

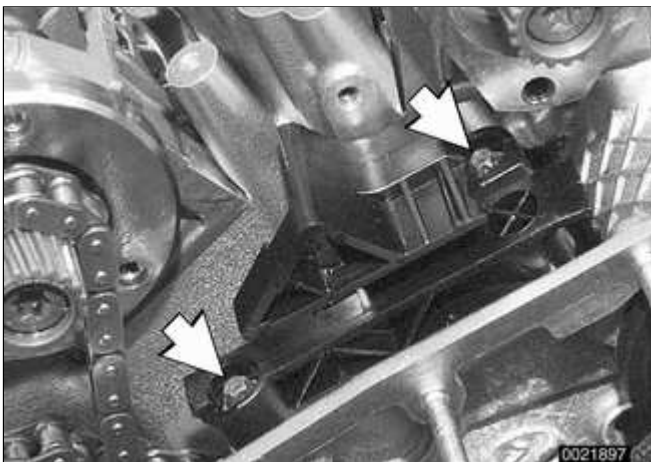
- ♦ *Hydraulic lifters should be stored in an upright position.*
- ♦ *Used hydraulic lifters must be replaced into original lifter bores.*

Cylinder head assembly, removing

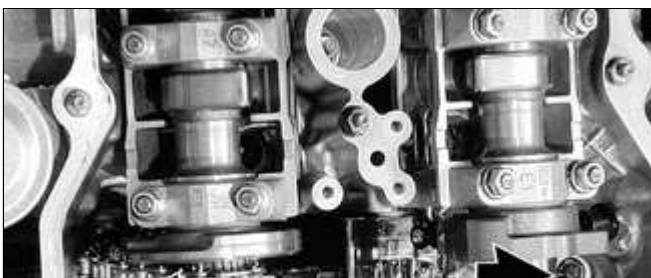
- Remove exhaust manifolds. See 180 Exhaust System.



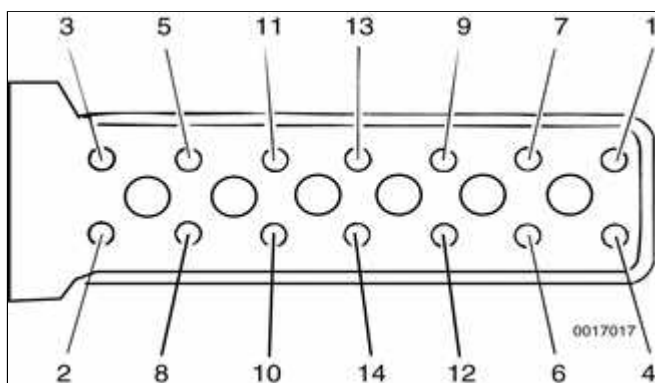
- ◀ Remove intake camshaft position sensor (**arrow**) from side of cylinder head.



- ◀ Remove secondary chain lower guide bolts (**arrows**). Remove chain guide. The bolt on the intake camshaft side is a long bolt that extends into the lower timing chain cover.



- ◀ Remove screws (**arrows**) holding lower timing chain cover to cylinder head. (Photo shows camshafts in place).



- Using BMW special tool 11 2 250 or equivalent, loosen cylinder head bolts in several stages in sequence shown. Discard head bolts.

Note:

BMW special tool 11 2 250 is a thin-walled Torx E12 socket with an extended reach. The cylinder head bolts are recessed into the head below the camshaft towers with little working space.

- Lift off cylinder head. Refer to ⇒ [116 Cylinder Head and Valvetrain](#) to evaluate the head.

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Cylinder Head Installation

Clean cylinder head and gasket surfaces of cylinder block and all timing chain covers.

Remove foreign matter and liquid from bolt holes.

CAUTION!

Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. If necessary, use a hard wooden or plastic scraper. Also available are abrasive discs to be used in conjunction with an electric drill. Be sure to use the correct disc for the type of metal being cleaned.

Evaluate cylinder head as shown in ⇒ [116 Cylinder Head and Valvetrain](#).

Note:

- ◆ *If the cylinder head has been machined, a special 0.3 mm (0.011 in.) thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.*
- ◆ *Cylinder head and valve specifications are covered in ⇒ [116 Cylinder Head and Valvetrain](#).*

Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters, friction washers, splined shafts and spline hubs with assembly lubricant before installation.

To assist the technician in cylinder head installation, the procedure has been organized as separate

operations. Please be advised that these individual jobs must be accomplished in the order in which they appear.

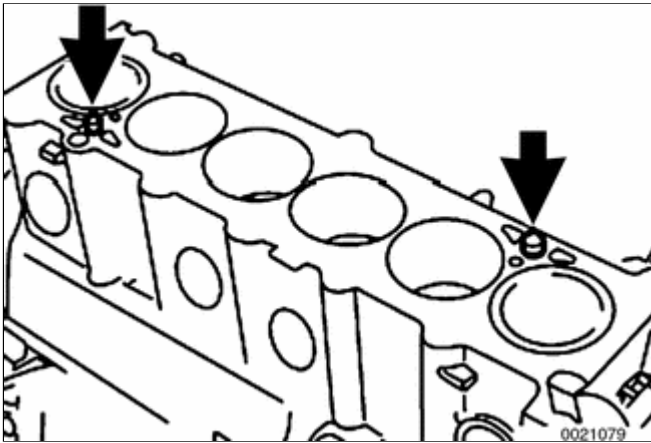
⇒ [Cylinder head assembly, installing](#)

⇒ [Camshafts and valvetrain, installing](#)

⇒ [VANOS control unit, installing](#)

⇒ [Cylinder head cover, manifolds, cooling system, installing](#)

Cylinder head assembly, installing



✦ Check that two cylinder head locating aligning sleeves (**arrows**) are correctly positioned in block and are not damaged.

- Apply permanently elastic sealing compound 3 Bond® 1209 to joints with timing belt cover.
- Place new cylinder head gasket on cylinder block.

Note:

The word OBEN, printed on the gasket, should face up. The cylinder head gasket will fit correctly in only one orientation.

- Set cylinder head in position, guiding primary chain through cylinder head opening.

CAUTION!

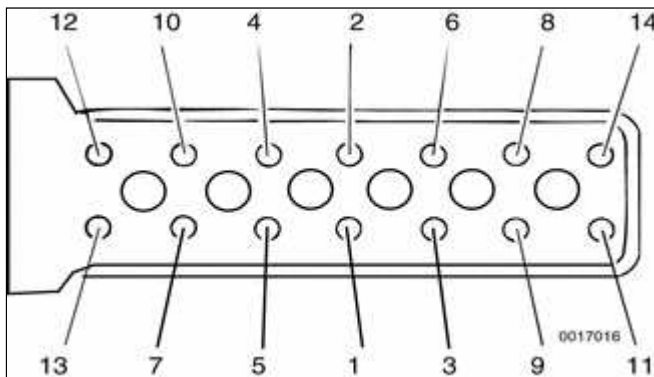
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that

position before lowering the cylinder head into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

- Lightly lubricate new cylinder head bolts. Install bolts and washers finger tight. Install cylinder head-to-lower timing chain cover bolts finger tight.

Note:

- ◆ *Cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.*
- ◆ *Check that all washers for the head bolts are in place before installing the bolts. Some of the washers may be staked to the cylinder head.*



Tighten cylinder head bolts in correct sequence (1-14).

CAUTION!

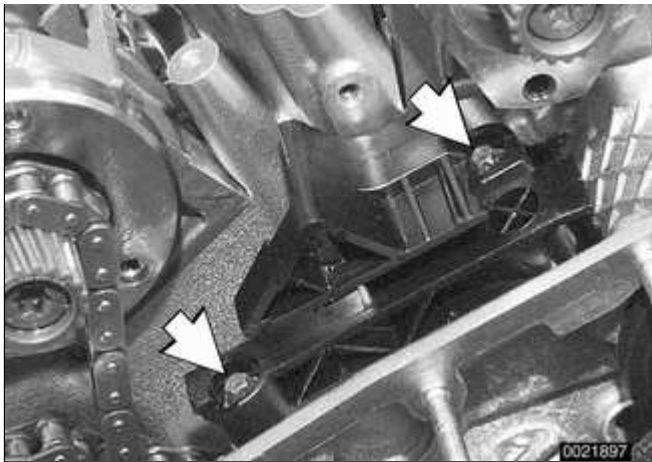
The bolts should be tightened in three stages as listed below. The final stages require the use of a BMW special tool 11 2 110 or a suitable protractor to tighten the bolts to a specified torque angle.

- Secure cylinder head bolts by torquing an additional 90° each for Stage 2 and 3.

Tightening torques	
Cylinder head to engine block (Torx E12 M10 bolts)	
Stage 1	40 Nm (30 ft-lb)



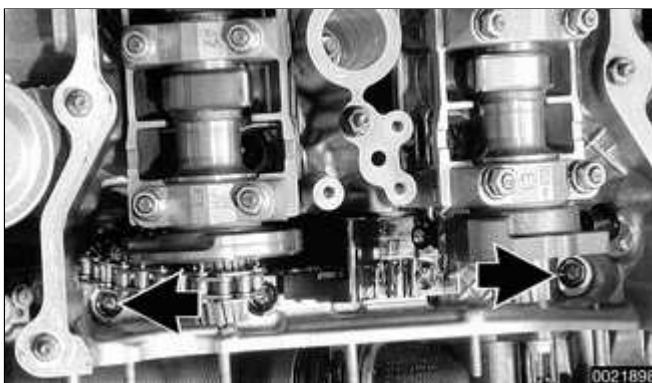
- Install intake camshaft position sensor (**arrow**).
- Install exhaust manifolds. See 180 Exhaust System.



- Install lower secondary chain guide. Tighten Torx bolts (**arrows**) to specifications. The bolt on the intake camshaft side is long and extends into the engine block.

Tightening torque	
Secondary chain guide to cylinder head	10 Nm (89 in-lb)

Secondary chain guide to cylinder head	10 Nm (89 in-lb)
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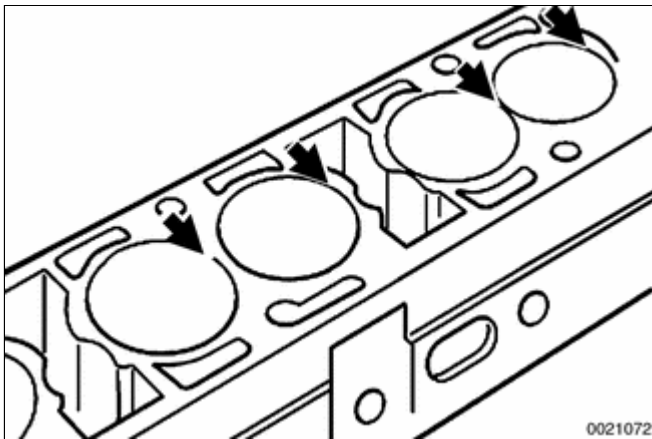


- Install and tighten cylinder head-to-lower timing chain cover bolts (**arrows**). (Photo shows camshafts in place)

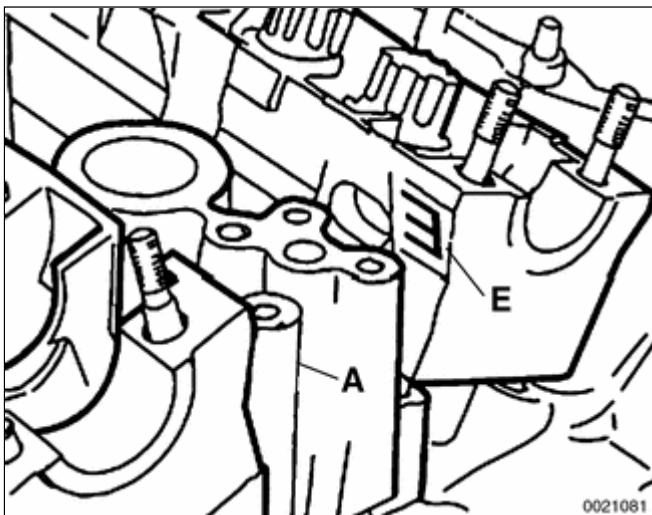
Camshafts and valvetrain, installing

CAUTION!

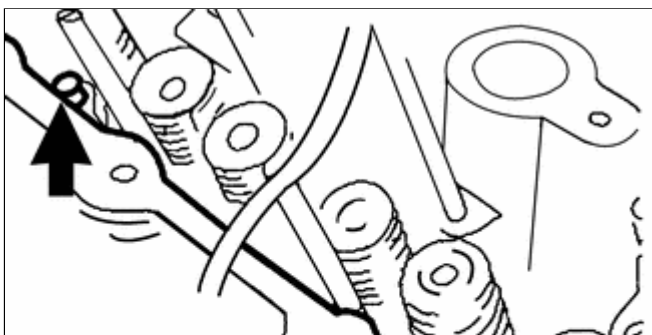
A minimum waiting time is required for the hydraulic lifters to "bleed down" after installing the camshafts into the cylinder head, but before synchronizing the crankshaft and valve train timing. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.



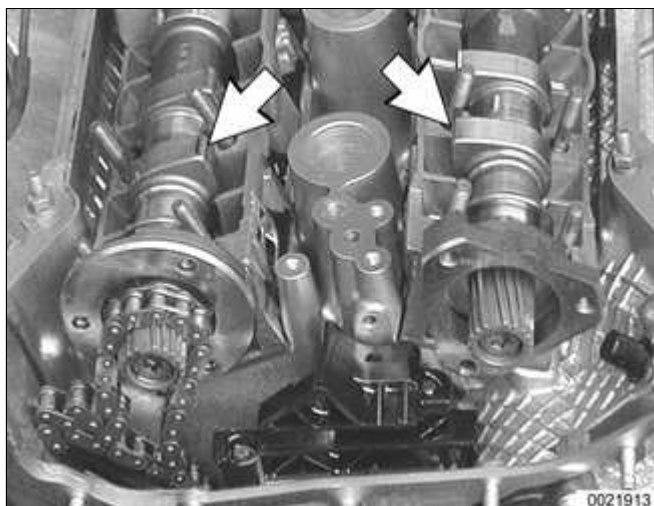
- Before installing camshaft carriers, examine bearing points (**arrows**) on hydraulic lifter bores for signs of wear.



- Install camshaft carriers with hydraulic lifters into cylinder head. Note marks on carriers: (**E**) for intake side and (**A**) for exhaust side.



- Center camshaft carrier on pins (**arrows**) at bearing positions 2 and 7.
 - Lift timing chain and place exhaust camshaft onto exhaust camshaft carrier. Place intake camshaft on intake camshaft carrier.

