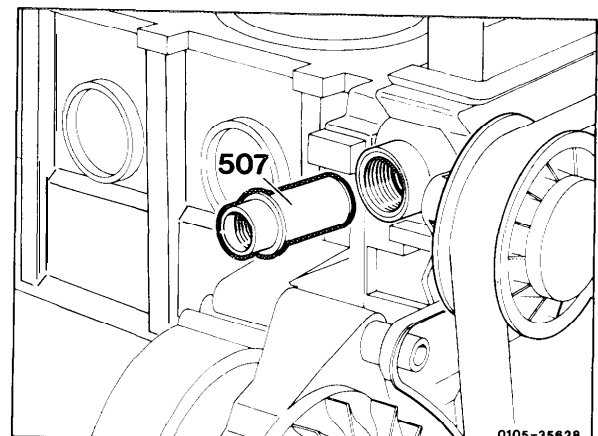


4 Chain tensioner must be disassembled before installing. This is done by pressing the pressure pin (506) with detent spring (508) out of the chain tensioner housing (507) in direction of arrow.

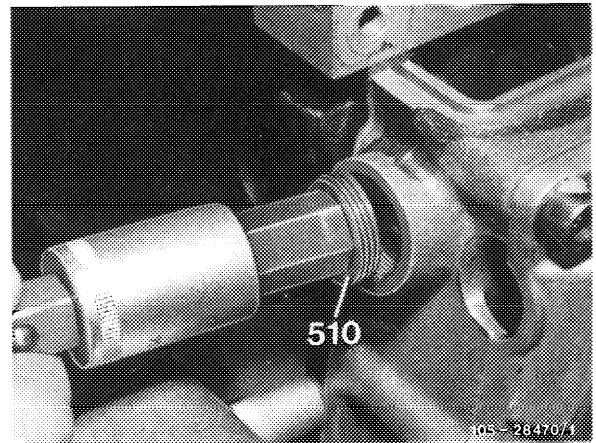
Thoroughly clean all parts.



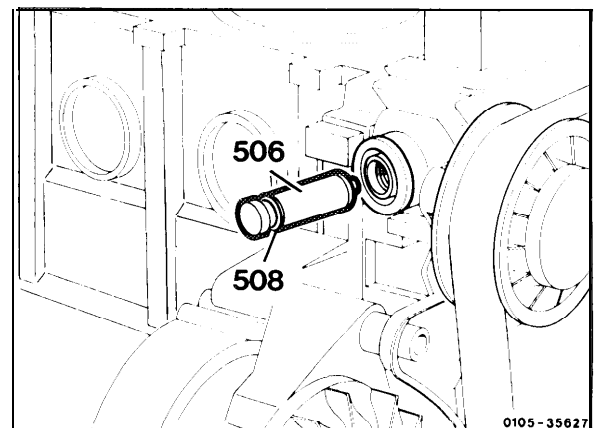
5 Insert chain tensioner housing (507) into mounting bore.



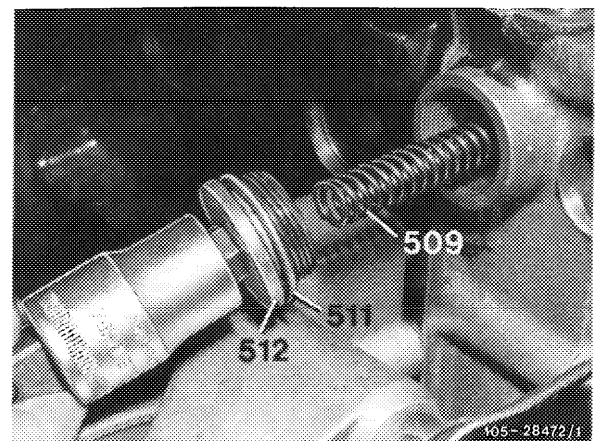
6 Screw in threaded ring (510), tightening torque 30 Nm.



7 insert pressure pin (506) with detent spring (508) into the assembled chain tensioner housing.



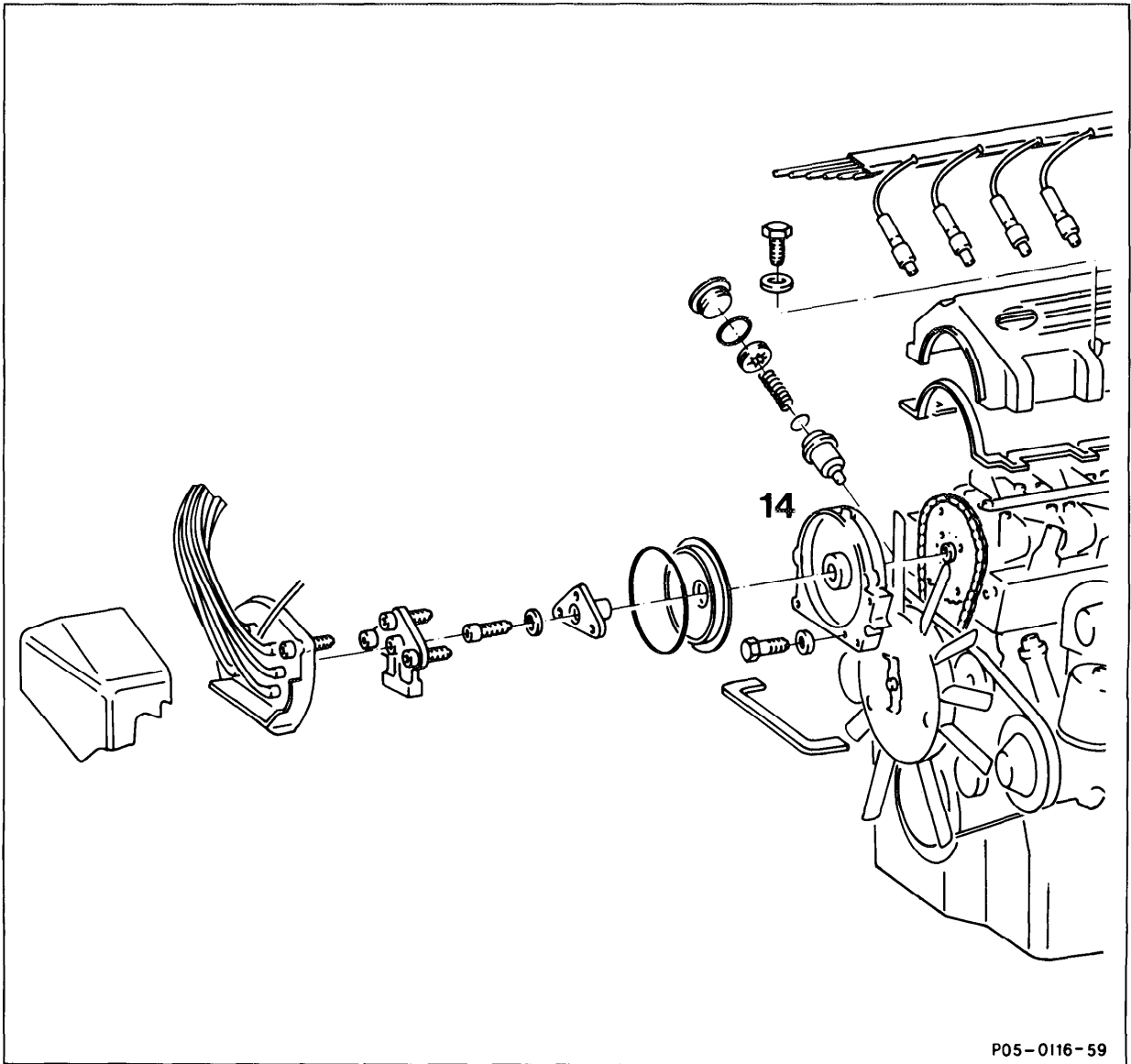
8 Install compression spring (509) and screw plug (512) with new seal (511). Tighten screw plug (512) to 50 Nm.



