

117 Camshaft Timing Chain

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GENERAL

This repair group provides removal and repair information for crankshaft vibration damper, engine timing chain and camshaft adjustment (VANOS) units. Camshaft timing procedure is also included.

Repair procedures in this repair group assume that the engine is installed in the engine bay.

The 5 Series engine cylinder head is equipped with variable camshaft timing or VANOS (from the German words *VAriable NOckenwellen Steuerung*). Special tools and procedures are required to remove and install camshaft adjustment units and to time camshafts. Be sure to read each procedure through before starting work.

117-2 Camshaft Timing Chain

Warnings

See also:

- **020 Maintenance**
- **100 Engine—General** for engine code and application information.
- **113 Cylinder Head Removal and Installation** for cylinder head cover removal
- **130, 131, 132, 133 Fuel Injection** for air filter housing and intake manifold removal
- **170 Radiator and Cooling System** for radiator drain and refill

Warnings

WARNING —

- *Due to risk of personal injury, be sure the engine is cold before beginning work on engine components.*
- *Use extreme 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. Seek medical attention immediately if coolant is ingested.*
- *Fuel is highly flammable. When working around fuel, do not disconnect wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.*

VIBRATION DAMPER

Vibration damper, removing and installing (M54 engine)

The M54 engine uses a 1-piece crankshaft vibration damper, integrated with the hub.

- Raise front of vehicle and support in a safe manner.

CAUTION—

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove splash guard under engine. See **020 Maintenance**.
- Remove electric cooling fan and cooling fan cowl. See **170 Radiator and Cooling System**.

NOTE—

- Protect radiator from damage with a piece of wood.

- With engine fully cooled off, mark direction of rotation on engine accessory belts. Remove belts. See **020 Maintenance**.

- ▲ Bolt BMW special tools 11 8 190 and 11 8 200 together. Insert fingers of special tool 11 8 200 in vibration damper openings. Use this tool setup to counterhold vibration damper hub while loosening vibration damper mounting bolt (arrow).

CAUTION—

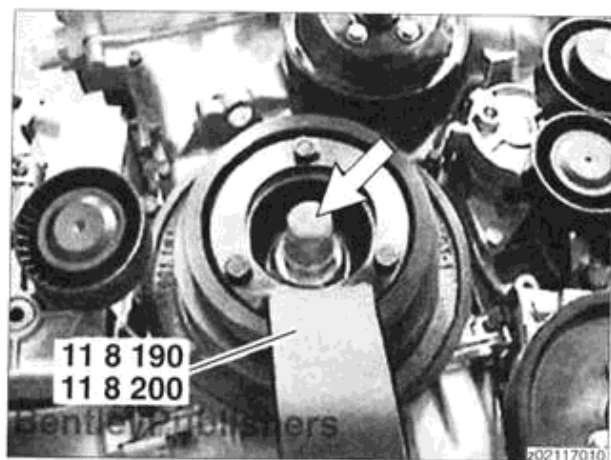
- Make sure an assistant holds special tool.
- If assistant is not available to grip the tool, rest handle of tool on front subframe. Protect subframe from damage with a piece of wood.
- Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten vibration damper mounting bolt.

- Remove vibration damper mounting bolt and discard.
- Pull off vibration damper using BMW special tools 11 8 210 and 11 8 200.

CAUTION—

- Avoid damaging radiator.
- If using a different puller than the BMW special tools, be careful to avoid damaging crankshaft threads.

- Inspect front crankshaft seal for leaks. For seal replacement, see **119 Lubrication System**.



117-4 Camshaft Timing Chain

Vibration damper, removing and installing (N52, N54 engine)

- When reinstalling:
 - Align vibration damper groove to crankshaft woodruff key.
 - Insert new vibration damper mounting bolt and washer.

CAUTION—

- Inspect woodruff key for damage before installing vibration damper. Replace if necessary

- Use BMW special tools 111 8 190 and 11 8 200 to counterhold vibration damper while tightening mounting bolt.

CAUTION—

- Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten vibration damper mounting bolt. Use only the recommended special tools, or equivalent tools for counterholding the pulley.

Tightening torque

Vibration damper to crankshaft (replace damper bolt)	410 Nm (300 ft-lb)
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Vibration damper, removing and installing (N52, N54 engine)

The crankshaft vibration damper is also referred to as the front pulley.

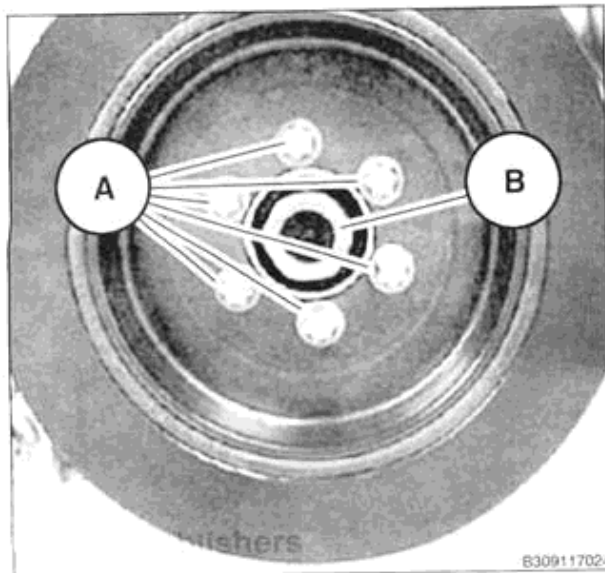
WARNING—

- To avoid personal injury, be sure the engine is cold before beginning the procedure.

- Raise vehicle and support safely.

WARNING—

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.



- Remove engine compartment splash shield. See **020 Maintenance**.
- Remove electric cooling fan and cooling fan cowl. See **170 Radiator and Cooling System**.

NOTE—

- Protect radiator from damage with a piece of wood.
- With engine fully cooled off, mark direction of rotation on engine accessory belt. Remove belt. See **020 Maintenance**.

- Remove vibration damper mounting Torx bolts (A) and discard. Lift off vibration damper.

CAUTION—

- Do not remove vibration damper hub bolt (B). If this bolt is removed, the timing chain drive sprocket becomes free to rotate, resulting in valve damage.

Camshaft Timing Chain 117-5

Vibration damper, removing and installing (V8 engine)

- Installation is reverse of removal.

Tightening torque

Vibration damper to hub (replace damper M8 x 16 mm Torx bolts)	35 Nm (26 ft-lb)
---	------------------

Vibration damper, removing and installing (V8 engine)

- Raise front of vehicle and support in a safe manner.

CAUTION—

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove splash guard under engine. See **020 Maintenance**.
- Remove electric cooling fan and cooling fan cowl. See **170 Radiator and Cooling System**.

NOTE—

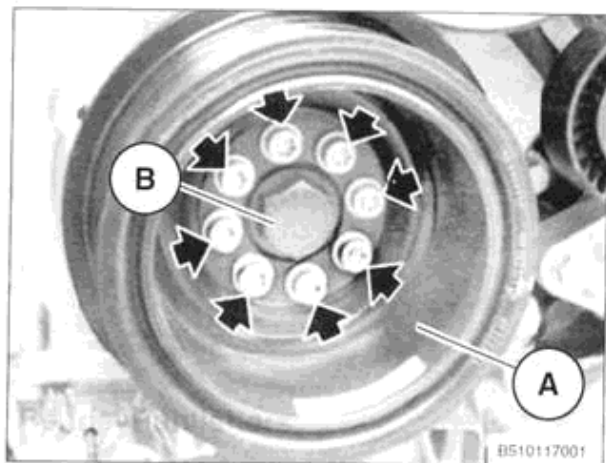
- Protect radiator from damage with a piece of wood.

- With engine fully cooled off, mark direction of rotation on engine accessory belts. Remove belts. See **020 Maintenance**.

- Remove vibration damper mounting bolts (arrows) and discard. Lift off vibration damper (A).

CAUTION—

- Do not remove vibration damper hub bolt (B).

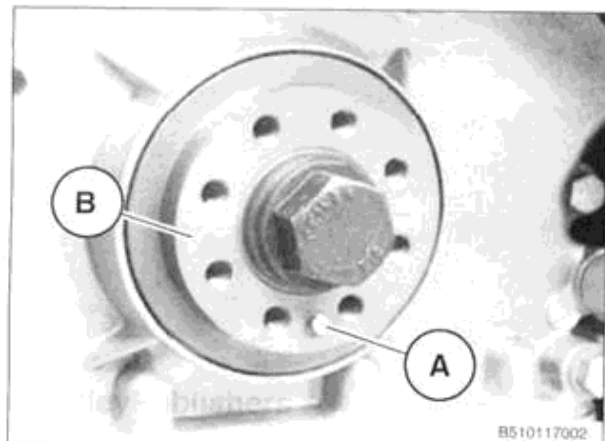


- Installation is reverse of removal.

- Align vibration damper with locating pin (A) on damper hub (B).

Tightening torque

Vibration damper to hub (replace damper bolts)	22 Nm (16.2 ft-lb)
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117-6 Camshaft Timing Chain

Double VANOS unit components (M54 engine)

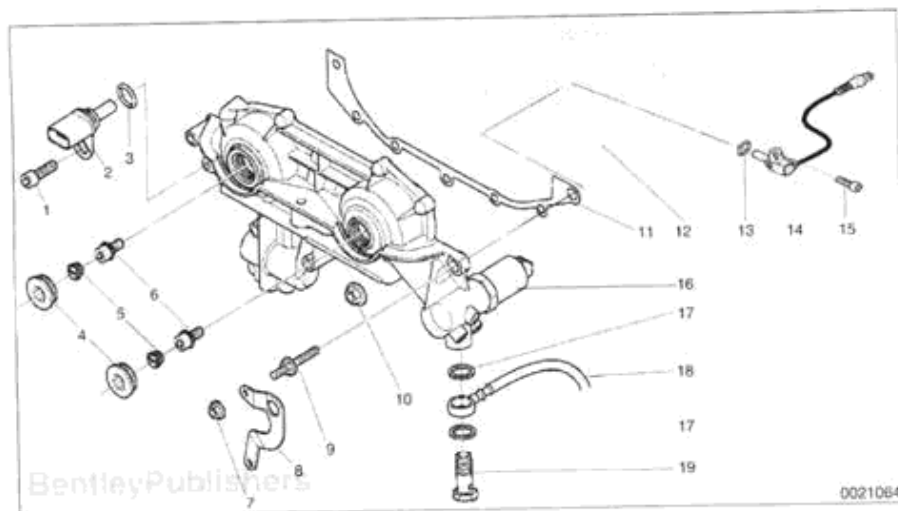
TIMING CHAIN SERVICE (M54 ENGINE)

The M54 engine uses a pair of chains to drive the camshafts. A primary chain is driven off the crankshaft and drives the primary sprocket on the exhaust camshaft. The secondary chain drives the intake camshaft. Each chain is tensioned by a hydraulic tensioner.

Intake and exhaust camshaft timing is variable and is controlled by the engine control module (ECM). This system is known as double VANOS.

Camshaft timing chain service and repair requires the removal of front crankshaft vibration damper, double VANOS unit, engine oil pan and timing chain housing cover. Be sure to read the procedures before starting work.

Double VANOS unit components (M54 engine)



1. Bolt (M6)
2. Exhaust camshaft sensor
3. Sealing ring
4. Camshaft end sealing plug
 - Tighten to 50 Nm (37 ft-lb)
5. Camshaft seal cap
6. VANOS hydraulic piston set screw
 - Left hand thread
 - Tighten to 10 Nm (7 ft-lb)
7. Nut (M7)
 - Tighten to 14 Nm (10 ft-lb)
8. Engine lifting hook
9. Stud (M7)
10. Nut (M6)
 - Tighten to 10 Nm (7 ft-lb)
11. Gasket
12. Cylinder head
13. Sealing ring
14. Intake camshaft sensor
15. Bolt (M6)
16. VANOS unit
17. Copper sealing ring
18. VANOS oil feed line
19. Banjo bolt
 - Tighten to 32 Nm (24 ft-lb)

Double VANOS unit, removing (M54 engine)

WARNING—

- Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

CAUTION—

- Special BMW service tools are required to remove and install the VANOS unit. Read the procedure through before starting the job.
- If the camshafts are not properly timed, the pistons can contact the valves, causing engine damage.

- Disconnect negative (–) cable from battery.

CAUTION—

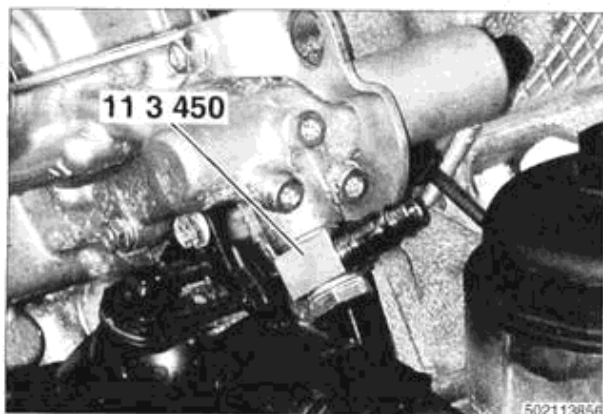
- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- Remove air filter housing with mass air flow sensor. See 130 Fuel Injection.
- Remove electric cooling fan and cooling fan cowl. See 170 Radiator and Cooling System.