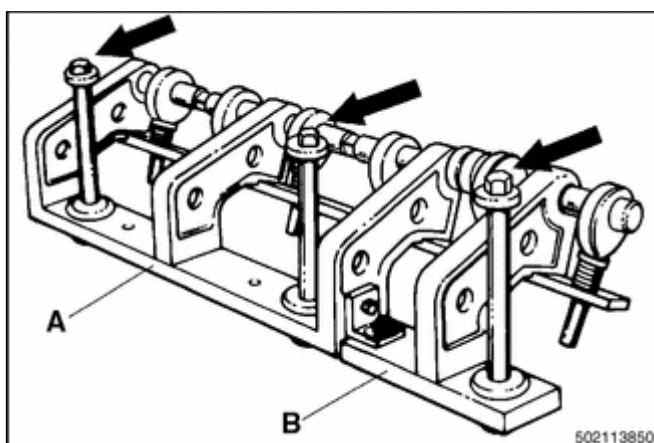


- Rotate camshafts so that intake and exhaust lobes for cylinder 1 face each other (**arrows**).

CAUTION!

Be sure that crankshaft is still positioned at least 30° back from TDC.

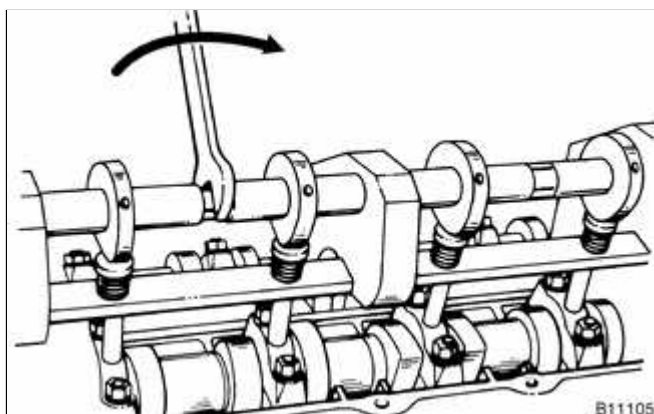
- Place bearing caps on cams, but do not install retaining nuts.



- Fit BMW special tools 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head over intake camshaft and screw long bolts (**arrows**) into spark plug threads.

CAUTION!

Do not overtighten bolts into spark plug holes.



- Turn eccentric shaft of special tool to pretension bearing caps. Install and torque nuts on intake camshaft bearing caps.

Tightening torque

Camshaft bearing cap to cylinder head (M7)	14 Nm (10 ft-lb)
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- Release tension on eccentric shaft and remove BMW special tool 11 3 260/270.

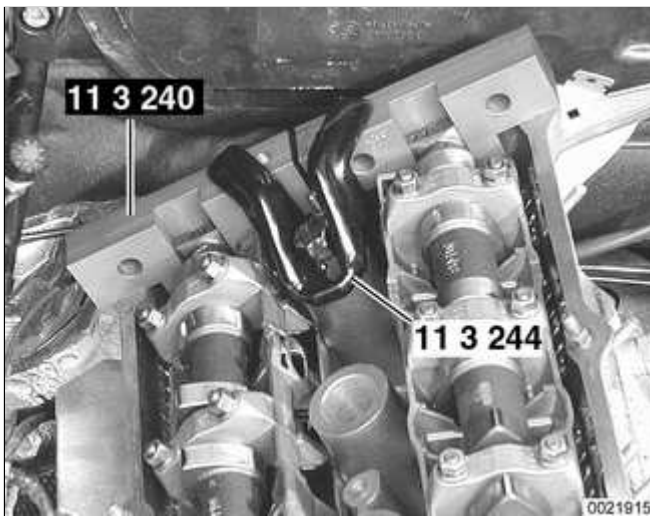
- Repeat procedure for exhaust camshaft.

Note:

Before the next step, observe waiting time for lifter bleed down before continuing with camshaft installation.

Crankshaft / valve timing waiting times

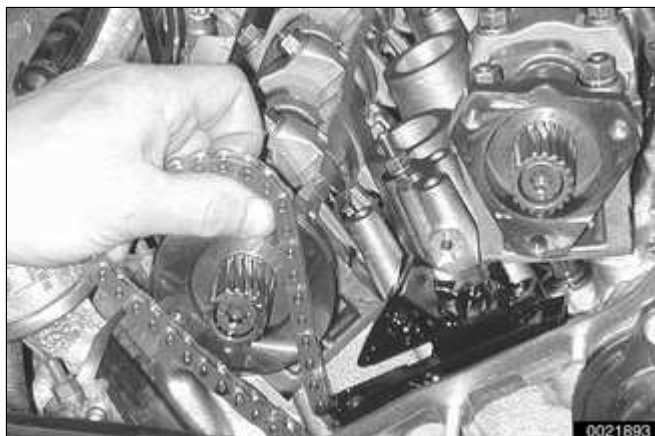
68°F (20°C) and higher	4 minutes
50 - 68°F (10 - 20°C)	11 minutes
32 - 50°F (0 - 10°C)	30 minutes



- Secure camshafts in TDC position using BMW special tools 11 3 240 and 11 3 244.



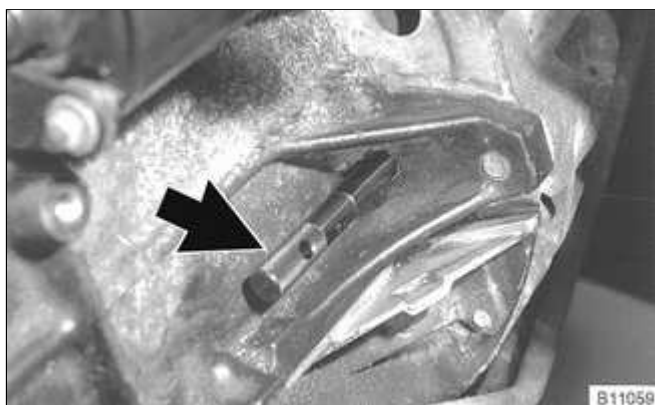
- If necessary, turn camshaft so that special tools are squarely seated on cylinder head.



- ✦ Lift timing chain and hold under tension.



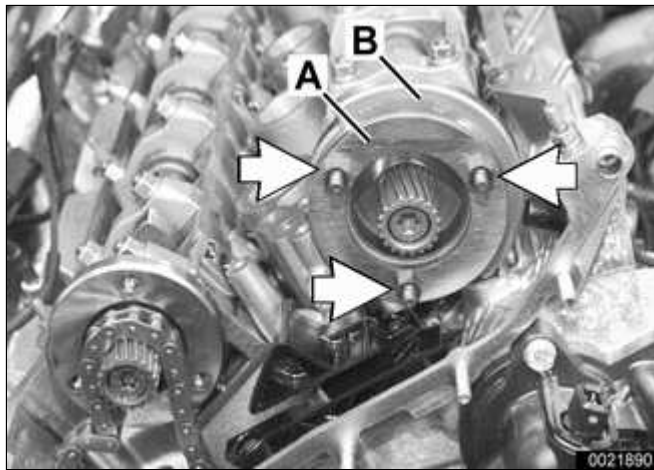
- ✦ While maintaining tension on timing chain, rotate crankshaft from 30° before TDC in direction of rotation up to cylinder 1 TDC position (**01T** on front pulley lined up with pointer on lower timing chain cover).



- ✦ Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



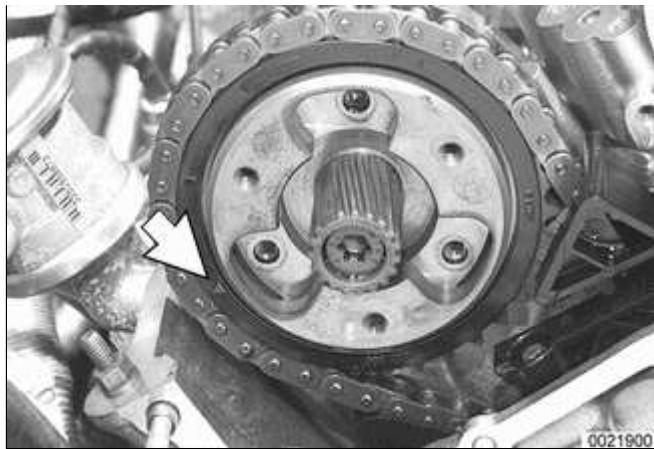
- ✦ Slide impulse wheel on intake camshaft, aligning boss with raised portion on camshaft (**arrow**).



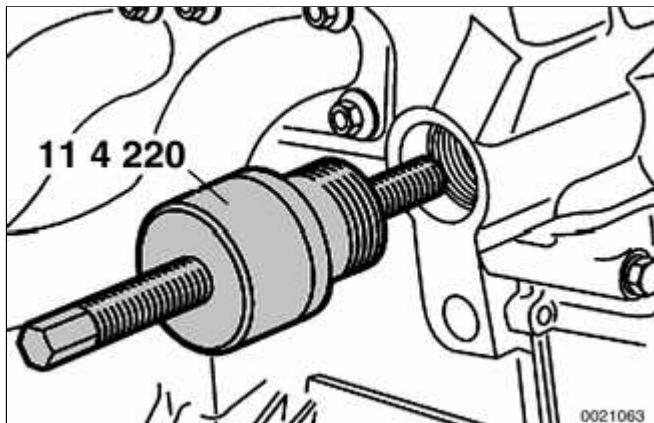
- Fit thrust spacer to intake camshaft and tighten down with threaded locating studs (place longer threaded portion of studs into camshaft).

Tightening torque

Impulse wheel studs to intake camshaft (M7)	20 Nm (15 ft-lb)
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- Fit top sprocket to primary timing chain and install on exhaust camshaft so that pointer on sprocket (**arrow**) lines up with cylinder head sealing surface.

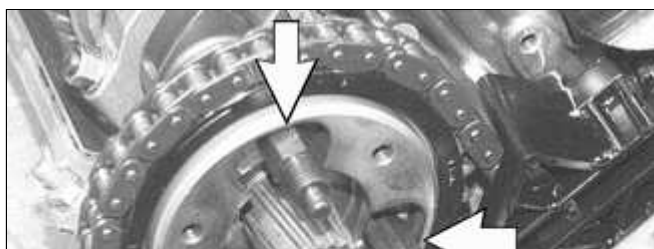


- Insert BMW special tool 11 4 220 into timing chain tensioning piston bore and bring adjustment screw into contact with tensioning rail, but do not pretension timing chain.

Note:

BMW special tool 11 4 220 is a dummy primary chain tensioner and simulates the function of the tensioner.

- Recheck that arrow on top primary sprocket is aligned with upper edge of cylinder head. Reposition sprocket if necessary.



- Insert and tighten down threaded locating studs (**arrows**) in end of exhaust camshaft.

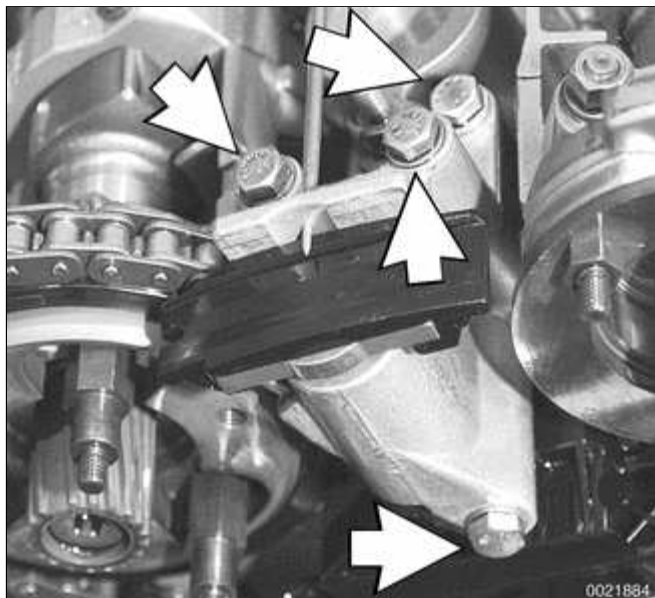
Tightening torques



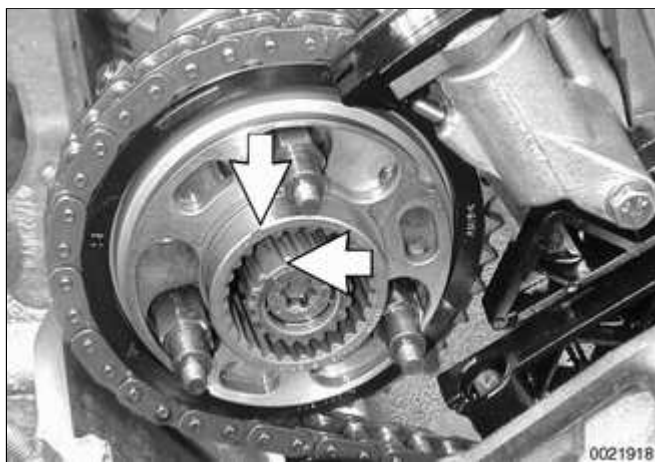
Tightening torques

Exhaust camshaft
locating stud

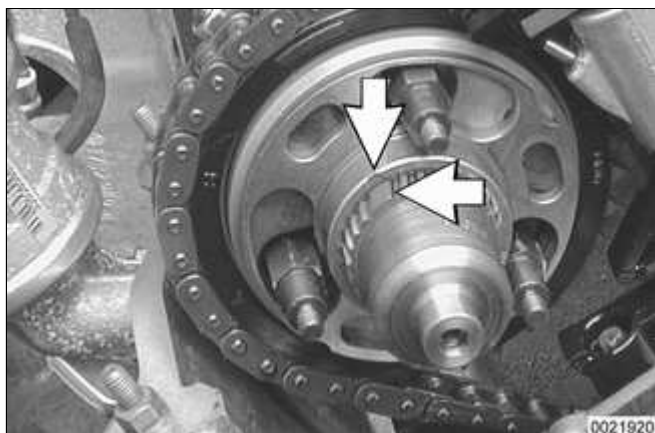
20 Nm (15 ft-lb)



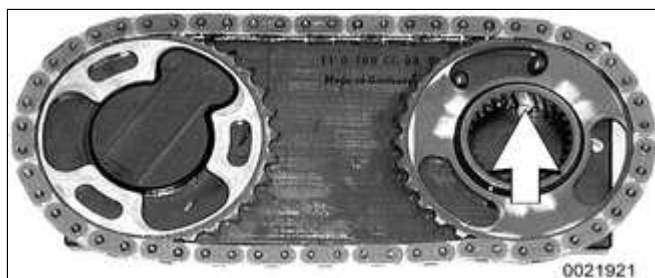
- ✦ Install secondary chain tensioner on cylinder head (**arrows**). Keep tensioner compressed using BMW special tool 11 3 292 or suitable pin.