9 Run engine and check for signs of leaks.

05-320 Renewing Timing Chain

Job No. of job texts and job values or standard
 texts and flat rates 05-7601

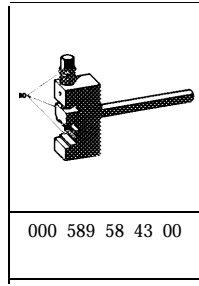
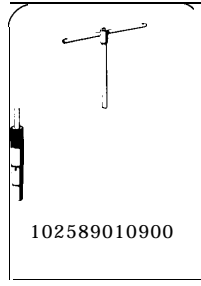
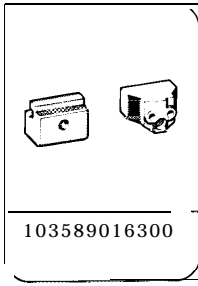


P05-0116-59

Front cover at top (14)	remove, install (01-212).
Chain tensioner	remove, install (05310).
All spark plugs	remove, install, 20 Nm (steps 3 to 5).
Chain pin	grind open (step 6).
New timing chain to old timing chain	connect, draw in (step 7 to 9).
New timing chain with rivet link	connect (step 10).
Plate	103 589 01 63 00, insert in rivet tool 000 589 58 43 00, press on (steps 13 to 15).

Rivet tool take off, change over (step 16).
Individual pins of rivet link rivet, 30 Nm (steps 17 and 18).

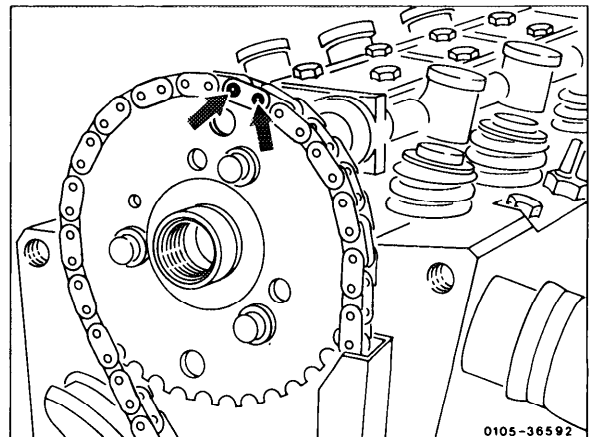
Special tools



- 1 Remove front cover (14) at top (01-212).
- 2 Remove chain tensioner (14) (05310).
- 3 Detach all spark plug connections.
- 4 Blow out spark plug recesses with compressed air.
- 5 Unscrew all spark plugs, tightening torque 20 Nm.

6 Cover over the exposed part of the chain box with a clean cloth and grind open both chain pins (arrows) **at a double link** of the timing chain.

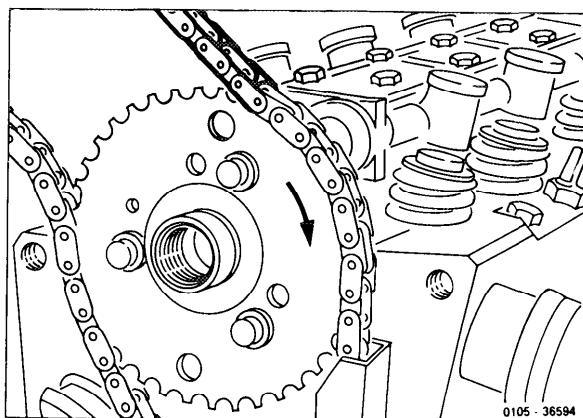
7 Attach new timing chain with the rivet link to the old timing chain.
This is done by pressing out the ground open double link.



8 Fit new timing chain connected to old timing chain onto the camshaft gear. Slowly turn crankshaft in direction of rotation of engine.



The timing chain must remain meshed when turning the camshaft gear.

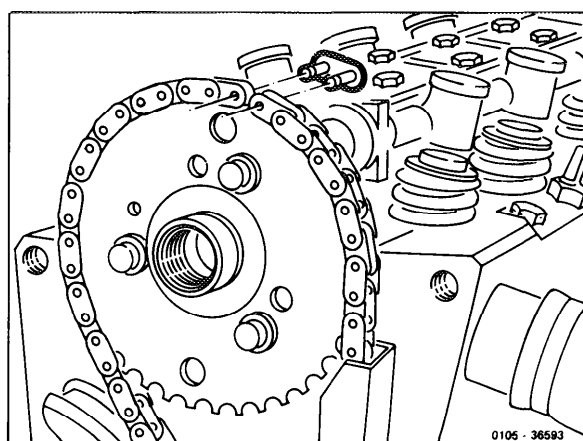


9 Pull out the exposed end of the old timing chain evenly corresponding to the new timing chain being drawn in.

10 Turn crankshaft long enough for it to be possible to connect the ends of the new timing chain to the rivet link.

Note

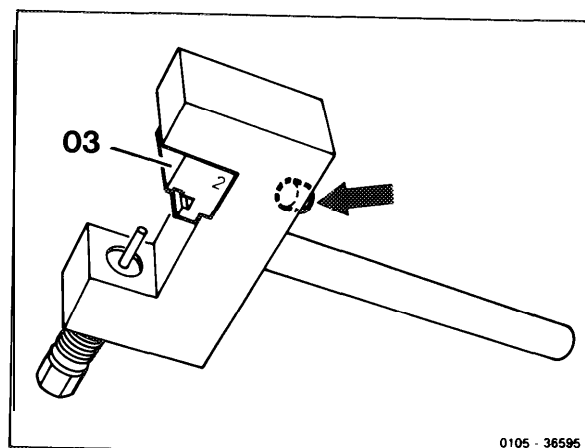
Rivet link must be inserted from behind.