NOTE—

- Protect radiator from damage with a piece of wood.

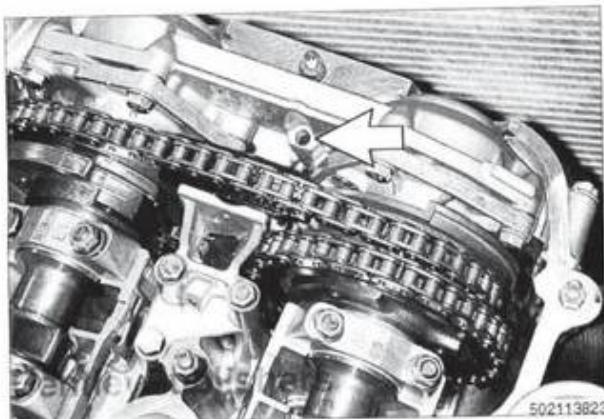
- Remove engine covers and cylinder head cover. See 113 Cylinder Head Removal and Installation.
- Remove spark plugs. Plug spark plug bores to prevent debris from falling into engine.
- ◀ Remove oil baffle cover from above intake camshaft.



- ◀ Remove banjo bolt from VANOS unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) to VANOS unit.
- Be prepared to catch spraying oil. Do not allow oil to contaminate accessory belts.

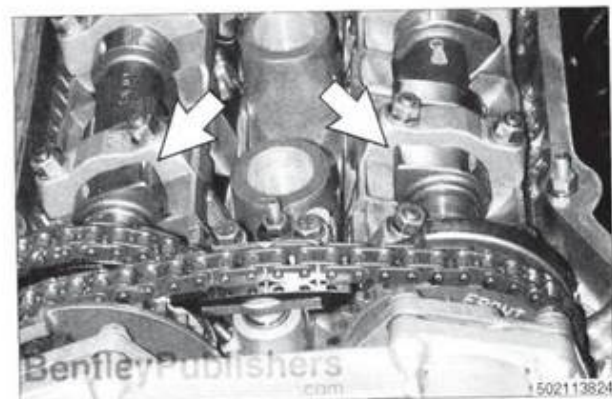
117-8 Camshaft Timing Chain

Double VANOS unit, removing (M54 engine)



➤ Cover oil bore (**arrow**) in VANOS unit with shop towel to capture oil which sprays when compressed air is applied.

- Connect compressed air line to air fitting. Apply air pressure set to 2 – 8 bar (30 – 115 psi).



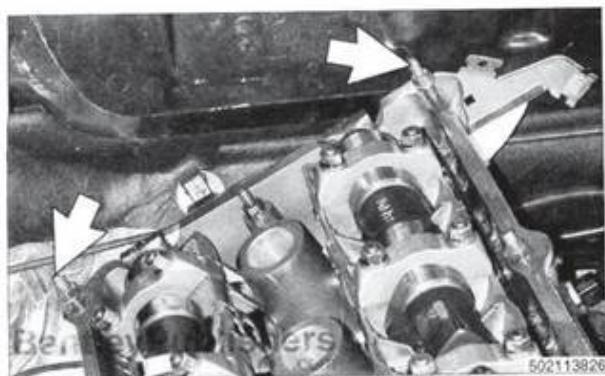
➤ With compressed air line connected, use crankshaft vibration damper bolt to rotate engine in direction of rotation (clockwise) at least twice, until cylinder 1 intake and exhaust camshaft lobes face each other (**arrows**) in top dead center (TDC) position for cylinder 1.

CAUTION—

- Do not rotate engine counterclockwise to reach TDC. If engine rotates past TDC, continue another two complete rotations.



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



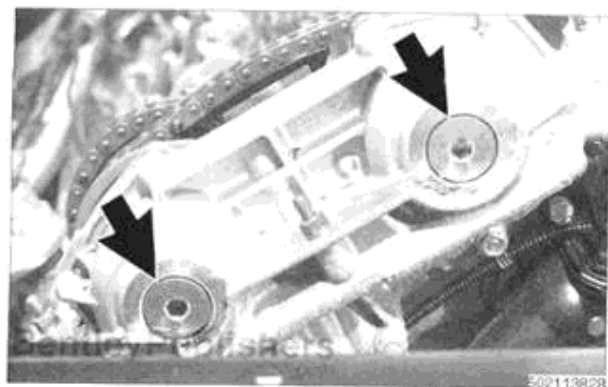
➤ Unscrew and remove two cylinder head cover studs (**arrows**) at rear of cylinder head.

Camshaft Timing Chain 117-9

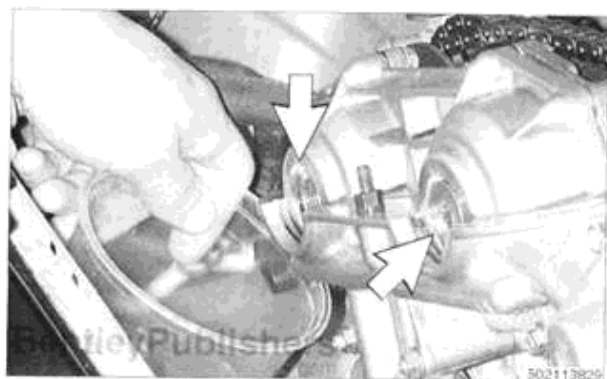
Double VANOS unit, removing (M54 engine)



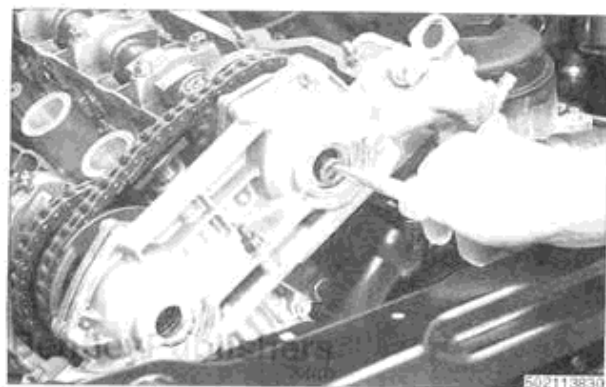
- Secure camshafts in TDC position using BMW special tool set 11 3 240 (includes 11 3 241 and 11 3 244).
- Disconnect compressed air line, leaving compressed air fitting attached to VANOS unit.
 - Be prepared to catch dripping oil. Do not allow oil to contaminate accessory belts.



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



- Be prepared to catch dripping oil. Do not allow oil to contaminate accessory belts.



- Pull sealing caps straight out of VANOS unit with BMW special tool 11 6 170, or with short needle-nosed pliers.
 - Additional oil may drain from VANOS unit.

117-10 Camshaft Timing Chain

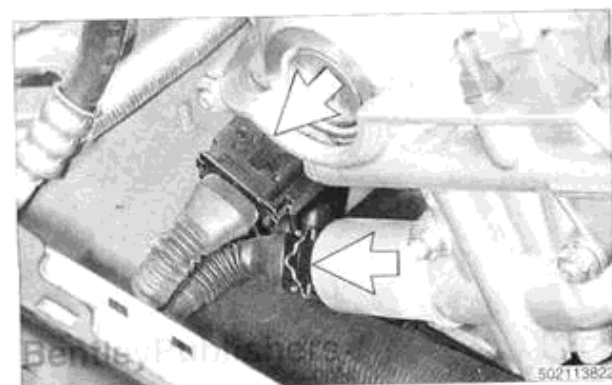
Double VANOS unit, installing (M54 engine)



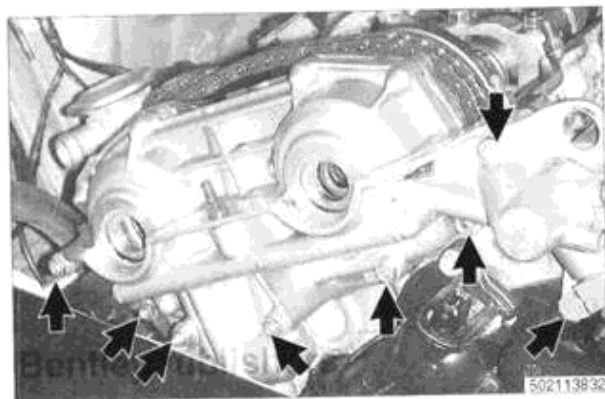
- Remove set screws on ends of intake and exhaust camshafts.

CAUTION—

- Set screws have left hand threads. Unscrew clockwise.



- Detach harness connectors at exhaust camshaft position sensor and exhaust camshaft VANOS control valve (arrows).



- Remove VANOS unit:

- Remove fasteners from engine support eye.
- Remove VANOS mounting nuts (arrows) from cylinder head. Slide VANOS unit and metal gasket off.
- The VANOS unit contains residual oil. Place shop towels underneath when removing.

CAUTION—

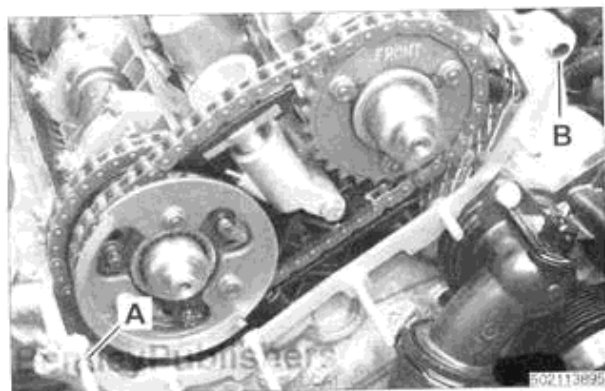
- Do not crank the engine with VANOS unit removed. Damage to engine may result from piston-to-valve interference.

Double VANOS unit, installing (M54 engine)

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

CAUTION—

- Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.
- Make sure gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If foreign material is present on the sealing surface, camshaft timing will be incorrect.



Camshaft Timing Chain 117-11

Double VANOS unit, installing (M54 engine)

- Using new gasket, install VANOS unit to cylinder head.
- Reinstall engine support eye.

Tightening torques

VANOS unit to cylinder head	
• M6 nut	10 Nm (7 ft-lb)
• M7 nut	14 Nm (10 ft-lb)

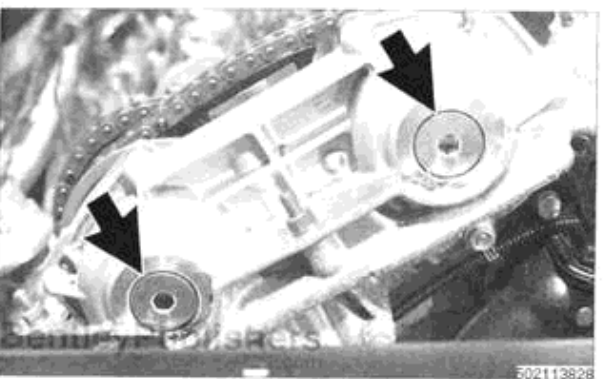
- ◀ Insert and tighten VANOS hydraulic piston set screws on intake and exhaust camshafts.

Tightening torque

Hydraulic piston to splined shaft (Left-handed set screw)	10 Nm (7 ft-lb)
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CAUTION—

- Set screws have left-hand threads. Tighten counterclockwise.



- ◀ Replace sealing caps inside VANOS unit with BMW special tool 11 6 170 or short needle-nosed pliers.

- ◀ Insert and secure VANOS sealing plugs (arrows), using new sealing O-rings.

Tightening torque

Sealing plug to VANOS unit	50 Nm (37 ft-lb)
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- Remove compressed air fitting from VANOS unit.
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS unit.

Tightening torque

Oil line to VANOS unit (banjo bolt)	32 Nm (24 ft-lb)
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- Connect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.
- If double VANOS unit is replaced, or if repair operations are completed that may change camshaft timing, recheck and adjust camshaft timing. See **Camshaft timing, checking and adjusting (M54 engine)** in this repair group.

117-12 Camshaft Timing Chain

Double VANOS unit, installing (M54 engine)



- Remove BMW special locking tools from rear of cylinder head.
- Remove crankshaft locking tool and replace sealing plug.
- ◀ Install intake camshaft baffle 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.
 - Similarly, seat gasket and seal corners in front of cylinder head, at VANOS unit.

Tightening torque

Cylinder head cover to cylinder head (M6)	10 Nm (7 ft-lb)
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- Remainder of installation is reverse of removal.