- ✦ Fit exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



- ✦ Slide splined shaft onto exhaust camshaft. Be sure that locating tooth of shaft (**arrow**) fits into spline gaps of camshaft and splined sleeve.
- ◆ Slide splined shaft in further until three small slots on splined sleeve are centered on three threaded holes in primary chain sprocket.



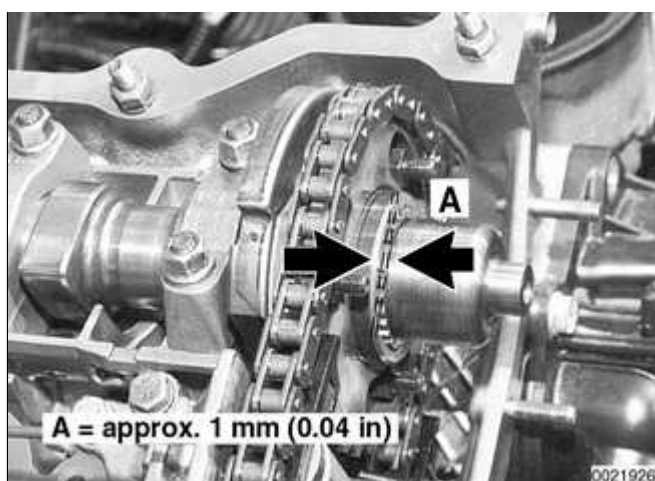
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.



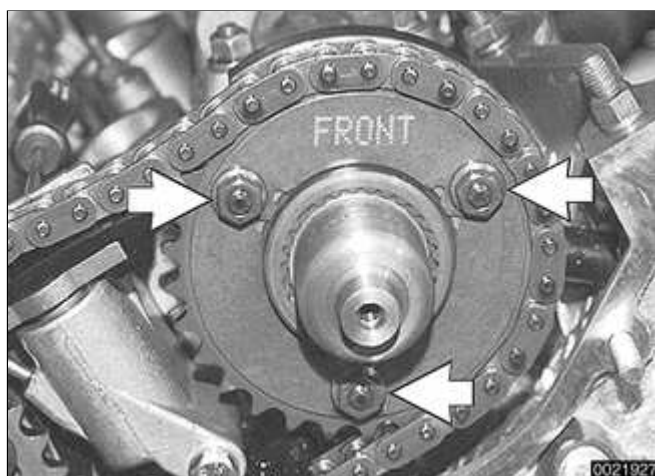
- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (**arrow**).

CAUTION!

Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.



- Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines (**arrows**) are visible. Confirm that locating tooth of shaft fits into spline gaps on camshaft and sprocket.



- Install intake camshaft spring plate so that **FRONT** mark is visible. Install mounting nuts (**arrows**) finger tight.

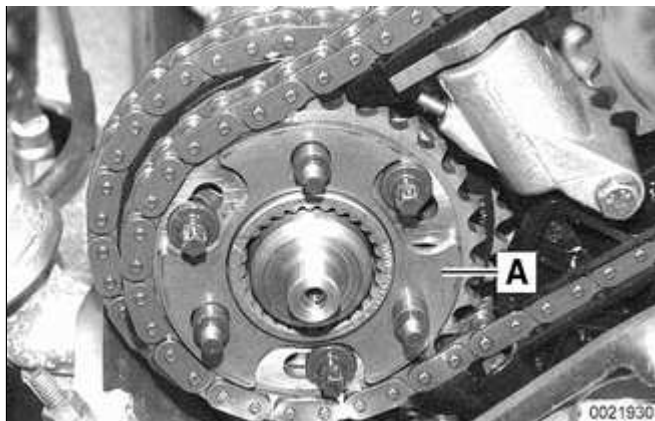


- Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft

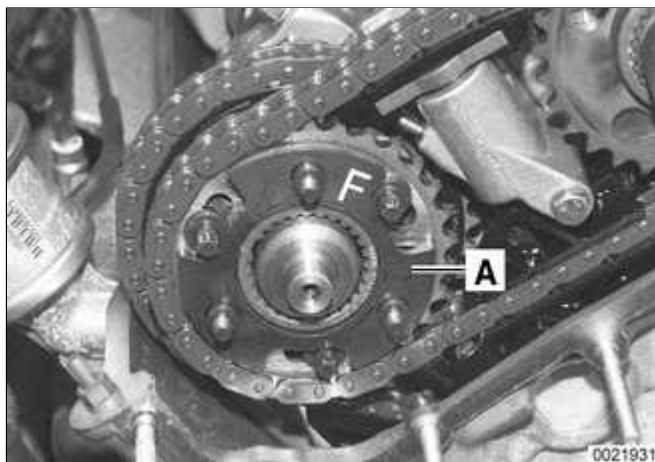


assembly.

- ◆ Initially tighten to approx. 5 Nm (44 in-lb) and then back off by half a turn.



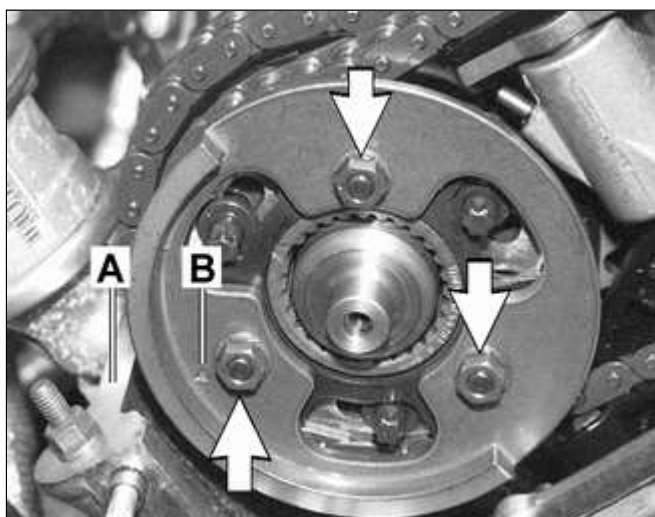
- ✦ Fit thrust spacer (A) on exhaust camshaft.



- ✦ Install spring plate (A) to exhaust camshaft. Make sure that F mark is visible.

Note:

If F mark is no longer visible, install spring plate so that convex side points forward (toward front of car).

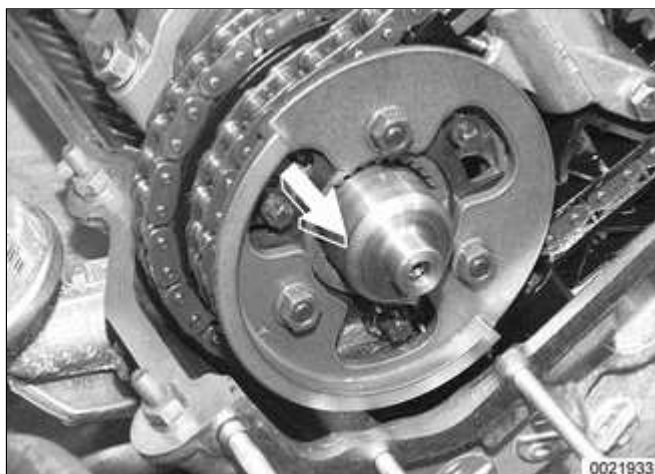


- ✦ Install exhaust camshaft impulse wheel, aligning pointer (B) with top edge of cylinder head (A). Install mounting nuts (arrows) finger tight.



- ✦ Pull out exhaust camshaft splined shaft to stop.

- Press down on secondary chain tensioner and remove tensioner lock-down tool.



- ✦ Preload primary chain:

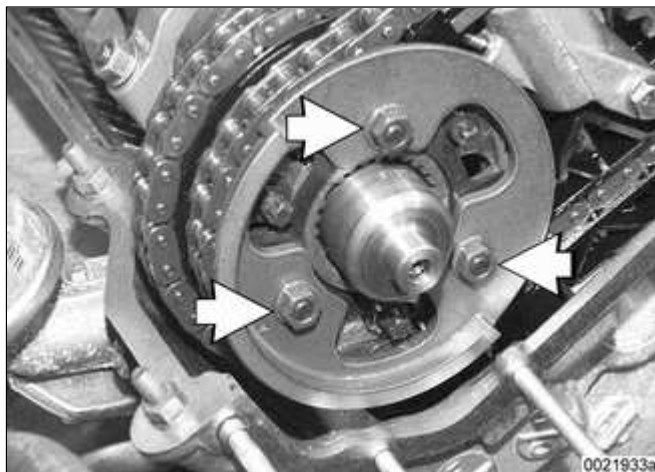
- ◆ Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

Tightening torque	
Primary chain tensioner preload	0.7 Nm (6 in-lb)

Primary chain tensioner preload	0.7 Nm (6 in-lb)
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- ✦ Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



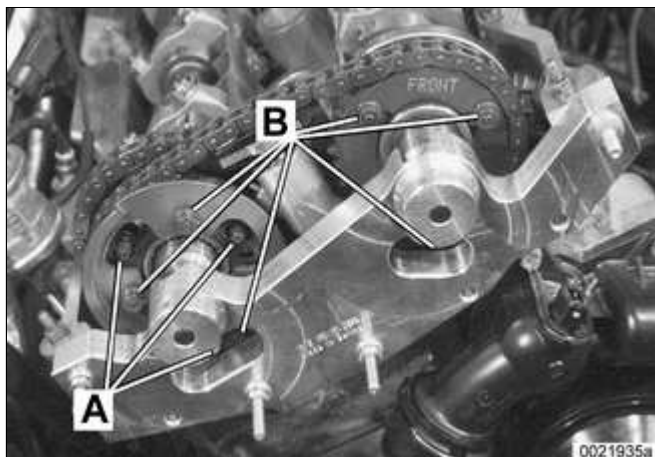
- ✦ Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Install nuts (**arrows**) finger tight, then tighten down uniformly until special tool is in full contact with cylinder head.



CAUTION!



Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If any foreign material is present on the sealing surface, the camshaft timing will be incorrect.



Secure camshaft sprockets and impulse wheels:

- ◆ Tighten mounting screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
- ◆ Tighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
- ◆ Torque down mounting screws (**A**) and nuts (**B**) to final specifications.

Tightening torques

Sprocket assembly to camshaft

initial torque	5 Nm (44 in-lb)
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Sprocket assembly wheel to camshaft

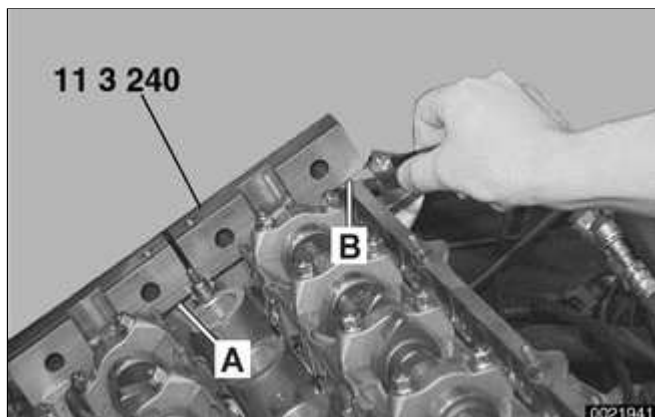
M7 Torx screws (A)	20 Nm (15 ft-lb)
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M6 mounting nut (B)	10 Nm (8 ft-lb)
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- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer secured.
- Remove camshaft locking tools from cylinder head.



Turn engine over twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face



each other.

- Secure crankshaft in TDC position with BMW special tool 11 2 300.

- Place BMW special tool 11 3 240 over camshafts and measure clearances.

Note:

- ◆ *If the exhaust side of the tool (A) is not flush with the head, camshaft timing is incorrect. Reset camshaft timing as described in ⇒ [117 Camshaft Timing Chains](#).*
- ◆ *Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS splines, when the camshaft timing is set correctly, the intake side of special tool 11 3 240 (B) may be up to 1 mm (0.04 in) above the surface of the cylinder head. This is normal. Reassemble engine. Otherwise, reset camshaft timing as described in ⇒ [117 Camshaft Timing Chains](#)*

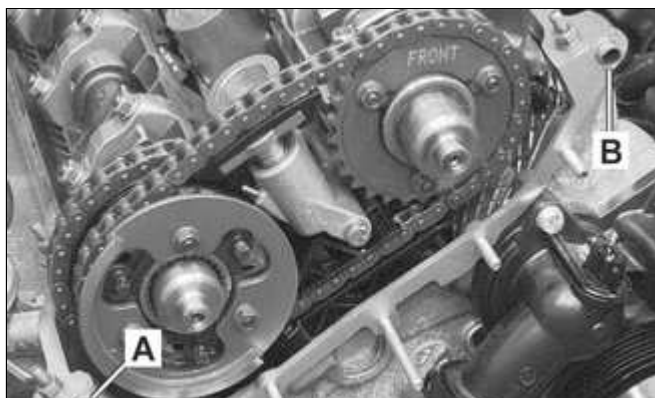
- Remove BMW special tool 11 6 150 from front of cylinder head.

VANOS control unit, installing

- Clean contact edges of cylinder head face and VANOS unit and apply a thin coat of sealing compound 3-Bond®1209 or equivalent to surfaces.

CAUTION!

- ◆ **Make sure all gasket material is**





removed from face of cylinder head. Clean sealing face and keep free of oil. If any foreign material is present on the sealing surface, the camshaft timing will be incorrect.

- ♦ **Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.**

- Replace steel gasket.
- Install VANOS unit to front of cylinder head.

Note:

If Double VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described in ⇒ [117 Camshaft Timing Chains](#).

- Reinstall engine support hook.

Tightening torque	
VANOS unit to cylinder head	
M6 nut	10 Nm (89int-lb)
M7 nut	14 Nm (10 ft-lb)

- Reconnect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.



- ✦ Insert and tighten down VANOS hydraulic piston set screws (**arrows**) in splined shafts on intake and exhaust camshafts.

CAUTION!



**Set screws have left hand thread.
Tighten counterclockwise.**

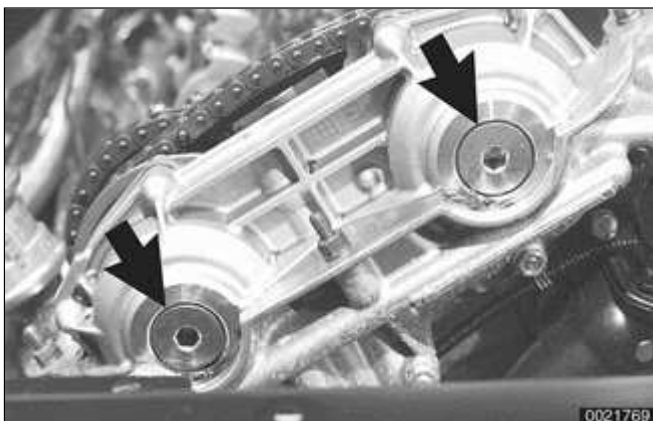
Tightening torque

Hydraulic piston to splined shaft

M6 set screw	10 Nm (89 in-lb)
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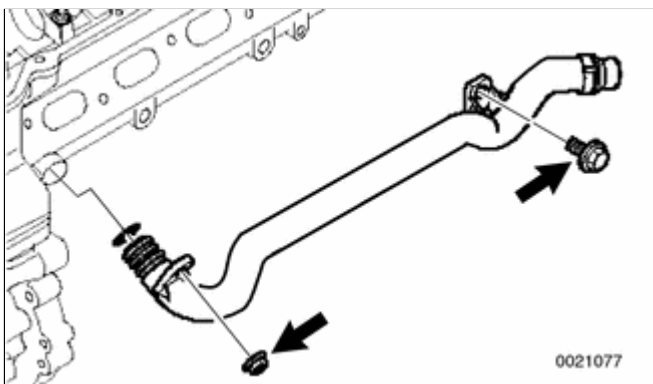
- Replace sealing caps inside VANOS unit with BMW special tool 11 6 170, or short flat nosed pliers.



