

Cylinder Head, Valve Drive

Replacing the camshaft toothed belt (with hydraulic belt tensioner)

Removal

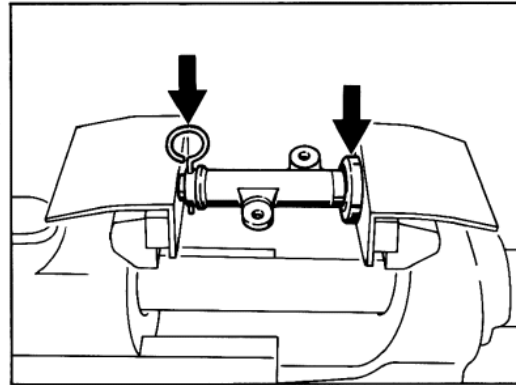
1. Turn engine in direction of rotation and set cylinder 1 to firing TDC. Refer to Figs. on page 15 - 4.
2. Remove engine undertray. Slacken and take off Poly-Rib belt for air conditioning compressor / alternator and belt for power pump.
3. Loosen crankshaft bolts, remove toothed belt cover, guide rail (balance shaft toothed belt) as well as toothed belt.
4. Take guide rail off coolant pump housing and toothed belt tensioner off support. The toothed belt tensioner may be taken off in forward direction without having to lock the parts.
5. Remove tensioner lever and take off toothed belt.

Pre-tensioning the hydraulic toothed belt tensioner

6. After removal, the hydraulic toothed belt tensioner must be pre-tensioned in a vise. Fit aluminum jaws into vise. Insert the crankshaft bolt washer (part no. 944.102.210.02) at the lower section of the tensioner housing to protect the tensioner bottom.

Note

Do not apply pressure to inner surface of the tensioner housing. Press only on outer edge of the tensioner housing.



7. Tighten vise slowly until resistance is felt. Wait for a couple of seconds and then tighten somewhat more.
8. Continue to tighten in this order until the push rod /housing bores are flush with each other and the push rod may be locked with Special Tool 9530 (upper Fig.).

Note

Never continue to rotate engine if the toothed camshaft belt is not fitted or has not been tightened since this may lead to valve damage.

Installation

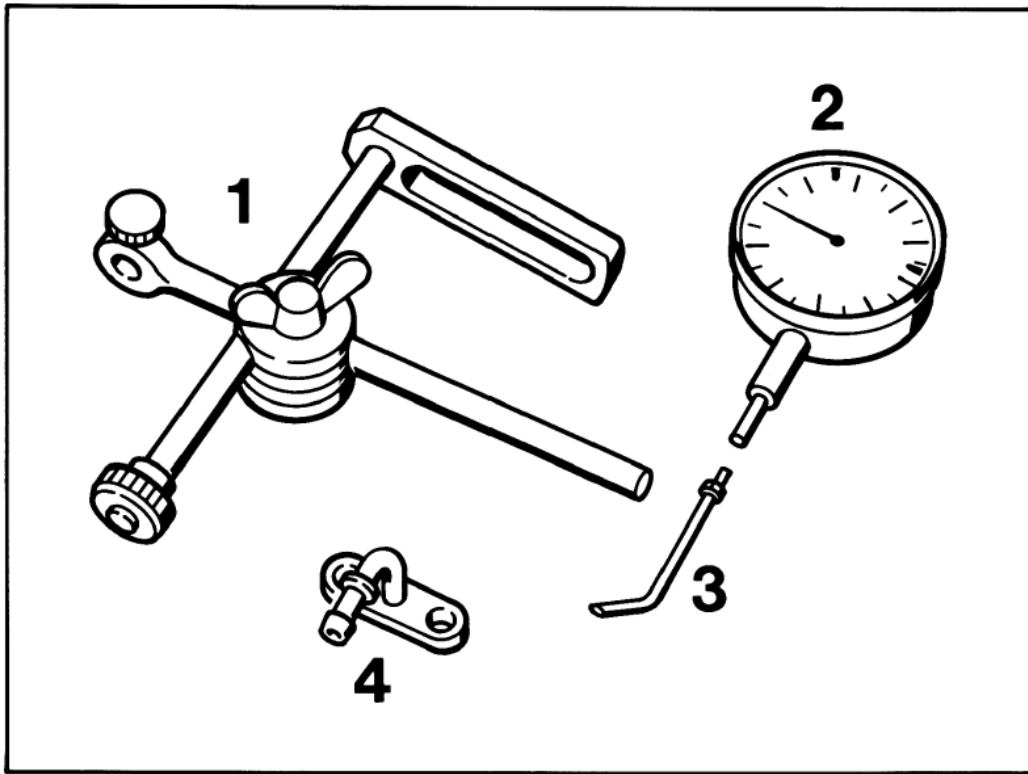
9. When refitting the toothed belt, observe the following sequence:
 - Crankshaft drive pinion
 - Install and lock tensioning lever
(Preload the lock ring, replace if required)
 - Camshaft drive pinion
 - Coolant pump recirculation gear
 - Tensioning pulley

10. Install hydraulic toothed belt tensioner and rotate Special Tool 9530 to pull tool out. Rotate crankshaft by two turns and check TDC marks on flywheel and camshaft drive pinion, respectively.

LAUNCH

Adjusting and checking the camshaft setting

Tools



No.	Designation	Special tool	Order number	Explanation
1	Dial gauge support	VW 387	VW 387	
2	Dial gauges			commercial items
3	Dial gauge insert for push-rod stroke measurements	9232	000.721.923.20	
4	Flange Dial gauge insert for push-rod stroke measurements	9529	000.721.952.90	shop-made (approx. 205 mm long)

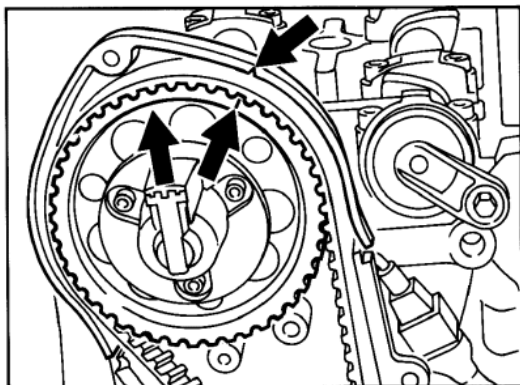
Checking and adjusting the camshaft setting

Engine Type M 44.43/44

Check requirements: Belt tension o.k.