Tightening torques

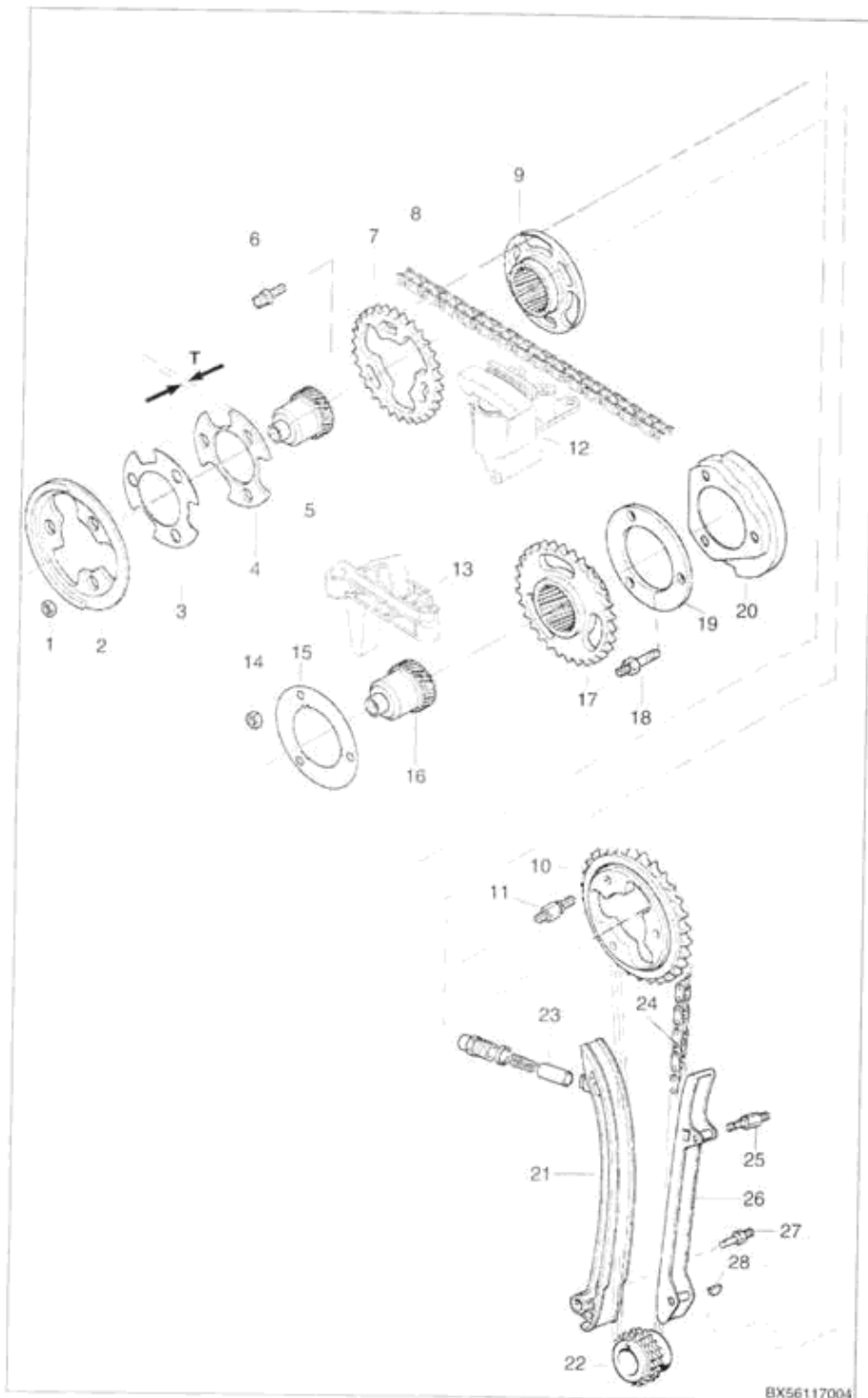
Spark plug to cylinder head	25 Nm (18 ft-lb)
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- After completing work, check VANOS operation using BMW scan tool.

Camshaft Timing Chain 117-13

Timing chain components (M54 engine)

Timing chain components (M54 engine)



1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate
4. Thrust spacer
• Thickness (T) = 3.5 mm
5. Splined shaft
6. Torx screw
7. Exhaust secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded locating stud
12. Secondary chain tensioner
13. Secondary chain lower guide
14. Sprocket mounting nut
15. Spring plate
16. Splined shaft
17. Intake camshaft sprocket
18. Locating stud
19. Thrust spacer
20. Intake camshaft impulse wheel
21. Chain tensioner rail
22. Crankshaft sprocket
23. Primary chain tensioner
24. Primary chain
25. Locating stud
26. Guide rail
27. Locating stud
28. Woodruff key

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117-14 Camshaft Timing Chain

Timing chains, removing (M54 engine)

Timing chains, removing (M54 engine)

When removing camshaft timing chains, first remove the oil pan. See **119 Lubrication System**. Also required is removal of the VANOS unit and disassembly of the intake and exhaust camshaft sprocket assemblies. See **Double VANOS unit, removing (M54 engine)** in this repair group.

Special BMW service tools are needed for timing chain removal and installation. These 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.

WARNING—

- Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

CAUTION—

- Special BMW service tools are required to remove and install the VANOS unit and time the camshafts. Read the procedure through before starting the job.
- If the camshafts are not properly timed, the pistons can contact the valves, causing engine damage.

- Disconnect negative (–) cable from battery.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove air intake hood above radiator.
- Remove air filter housing. See **130 Fuel Injection**.
- Remove viscous clutch cooling fan and fan shroud. See **170 Radiator and Cooling System**.

CAUTION—

- The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Mark direction of engine rotation on accessory belts. Remove belts. See **020 Maintenance**.
- Remove coolant pump pulley.
- Remove engine covers and cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove spark plugs. Plug spark plug bores to prevent debris from falling into engine.
- Remove VANOS unit. See **Double VANOS unit, removing (M54 engine)** in this repair group.

Camshaft Timing Chain 117-15

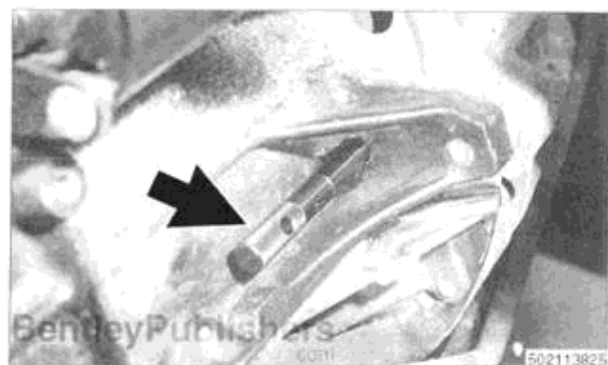
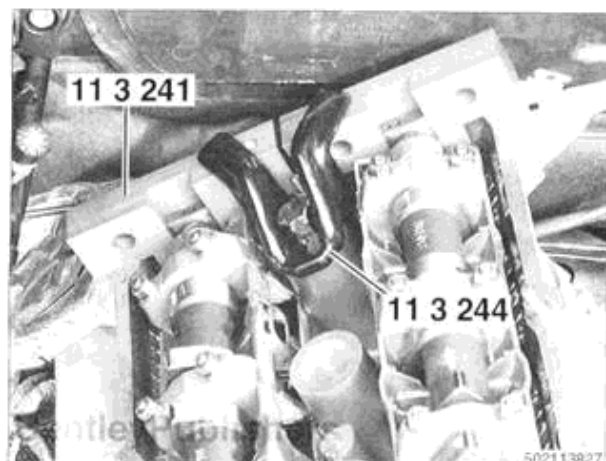
Timing chains, removing (M54 engine)

- Raise car and support safely.

WARNING—

- Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Drain engine cooling system. See **170 Radiator and Cooling System**.
- Drain engine oil and remove oil pan. See **119 Lubrication System**.
- Make sure camshafts are locked in TDC position using BMW special tool set 11 3 240. See **Double VANOS unit, removing (M54 engine)** in this repair group.



- Make sure crankshaft is still locked with BMW special tool 11 2 300. See **Double VANOS unit, removing (M54 engine)** in this repair group.



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

CAUTION—

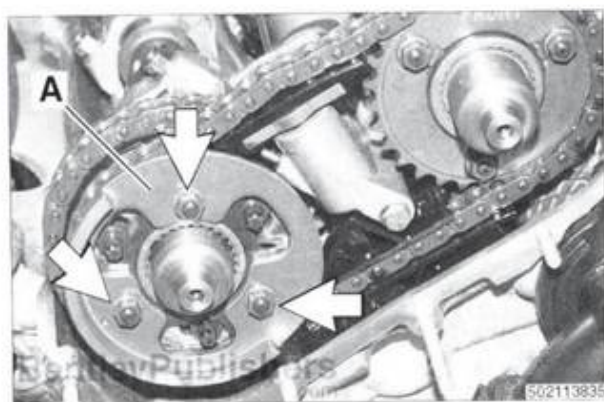
- Chain tensioner piston is under spring pressure.

117-16 Camshaft Timing Chain

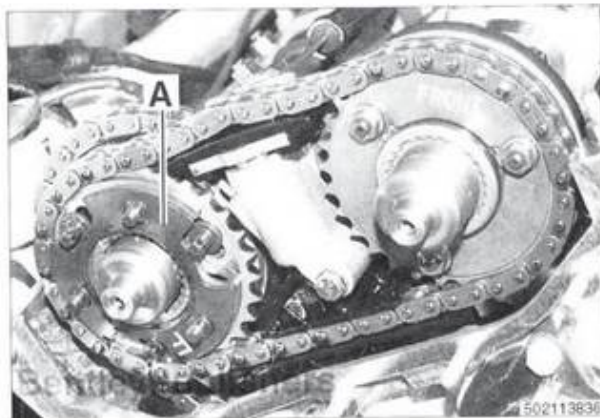
Timing chains, removing (M54 engine)



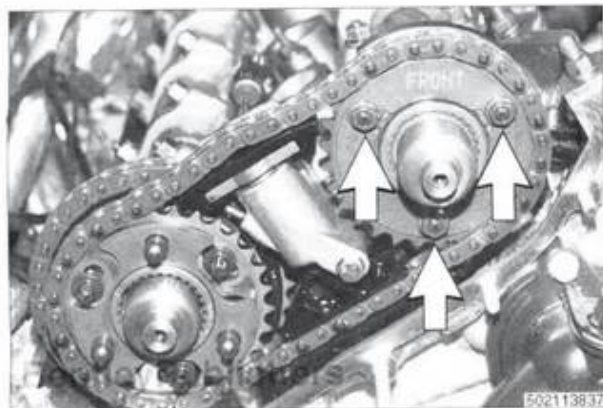
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or a similar size pin tool.



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



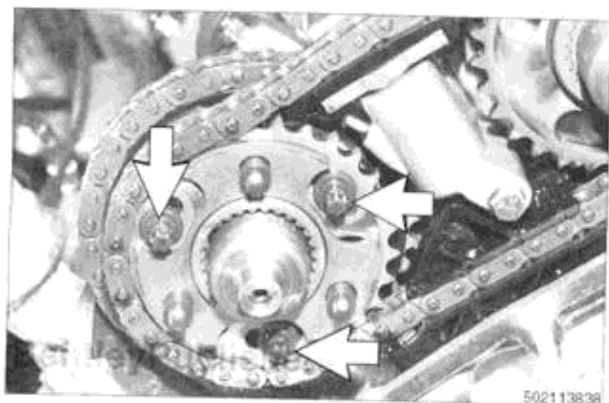
- Remove spring plate (**A**).



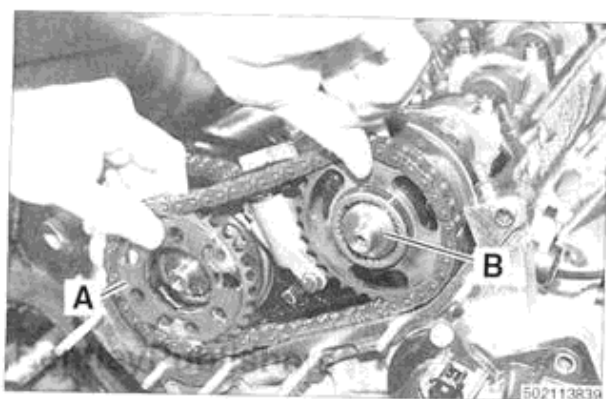
- Remove intake camshaft sprocket mounting nuts (**arrows**) and remove spring plate (labeled **FRONT**).

Camshaft Timing Chain 117-17

Timing chains, removing (M54 engine)



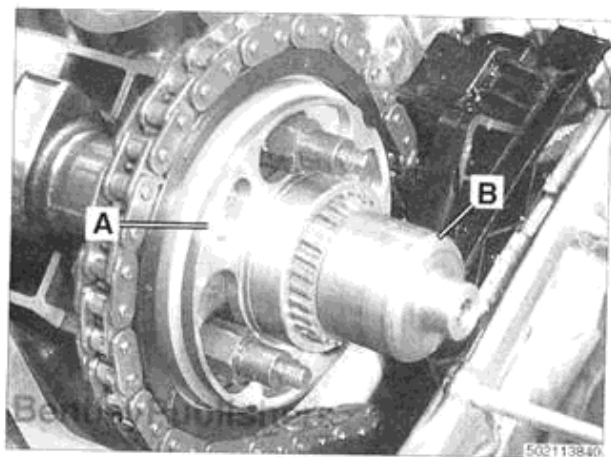
- Remove torx bolts (arrows) from exhaust camshaft sprocket.