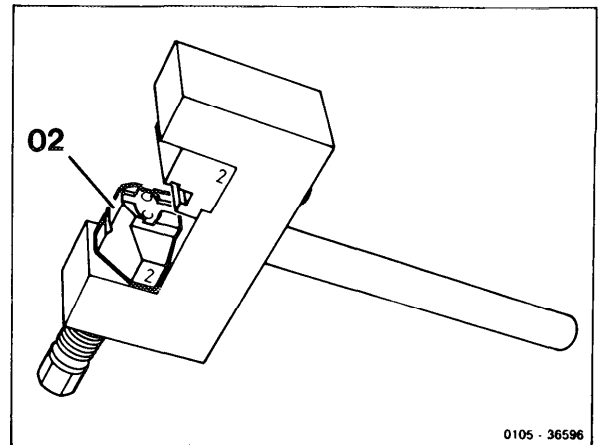
11 Insert thrust piece (03) as shown in drawing into the rivet tool and tighten with the screw (arrow).

Note

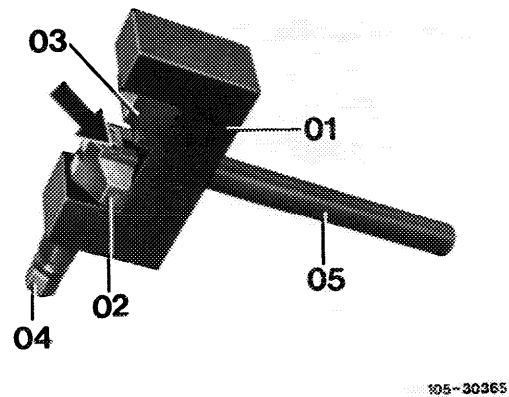
The figure 2 is stamped on the side of the thrust piece (03).



12 Insert moving jaw (02) with the figure 2 into the rivet tool as shown in the drawing.



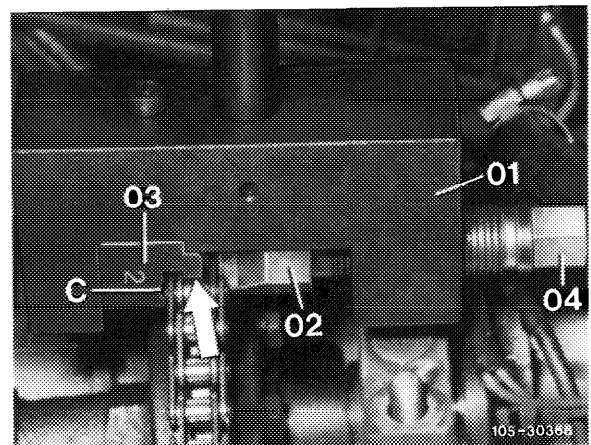
13 Insert plate (arrow) into the moving jaw (02).



14 Fit web (arrow) onto both rollers on the rivet link.

Note

Rivet heads of the rivet link pins must be guided in the slot (C).

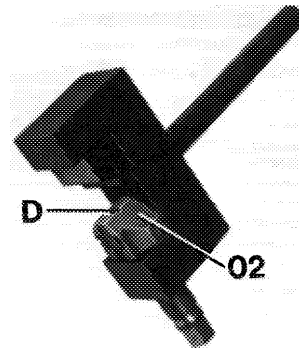


15 Screw in spindle (04) until a firm resistance is felt.

Note

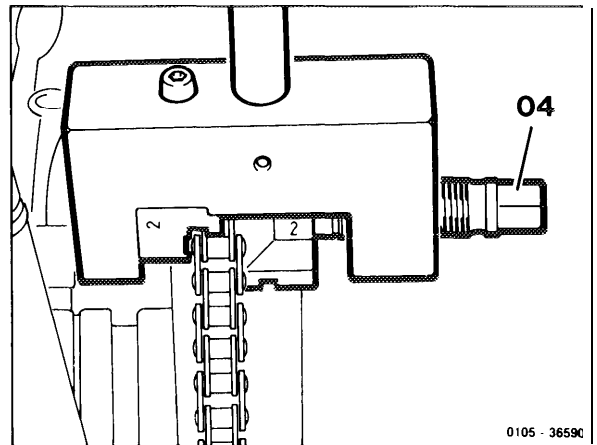
When screwing in, ensure that the pins of the rivet link can be guided into the holes of the plate.

16 Take off rivet tool and change over the moving jaw (02) to the rivet profile (D).



105-30367

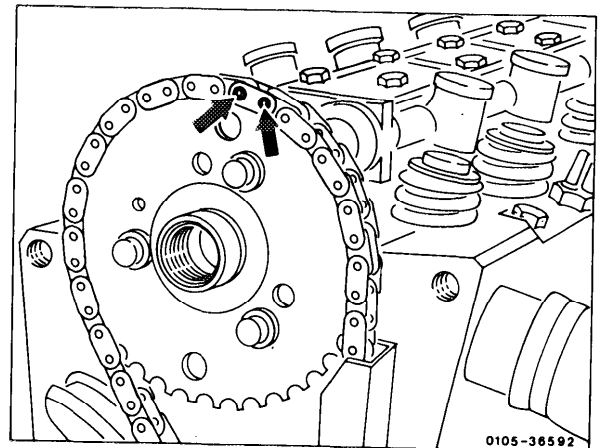
17 Position rivet tool exactly over center of pin.
Rivet pins of the rivet link individually by tightening the spindle (04) to approx. 30 Nm.