Visual check of TDC marks

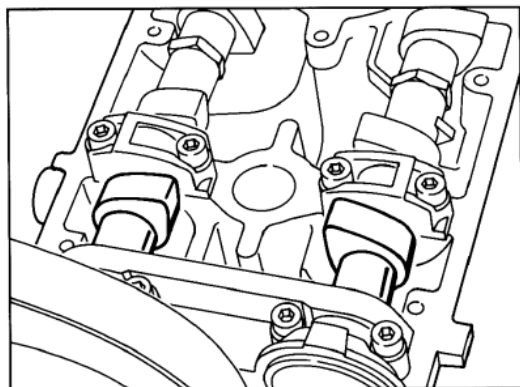
1. Turn engine in sense of rotation until cylinder no. 1 is at firing TDC



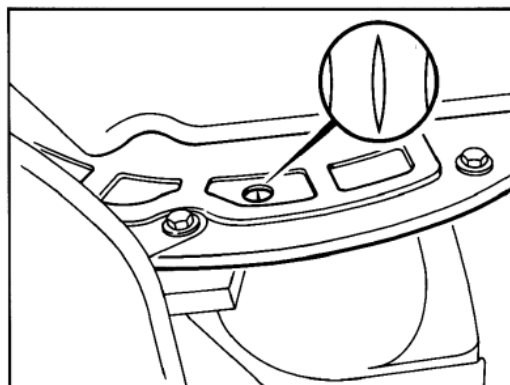
Note

Distributor rotor points up.

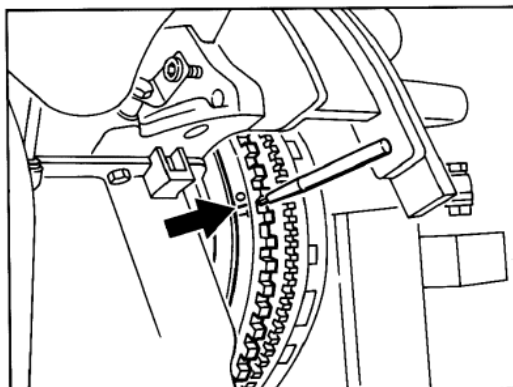
Camshaft position with cyl. 1 at firing TDC.



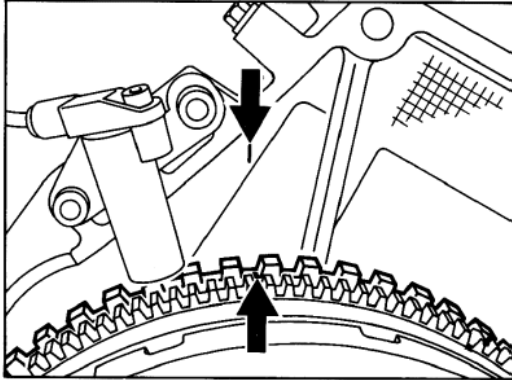
TDC mark on flywheel (center notch) with engine fitted (double-mass flywheel).



With the engine removed, transfer TDC flywheel mark with a color pen to the sensor ring gear.

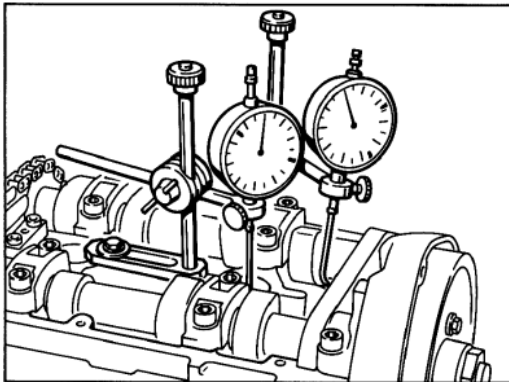


Set TDC flywheel mark opposite crankcase mark.

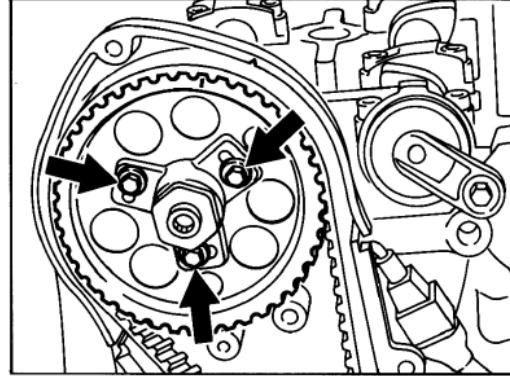


Adjusting with dial gauges

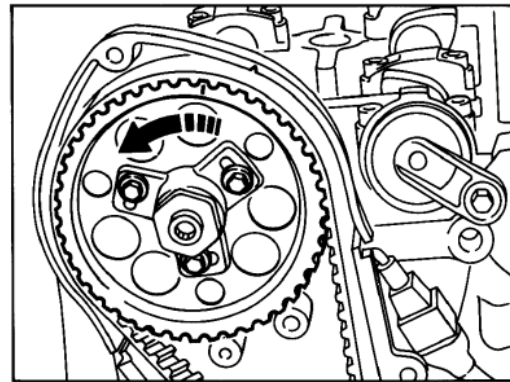
- Align dial gauge with shop-made extension (length 205 mm) to piston pin (cyl. 1). Preload 3 mm.
Align second dial gauge to hydraulic tappet of cyl. 1 inlet valve. The dial gauge must be set up perpendicular to the inlet valve. Preload: 3 mm.



- Remove distributor rotor and fit camshaft gear with 3 auxiliary bolts (M 5 x 15) to prevent the camshaft gear and the camshaft, respectively, from turning when the central camshaft bolt is undone.

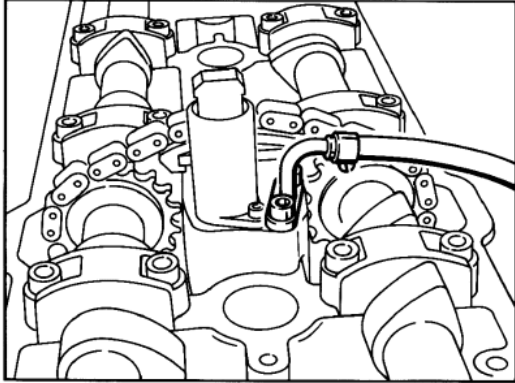


- Undo central camshaft bolt, using a suitable retainer to keep the camshaft from turning. Rotate engine against the sense of rotation until the camshaft gear is against the stop within the woodruff key groove.