- Lift off exhaust and intake sprockets with secondary chain, thrust spacer (A) and splined shaft (B).

CAUTION—

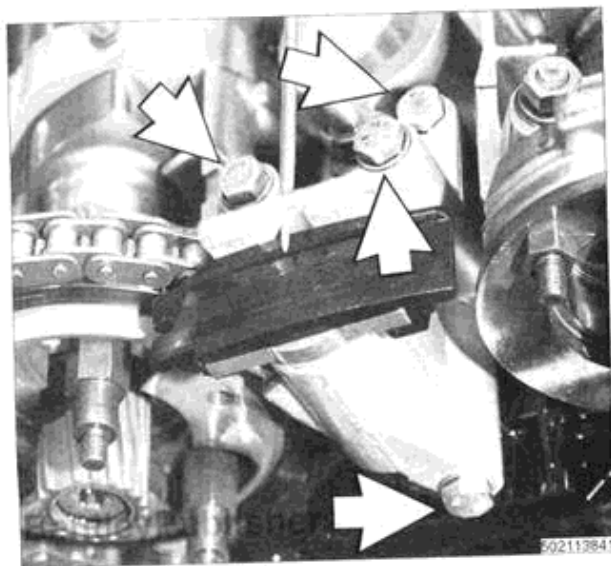
- Intake and exhaust camshaft splined shafts share the same part number. Be sure to mark splined shafts so they can be reinstalled in their original positions.



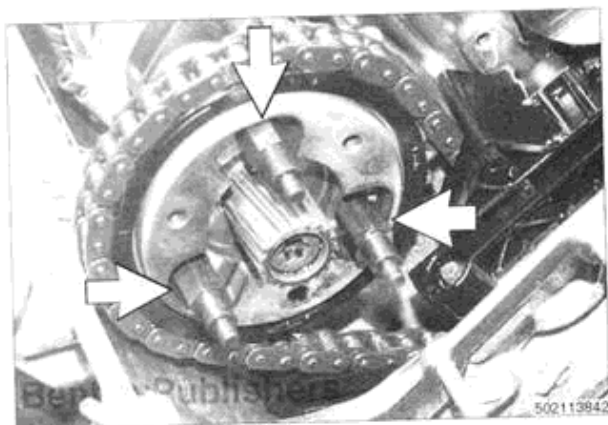
- Remove exhaust camshaft splined sleeve (A) and shaft (B).

117-18 Camshaft Timing Chain

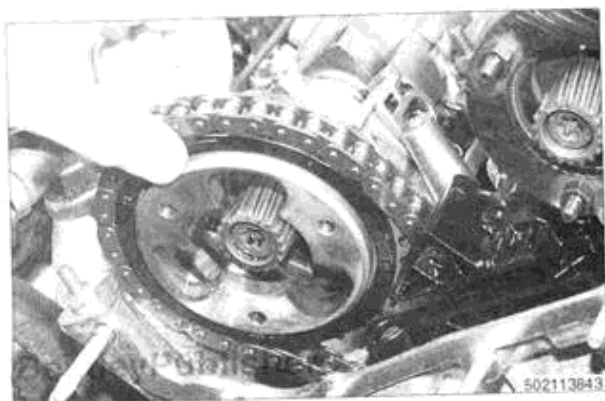
Timing chains, removing (M54 engine)



- Remove secondary chain tensioner mounting bolts (**arrows**). Remove tensioner while keeping locking pin in place.



- Remove primary chain sprocket mounting studs (**arrows**) on exhaust camshaft.

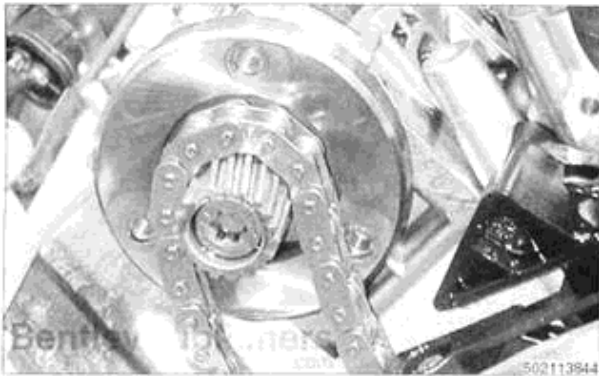


- Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.

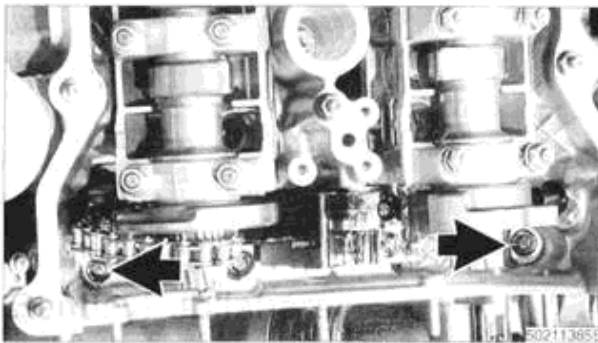
Camshaft Timing Chain 117-19

Timing chains, removing (M54 engine)

117



- ◀ Hang timing chain on exhaust camshaft end.



- ◀ Working in cylinder head cavity, remove timing chain cover bolts (arrows).



- ◀ Remove secondary chain lower guide mounting bolts (arrows). Remove chain guide.

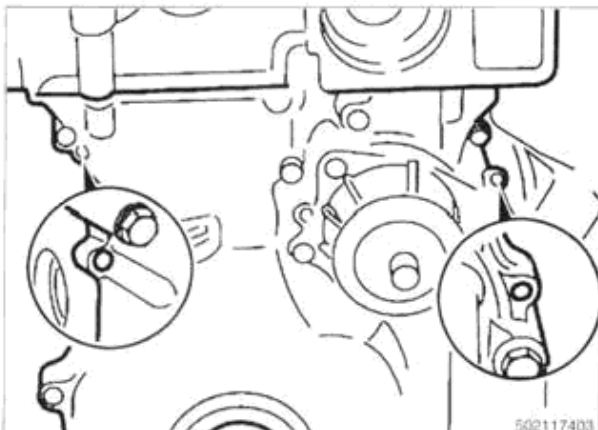
NOTE—

- Bolt on intake camshaft side is long and extends into timing chain cover.

- Remove crankshaft vibration damper. See **Vibration damper, removing and installing (M54 engine)** in this repair group.

CAUTION—

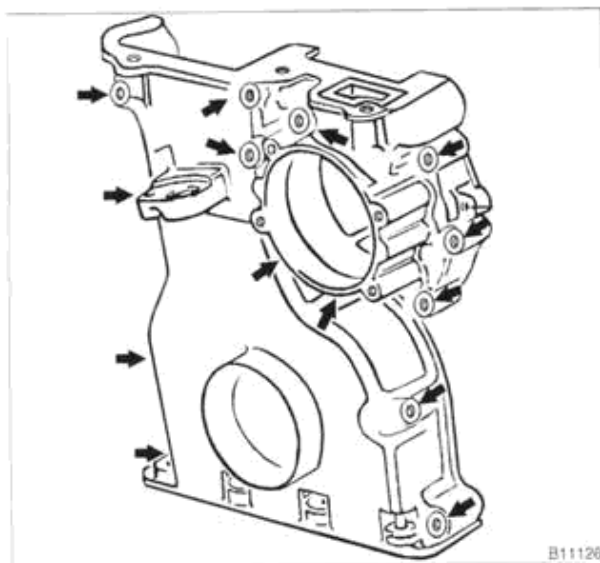
- Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten vibration damper mounting bolt. Use only the special tools specified, or equivalent hub holding tool.
- Do not allow crankshaft to rotate while timing chains are loosened or removed. The pistons can contact the valves, causing engine damage.



- ◀ Using a 5 mm or smaller drift, drive two locating dowels (insets) in lower timing cover toward rear of car.

117-20 Camshaft Timing Chain

Timing chains, installing (M54 engine)



- Remove timing cover mounting bolts (**arrows**). Slide cover with coolant pump forward to remove.

CAUTION—

- Use care when removing the cover from the cylinder head gasket. If the cover is stuck, use a sharp knife to separate it from the head gasket.
- If cylinder head gasket is damaged, remove cylinder head and replace head gasket. See **113 Cylinder Head Removal and Installation**.
- Use care when detaching front timing cover from coolant pipe at rear of cover.

NOTE—

- For clarity, front timing cover is illustrated with coolant pump removed.

- Push primary chain tensioner guide rail aside and remove chain.

Timing chains, installing (M54 engine)

- Make sure camshafts are locked in TDC position using BMW special tool set 11 3 240.

- Inspect timing chain sprockets. Inspect guide rail and tensioner rail for damage. Replace any part that is worn or damaged.

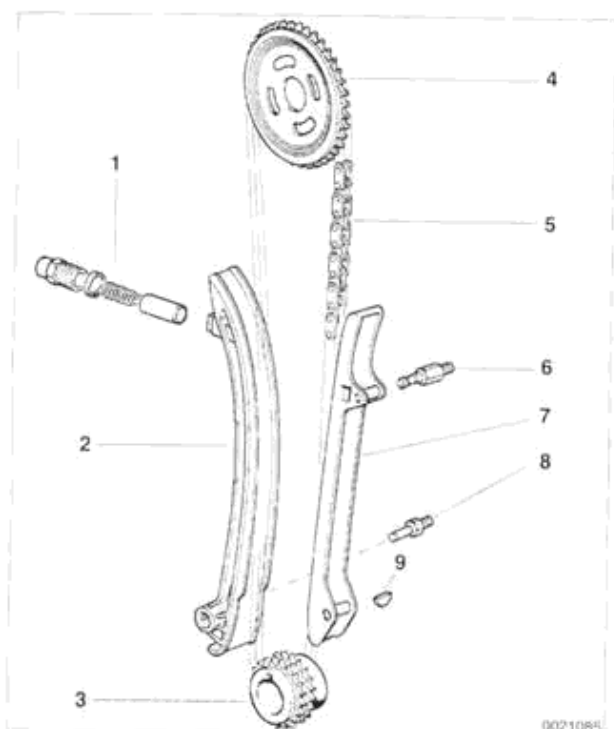
NOTE—

- If any sprockets are replaced due to wear, also replace chain.



Camshaft Timing Chain 117-21

Timing chains, installing (M54 engine)



Primary timing chain assembly

1. Primary chain tensioner
2. Chain tensioner rail
3. Crankshaft sprocket
4. Exhaust camshaft sprocket
5. Primary chain
6. Anchor bolt
7. Guide rail
8. Anchor bolt
9. Woodruff key

- Install primary timing chain to crankshaft sprocket and hang upper end from exhaust camshaft.
- If necessary, replace crankshaft front seal in timing chain cover. See **119 Lubrication System**.
- To install lower timing chain cover:
 - Clean cover and cylinder block sealing surfaces.
 - Use new gaskets and coolant pipe O-ring.
 - Remove timing chain cover dowel pins from engine block.
 - Drive dowels into cover until they just protrude slightly from sealing surface.
 - Apply a small bead of silicon sealer (3-Bond 1209® or equivalent) to corners of cylinder head where timing cover meets cylinder head and engine block.
 - Tap cover into position until firmly seated.
 - Install all bolts hand tight, including two Torx bolts from above.
 - Install secondary chain lower guide.
 - Tighten cover mounting bolts alternately and in stages.