- Insert and secure VANOS sealing plugs (**arrows**) with new sealing O-rings.

Tightening torque

Sealing plug to VANOS unit	50 Nm (37 ft-lb)
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- Install coolant pipe fasteners at base of cylinder head and tighten fasteners (**arrows**).

Note:

Use new sealing O-ring on coolant pipe.

- Install VANOS oil line banjo bolt with new seals. Attach oil line to VANOS unit.

Tightening torque

Tightening torque

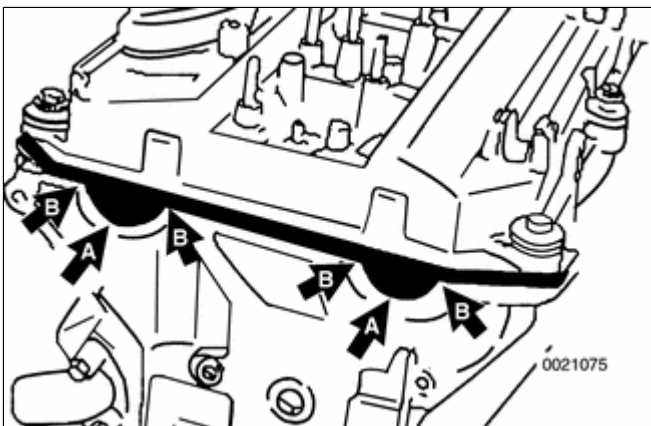
Oil line to VANOS unit (banjo bolt)	32 Nm (24 ft-lb)
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- Remove BMW special tool 11 4 220 and reinstall chain tensioner cylinder.

Tightening torque

Primary chain tensioner cylinder to cylinder head	70 Nm (52 ft-lb)
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- Remove flywheel locking tool from transmission bellhousing. Replace special tool bore sealing plug.
- Remove camshaft locking tools from cylinder head.

Cylinder head cover, manifolds, cooling system, installing

- Install intake camshaft cover and cylinder head cover.
 - ◆ Check for correct seating of half-moon seals (A) in back of cylinder head cover.
 - ◆ Use a small amount of 3-Bond®1209 or equivalent sealant at corners (B) of half-moon cutouts.
 - ◆ Seat gasket and seal corners in front of cylinder head at VANOS unit.

Tightening torque	
Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)

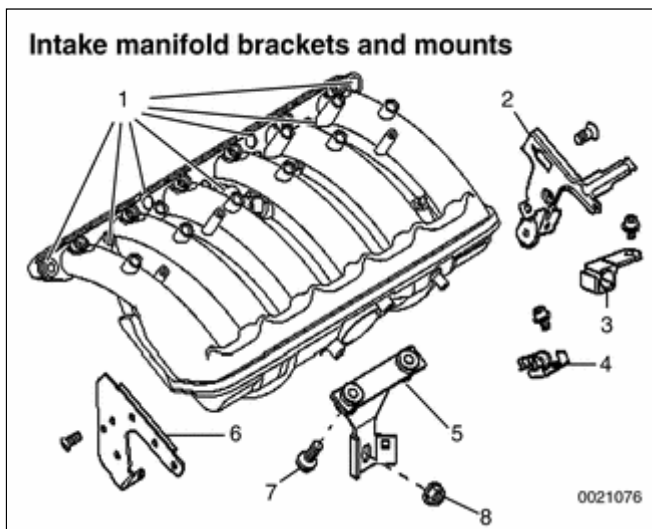
Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
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- Install exhaust manifolds using new gaskets and nuts. Coat manifold studs with copper paste prior to installing nuts.

Tightening torque	
Exhaust manifold to cylinder head (M7)	20 Nm (15 ft-lb)

Exhaust manifold to cylinder head (M7)	20 Nm (15 ft-lb)
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- Install electrical harness connectors for oil pressure sender and coolant temperature sensor before installing intake manifold.



Intake manifold Installation is reverse of removal.

- 1 - Manifold mounting nuts -tighten to 15 Nm (11 ft-lb)
- 2 - Fuel pipe bracket
- 3 - Fuel pipe bracket
- 4 - Vacuum pump bracket
- 5 - Manifold mounting bracket
- 6 - Tank venting valve bracket
- 7 - Mounting bracket to manifold bolt (M6) -tighten to 10 Nm (7 ft-lb)
- 8 - Mounting bracket to cylinder block nut (M10) -tighten to 47 Nm (33 ft-lb)

- ◆ Use new fuel injector seals.

- ◆ Carefully check intake manifold gasket and replace if necessary.
- ◆ Inspect O-ring seal between mass air flow sensor and air filter housing. To facilitate reassembly, coat seal with acid-free grease.

CAUTION!

When reattaching throttle assembly harness connector, connector is fully tightened when arrows on connector and plug line up.

Tightening torques	
Intake manifold to cylinder head	
M7	15 Nm (11 ft-lb)
M8	22 Nm (16 ft-lb)
Mounting bracket to cylinder block (M10)	47 Nm (33 ft-lb)
Mounting bracket to intake manifold (M6)	10 Nm (7 ft-lb)

- Installation of remaining parts is reverse of removal, noting the following:
- ◆ Refill cooling system as described in ⇒ [170 Radiator and Cooling System](#).
- ◆ Change engine oil and filter as described in ⇒ [020 Maintenance](#).
- ◆ If necessary, adjust accelerator cable.

- ◆ Reconnect battery.

CAUTION!

To prevent damaging engine electronic systems, install all ground wires previously removed, including the ground wires for the ignition coils.

Tightening torques	
Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

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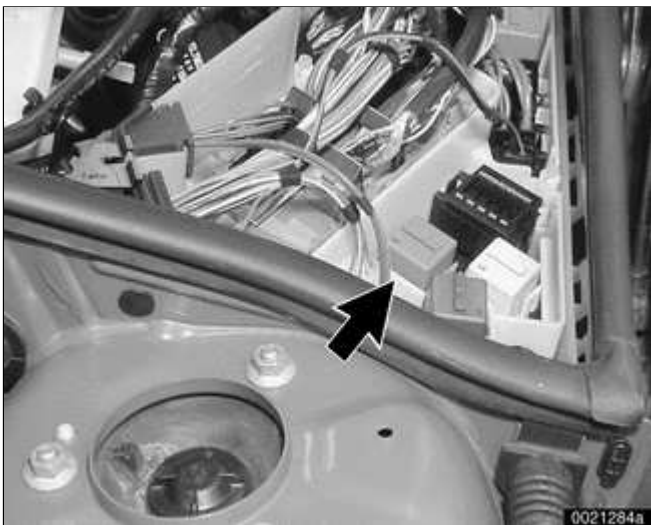
Diagnostic Testing

Cylinder compression, checking

A compression gauge is needed to make a compression test. For accurate test, the battery and starter must be capable of cranking the engine at least 300 rpm, and the engine should be at normal operating temperature.

Note:

Performing a compression test may cause a fault to set in the ECM and may illuminate the engine service light. The light can only be turned out using either BMW special service scan tools or an equivalent aftermarket scan tool. Disconnecting the battery will not erase the fault memory nor turn out the light.



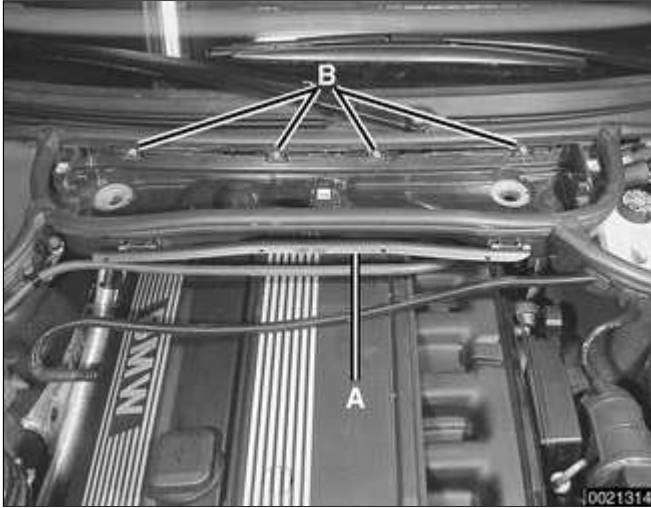
- ✦ Disable ignition system by removing DME main relay (**arrow**) from the electronics box (E-box) in left rear of engine compartment

WARNING!

- ✦ **The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme caution when working on a car with the ignition switched on or the engine running.**
- ✦ **Do not touch or disconnect ignition components while the engine is running or being cranked by the starter.**

CAUTION!

Failure to remove the DME main relay or attempting to disable the ignition system by other methods may result in damage to the engine control module (ECM).



➤ Remove housing for interior ventilation microfilter.

- ◆ Remove upper cover and microfilter.
- ◆ Open wiring harness loom cover (A) and remove wires.
- ◆ Unfasten screws (B) and remove lower microfilter housing.
- Remove oil filler cap.
- Remove engine cover over ignition coils. Replace oil filler cap.



➤ Remove ignition coils.

- ◆ Pull up on spring clips to disconnect ignition coil harness connectors.
- ◆ Remove coil grounding straps.
- ◆ Remove coils.
- ◆ Remove spark plugs.

Note:

Check the spark plugs for oil deposits that may indicate poor cylinder sealing, then set them aside in order. Used spark plugs should be reinstalled in the same cylinder from which they were



removed.



Install compression gauge in first cylinder's spark plug hole, tight enough to form a good seal.

- With parking brake set, transmission in PARK or NEUTRAL, and accelerator pedal pressed to floor, crank engine with starter. Record highest value indicated by gauge.

Note:

- ◆ *The compression gauge reading should increase with each compression stroke and reach near its maximum reading in about 4-6 strokes.*
- ◆ *All cylinders should reach maximum compression in the same number of strokes. If a cylinder needs significantly more strokes to reach maximum compression, there is a problem.*
- Release pressure at compression gauge valve, then remove gauge from spark plug hole. Repeat test for each cylinder and compare results with values given below.

Compression pressures	
Minimum	10 - 11 bar (142 - 156 psi)
Maximum difference between cylinders	0.5 bar (7 psi)

- Compression readings may be interpreted as follows:

- ◆ Low compression indicates a poorly sealed combustion chamber.
 - ◆ Relatively even pressures that are below specification normally indicate worn piston rings and/or cylinder walls.
 - ◆ Erratic values tend to indicate valve leakage.
 - ◆ Dramatic differences between cylinders are often the sign of a failed head gasket, burned valve, or broken piston ring.
- Reinstall spark plugs and ignition coils.

Note:

Used spark plugs should be reinstalled in the same cylinder from which they were removed.

- Remainder of installation is reverse of removal. Be sure to reinstall all wires disconnected during test, especially ground wires at coils and cylinder head cover (where applicable).

Tightening torque	
Spark plug to cylinder head	25 Nm (18 ft-lb)

Wet compression test

To further help analyze the source of poor compression, a wet compression test is the next step:

- Repeat compression test, this time with about a teaspoon of oil squirted into each cylinder. (The oil will temporarily help seal between piston rings and cylinder wall, practically eliminating leakage past rings for a short time.)
- If this test yields higher compression reading than "dry" compression test, there is probably leakage between piston rings and cylinder walls, due either to wear or to broken piston rings.
- Little or no change in compression reading indicates other leakage, probably from valves.

Cylinder leak-down test

The most conclusive diagnosis of low compression symptoms requires a cylinder leak-down test. Using a special tester and compressed air, each cylinder, in turn, is pressurized. The rate at which the air leaks out of the cylinder, as well as where the air leaks out, can accurately pinpoint the magnitude and location of the leakage.

Before attempting any repair that requires major engine disassembly, use a leak-down test to confirm low compression.

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General

This repair group covers cylinder head and valvetrain service and repair. Procedures described here require that the cylinder head first be removed as described in ⇒ [113 Cylinder Head Removal and Installation](#).

Note:

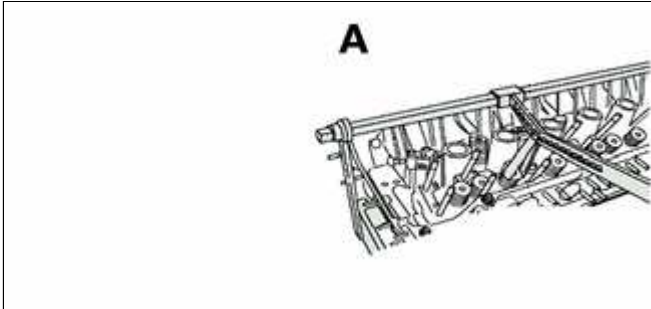
- ◆ *For timing chain and VANOS repair information, see ⇒ [117 Camshaft Timing Chains](#).*
- ◆ *If it is determined that the cylinder head will require significant reconditioning work, a remanufactured cylinder head may be a good alternative. Remanufactured cylinder heads are available from an authorized BMW dealer.*

The information given in this repair group is organized according to engine code. For engine application information, see ⇒ [100 Engine—General](#).

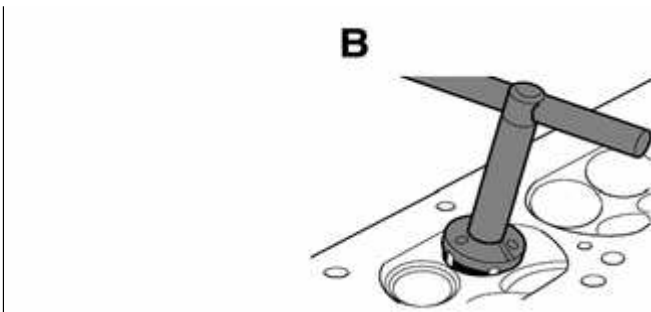
Special tools

BMW special tools are required for most cylinder head service described in this repair group. Many of these tools are expensive and only available through an authorized BMW dealer. If the special tools are not available, have the cylinder head disassembled and removed by an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools and equipment will be necessary.