0105-36590

18 Check riveting (arrows), re-rivet if necessary.

19 Install in the reverse order.

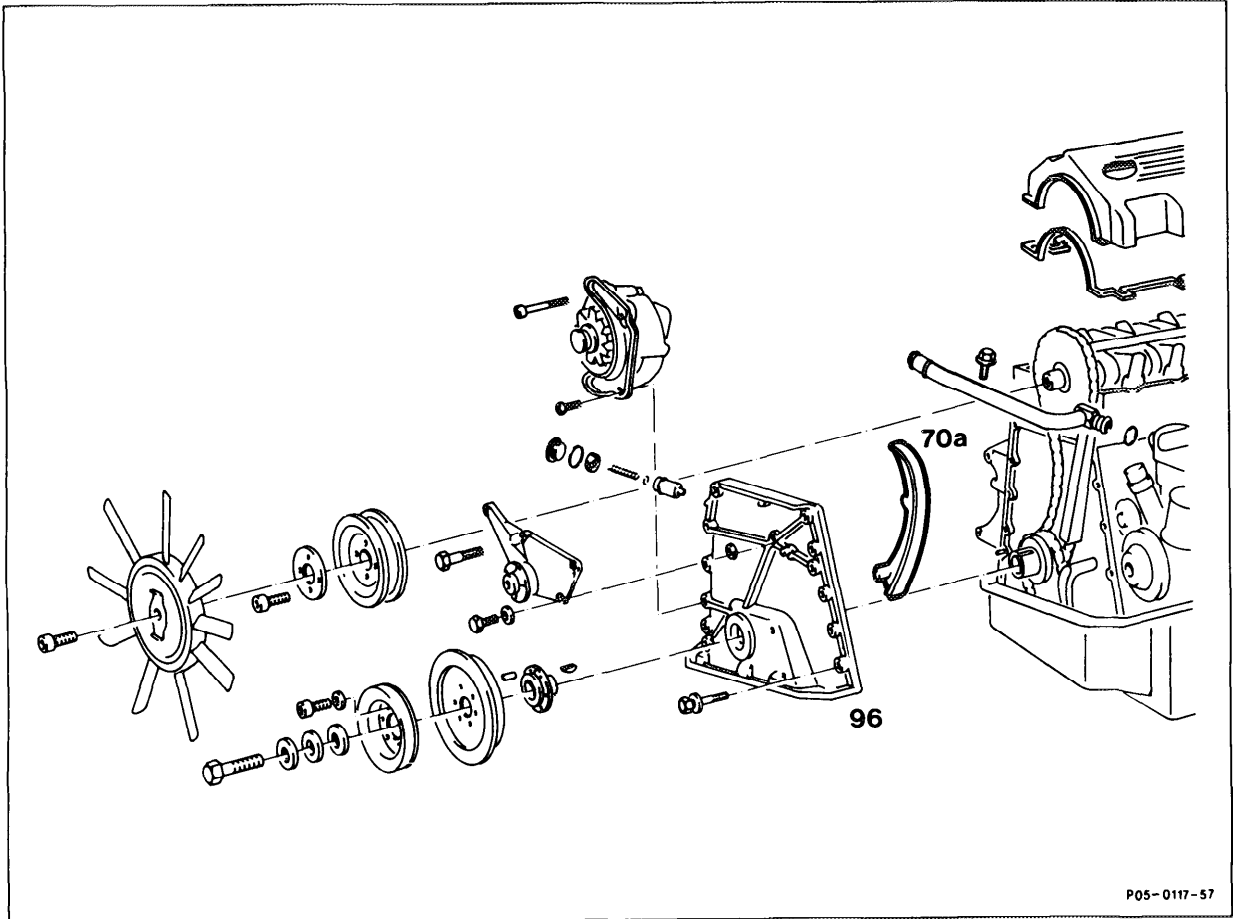


0105-36592

05-330 Removing, Installing Tensioning Rail

Job No. of job texts and job values or standard
texts and flat rates

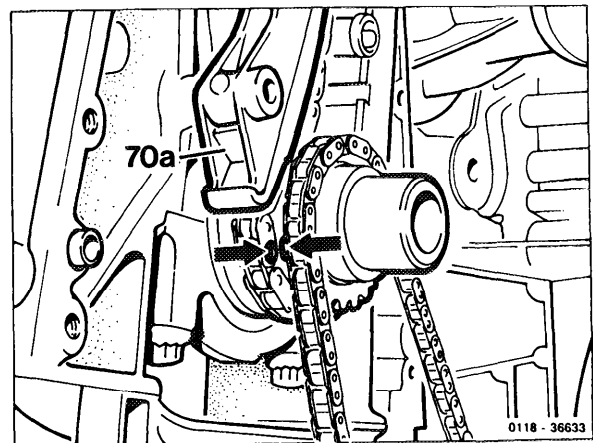
OS-81 21



Timing case cover (96)	remove, install (01-210).
Timing chain with crankshaft gear	mark (step 2).
Tensioning rail (70a)	remove, install.
Setting of camshaft	check.

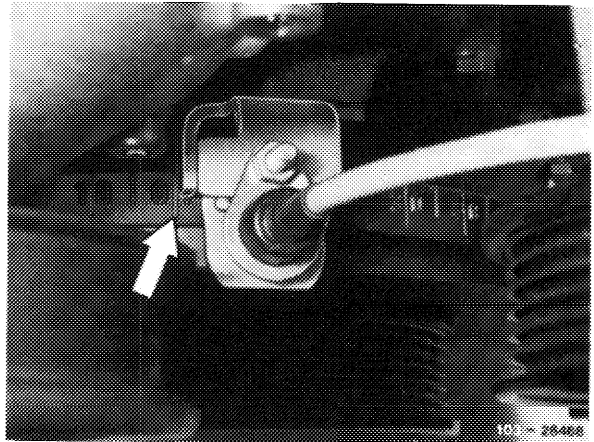
Removal, installation

- 1 Remove timing case cover (96) (01-210).
- 2 Mark timing chain with crankshaft gear (arrows).
- 3 Take off tensioning rail (70a).

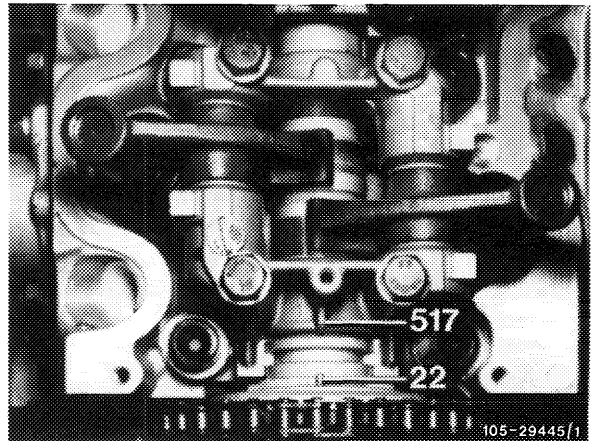


Installation instruction

Position piston of No. 1 cylinder to TDC (arrow).

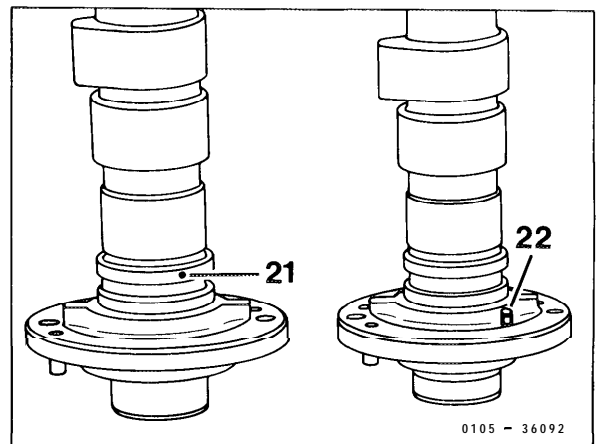


Positioning marking (22) or positioning hole of camshaft must be aligned with the marking (517) on 1st camshaft bearing.