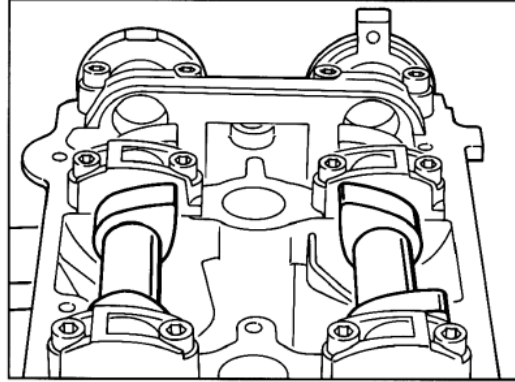


- Tighten auxiliary bolts to 6 Nm (4 ftlb) and central bolt to approx. 40 Nm (29 ftlb).

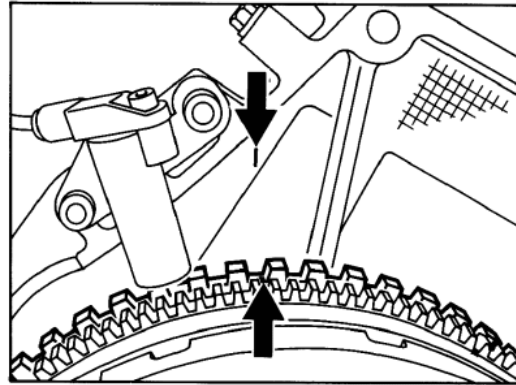
6. Remove oil line from camshaft adjuster. Connect flange (Special Tool 9529) to camshaft adjuster and pressurize (pressure flow approx. 3.0 bar). A consistent supply of compressed air is required since air can escape across a vent hole.



11. Continue to rotate the crankshaft slowly until maximum piston stroke on the dial gauge is reached. This crankshaft position corresponds to the cyl. 4 firing TDC setting of the camshafts.



7. Turn engine in sense of rotation until maximum piston stroke is reached.
8. Set dial gauge of hydraulic tappet of cyl. 1 inlet valve to zero.
9. The crankshaft is now rotated from the firing TDC (cyl. 1). Observe dial gauge of cyl. 1 inlet valve at the same time. Rotate until a stroke of 0.39 ± 0.03 mm is reached.



Note

Do not rotate crankshaft against the sense of rotation.

10. Undo central bolt and auxiliary bolts, making sure the setting of 0.39 ± 0.03 mm on the dial gauge does not change.

12. Tighten auxiliary bolts and central bolt. Tightening torque of central bolt: 65 (48) to 70 Nm (52 ftlb).

13. To verify the setting, rotate crankshaft by two more turns and check setting.

14. Remove Special Tool and auxiliary bolts and reinstall distributor rotor.

Applying TDC mark to camshaft sprocket

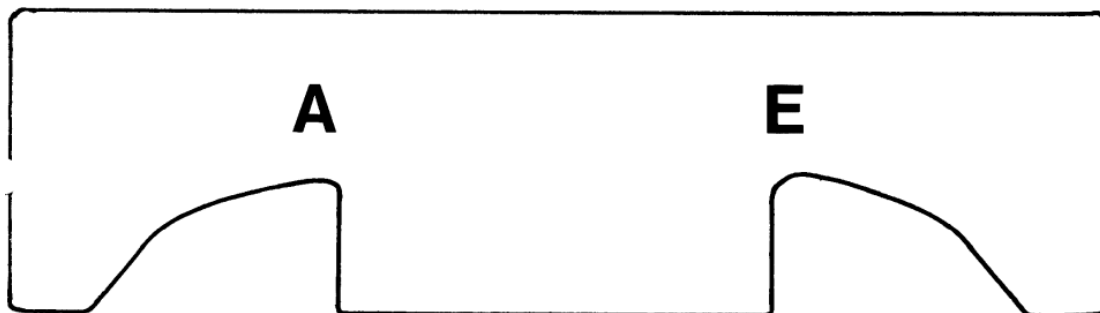
Engine Type M 44.43/44

Note

Camshaft sprockets supplied by the spares department do not have the TDC marks. The TDC mark is applied after the camshaft has been adjusted on the new engine.

1. Place new camshaft sprocket exactly over old camshaft sprocket and transfer TDC mark to new sprocket using a color pen.
2. Fit new camshaft sprocket and adjust camshaft according to instructions on page 15 - 4 to 15 - 6 in Repair Manual.
3. Following item 13, page 15 - 6, apply the final TDC mark to the new camshaft sprocket, using a three-square file and referring to page 15 - 4, Fig. 1.

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Camshaft adjustment gauge (shop-made)**Engine Type M 44.43/44****Tools**