Tightening torque

Lower timing cover to cylinder block (M6)	10 Nm (7 ft-lb)
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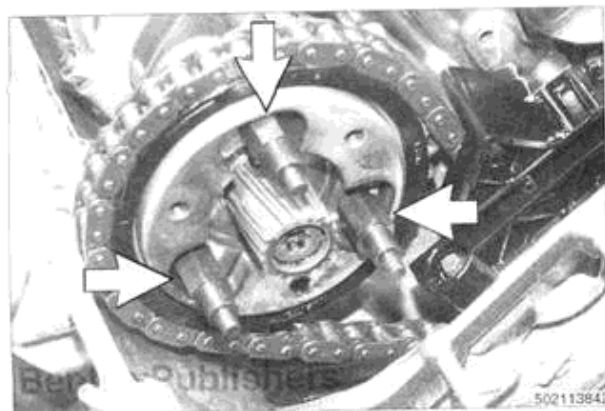
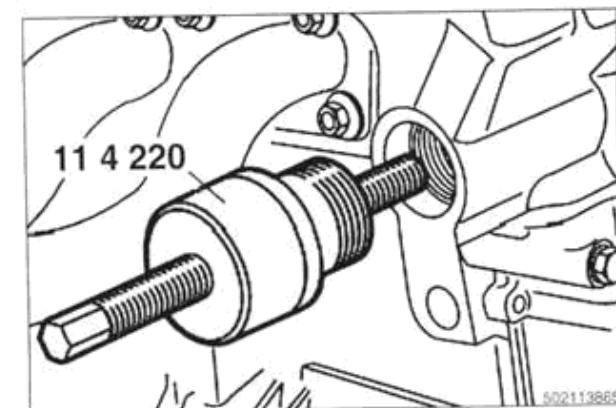
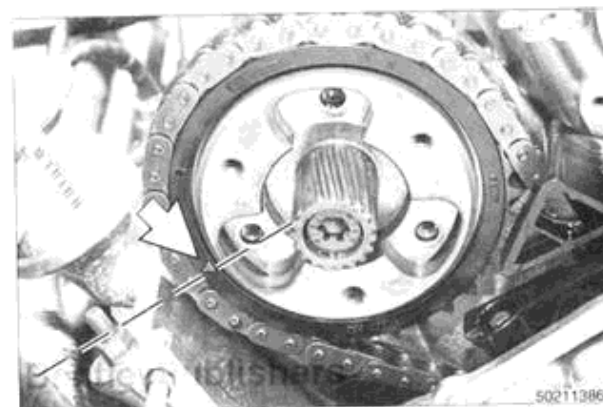
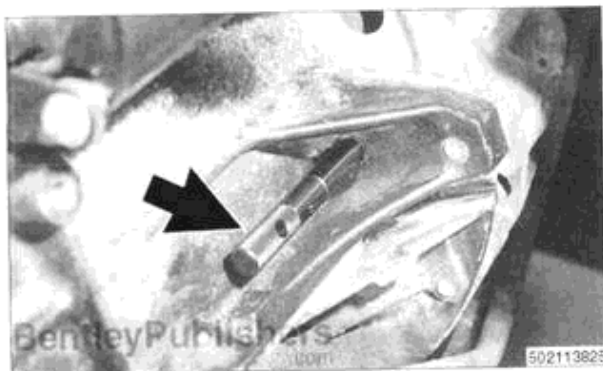
- Install oil pan with new gasket. See **119 Lubrication System**.

Tightening torques

Oil pan to engine block (M6)	
• 8.8 grade	10 Nm (7 ft-lb)
• 10.9 grade	12 Nm (9 ft-lb)

117-22 Camshaft Timing Chain

Timing chains, installing (M54 engine)



- Reinstall crankshaft vibration damper. See **Vibration damper, removing and installing (M54 engine)** in this repair group.

CAUTION—

- Do not use BMW special tool 11 2 300 to hold crankshaft stationary to tighten vibration damper mounting bolt. Use only the special tools specified, or equivalent hub holding tool.
- Have a second person hold special tool 11 8 190 while tightening vibration damper mounting bolt.

Tightening torque

Vibration damper hub to crankshaft (use new bolt)	410 Nm (300 ft-lb)
--	--------------------

- Remove crankshaft locking tool (arrow).
- 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 (dashed line).
- Position sprocket so that chain slack is on tensioner rail side.

- Insert BMW special tool 11 4 220 in cylinder head and screw in adjustment screw by hand just until it contacts tensioning rail and chain slack is removed.

NOTE—

- BMW special tool 11 4 220 is an adjustable dummy tensioner that simulates the function of the primary chain tensioner.
- Make sure that arrow on upper primary sprocket still lines up with upper edge of cylinder head. Reposition sprocket if necessary.

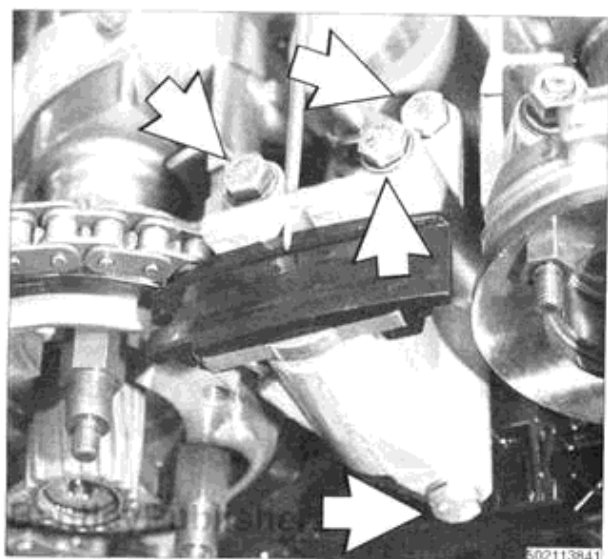
- Install and tighten down threaded locating studs (arrows) in end of exhaust camshaft.

Tightening torque

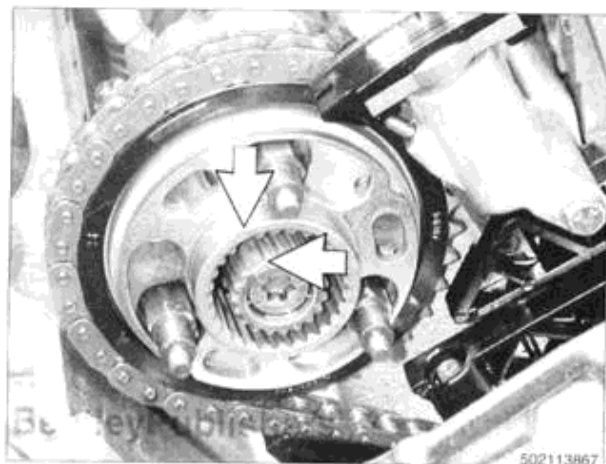
Exhaust camshaft locating stud	20 Nm (15 ft-lb)
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Camshaft Timing Chain 117-23

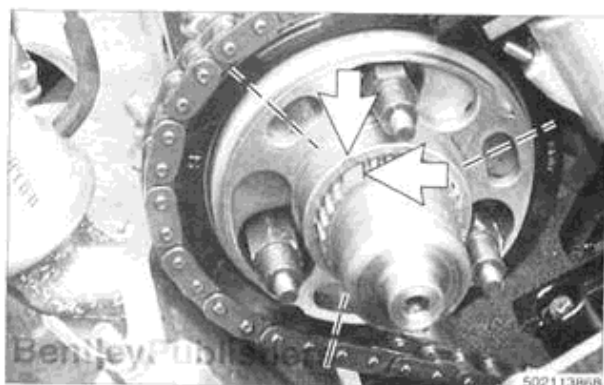
Timing chains, installing (M54 engine)



- ◀ Install secondary chain tensioner on cylinder head (**arrows**). Keep tensioner compressed using BMW special tool 11 3 291 or suitable pin tool.



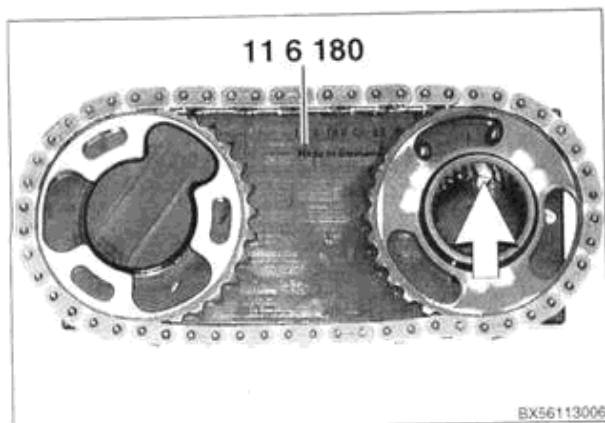
- ◀ Fit exhaust camshaft splined sleeve, aligning gap in sleeve splines with corresponding gap on camshaft splines (**arrows**).



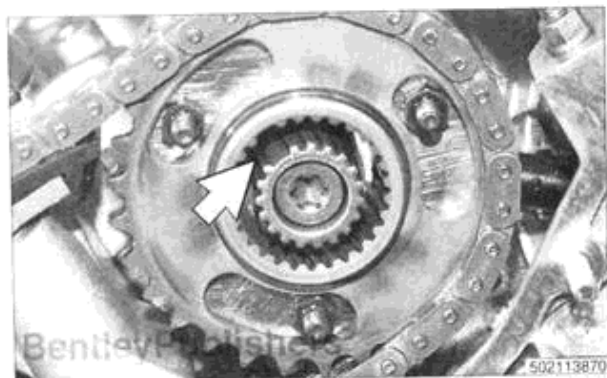
- ◀ Slide splined shaft on exhaust camshaft. Be sure that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).
- Push splined shaft in further to rotate splined sleeve until three threaded holes in primary chain sprocket are centered in splined sleeve slots (**dashed lines**).

117-24 Camshaft Timing Chain

Timing chains, installing (M54 engine)



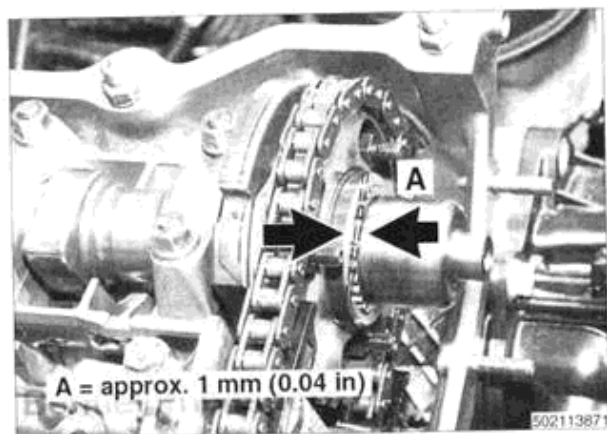
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.



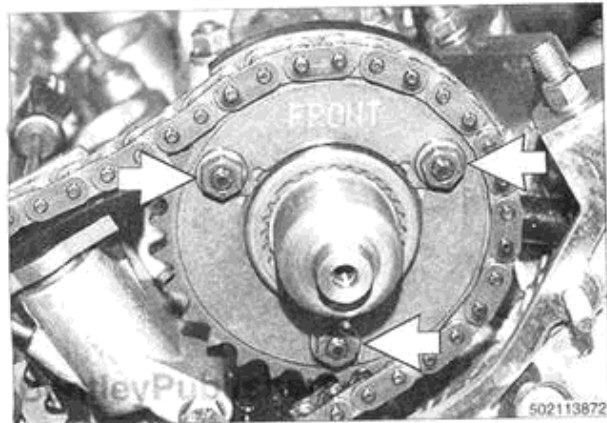
- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (**arrow**).

CAUTION—

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



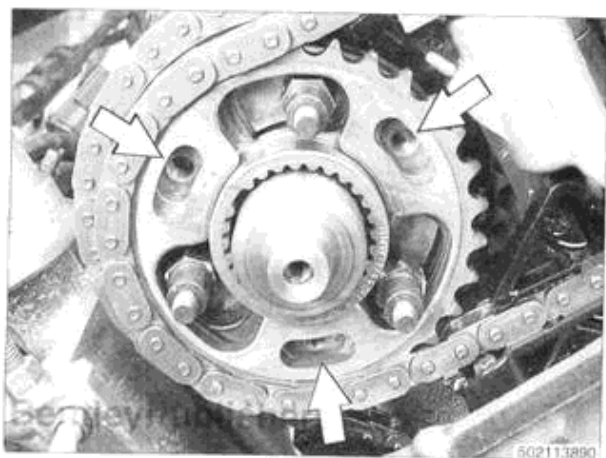
- Align locating tooth of splined shaft with gaps on camshaft and sprocket. Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in) of splines (**arrows**) are visible.



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

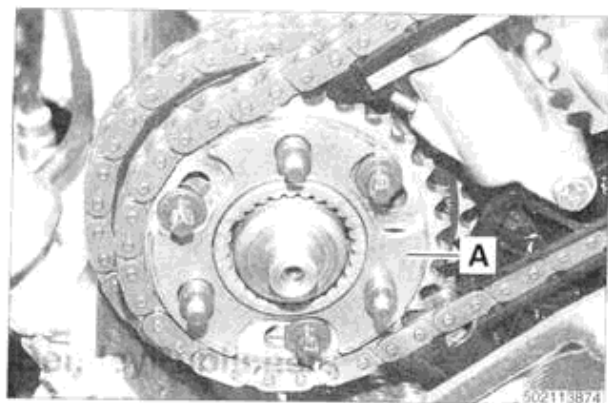
Camshaft Timing Chain 117-25

Timing chains, installing (M54 engine)

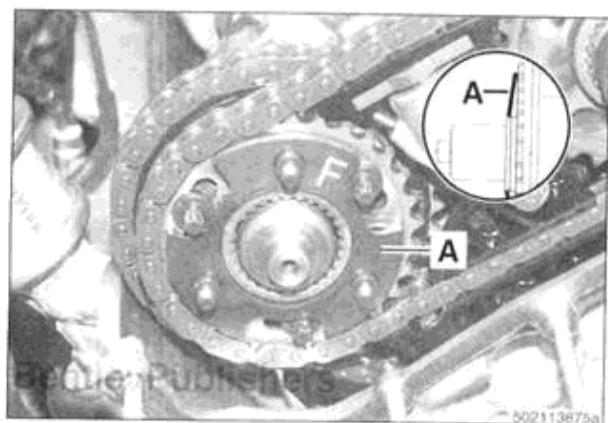


Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft assembly.