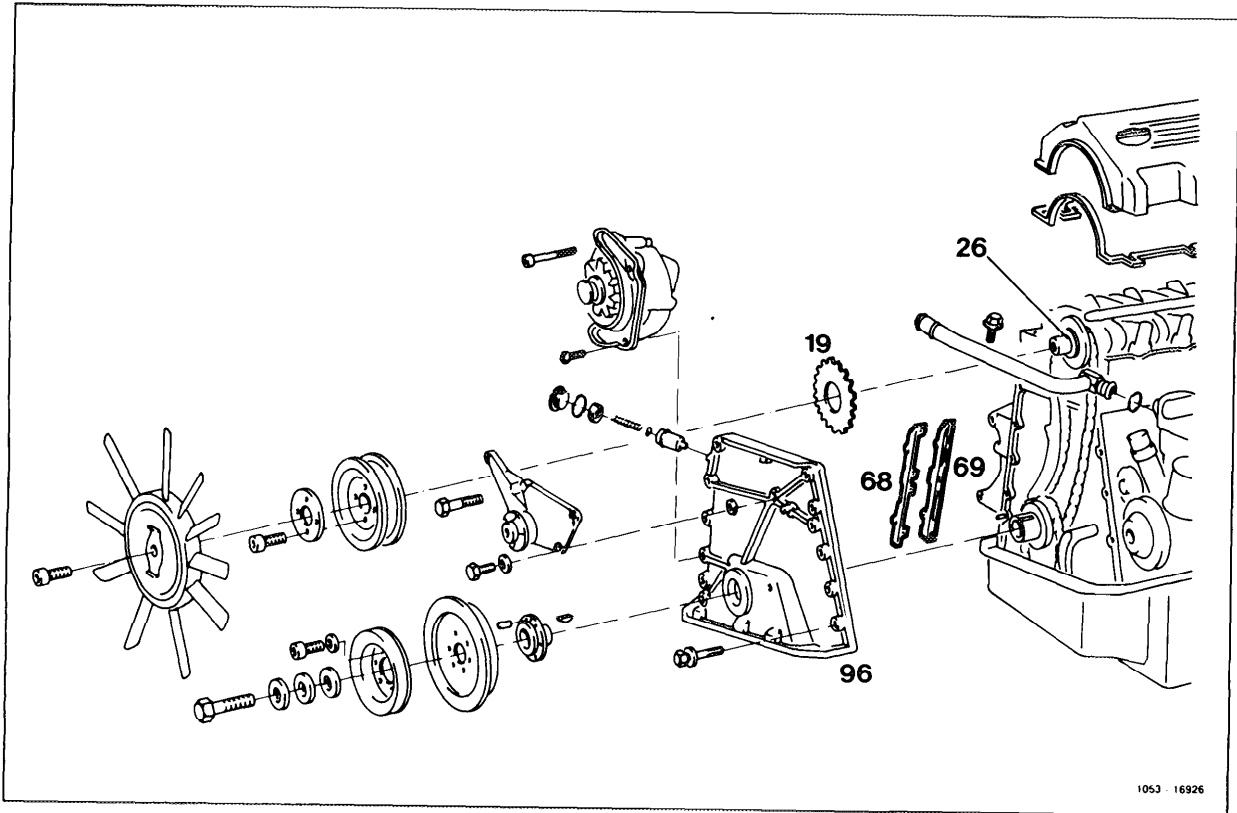
Only the positioning hole (21) is provided in place of the pin (22) as from 12/86.

Install in the reverse order.



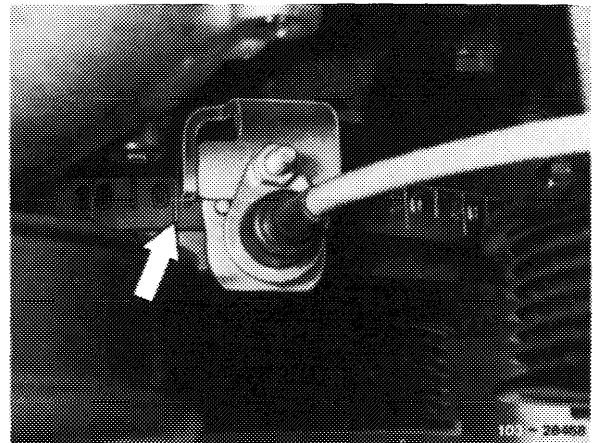
05-335 Removing, Installing Guide Rail

Job No. of job texts and job values or standard texts and flat rates

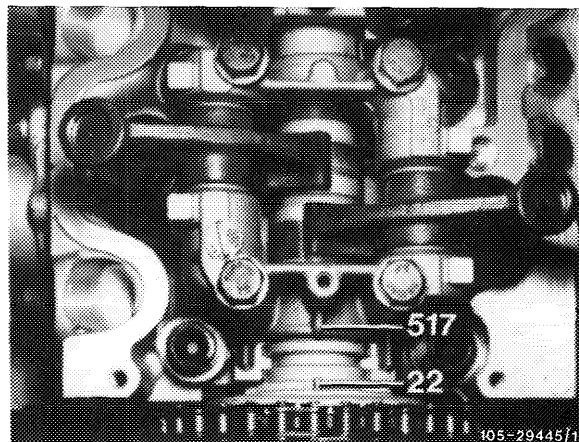


Piston of No. 1 cylinder	set to TDC (step 1).	
Timing case cover (96)	remove, install (01-210).	
Camshaft gear (19) to camshaft (26)	mark, detach and attach,	M6 11 Nm
	tightening torque	M7 16Nm
	(steps 4 and 5).	
Guide rail (68, 69)	remove, install (step 6).	

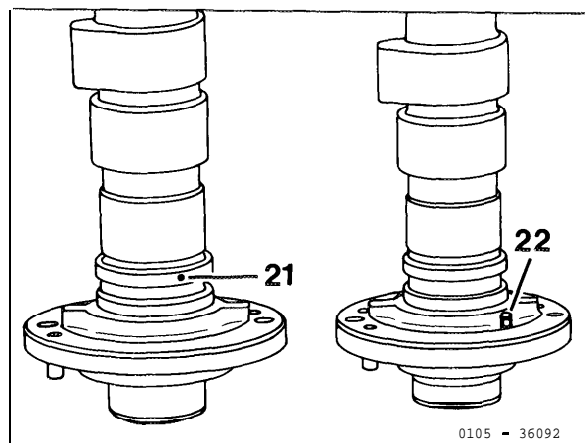
- 1 Set piston of No. 1 cylinder to TDC (arrow).
- 2 Remove timing case cover (01-210).



3 Positioning marking (22) or positioning hole of camshaft must be aligned with the marking (517) on 1st camshaft bearing.