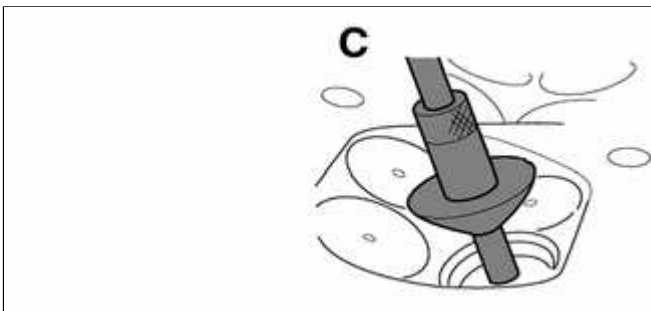
Most of the repairs to a cylinder head require precision machine work to specific tolerances. This type of work should be performed by an authorized BMW repair facility or an ASE certified machinist.



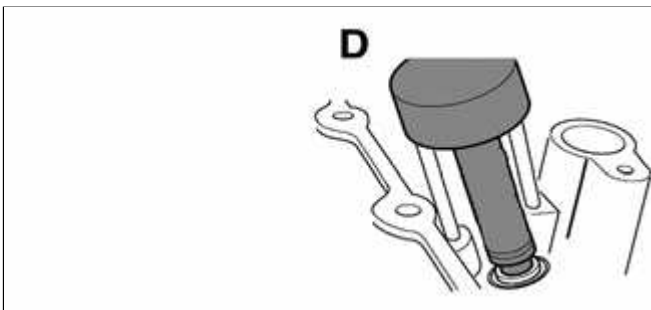
◀ Cylinder head jig BMW 00 1 490



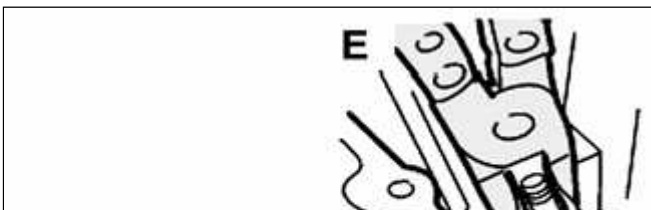
◀ Valve seat grinder BMW 00 3 520



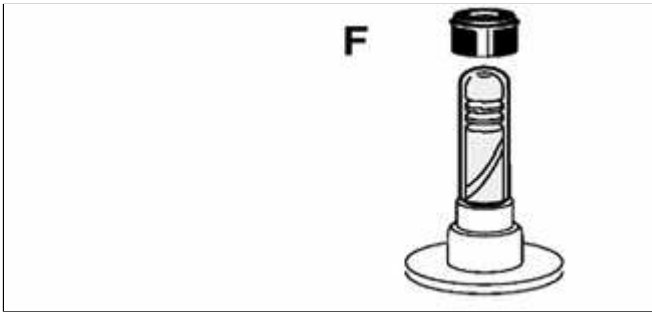
◀ Valve guide reamer BMW 00 4 210



◀ Valve stem seal driver BMW 11 1 200



◀ Valve stem seal puller BMW special tool 11 1 480



◀ Valve stem seal guide BMW special tool 11 1 960

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Cylinder Head

This section provides the specifications and special reconditioning information necessary to repair the cylinder heads covered by this manual.

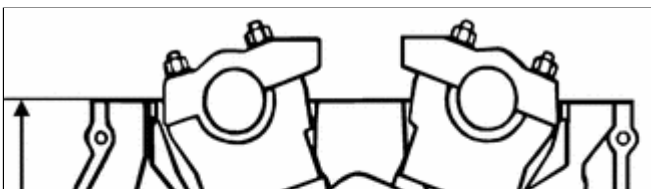
The disassembled cylinder head should be inspected for warpage and cracks. Check the valve guides and valve seats for wear before machining a warped head. Always decarbonize and clean the head before inspecting it. A high-quality straight edge can be used to check for warpage.

Visually inspect the cylinder head for cracks. If a cracked cylinder head is suspected and no cracks are detected through the visual inspection, have the head further tested for cracks by an authorized BMW dealer or an ASE certified machinist. A cracked cylinder head must be replaced.

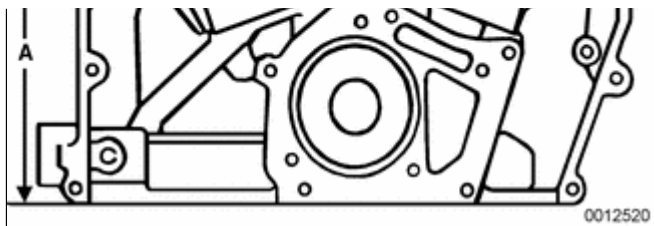
Note:

When disassembling and inspecting the cylinder head on an engine, be sure to check the camshaft carrier bearing surfaces for warpage.

A warped cylinder head can be machined provided no more than 0.3 mm (0.012 in.) of material is removed. If further machining is required, the head should be replaced. Removing more than this amount will reduce the size of the combustion chamber and adversely affect engine performance. A 0.3 mm thicker gasket is available from an authorized BMW parts department for machined heads.



Before machining the head to correct for warpage, measure the total height (A) (thickness of the cylinder head). Minimum height specifications are



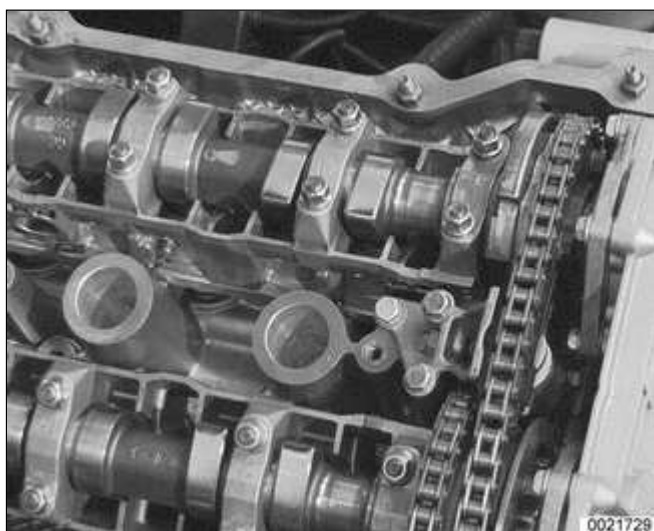
given in \Rightarrow [Table a.](#)

Table a. Cylinder head height	
New	Minimum height (dimension A)
140.0 mm (5.512 in)	139.7 mm (5.500 in)

Valves, leak test

To test the valves for leakage, the cylinder head must be disassembled with camshafts and camshaft carriers removed. Install the valve assemblies and the spark plugs in each cylinder. Place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with a thin non-flammable liquid, such as a parts cleaning fluid. After fifteen minutes, check the level of the fluid. If the fluid level in any cylinder drops, that cylinder is not sealing properly.

Camshaft



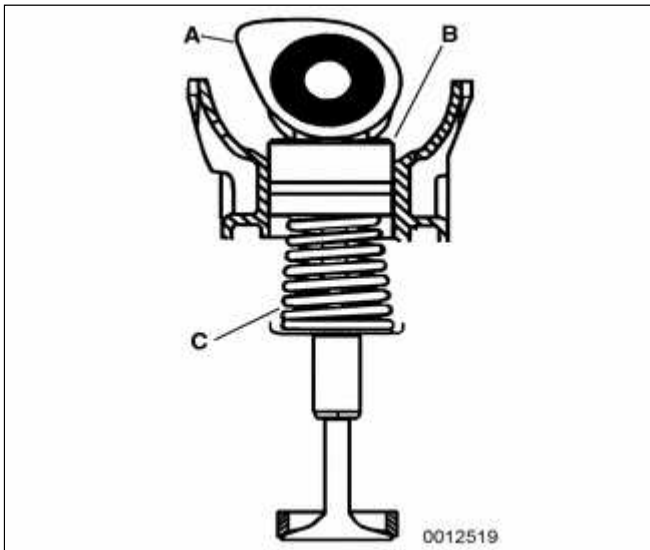
- Camshaft wear is usually caused by insufficient lubrication. Visually inspect camshaft lobes and journals for wear. Camshaft wear specifications are given in \Rightarrow [Table b.](#)

Table b. Camshaft wear specifications	
Axial play	0.150-0.330 mm (0.0060-0.013 in.)
Radial play (Plastigage)	0.020-0.054 mm (0.0008-0.0021 in.)

CAUTION!

If the camshaft is being replaced due to cam lobe wear, it is recommended that the corresponding lifters should also be replaced to avoid damaging the new camshaft.

Hydraulic lifters, checking and replacing



- ✦ Modern BMW 6 cylinder engines use self-adjusting hydraulic lifters to keep the valve clearances within a limited working range. (A) section view of camshaft, (B) hydraulic lifters are sealed units and require no maintenance, (C) valve with conical valve spring.

Under some circumstances, such as a cold start, the cam followers may become noisy. Hydraulic lifter noise is usually a high-pitched tapping or chattering noise. In most instances, this is considered normal as long as the noise goes away in a few minutes (maximum 20 minutes). If the noise does not go away, either the lifter is faulty or the oil pressure to the lifter is low. Hydraulic lifter replacement requires that the camshaft first be removed.

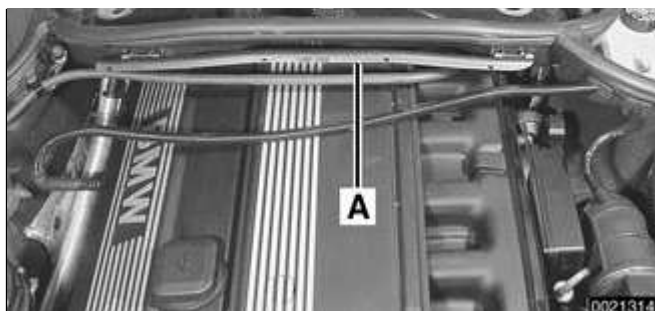
Note:

Before checking hydraulic lifters, make sure engine oil is fresh and at the proper level.

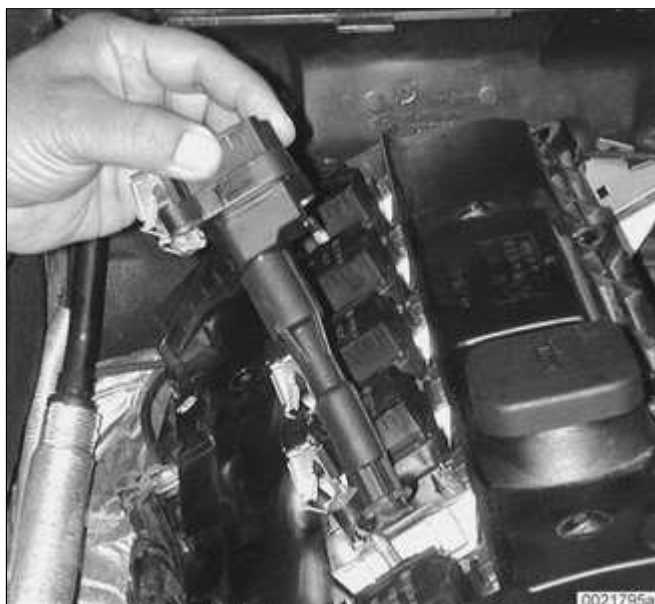
- Run engine until it reaches normal operating temperature.



- ✦ Remove microfilter housing:
 - ◆ Remove microfilter for interior ventilation.



- ◆ Open wiring harness loom (**A**), remove harness and lay aside.
- ◆ Unfasten screws (**B**) and take off lower microfilter housing.
- Remove engine cover.
- Detach positive and ground connections from intake manifold and cylinder head cover, as necessary.



- ✦ Remove ignition coils.
- ◆ Disconnect ignition coil harness connectors and lay harness aside.
- ◆ Remove coil grounding straps.
- ◆ Remove coils.
- ◆ Remove spark plugs.
- Remove cylinder head cover mounting fasteners and remove cylinder head cover.

Note:

The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original locations. Make note of their arrangement during removal.



- ✦ Remove oil baffle cover from above intake camshaft.



- ✦ Use a plastic or wooden stick to press down on top of lifter. If there is any noticeable clearance, the lifter is faulty and should be replaced.

Note:

When checking a hydraulic lifter, make sure the corresponding camshaft lobe is facing up so that there is no valve spring pressure on the follower.

- To replace a hydraulic lifter, remove appropriate camshaft. Refer to camshaft removal procedures given in ⇒ [113 Cylinder Head Removal and Installation](#).
- Once camshaft is removed, withdraw faulty lifter and replace with new one. Inspect lifter bores for wear and scoring.
- Camshaft, timing chain and cylinder head cover reassembly is reverse of disassembly.

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Valves

Valves, removing and installing

- Remove cylinder head as described in ⇒ [113 Cylinder Head Removal and Installation](#).

CAUTION!

- ♦ *Do not let the hydraulic lifters fall out as the camshaft carrier is removed. Special suction cups are available from BMW to hold the hydraulic lifters in place during carrier removal.*
- ♦ *Hydraulic cam lifters should be stored in an upright position. If necessary, use a magnetic tool to aid in removal of the lifters.*
- Remove valves using a valve spring compressor.

CAUTION!

Label each valve assembly as it is removed so it can be installed in its original position.

- Remove and discard valve stem oil seals from valve guides. See ⇒ [Valve stem oil seals](#) later in this section.
- Valve installation is reverse of removal.

Valve specifications are listed in ⇒ [Table c](#). Remove carbon deposits from

the valves using a wire brush or wire wheel.

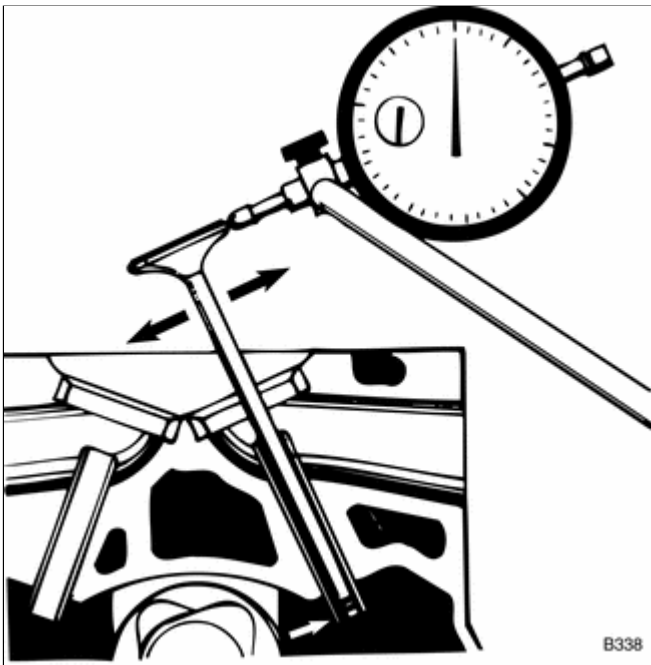
Table c. Valve specifications	
Specification	M 52TU 2.5/2.8 engines (1999 - 2000) M 54 2.5/3.0 engines (2000 - 2001)
Valve head dia.	
Intake	33.0 mm (1.299 in.)
Exhaust	30.5 mm (1.201 in.)
Valve stem dia. Standard	
Intake	6.0 ^{-0.015} mm
	(0.2362 ^{-0.0006} in.)
Exhaust	6.0 ^{-0.015} mm
	(0.2362 ^{-0.0006} in.)
Oversize 1	
Intake	6.1 ^{-0.025} mm
	(0.2401 ^{-0.0010} in.)
Exhaust	6.1 ^{-0.040} mm
	(0.2401 ^{-0.0016} in.)
Oversize 2	
Intake	6.2 ^{-0.025} mm
	(0.2441 ^{-0.0010} in.)