A - Exhaust

Scale 1 : 1

E - Inlet

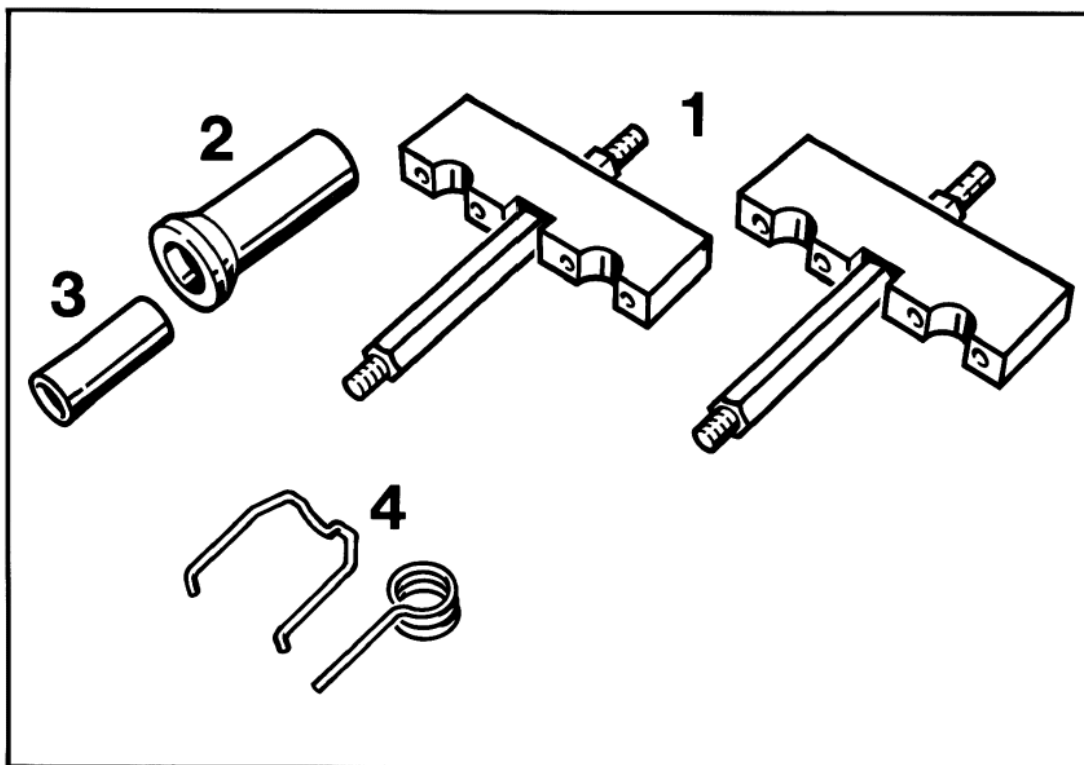
Note

1. If color marks or casting lugs are missing on the camshafts, use the camshaft adjusting gauge (shop-made) for referencing the camshafts.
2. After having placed the camshafts into the timing chain, the attribution of the cams of **cylinder 1** may be checked with the gauge. Rotate both camshafts against each other so that the lower chain section is tensioned.

Check again after the bearing saddles have been tightened.

Fitting the camshafts

Tools



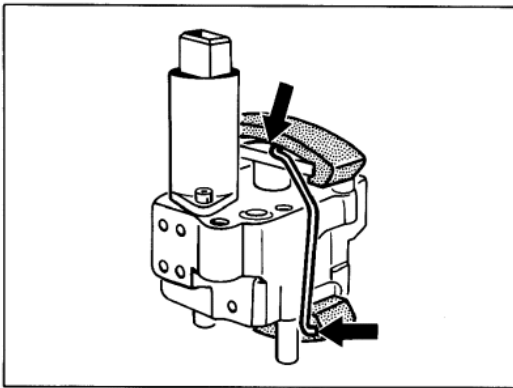
No.	Designation	Special tool	Order number	Explanation
1	Mounting saddles for removal and installation of camshafts	9248	000.721.924.80	Used in conjunction with tensioning pins of Special Tool 9226
2	Thrust piece for seal	9234	000.721.923.40	
3	Assembly sleeve for seal	9233	000.721.923.30	
4	Assembly tools	9530	000.721.953.00	For fitting of "VarioCam" camshaft adjuster and hydraulic toothed belt tensioner

Fitting the camshafts

1. Rotate engine in direction of rotation to approx. 45° before firing TDC (cylinder 1).
2. Compress "VarioCam" camshaft adjuster and lock with Special Tool 9530.

Note

The oil check valve in the camshaft adjuster may drop out when the adjuster is compressed. Retain oil check valve and take it out if required.

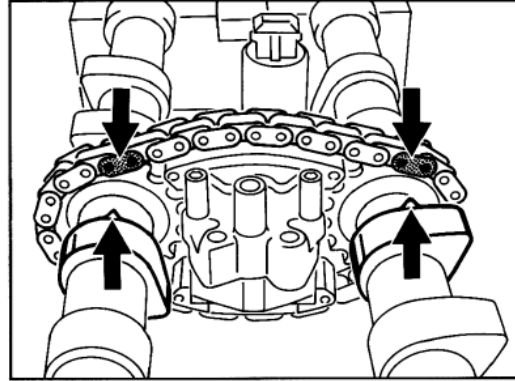


3. Place inlet camshaft and exhaust camshaft into timing chain.
Place both camshafts into timing chain in such a manner that the color marks or casting lugs line up with the chain links marked.

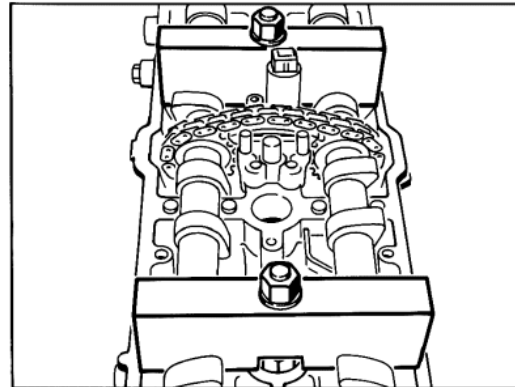
Note

The distance between the inlet camshaft mark and the exhaust camshaft mark is 7 chain outer links.

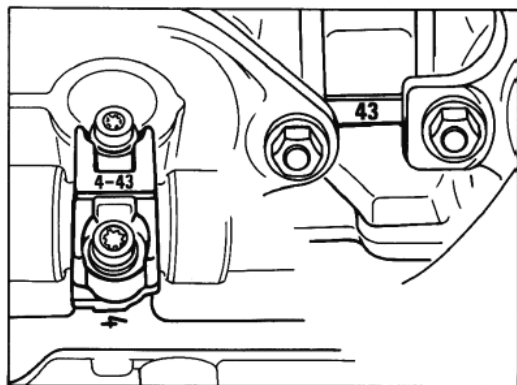
4. Place "VarioCam" camshaft adjuster between the camshafts into the chain.



5. Oil bearing surfaces of camshaft, cylinder head and cams. Fit camshafts with assembly saddles, Special Tool 9248, used in conjunction with tensioning pins of Special Tool 9226, to cylinder head.

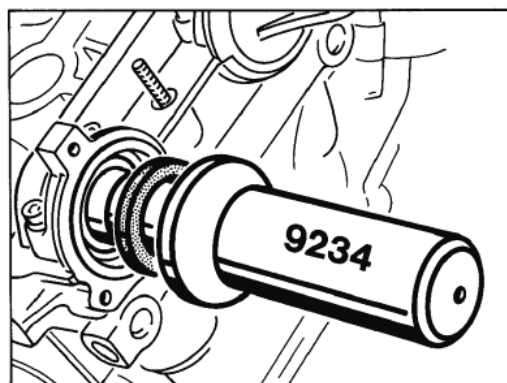


6. Fit camshaft bearing saddles and bearing covers. The bearing saddles or covers are machined as a unit with the cylinder head and must always be fitted as a unit. Observe correct identification character and matching number. Tighten bearing saddles or covers to 20 Nm (15 ftlb).