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



Fit thrust spacer (**A**) on exhaust camshaft.



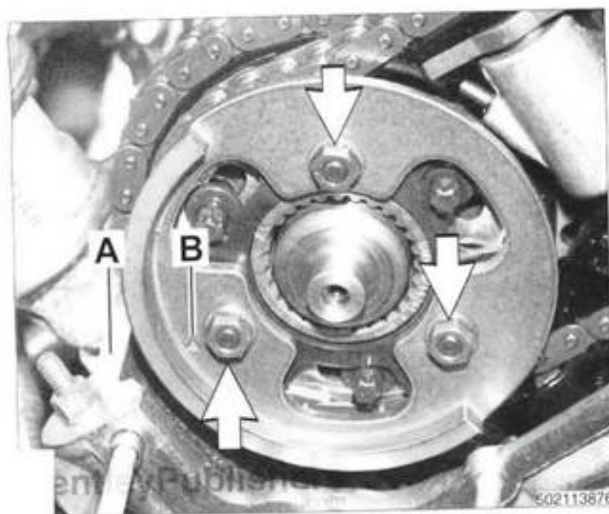
Install spring plate (**A**) to exhaust camshaft. Make sure that **F** mark is visible.

NOTE—

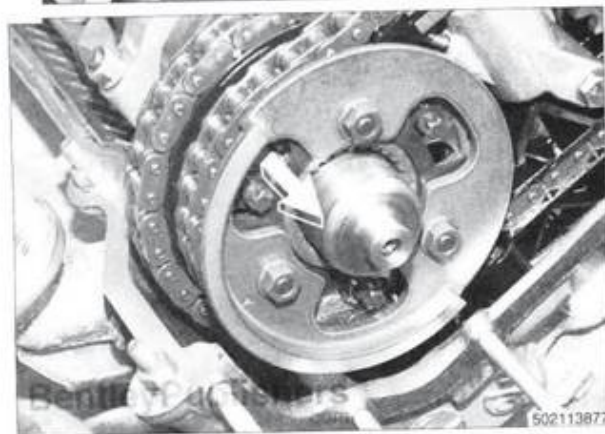
- If **F** mark is no longer visible, install spring plate as shown in inset: convex side facing forward.

117-26 Camshaft Timing Chain

Timing chains, installing (M54 engine)



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



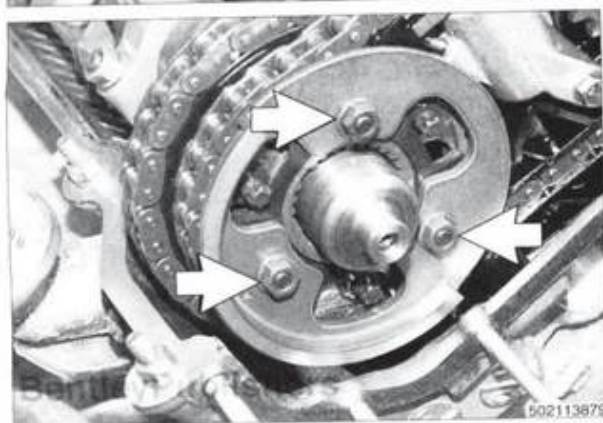
- Pull out exhaust camshaft splined shaft to stop (arrow).
- Press down on secondary chain tensioner and remove tensioner lock-down tool.



- Preload primary chain:
- Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

Tightening torque

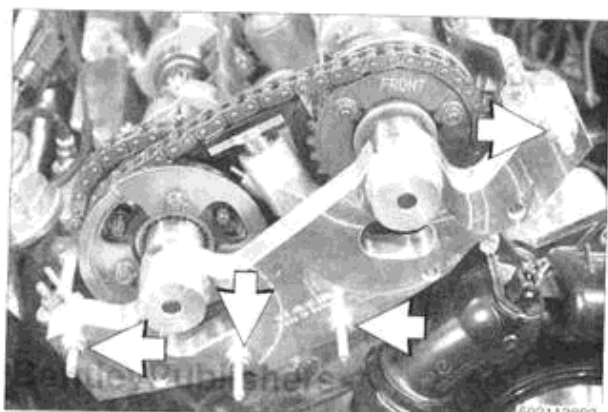
Primary chain tensioner preload	0.7 Nm (6 in-lb)
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- Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (arrows) finger tight.

Camshaft Timing Chain 117-27

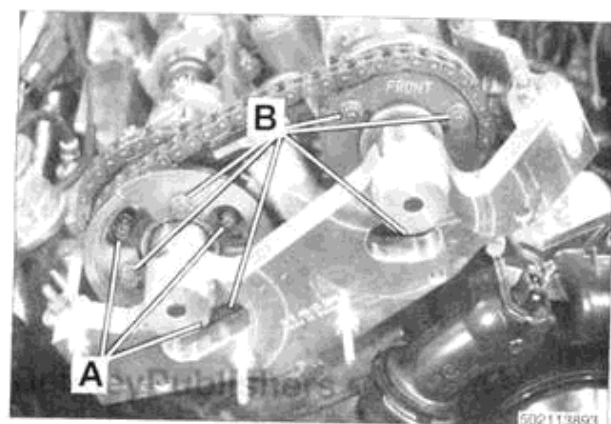
Timing chains, installing (M54 engine)



- 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—

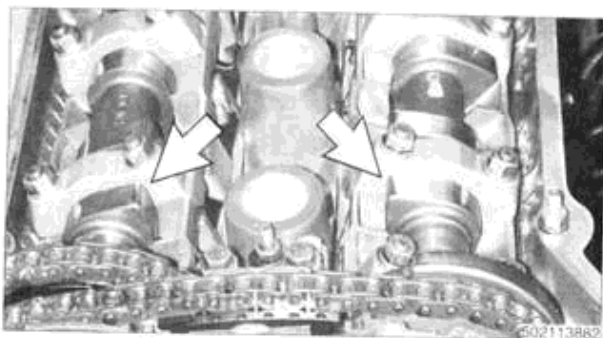
- Make sure gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If foreign material is present on the sealing surface, camshaft timing will be incorrect.



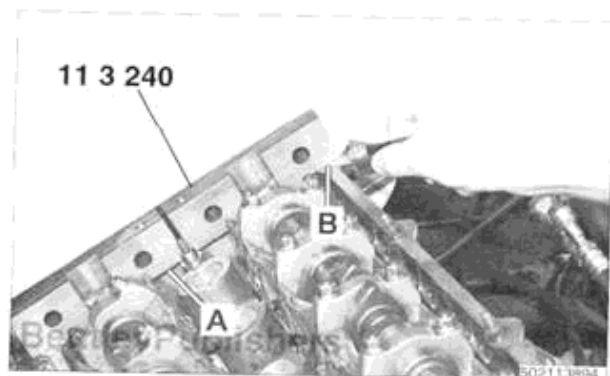
- Secure camshaft sprockets and impulse wheels:
 - Tighten mounting screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
 - Tighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
 - Torque down mounting screws (**A**) and nuts (**B**)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

Tightening torques

Sprocket assembly wheel to camshaft (initial torque)	5 Nm (44 in-lb)
Sprocket assembly wheel to camshaft	
• M7 torx screws (A)	20 Nm (15 ft-lb)
• M6 mounting nuts (B)	10 Nm (8 ft-lb)



- Remove crankshaft locking tool so that crankshaft is no longer secured in TDC position.
- 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 set 11 3 240 over camshafts and measure clearances.
 - 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. See **Camshaft timing, checking and adjusting (M54 engine)** in this repair group.

CAUTION—

- If the exhaust side of the tool (**A**) is not flush with the cylinder head, camshaft timing is incorrect. Reset camshaft timing.

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

117-28 Camshaft Timing Chain

Camshaft timing, checking and adjusting (M54 engine)

- Reinstall VANOS unit. See **Double VANOS unit, installing (M54 engine)** in this repair group.
- Remove BMW special tool 11 4 220 (adjustable dummy tensioner). Reinstall primary chain tensioner.

Tightening torque

Primary chain tensioner to timing chain cover (M26 x 1.5)	70 Nm (52 ft-lb)
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- Install intake camshaft oil baffle.

Install 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. Seal corners in front of cylinder head at VANOS unit.

Tightening torque

Cylinder head cover to cylinder head	10 Nm (7 ft-lb)
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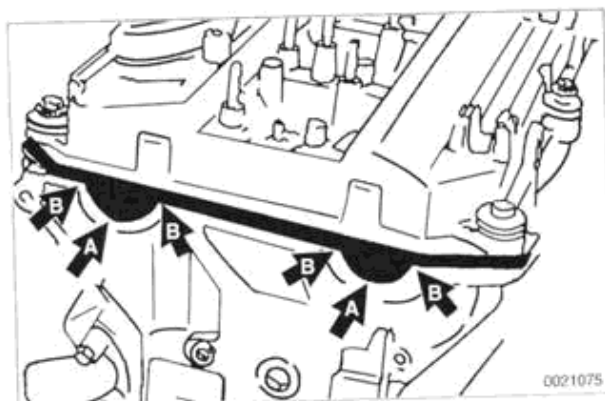
- Remainder of assembly is reverse of removal, noting the following:
 - Secure all coolant hoses, thermostat housing, engine coolant drains.
 - Install new engine oil filter and oil. See **119 Lubrication System**.
 - Refill and bleed cooling system. See **170 Radiator and Cooling system**.
 - Use scan tool to check VANOS operation with engine idling.

Tightening torques

Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Vibration damper hub to crankshaft (use new bolt)	410 Nm (300 ft-lb)

Camshaft timing, checking and adjusting (M54 engine)

- Remove engine top covers and cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove oil baffle cover from above intake camshaft.
- Remove engine drive belts and cooling fan. See **170 Radiator and Cooling System**.
- Remove spark plugs. Plug spark plug bores to prevent debris from falling into engine.



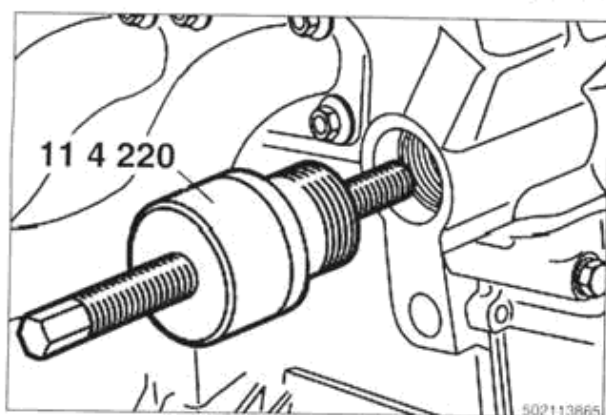
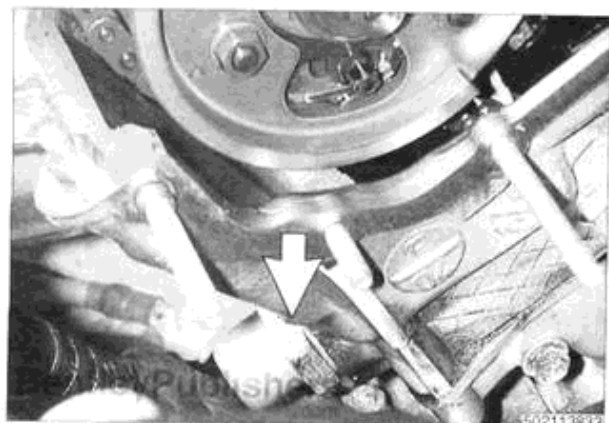
Camshaft Timing Chain 117-29

Camshaft timing, checking and adjusting (M54 engine)

- Remove primary camshaft chain tensioner cylinder (arrow).

CAUTION—

- Chain tensioner piston is under spring pressure.



- Insert BMW special tool 11 4 220 in cylinder head and screw in adjustment screw by hand just until it contacts tensioning rail and chain slack is removed.

NOTE—

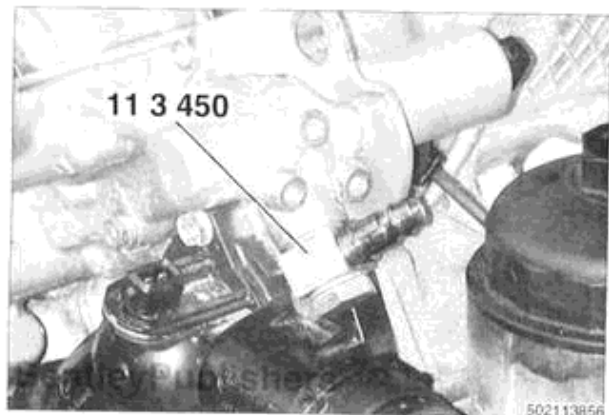
- BMW special tool 11 4 220 is an adjustable dummy tensioner that simulates the function of the primary chain tensioner.