Only the positioning hole (21) is provided in place of the pin (22) as from 12/86.



4 Unscrew bolts (16).

Tightening torque:

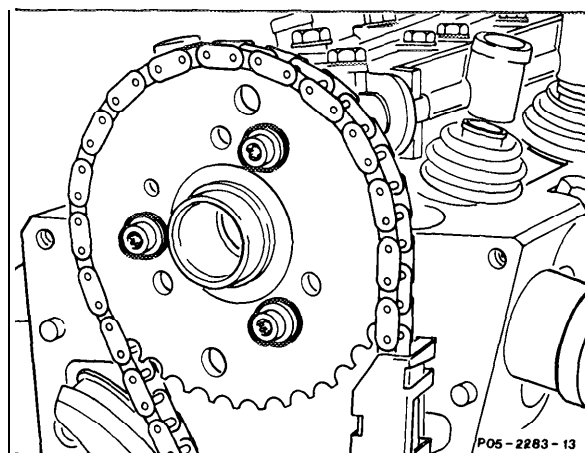
Hex. socket bolts

M 6 : 11 Nm

Torx bolts

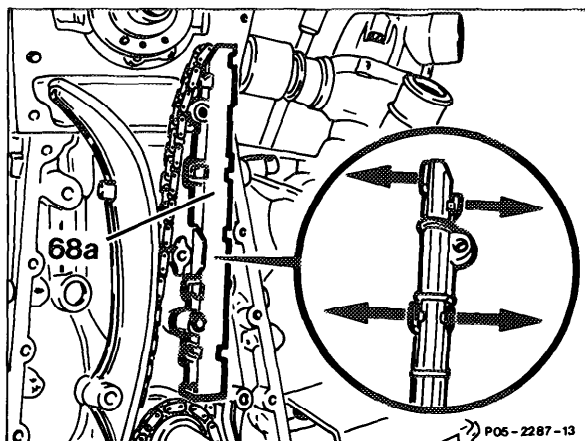
M 7 : 16 Nm

5 Pull off camshaft gear (19) by hand.



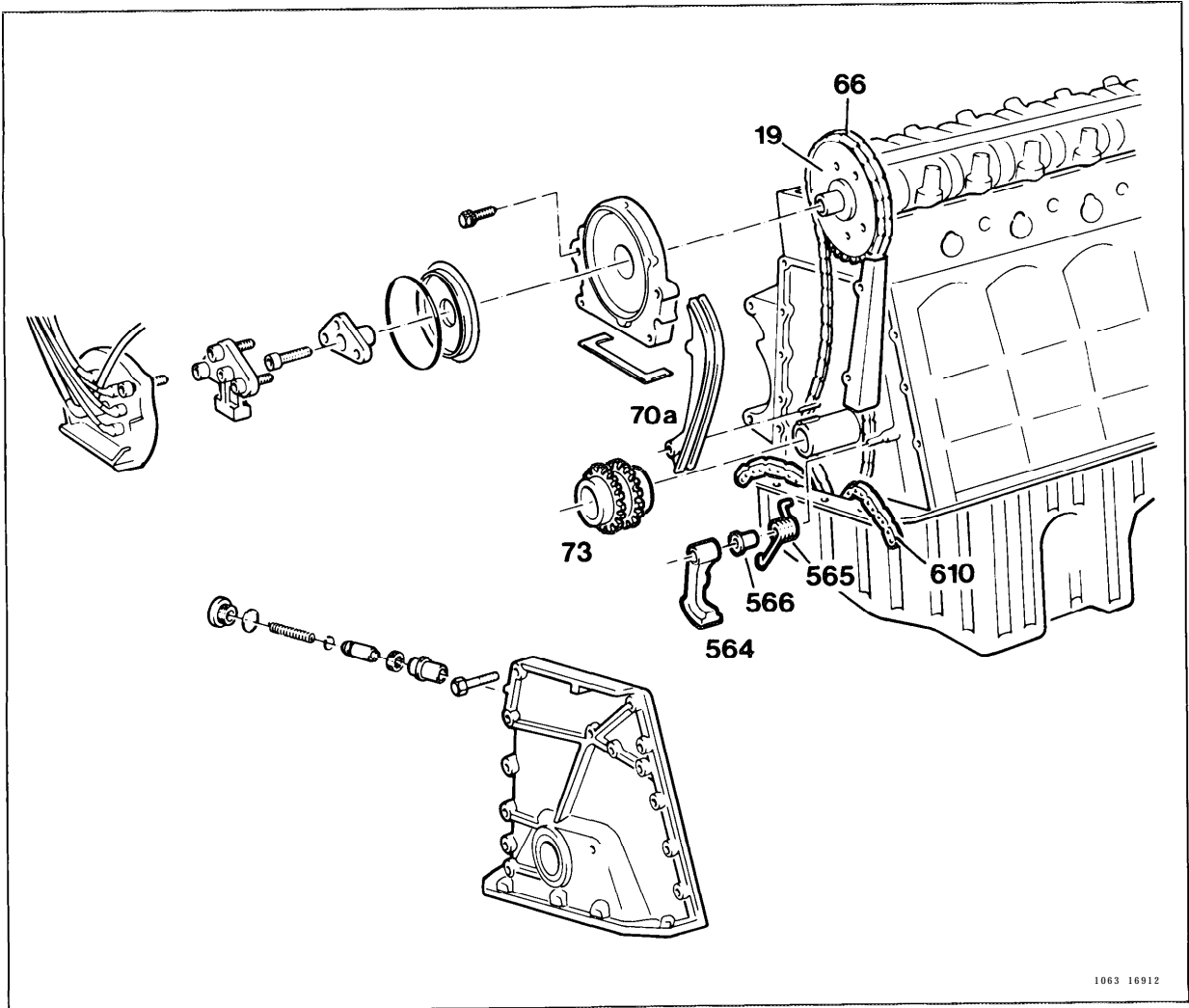
6 Unclip retaining lugs in direction of arrow and remove guide rail (68a).