7. When fitting, apply Loctite 574 to the sealing surfaces of the front and rear double bearing saddles.
8. Fit "VarioCam" camshaft adjuster to cylinder head. **Take out Special Tool 9530.** Fit oil pipe. Tightening torque of banjo bolt: 10 Nm (7 ftlb).

9. Use Special Tool 9233 (assembly sleeve) and thrust piece 9234 to press the seal into the drive side of the camshaft. Oil sealing lip before fitting the seal.

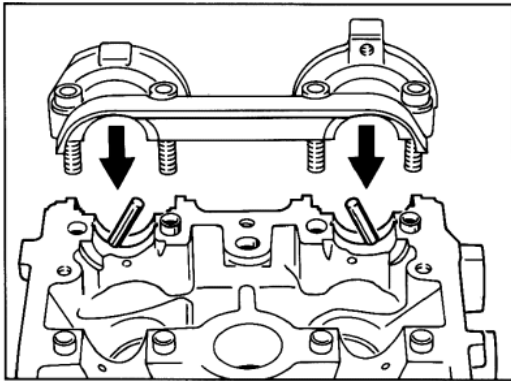


Note

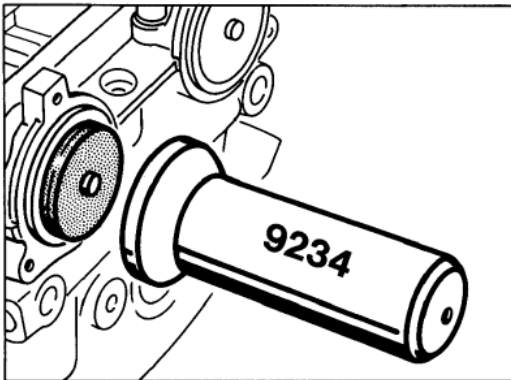
If a damaged toothed belt has caused the valves to be damaged by the pistons, it is mandatory to replace the timing chain. Visually check chain sprockets and chain tensioner thoroughly.

Fitting the camshaft seal

1. Place sealing washers or lock pins, respectively, into bearing surfaces and fit bearing saddle, applying some Loctite 574.
Tightening torque: 20 Nm (15 ftlb).



2. The seal cover may only be used with Special Tool 9234 after the bearing saddle has been tightened.

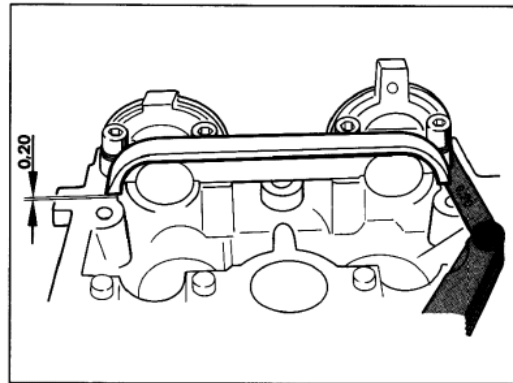


Engine fitted

Note

If the sealing cover leaks with the engine fitted to the vehicle, fit the sealing cover as follows:

1. Place sealing washers or lock pins, respectively, into bearing surfaces.
2. Coat bearing saddle with Loctite 574 and fit saddle. Place a 0.02 mm feeler gauge between bearing saddle and cylinder head and manually tighten bolts lightly.



3. Oil sealing cover lightly and press in manually. Tighten bearing saddle to specified torque.
Tightening torque: 20 Nm (15 ftlb)

Camshaft references

Camshaft references	Worldwide as of MY '92
	Engine Type 968 M 44.43/44
Camshafts	
Inlet camshaft	944.105.277.09
Exhaust camshaft	944.105.275.10
Marking between thrust bearing and cam of cylinder 1 or on rear face	277.09 275.10
Camshaft timing 1 mm stroke, zero clearance	
Basic timing	
Inlet opens	7.5° CR after TDC
Inlet closes	52 ° CR after BDC
Exhaust opens	31 ° CR bef. BDC
Exhaust closes	1 ° CR after TDC
Torque timing	
Inlet opens	7.5° CR bef. TDC
Inlet closes	37 ° CR after BDC
Exhaust opens	31 ° CR bef. BDC
Exhaust closes	1 ° CR after TDC

Machining the cylinder head mating face

Checking cylinder head for distortion

Using a feeler gauge and ruler or straight edge, check the cylinder head mating face for distortion.

Admissible distortion of the mating face:
0.05 mm

Distorted cylinder heads may be repaired by machining the mating face. Admissible distortion after machining: 0.03 mm.

Machining the cylinder head

Reface cylinder head mating face only until the surface is level. Max. wear limit: 146,6 mm

Note for refacing the mating face:
Max. roughness = 0,015 mm

If the new-dimension tolerance is exceeded during machining, a cylinder head gasket with a thickness of 1.4 mm must be fitted.

New dimension A = 147 ± 0.1 mm
Wear limit A = 146.6 mm

Machining dimension and identification of the cylinder head

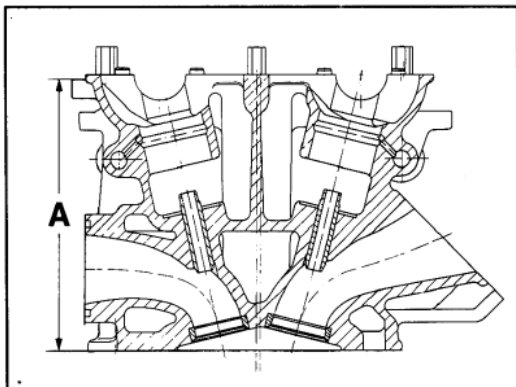
New dimension : 147 ± 0.1 mm
Gasket : 1.1 mm
Identification : none

Refacing dimension : 146.8...146.6 mm
Gasket : 1.4 mm
Identification : N

Identification „N”

To be applied on the exhaust side between cylinder nos. 2 and 3, on the boss below the mating surface of the cylinder head cover.