Table c. Valve specifications

Specification	M 52TU 2.5/2.8 engines (1999 - 2000) M 54 2.5/3.0 engines (2000 - 2001)
Exhaust	$6.2^{-0.040}$ mm
	($0.2441^{-0.0016}$ in.)

Valve guides

BMW does not supply valve guides as replacement parts. If a valve guide is excessively worn, it should be reamed to accept oversized valve stems. Valve guide specifications are listed in ⇒ [Table d.](#)



- ✦ Valve guides should be checked for wear using a new valve. Be sure to thoroughly inspect the cylinder head to ensure that it can be reused before reworking the guides.

Note:

- ◆ *International Organization for Standardization (ISO) tolerance classes are listed in ⇒ [Table c.](#) ISO allowances are based on nominal sizes and should be used to determine proper fit. Most machine shops should have this information available.*
- ◆ *Replacement valve guides may be available through aftermarket suppliers. Valve guide replacement requires special tools and a press. It is also necessary to heat the cylinder head and chill the*

valve guides when replacing the guides.

BMW supplies oversize valves. See ⇒ [Table d](#) for additional information.

Table d. Valve guide specifications	
Specifications	M52TU / M54 engine(1999 - 2001)
Valve guide wear, maximum (valve tilt clearance measured with new valve)	0.5 mm (0.020 in.)
Valve guide inside diameter, installed (tolerance per ISO allowance H7)	
Standard	6.0 mm (0.236 in.)
Oversize 1	6.1 mm (0.240 in.)
Oversize 2	6.2 mm (0.244 in.)

Valve stem oil seals

The purpose of the valve stem oil seal is to prevent excess oil from entering the combustion chamber. The sign of faulty valve stem oil seals is excessive oil consumption and smoke from the exhaust immediately after starting and during deceleration

Note:

Valve stem oil seals should not be reused. If valves are removed, new valve stem oil seals should be installed.

Valve stem oil seal replacement requires that the cylinder head be

disassembled and the valves removed as described above under ⇒ [Valves, removing and installing](#).

Note:

BMW special tools are available to remove the valve stem oil seals. As an alternative, standard valve seal removal tools are available from most automotive parts stores.

Lubricate new seal and install using hand pressure only. Be sure to install valve spring seat(s) before installing seal.

Valve seats

The valve seats should be resurfaced whenever new valves or valve guides are installed. Cutters are required to resurface the seats. Always check the valves for leaks after reconditioning a valve seat as described above. ⇒ [Table e](#) lists valve seat dimensions.

Note:

Standard size replacement valve seats are not available from BMW. Replacement valve seats are only available from BMW in 0.4 mm oversize (oversized in both height and diameter). The manufacturer does not provide specifications for valve seat replacement for the engines covered by this manual.

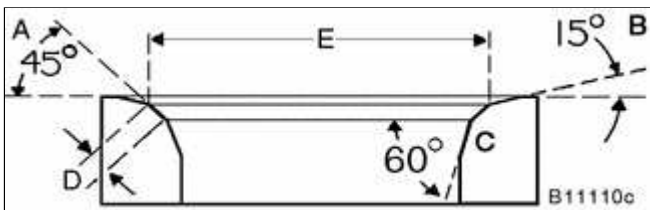


Table e. Valve seat specifications

Specification	M52TU/M54 engines (1999-2001)
A: Valve seat angle	45°

Table e. Valve seat specifications	
Specification	M52TU/M54 engines (1999-2001)
B: Correction angle, outside	15°
C: Correction angle, inside	60°
D: Valve seat width	
intake	1.65 ± 0.25 mm (0.065 ± 0.010 in)
exhaust	1.65 ± 0.25 mm (0.065 ± 0.010 in)
E: Valve seat outside dia.	
intake	32.4 mm (1.276 in)
exhaust	30.0 mm (1.181 in)

Valve springs

The valve springs should be checked for fatigue. To quickly check the springs, line them up in a row. Place a straight edge across the top of the springs. Any spring that is significantly shorter than the others is worn and should be replaced.

Note:

Valve spring specifications and wear limits are not available from BMW.

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General

This repair group covers timing chain and Variable Camshaft Timing (VANOS) repair information.

The timing chains are lubricated by engine oil and do not require maintenance. Worn timing chains and sprockets can lead to noisy operation and erratic valve timing. A faulty tensioner can also cause timing chain noises.

Note:

See ⇒ [100 Engine-General](#) for engine code and application information.

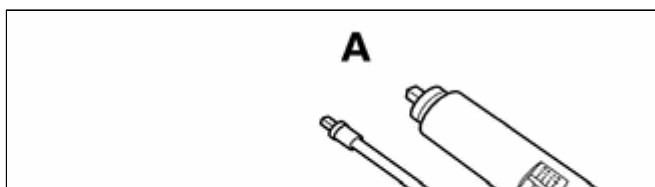
Special tools

Special BMW service tools are needed to remove and disassemble the timing chain, the VANOS control unit, the camshafts and the valvetrain. Many of these tools are expensive and only available through an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools will be necessary.

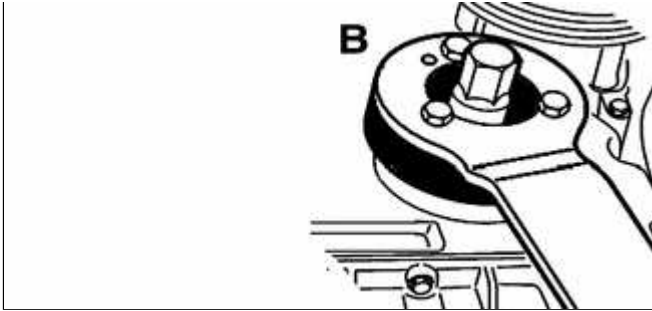
In addition, VANOS system diagnosis can only be carried out by using BMW specific electronic scan tools, such as BMW DIS or MoDiC or equivalent.

CAUTION!

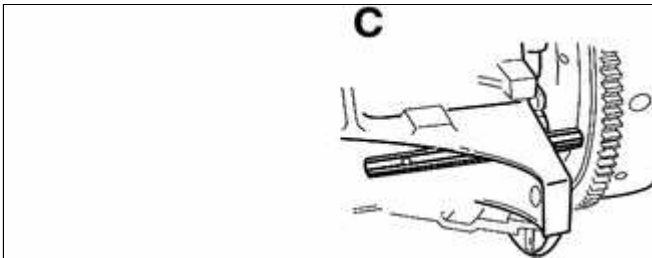
The VANOS system must be removed and installed exactly as described later in this repair group.



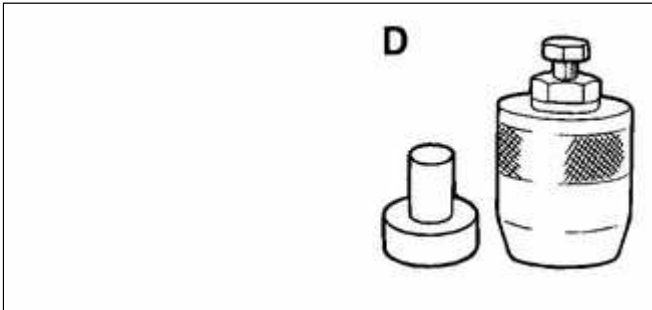
Torque wrench w/ flex extension BMW 00 9 250



- Crankshaft hub locking tools BMW 11 2 150 / 11 2 410



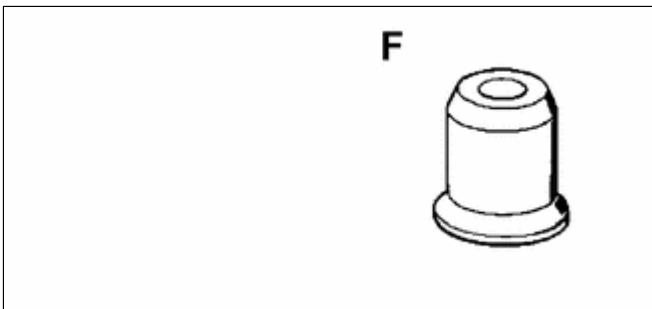
- Crankshaft locking tool BMW 11 2 300



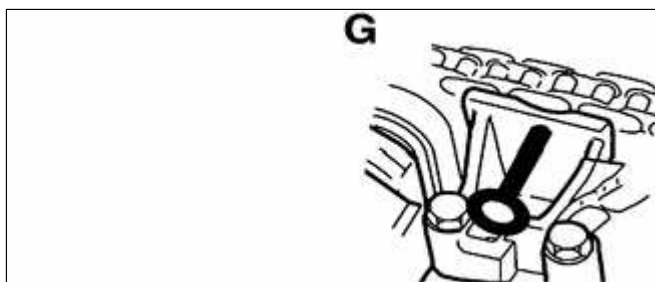
- Seal extractor tool BMW 11 2 380



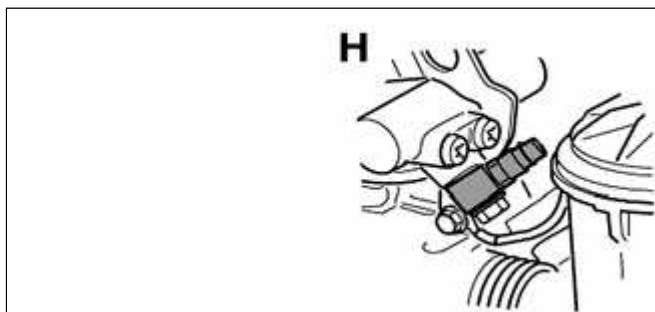
- Camshaft locking tools BMW 11 3 240/11 3 244



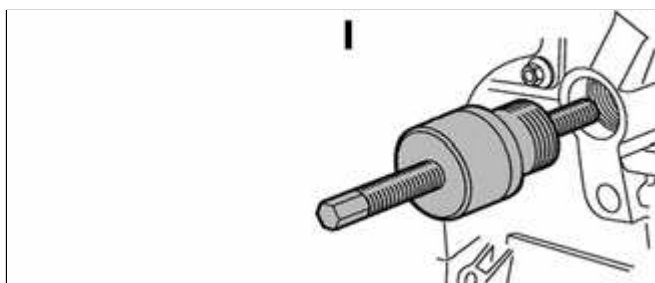
- Installer bush BMW 11 3 280



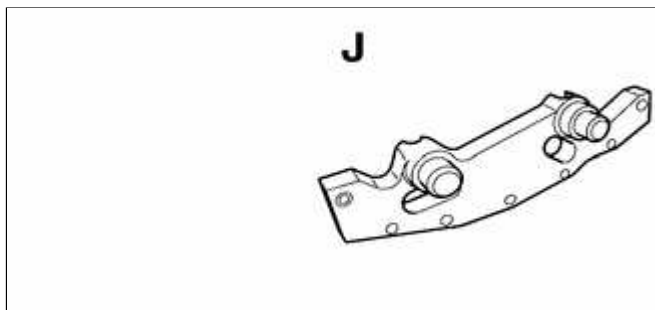
- Secondary chain tensioner locking pin
BMW 11 3 292



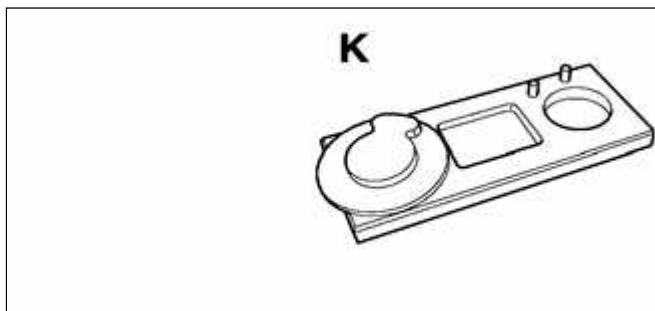
- Air line fitting BMW 11 3 450



- Primary chain tensioner tool BMW 11 4 220



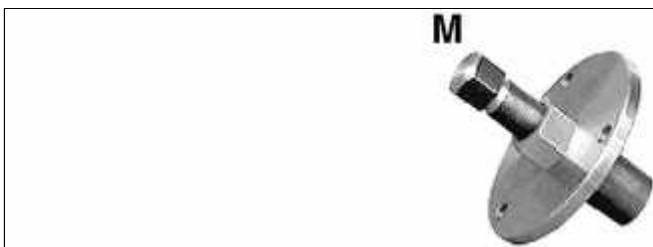
- VANOS setup bracket BMW 11 6 150



- Secondary sprocket tool BMW 11 6 180



- Crankshaft hub locking tool BMW 11 8 190 / 11 8 200



➤ Puller for crankshaft hub BMW 11 8 210

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Crankshaft Front Oil Seal

The crankshaft front seal is located in the lower timing cover on the front of the engine, behind the vibration damper.

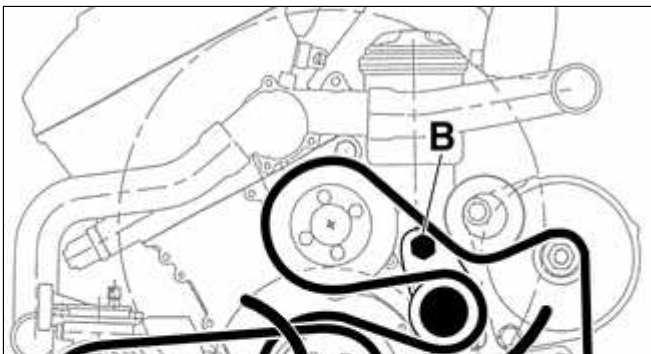
Note:

Cars built up to January 2000 are fitted with a 2-piece vibration damper and hub assembly. Cars built from January 2000 use an integral vibration damper and hub assembly. If the early vibration damper needs to be replaced, only the single piece with integral hub is available from BMW.