7 Install in the reverse order.



05-460 Removing, Installing Crankshaft Gear

Job No. of job texts and job values or standard texts and flat rates



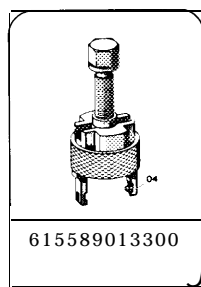
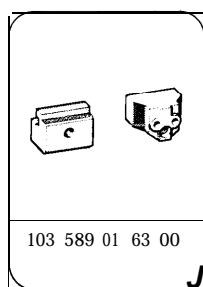
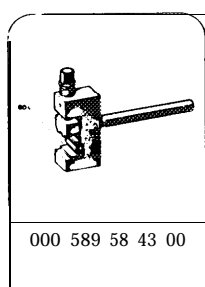
- | | |
|--|--------------------------------------|
| Hood | raise to vertical position (01-008). |
| Piston of No. 1 cylinder | set to TDC (step 2). |
| Tensioning rail (70a) | remove (05-330). |
| Tensioning bracket (564), spring (565) with bush (566) | pull off (step 6). |
| Oil pump chain (610) | grind open rivet link pins (step 7). |
| Timing chain (66) to camshaft gear (19) | mark, take off (step 8). |
| Crankshaft gear (73) with puller 615 589 01 33 00 | pull off (step 9). |
| Crankshaft gear (73) | heat, fit on (step 10). |

Timing chain (66)	fit onto camshaft gear (19).
Oil pump chain (610)	fit onto crankshaft gear (73).
Rivet link	insert from rear into oil pump chain.
Plate	insert in rivet tool, press on (steps 14 to 16).
Individual rivet link pins of oil pump chain	rivet (steps 17 to 19), 30 Nm.
Spring (565), bush (566) and tensioning bracket (564)	install.
Tensioning rail (70a)	install (05-330).

Tightening torques

	Nm
Camshaft gear to camshaft (hex. socket bolt M6)	11
Camshaft gear to camshaft (Torx bolt M7)	16

Special tools

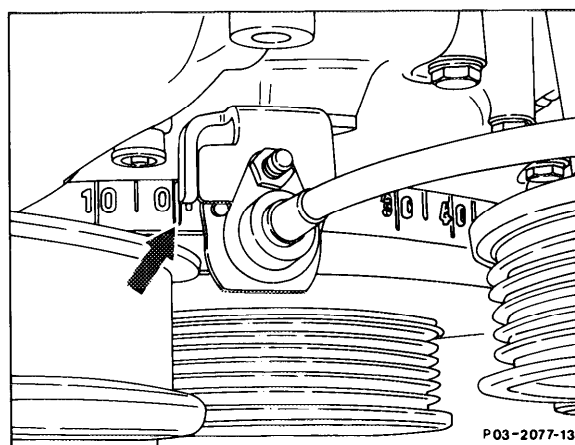


Note

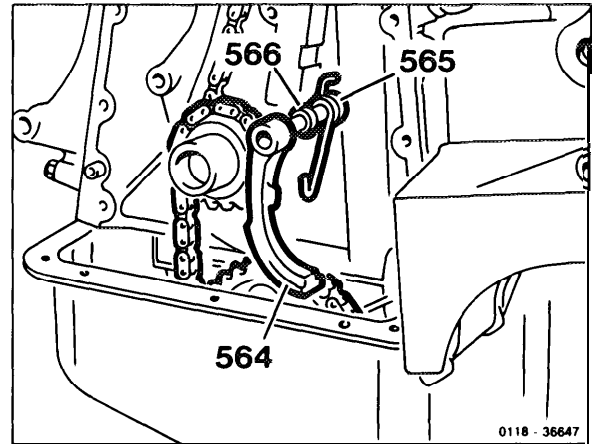
When renewing a worn crankshaft gear, timing chain and camshaft gear must also be renewed.

Removal

- 1 Raise hood to vertical position (01-008).
- 2 Position piston of No. 1 cylinder to TDC.
- 3 Remove tensioning rail (05-330).
- 4 Cover over oil sump with clean cloth.



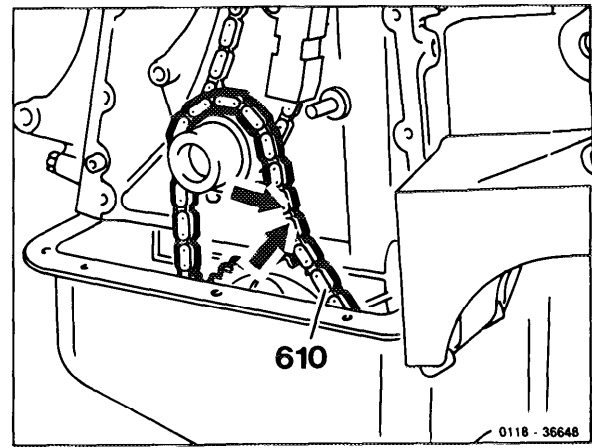
5 Pull off tensioning bracket (564), spring (565) with bush (566).



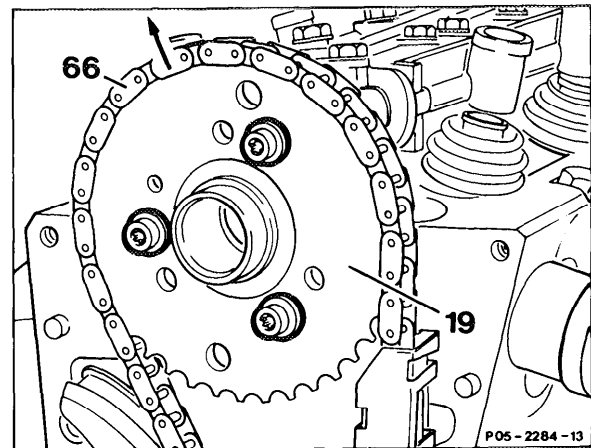
6 Grind open both rivet link pins (arrows) on a double link of the oil pump chain (610). Press out ground open double link.

Note

Do not take oil pump chain off the oil pump drive gear, tie on left and right with wire.



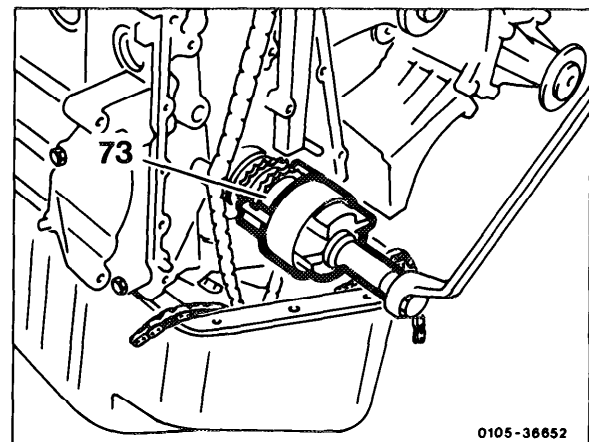
7 Mark position of timing chain (66) relative to camshaft gear (19) with a colored pen. Take timing chain off camshaft gear (19) in direction of arrow.