Height of stamped character „N” 6 mm

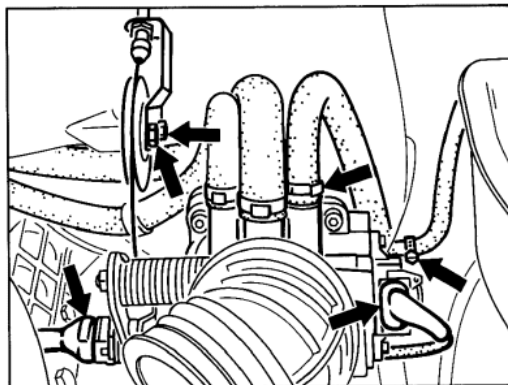


Removing and installing cylinder head

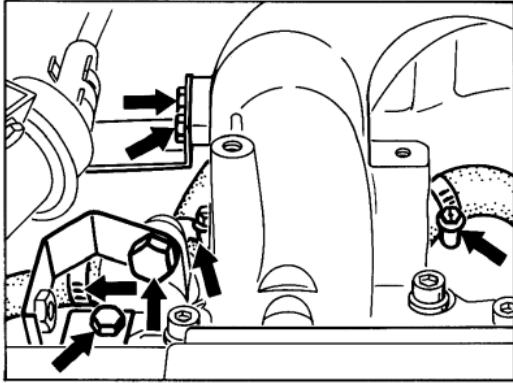
Engine Type M 44.43/44

Removal

1. Place protective covers on fenders and disconnect ground cable from battery.
2. Remove air cleaner assembly complete with air mass sensor. Remove engine covers.
3. Undo distributor cap, pull off plug connectors, unclip cover for fuel rail and put aside along with ignition leads.
4. Pull off connector for oil temperature sender and camshaft adjuster. Unscrew fuel return and feed lines from fuel pipe, making sure a second wrench is used to lock. Undo fuel rail at intake distributor and take out along with injector valves. Put fuel rail complete with wiring harness to the rear. Do not kink fuel lines.
5. Remove engine undertray. Undo exhaust system at exhaust manifold / exhaust pipe flange.
6. Pull off coolant hose between reservoir and thermostat housing and catch coolant in a suitable container.
7. Remove ATF reservoir from body. Remove coolant pipe with heater valve. Bend heat shroud slightly forwards.
8. Pull connector off idle speed positioner and throttle valve switch. Unhook throttle valve operating gear and remove bracket complete with idler. Pull vacuum hose off intake rail and throttle body. Remove coolant hose from reservoir at throttle body.
9. Remove oil dipstick. Pull vacuum non-return valve from brake booster. Remove coolant hose between radiator and cylinder head from breather flange. Undo intake rail at left-hand engine mount.



10. Remove bracket for oxygen sensor connector from intake rail. Loosen breather hose at oil separator and coolant hoses at connecting flange and pull off. Remove wiring harness bracket from connector flange.



11. Detach and remove intake rail from cylinder head. Remove rocker cover, toothed belt cover and camshaft sprocket console.
12. Rotate engine in direction of rotation and set engine to firing TDC of cylinder No. 1. Slacken camshaft toothed belt and pull belt off camshaft sprocket. Refer to page 15 - 1 to 15 - 4.
13. Take out distributor rotor. Tighten camshaft sprocket with three M 5 x 20 mm auxiliary screws to keep the basic camshaft setting from shifting when the central camshaft bolt is removed.
14. Undo central bolt, making sure a second wrench is used to lock. Remove camshaft sprocket and rear console. Disconnect connector for Hall sender unit.

15. Remove „VarioCam“ camshaft adjuster from cylinder head. Remove bearing cap from cylinders No. 1 and 3. Retain both camshafts in bearings using Special Tool 9226. Undo and lift off front twin bearing saddle and remaining bearing caps. For installation of camshafts, refer to page 15 - 11 to 15 - 13.

16. The rear twin bearing saddle may remain attached to the cylinder head. Loosen Special Tool 9226 in a uniform manner and remove both camshafts complete with camshaft adjuster and put them aside.

17. Undo cylinder head. Undoing sequence: From outside to inside. Lift off cylinder head. (If tolerances are too narrow, the right-hand engine bracket must be separated from the hydraulic mount)

Note

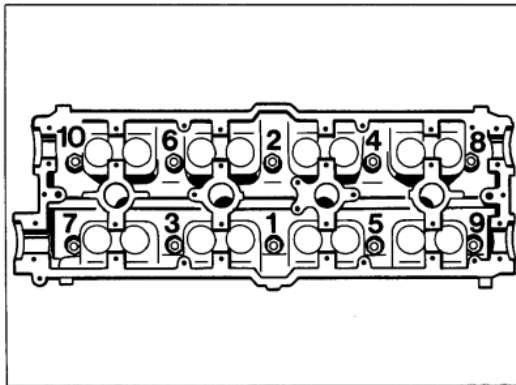
If traces of oil ingress in the water are found, the cylinder head must be examined closely by visual inspection for hairline cracks. For this purpose, check the cooling system for tightness. Run tightness check with tester VW 1274 across the reservoir (max. pressure 1 bar). The camshaft cap must be removed for visual checking.

Installation

Note

The cylinder head may be fitted with the engine remaining in the car.

1. Place cylinder head gasket into correct position.
2. Fit cylinder head.
Tightening sequence:



3. Replace gaskets, seals and O-rings before fitting the cylinder head. Tighten nuts and bolts to the specified torque.
4. Top up coolant and bleed cooling system. Warm up engine to operating temperature, check coolant level again and top up if required.

For unbolting, follow opposite sequence.

Cylinder head tightening specifications

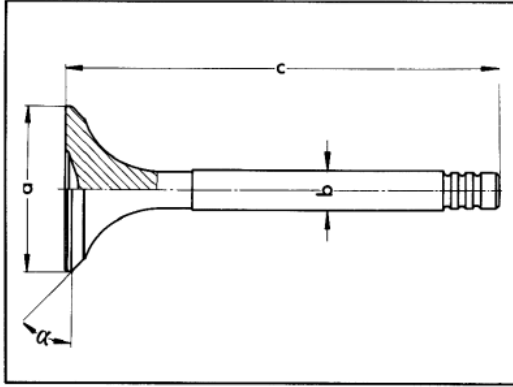
Engine Type M 44.43/44

1st stage	20 Nm (15 ftlb)
2nd stage	60° turning angle
3rd stage	90° turning angle

Note

Do not use any lubricant when fitting the cylinder head nuts and washers. Only the threads of the studs should receive a thin coat of engine oil.