- Disconnect negative (-) cable from battery.

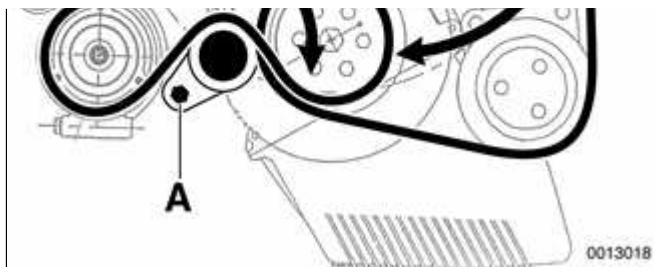
CAUTION!

- ♦ **Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.**
- ♦ **Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.**



Remove drive belts:

- ♦ Use long-handled wrench to turn A/C belt tensioner hex (A) clockwise (against spring tension). Remove A/C belt.



- ◆ Similarly, turn main engine drive belt tensioner hex (**B**) clockwise and remove belt.

- Secure crankshaft hub using special holding tools:

- ◆ Up to 1/2000 production: use special tools 11 2 150 and 11 2 410.

- ◆ From 01/2000 production: use special tools 11 8 190 and 11 8 200.

CAUTION!

Do not use BMW special tool 11 2 300 to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.

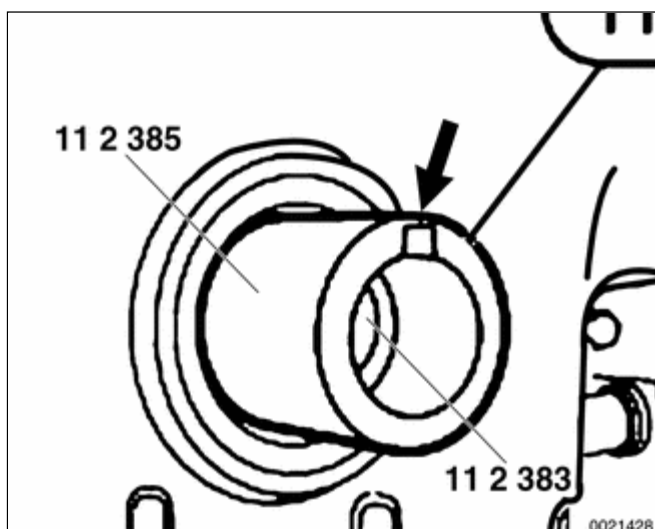
Note:

The crankshaft hub center bolt is tightened to a torque of 410 Nm (300 ft-lb).

- On cars built up to 1/2000 (2-piece vibration damper assembly), remove vibration damper mounting bolts and remove vibration damper and pulley from hub.
- Remove crankshaft hub (up to 1/2000 production) or vibration damper (1/2000 and later production).

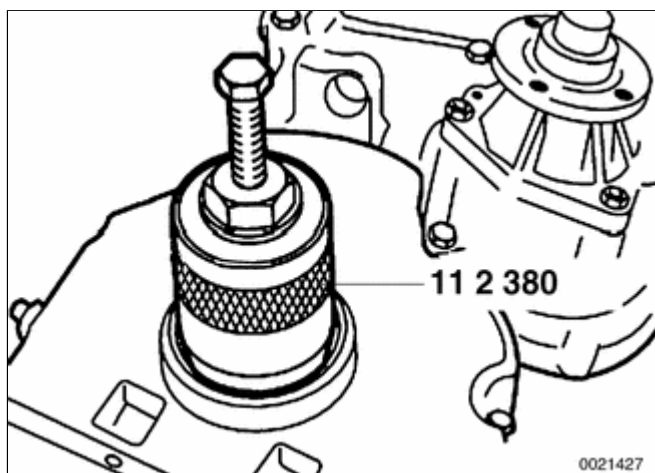
Note:

If necessary, use BMW special tool 11 8 219 or equivalent puller to remove

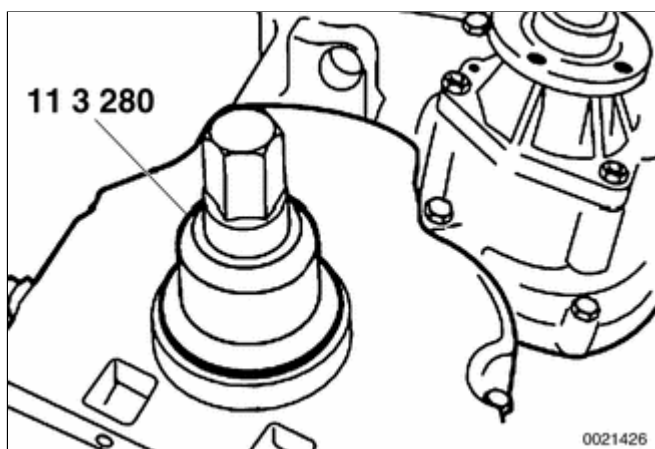


hub from crankshaft.

- Place special tool 11 2 383 on end of crankshaft to cover threaded hole, and fit special tool 11 2 385, aligning groove in 11 2 385 with keyway on crankshaft (arrow).



- Put special tool 11 2 380 over tools installed on crankshaft, and screw in until it makes firm contact with the seal. Tighten screw in end of 11 2 380 to draw out seal.



- To install new seal, coat with oil, and use special tool 11 3 280 and crankshaft center bolt to draw seal in flush with timing case cover.
 - Install crankshaft hub (up to 1/2000) or vibration damper (from 1/2000) to crankshaft. Install new crankshaft center bolt finger tight.
 - Torque crankshaft hub center bolt, using special tools 11 2 150/11 2 410 (up to 1/2000) or 11 8 190/11 8 200 (from 1/2000). nothing

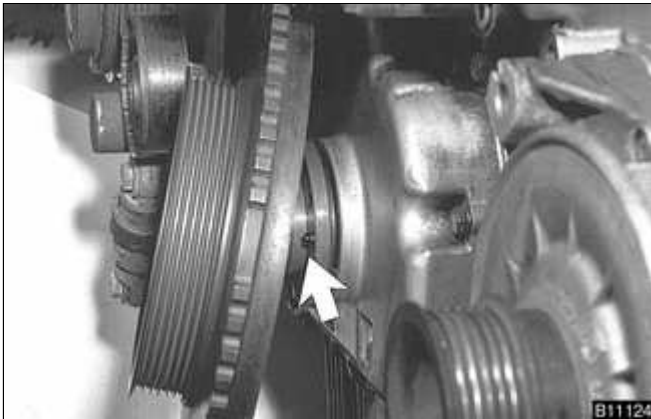
Tightening torque

Vibration damper	410 Nm (302
------------------	-------------

Tightening torque	
hub to crankshaft	ft-lb)

CAUTION!

Do not use BMW special tool 11 2 300 to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.



- ✦ Install vibration damper mounting bolts, where applicable. Note hub locating dowel (**arrow**).

Tightening torque	
Vibration damper to crankshaft hub (M8)	22 Nm (16 ft-lb)

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Camshaft Timing Chains, Removing

Camshaft timing chain removal requires that the engine oil pan be removed. This requires raising the engine and/or lowering the front suspension subframe. See ⇒ [119 Lubrication System](#). Also required is removal of the VANOS unit and disassembly of the intake and exhaust camshaft sprocket assemblies as described later in this repair group.

Special BMW service tools are needed for timing chain removal and installation procedures. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

CAUTION!

If the camshafts are not properly timed, the pistons can contact the valves.

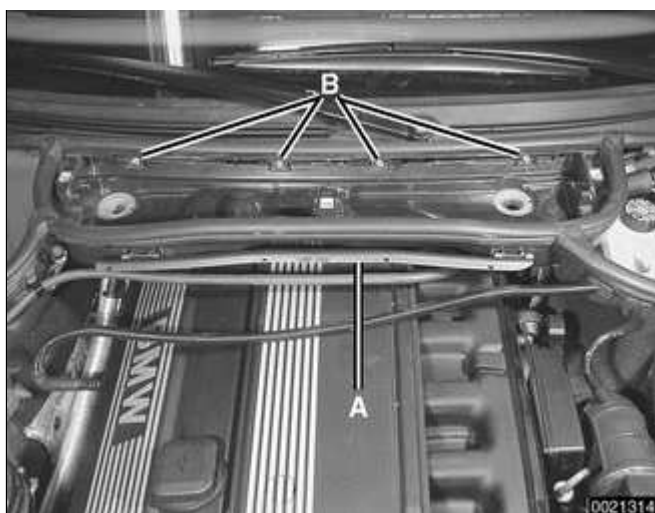
- Disconnect negative (-) cable from battery.

CAUTION!

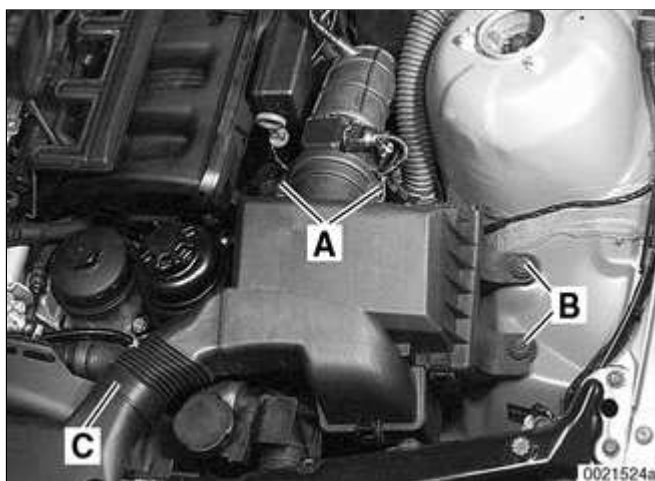
- ♦ ***Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.***
- ♦ ***Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page***

viii.

- Remove microfilter for interior ventilation.



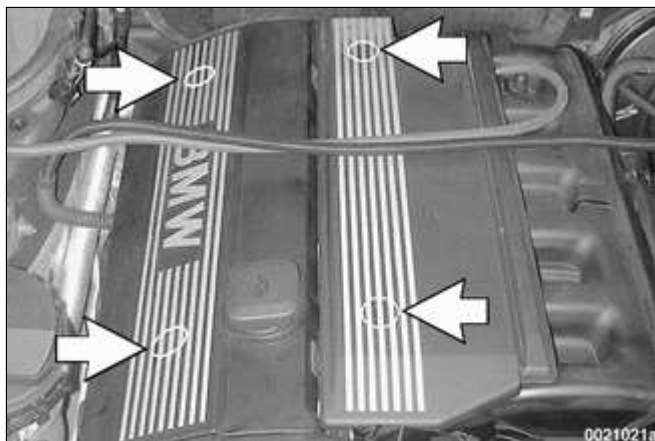
- Remove microfilter housing:
 - Open wiring harness loom (A), remove harness and lay aside.
 - Unfasten screws (B) and take off lower microfilter housing.



- Remove complete air filter housing:
 - Release mass air flow sensor clips (A).
 - Remove filter housing mounting screws (B).
 - Disconnect air duct connections (C) and lift complete air filter housing out of engine compartment, pulling it forward away from mass air flow sensor.

Note:

Mass air flow sensor remains attached to air duct in above step.



Remove engine covers:

- ◆ Remove plastic trim covers (arrows).
- ◆ Remove cover hold down bolts.



Drain engine coolant and remove coolant hoses.

- ◆ Remove expansion tank cap on radiator.
- ◆ Place a 3-gallon pail beneath engine to capture coolant.
- ◆ Remove engine block drain plug on exhaust side near cylinder 2 (arrow).

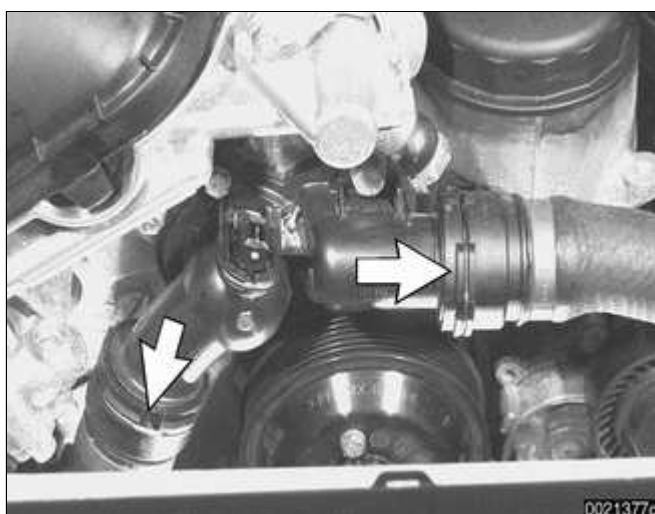
WARNING!

- ◆ **Allow engine to cool before opening or draining cooling system.**
- ◆ **Use caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Consult a veterinarian immediately if ingested by an animal.**
- Drain radiator into 3-gallon pail by removing plastic drain plug at lower left corner of radiator.

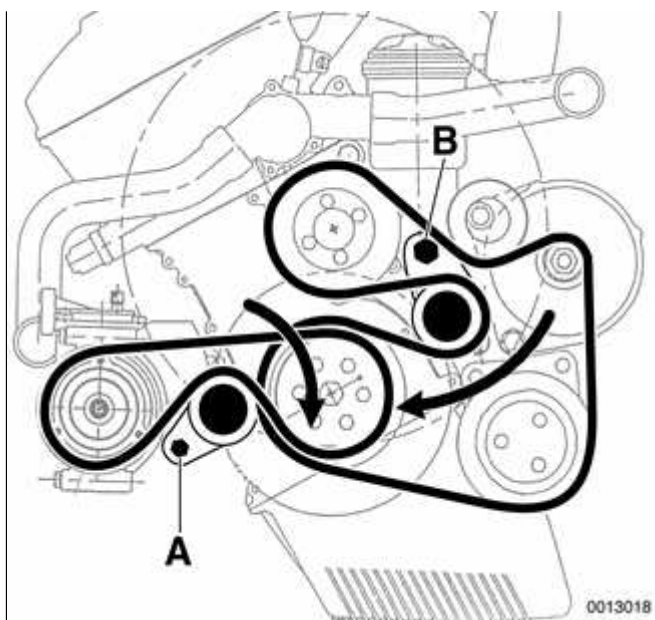
- Remove radiator cooling fan shroud and viscous clutch cooling fan (cars with automatic transmission) or electric cooling fan (cars with manual transmission). See ⇒ [170 Radiator and Cooling System](#)

CAUTION!

On cars with viscous clutch, 32 mm cooling fan mounting nut has left hand threads.



- ✦ Release locking clips and pull hoses from thermostat housing (**arrows**). Unbolt and remove thermostat houses.