- Preload primary chain tensioner rail:
- Tighten adjusting screw on BMW special tool 11 4 220.

Tightening torque

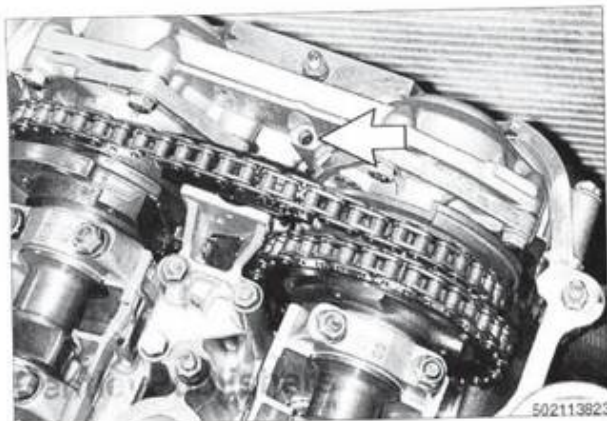
Primary chain tensioner preload	0.7 Nm (6 in-lb)
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- Remove banjo bolt from VANOS unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) to VANOS unit.
- Be prepared to catch dripping oil. Do not allow oil to contaminate accessory belts.

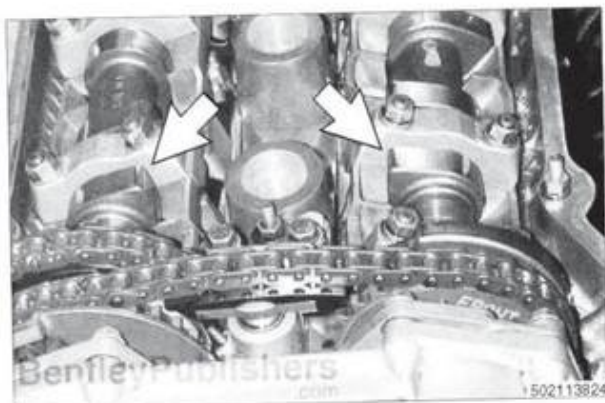
117-30 Camshaft Timing Chain

Camshaft timing, checking and adjusting (M54 engine)



➤ Cover oil bore (**arrow**) in VANOS unit with shop towel to capture oil which sprays when compressed air is applied.

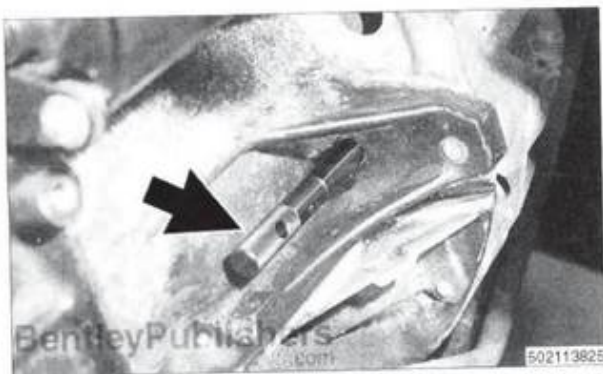
- Connect compressed air line to air fitting. Apply air pressure set to 2 – 8 bar (30 – 115 psi).



➤ With compressed air line connected, use crankshaft vibration damper bolt to rotate engine in direction of rotation (clockwise) at least twice, until cylinder 1 intake and exhaust camshaft lobes face each other (**arrows**) in top dead center (TDC) position for cylinder 1.

CAUTION—

- Do not rotate engine counterclockwise to reach TDC. If engine rotates past TDC, complete another two complete rotations.



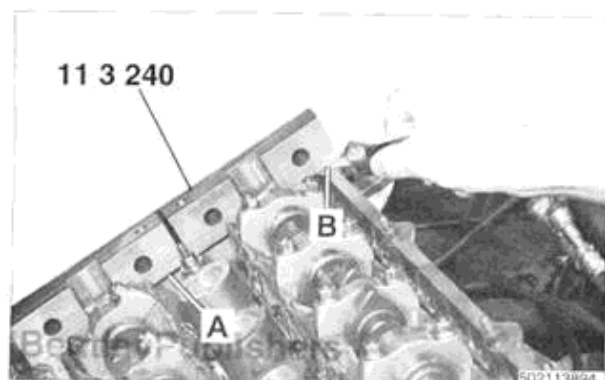
➤ Remove sealing plug from special tool bore on lower left side of engine block near flywheel. Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



➤ Unscrew and remove two cylinder head cover studs (**arrows**) at rear of cylinder head.

Camshaft Timing Chain 117-31

Camshaft timing, checking and adjusting (M54 engine)



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

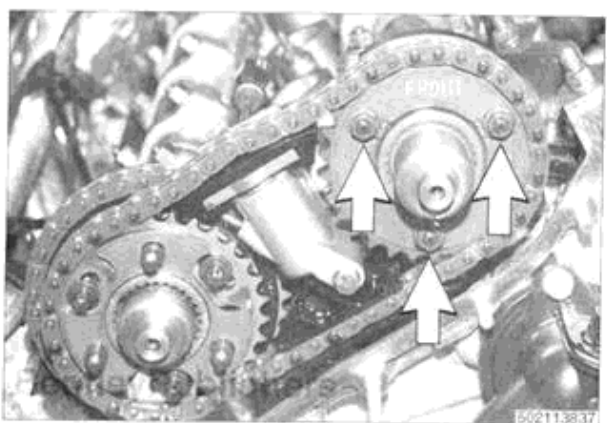
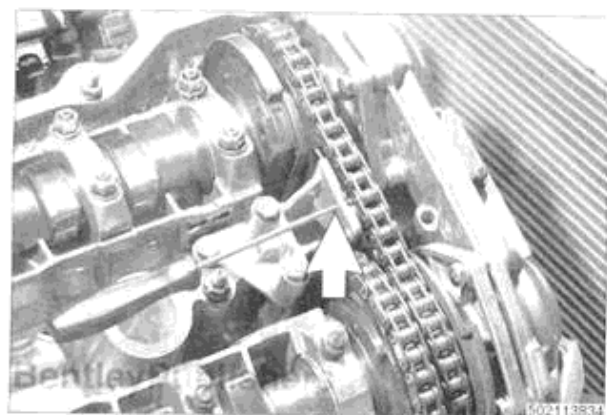
- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS splines, when the camshaft timing is set correctly, the intake side of special tool 11 3 240 (B) may be up to 1 mm (0.04 in) above the surface of the cylinder head. This is normal. Reassemble engine.
- Otherwise, continue with camshaft timing adjustment procedure.

CAUTION—

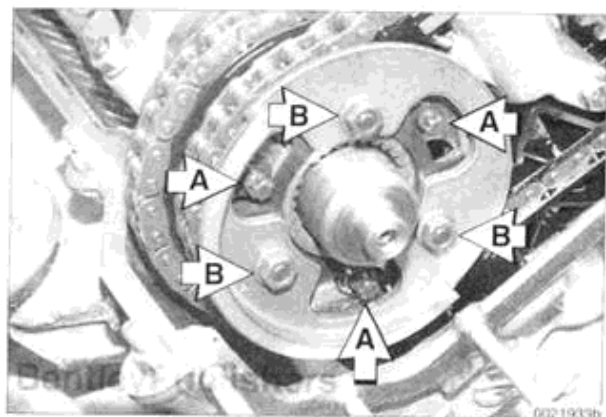
- If the exhaust side of the tool (A) is not flush with the cylinder head, camshaft timing is incorrect. Reset camshaft timing.

Remove double VANOS unit. See **Double VANOS unit, removing (M54 engine)** in this repair group.

Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or equivalent pin or drift.



Loosen intake camshaft sprocket mounting nuts (arrows) by 1 turn.

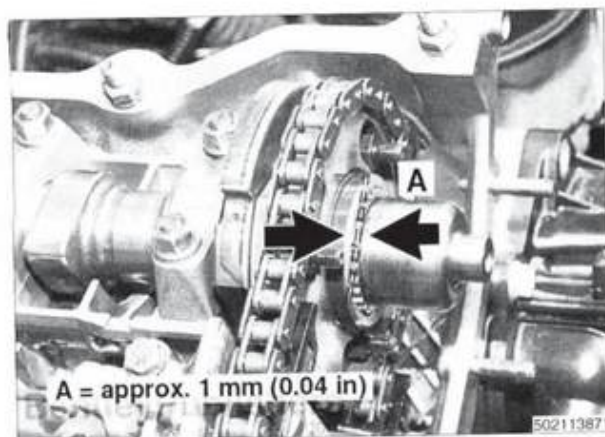


Loosen exhaust camshaft sprocket mounting fasteners:

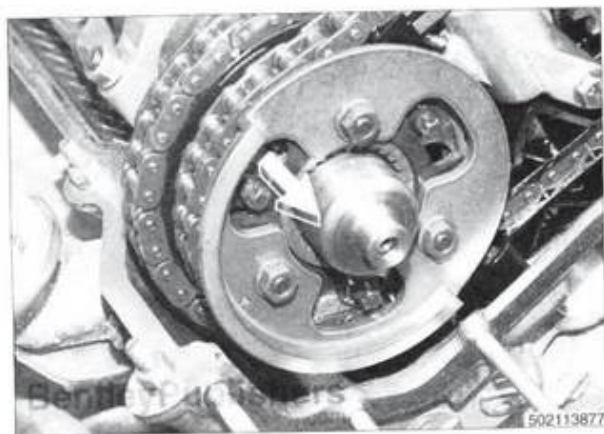
- Release bolts A 1/2 turn.
- Release nuts B 2 turns.

117-32 Camshaft Timing Chain

Camshaft timing, checking and adjusting (M54 engine)



- ⚡ Pull out intake camshaft splined shaft out so that approx. 1 mm (0.04 in) of splines (**arrows**) can be seen.

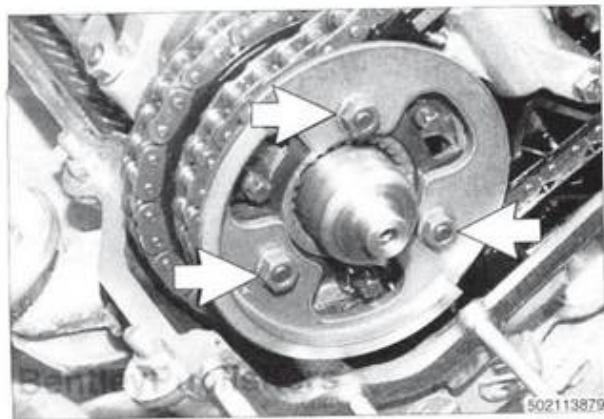


- ⚡ Pull out exhaust camshaft splined shaft to stop (**arrow**).
- Make sure camshafts are secured in TDC position using BMW special tools 11 3 240 and 11 3 244.



- ⚡ Make sure chain tensioning rail is preloaded.

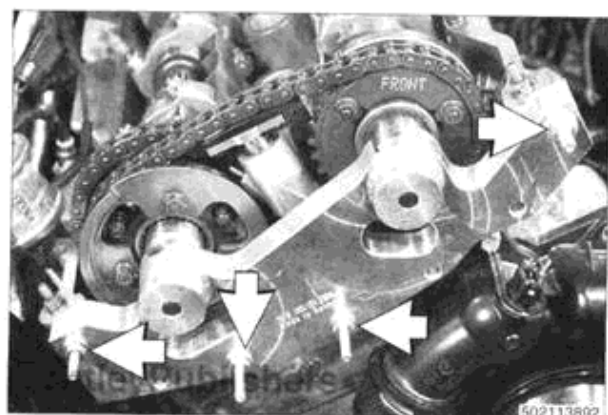
Tightening torque	
Primary chain tensioner preload	0.7 Nm (6 in-lb)



- ⚡ Preload exhaust camshaft spring plate by pressing on impulse wheel. Tighten mounting nuts (**arrows**) by hand. Do not tighten fully.

Camshaft Timing Chain 117-33

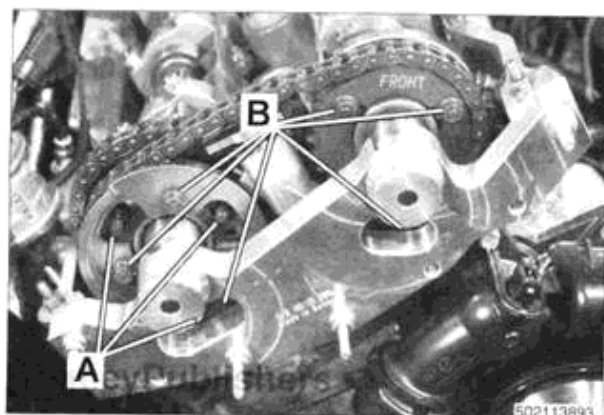
Camshaft timing, checking and adjusting (M54 engine)



- Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Tighten nuts (**arrows**) by hand, and then tighten down uniformly until special tool contacts cylinder head firmly.