Valve dimensions



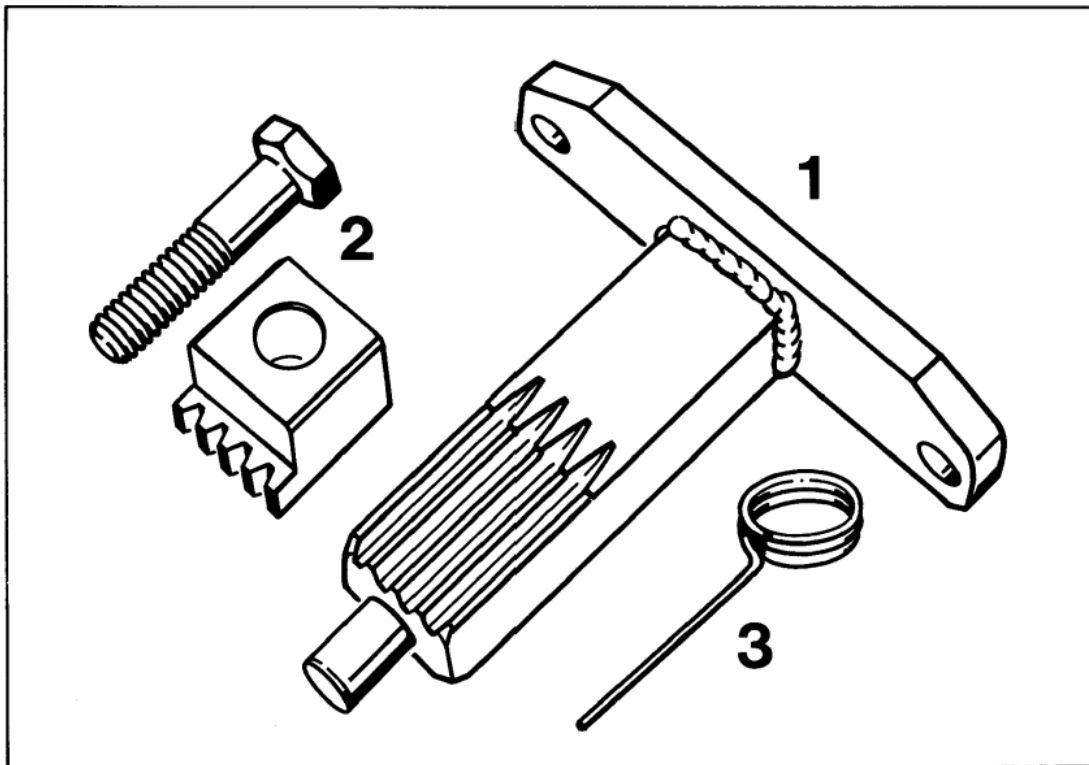
Valve dimensions

Engine type M 44.43/44

Dimens.	Inlet	Exhaust
a	39 mm	33 mm
b	6.98 mm	6.97 mm
c	114.70 mm	113.60 mm
α	45°	45°

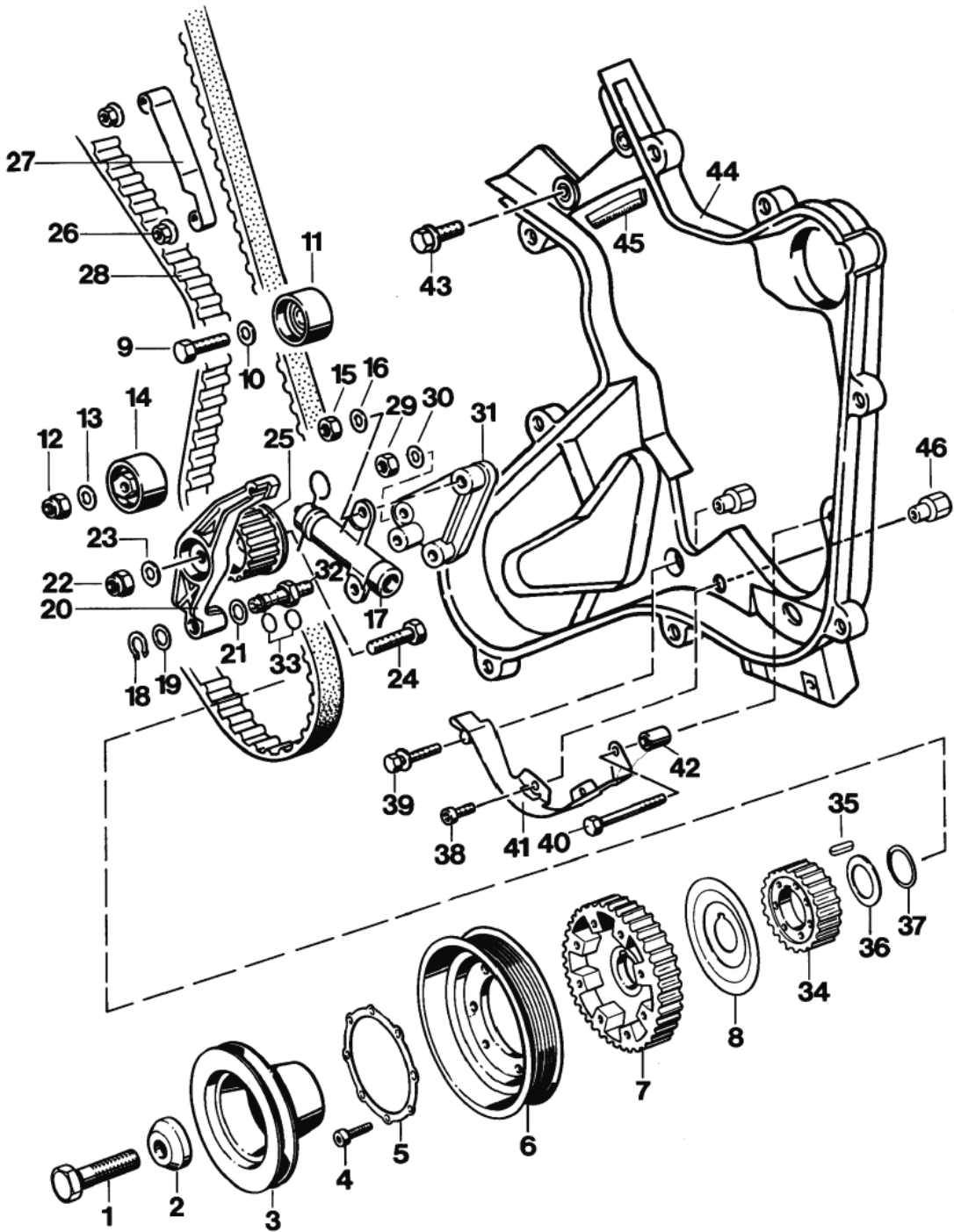
Dismantling and assembling camshaft drive