- ✦ Remove drive belts:
 - ◆ Use long-handled wrench to turn A/C belt tensioner hex (**A**) clockwise (against spring tension). Remove A/C belt.
 - ◆ Similarly, turn main engine drive belt tensioner hex (**B**) clockwise and remove belt.
- Remove coolant pump pulley.
- Remove alternator cooling duct at radiator support.

- Drain engine oil and remove oil pan as described in ⇒ [119 Lubrication System](#).
- On cars produced up to 1/2000 with 2-piece vibration damper: Remove vibration damper mounting bolts and separate vibration damper and pulley from crankshaft hub.

Note:

Cars built up to January 2000 are fitted with a 2-piece vibration damper and hub assembly. Cars built from January 2000 use an integral vibration damper and hub assembly.

- Using BMW special holding tool, secure crankshaft hub to prevent crankshaft from turning. Loosen but do not remove crankshaft hub center bolt.

CAUTION!

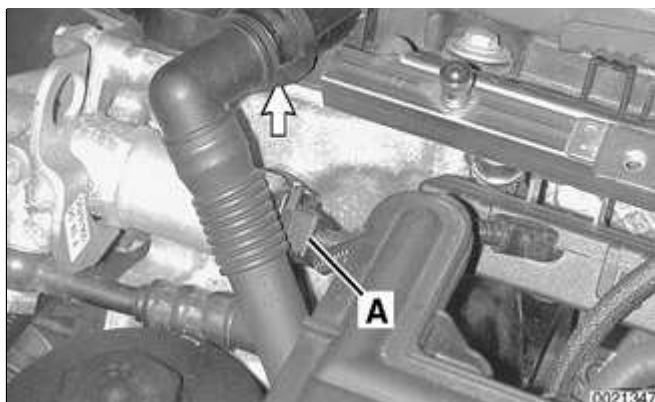
Do not use BMW special tool 11 2 300 (flywheel locking tool) to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.

Note:

The crankshaft hub center bolt is tightened to a torque of 410 Nm (300 ft-lb). BMW special tools 11 2 150 and 11 2 410 (up to 1/2000 models) or 11 8 190 and 11 8 200 (1/2000 and later models) should be used to hold the crankshaft stationary while the bolt is loosened.



Working at top center of engine, disconnect vent hose by squeezing at



fitting (**arrows**).

- Disconnect electrical connection at intake camshaft position sensor (**A**).



➤ Remove ignition coils and spark plugs:

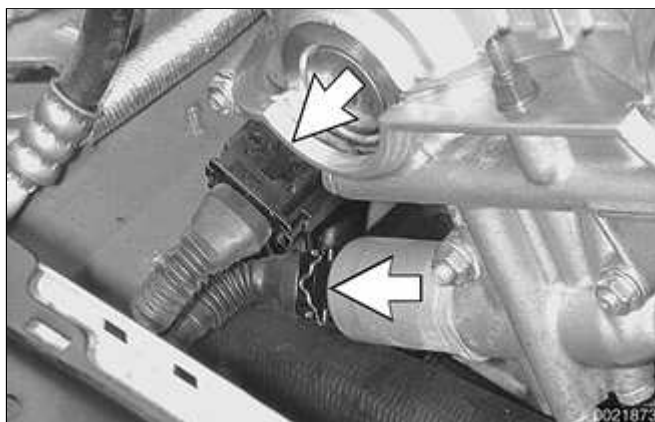
- ◆ Pull up on retaining clips to disconnect ignition coil harness connectors.
- ◆ Remove grounding straps at coil mounting studs.
- ◆ Remove all ignition coils.
- ◆ Remove spark plugs.
- Remove cylinder head cover mounting fasteners and remove cylinder head cover.

Note:

The cylinder head cover mounting bolt insulators, gaskets and coil grounds should be reinstalled in their original locations.



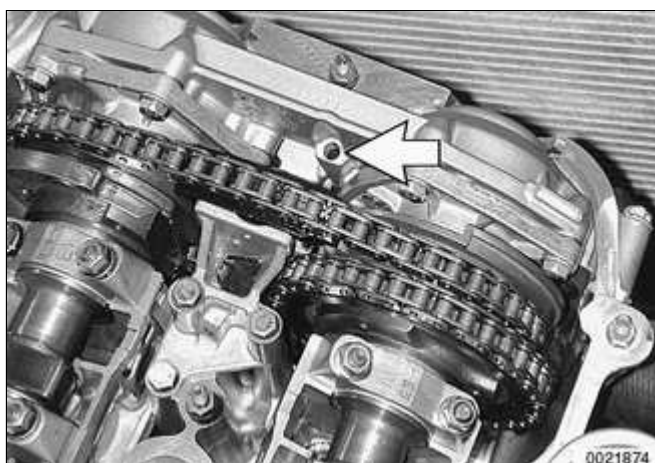
➤ Remove oil baffle cover from intake camshaft.



- Working at left front of cylinder head, disconnect electrical connections at exhaust camshaft position sensor and exhaust camshaft VANOS control valve (**arrows**).

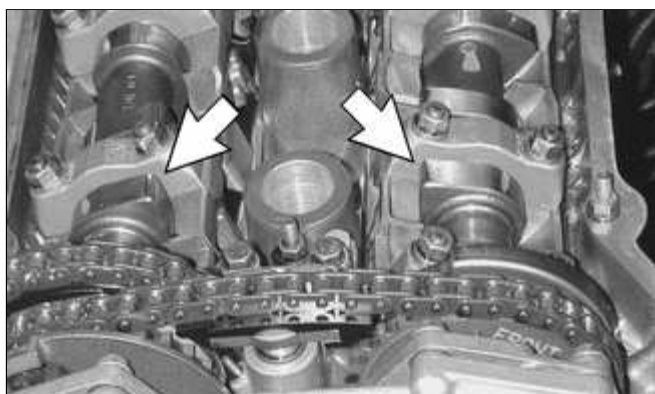


- Remove banjo bolt from VANOS control unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) (**arrow**) to VANOS unit.



- Cover oil hole in VANOS unit (**arrow**) with shop towel to capture oil which will spray when compressed air line is connected.

- Connect compressed air line to air fitting. Apply air pressure set to 2 - 8 bar (30 - 110 psi).



- With compressed air line connected, rotate engine in direction of rotation (clockwise) at least two full rotations, leaving cylinder 1 intake and exhaust camshaft lobes facing each other, as shown (**arrows**).

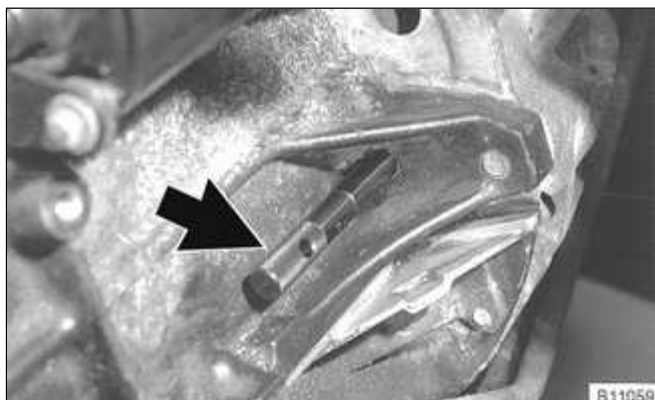
CAUTION!

Do not rotate engine



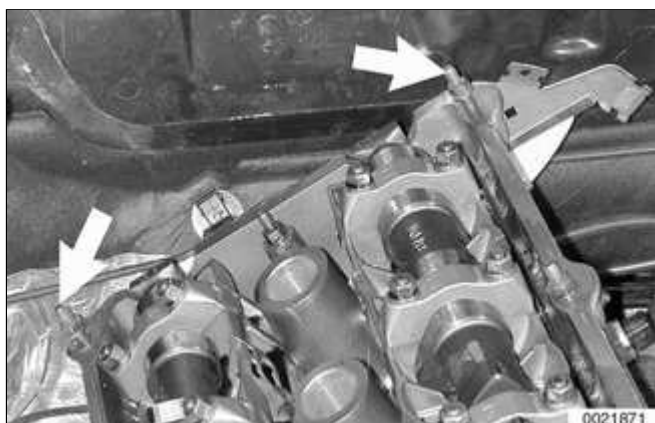
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counterclockwise to reach the top dead center position. Instead, complete another two complete rotations.



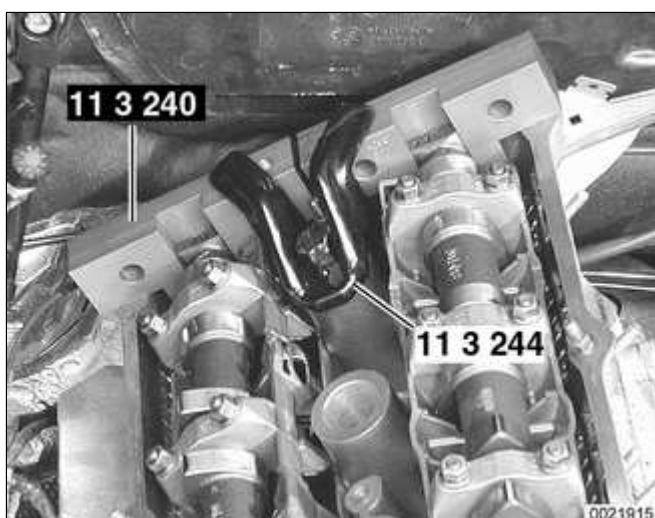
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- Remove sealing plug from bore on lower left side of engine block below starter. Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



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- Unscrew and remove threaded studs (**arrows**) at rear of cylinder head.



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- Secure camshafts in TDC position using BMW special tools 11 3 240 and 11 3 244.

- Detach compressed air line, leaving compressed air fitting attached to VANOS unit.

Note:

Oil will drain from pressure line. Have a container and rags ready.



- Unscrew sealing plugs from VANOS unit (**arrows**).

Note:

Oil will drain from sealing plug bores.



Have a container and rags ready.



- ✦ Pull sealing caps straight out of VANOS unit with BMW special tool 11 6 170, or with short nose pliers.

Note:

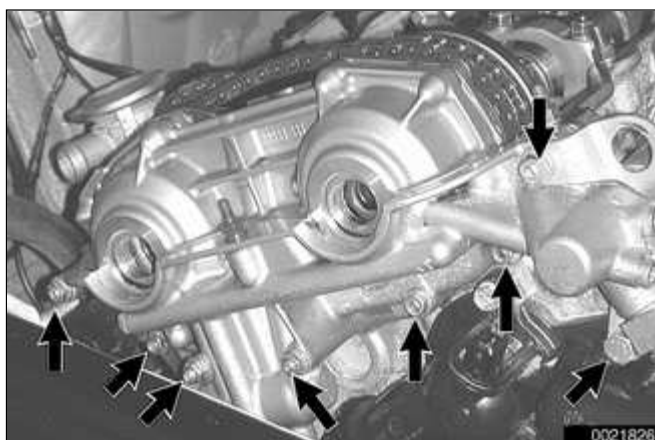
Additional oil may drain from VANOS unit.



- ✦ Remove set screws (left hand thread) on ends of intake and exhaust camshafts.

CAUTION!

Set screws have left hand threads. Remove with a clockwise motion.



- ✦ Remove VANOS unit:

- ◆ Remove fasteners from engine support eye.
- ◆ Remove VANOS mounting nuts (**arrows**) from cylinder head. Slide VANOS unit and metal gasket off.

CAUTION!

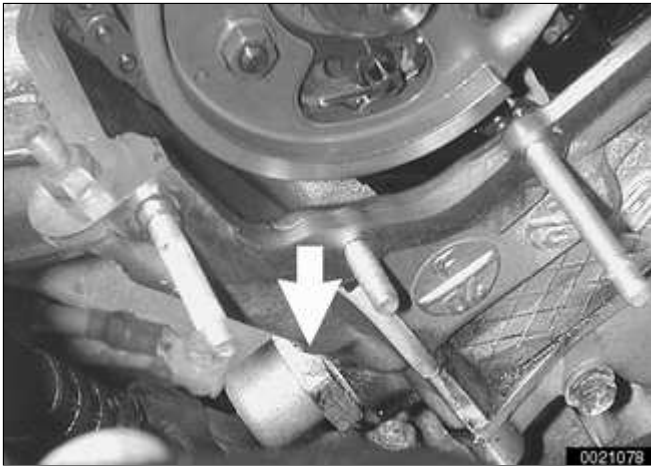
Do not crank or turn over engine with VANOS unit removed. Piston/valve interference is possible.

Note:

- ◆ The VANOS unit will contain

residual oil. Place shop towels beneath adjustment unit when removing.

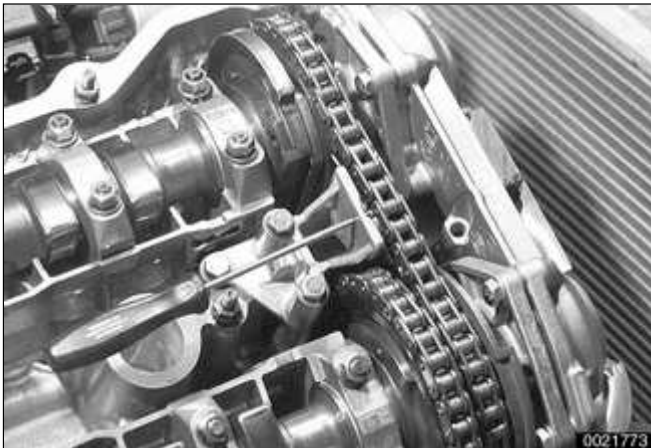
- ◆ *If the VANOS control unit is replaced, or if repair operations are completed that may change camshaft timing, the camshaft timing must be checked as described later in this chapter.*



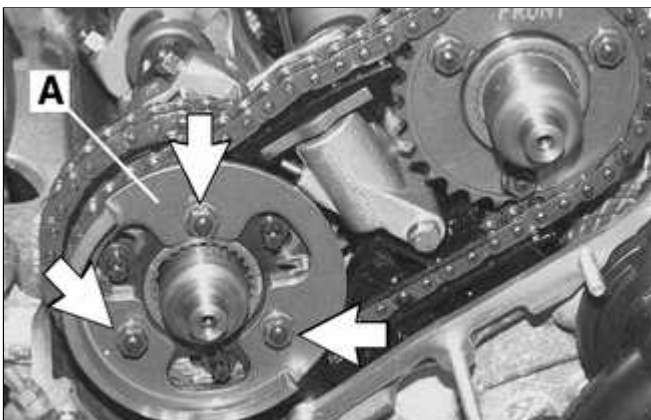
- ✦ Remove primary camshaft chain tensioner (**arrow**) from timing chain cover.

CAUTION!

Primary camshaft chain tensioning piston is under spring pressure.



- ✦ Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or a similar size rod.



- ✦ Remove exhaust camshaft impulse wheel mounting nuts (**arrows**). Remove impulse wheel (**A**).