8 Pull off crankshaft gear (73) with puller 615 589 01 33 00.

Installation

9 Heat crankshaft gear to approx. 50 °C and fit onto the crankshaft. Pay attention to the Woodruff keys.



10 Fit timing chain onto the camshaft gear.

Note

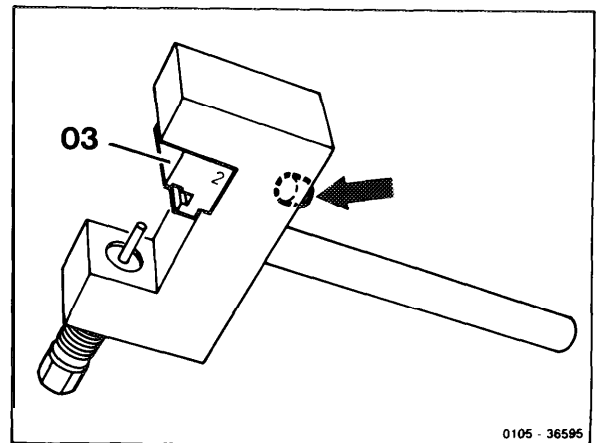
Pay attention to colored marking.

11 Fit oil pump chain onto the crankshaft gear.
Insert rivet link from behind into the oil pump chain.

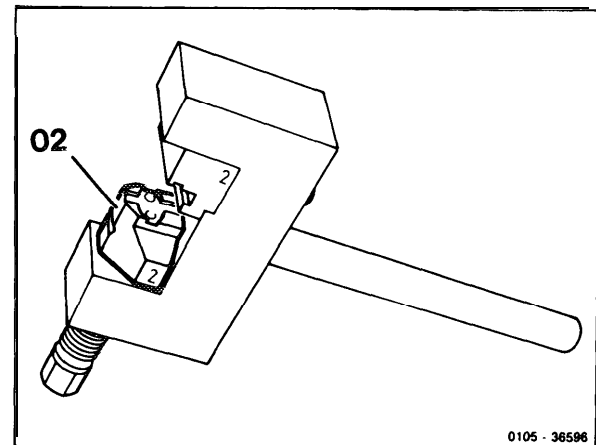
12 Insert thrust piece (03) into the rivet tool as shown in the drawing and tighten with the screw (arrow).

Note

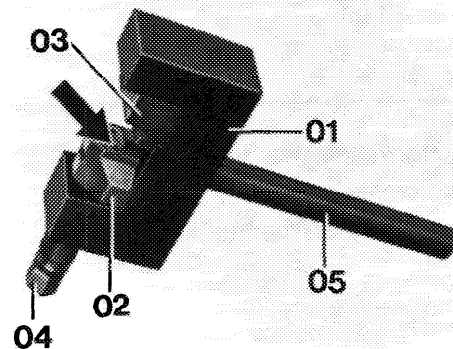
The figure 2 is stamped on the side of the thrust piece (03).



13 Insert moving jaw (02) with the figure 2 into the rivet tool as shown in the drawing.



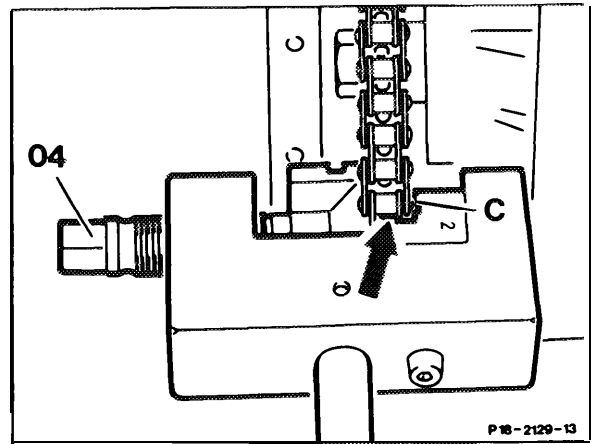
14 Insert plate (arrow) into the moving jaw (02) (magnetic surface).



15 Fit web (arrow) onto both rollers on the link.

Note

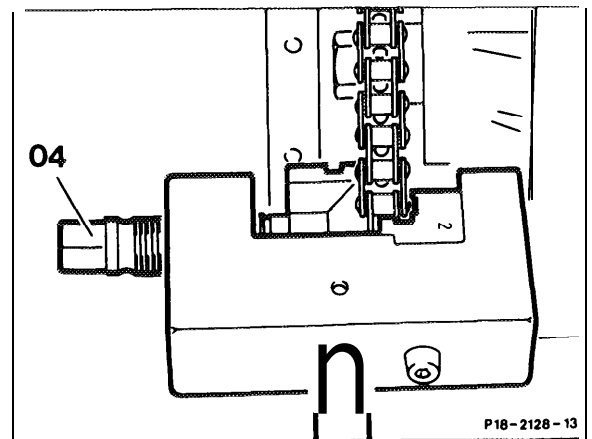
Rivet heads of rivet link pins must be guided in the slot (C).



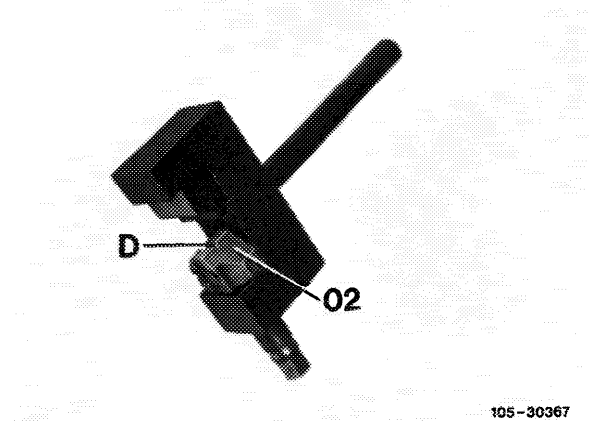
16 Screw in spindle (04) until a firm resistance is felt.

Note

When screwing in, ensure that the pins of the link are inserted into the holes of the plate.



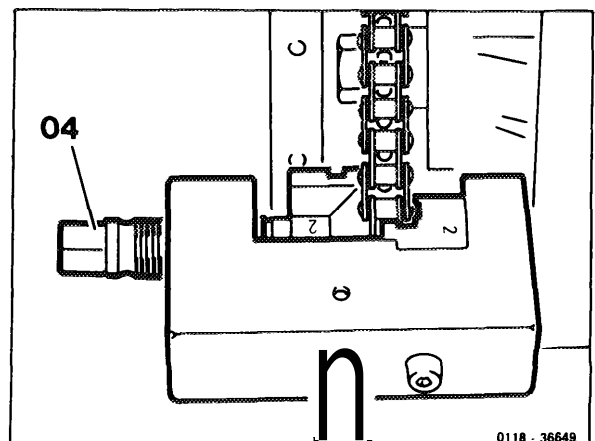
17 Take off rivet tool and change over the moving jaw (02) to the rivet profile (D).



18 Fit on rivet tool.

Rivet pins of the rivet link individually, by tightening the spindle (04) to 30 Nm.

19 Check riveting; re-rivet if necessary.



20 Install spring, bush and tensioning bracket.

21 Install tensioning rail (05330).

22 Install in the reverse order.

Check leaktightness with engine running.