Tools



No.	Designation	Special tool	Order number	Explanation
1	Toothed sector	9206/1	000.721.920.61	Engine installed
2	Toothed sector with hexagonal bolt M 12 x 1.5 x 60	9238/1	000.721.953.81	
3	Assembly tool for toothed belt tensioner	9530	000.721.953.00	
-	Spacer sleeve			refer to page 15 - 30
-	Piston retracting tool			refer to page 15 - 30

Dismantling and assembling camshaft drive



Nr.	Benennung	Stück	Beachte:	
			Ausbau	Einbau
1	Hexagon head bolt M 16 x 1.5 x 60	1		Tightening torque 210 Nm (155 ftlb)
2	Washer	1		
3	Pulley	1		
4	Pan head screw M 6 x 25	8		Tightening torque 15 Nm (11 ftlb)
5	Tab washer	1		
6	Pulley	1		
7	Gear drive for balance shafts	1		
8	Flange washer	1		
9	Hexagon head bolt M 10 x 30	1		Tightening torque 45 Nm (33 ftlb)
10	Washer A 10.5	1		
11	Pulley	1		
12	Lock nut M 10	1		
13	Washer A 10.5	1		
14	Pulley	1		
15	Hexagon head nut	2		
16	Washer A 8.4	2		
17	Hydraulic toothed belt ten- sioner	1		
18	Snap ring 14 x 1	1		
19	Shim 14 x 20 x 0.5	1		
20	Tensioning lever for toot- hed belt tensioner	1		
21	Shim 14 x 20 x 0.5	1		
22	Lock nut	1		Tightening torque 45 Nm (33 ftlb)
23	Washer			
24	Hexagon head bolt M 10 x 45	1		

Nr.	Benennung	Stück	Beachte:	
			Ausbau	Einbau
25	Tensioning pulley	1		
26	Lock nut	2		
27	Locking clamp	1		
28	Camshaft toothed belt	1	Treat carefully, do not twist or turn	
29	Hexagon head nut	1		
30	Washer A 8.4	1		
31	Console	1		
32	Shaft bolt M 10	1	Heat shaft bolt area with hot air gun	Use Loctite 270 to bond into crankshaft. Pack lubricating groove with Optitemp PU 035 grease, Part No. 000 043 110 00. Tightening torque 45 Nm (33 ftlb).
33	O-ring 12 x 1.5	2		Replace
34	Camshaft drive gear	1		Apply a thin coat of Optimoly HT to mount area. Lettering points to the front.
35	Woodruff key 5 x 5 x 22	1		
36	Support washer	1		
37	Round seal	1		Replace
38	Pan-head screw	2		
39	Hexagon head bolt with captive washer M 6 x 42	1		
40	Hexagon head bolt M 6 x 70	1		
41	Guide rail	1		For adjustment, refer to page 13 - 1

No.	Designation	Qty.	Note:	
			Removal	Installation
42	Spacer sleeve	1		
43	Combination screw	2		
44	Toothed belt cover	1		
45	Anti-chafing protection	1		
46	Spacer	3		

Special note on toothed belts and drive belts

As a rule, make sure the toothed belts and drive belts are **not kinked** during assembly, packing and storage. Improper handling may cause incipient damage to the camshaft toothed belts and may eventually lead to engine damage.

LAUNCH

Assembly note

Slackening camshaft toothed belt

1. Remove idler pulley. Fit spacer sleeve (shop-made tool) with a M 10 x 55 hexagon head bolt.

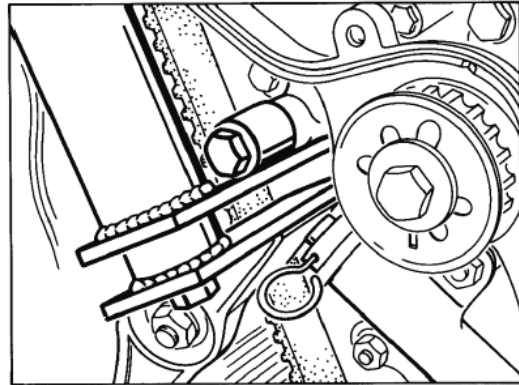
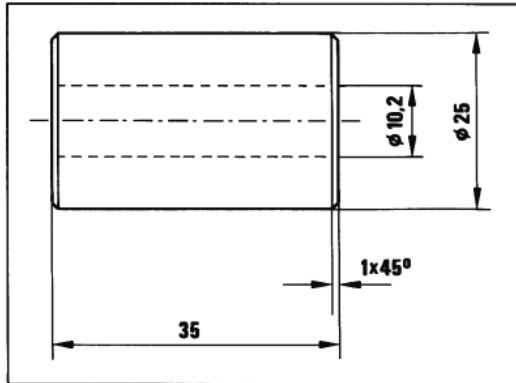


Illustration shows tensioned belt tensioner locked with **Special Tool 9530, assembly tool (pin)**.

Note

Never rotate the engine **if the camshaft toothed belt is not fitted or tensioned** as this may cause damage to the valves.

The piston retracting tool is available from tool suppliers.

Order No.:
03.9314-4950.3/01

Supplier:

Messrs.
Alfred Teves GmbH
Postfach 900 120
D-60441 Frankfurt 90

2. Align piston retracting tool between spacer sleeve and toothed belt tensioning lever. Compress toothed belt tensioner slowly until a resistance is felt. Wait for a few seconds and rotate somewhat more.
3. Keep on rotating in this sequence until the pushrod-to-housing holes are lined up and the pushrod can be locked with **Special Tool 9530**.