CAUTION—

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



- Secure camshaft impulse sprockets and wheels:
- Pretighten Torx screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
 - Pretighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
 - Torque down Torx screws (**A**) and nuts (**B**) to final specifications.

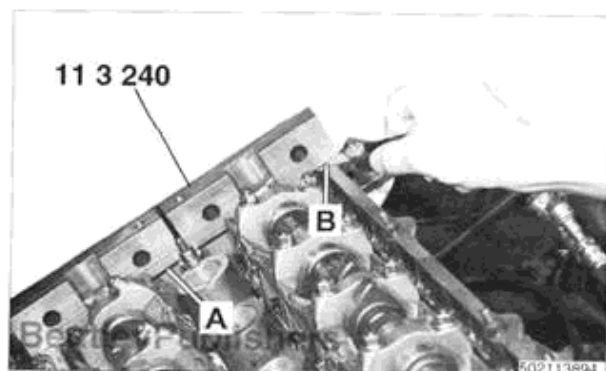
Tightening torques

Sprocket assembly to camshaft (initial torque)	5 Nm (44 in-lb)
Sprocket assembly to camshaft	
• M7 Torx screw (A)	20 Nm (15 ft-lb)
• M6 mounting nut (B)	10 Nm (7 ft-lb)

- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer locked.
- Remove camshaft locking tools from rear of cylinder head.
- Use crankshaft vibration damper bolt to crank engine over twice by hand in direction of rotation until cylinder 1 intake and exhaust camshaft lobes face each other again.
- Secure crankshaft with BMW special tool 11 2 300.
- Place BMW special tool set 11 3 240 over camshafts and measure clearances.
 - 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.
 - Otherwise, repeat camshaft timing adjustment procedure.

CAUTION—

- If the exhaust side of the tool (**A**) is not flush with the cylinder head, camshaft timing is incorrect. Reset camshaft timing.



- Remove camshaft locking tools from rear of camshafts.

117-34 Camshaft Timing Chain

Camshaft timing, checking and adjusting (M54 engine)

- Remove BMW special tool 11 4 220 (adjustable dummy tensioner). Reinstall primary chain tensioner.

Tightening torque	
Primary chain tensioner to timing chain cover (M26 x 1.5)	70 Nm (52 ft-lb)

- Remove crankshaft locking tool from transmission bellhousing. Reinstall sealing plug.
- Remove VANOS setup bracket from front of cylinder head.
- Install VANOS unit. See **Double VANOS unit, installing (M54 engine)** in this repair group.
- Remove compressed air line adapter (BMW special tool 11 3 450) from VANOS unit.
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS unit.

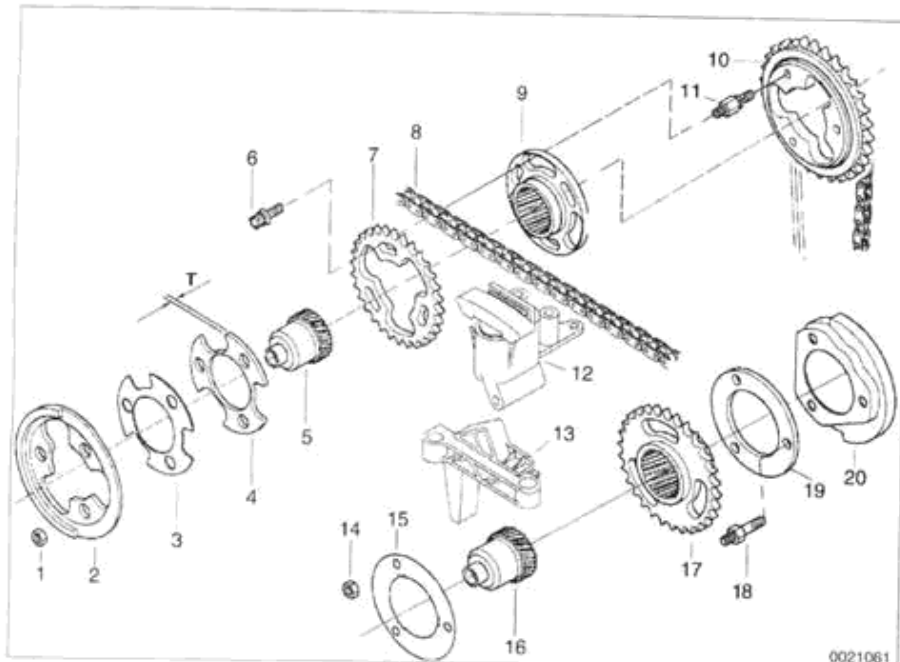
Tightening torque	
Oil line to VANOS unit (banjo bolt)	32 Nm (24 ft-lb)

- Remainder of installation is reverse of removal. Note the following:
 - Install spark plugs.
 - Install intake camshaft plastic baffle prior to installing cylinder head cover. Install ignition coil packs and connect electrical harness connectors.
 - Install accessory belts, radiator cooling fan and cooling fan shroud.
 - Install upper engine covers.

Tightening torques	
Cylinder head cover to cylinder head	10 Nm (7 ft-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

CAMSHAFT SERVICE (M54 ENGINE)

Camshaft sprockets assembly (M54 engine)



1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate, exhaust
4. Thrust spacer (T = 3.5 mm)
5. Splined shaft
6. Torx screw
7. Exhaust camshaft secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded locating stud
12. Secondary chain tensioner
13. Secondary chain lower guide
14. Sprocket mounting nut
15. Spring plate, intake
16. Splined shaft
17. Intake camshaft sprocket
18. Locating stud
19. Thrust spacer
20. Intake camshaft impulse wheel

Camshafts, removing (M54 engine)

WARNING—

- Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

CAUTION—

- Special BMW service tools are required to remove and install the camshafts and VANOS units. Read the procedure through before starting the job.
- If the camshafts are not properly timed, the pistons can contact the valves, causing engine damage.

- Disconnect negative (–) cable from battery.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- Remove air filter housing and ducts. See 130 Fuel Injection.

117-36 Camshaft Timing Chain

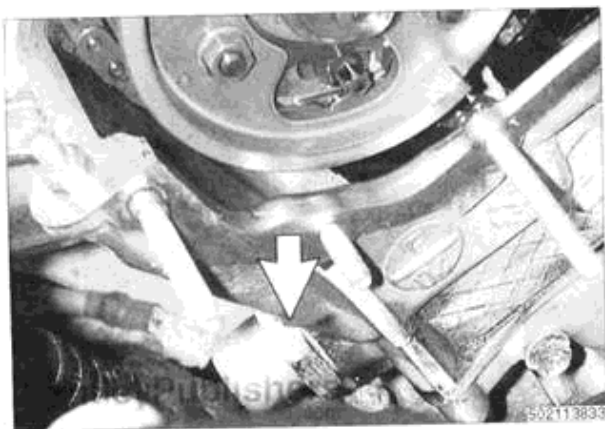
Camshafts, removing (M54 engine)

- Remove electric cooling fan and cooling fan shroud. See **170 Radiator and Cooling System**.
- Remove engine covers and cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove spark plugs. Plug spark plug bores to prevent debris from falling into engine.
- Remove VANOS unit. See **Double VANOS unit, removing (M54 engine)** in this repair group.

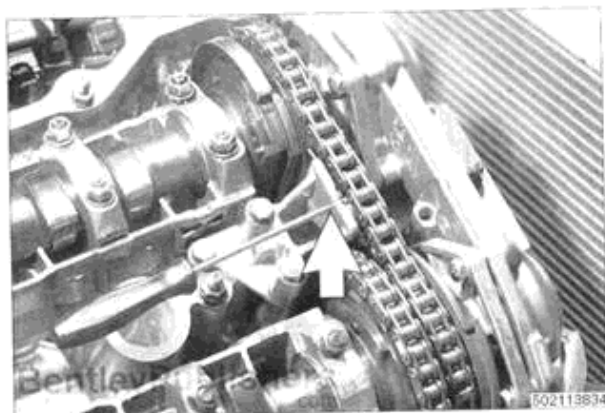
- Remove primary camshaft chain tensioner cylinder (arrow).

CAUTION—

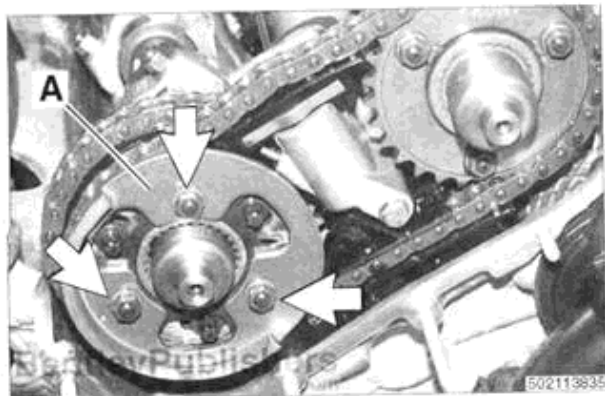
- Chain tensioner piston is under spring pressure.



- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 291, or a thin drift or pin.



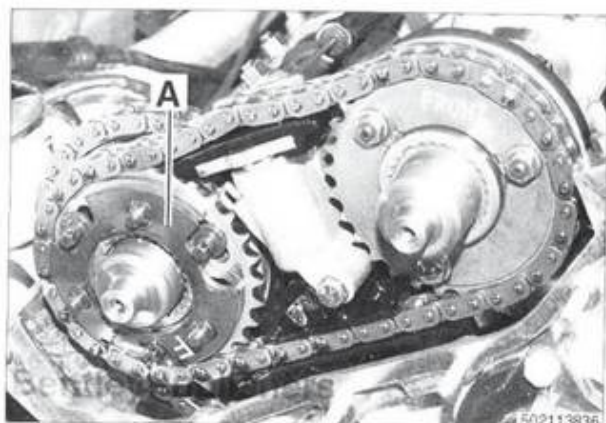
- Remove exhaust camshaft impulse wheel mounting nuts (arrows). Remove impulse wheel (A).



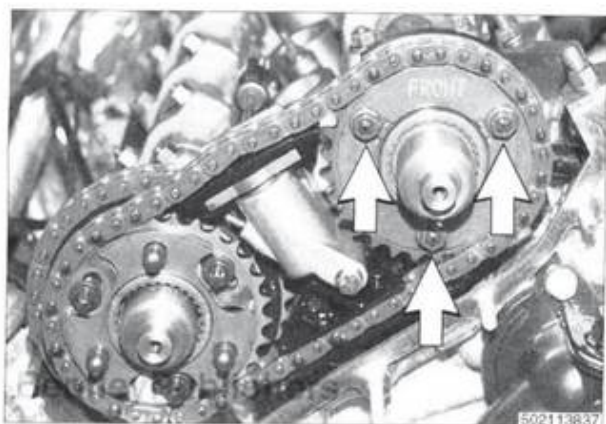
Camshaft Timing Chain 117-37

Camshafts, removing (M54 engine)

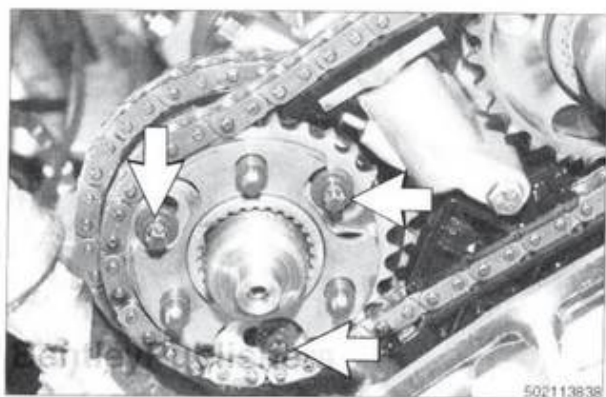
117



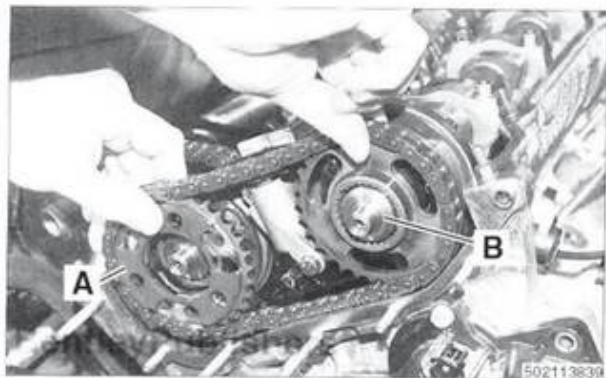
- Remove spring plate (A).



- Remove intake camshaft sprocket mounting nuts (arrows) and remove spring plate (labeled **FRONT**).



- Remove torx bolts (arrows) from exhaust camshaft sprocket.



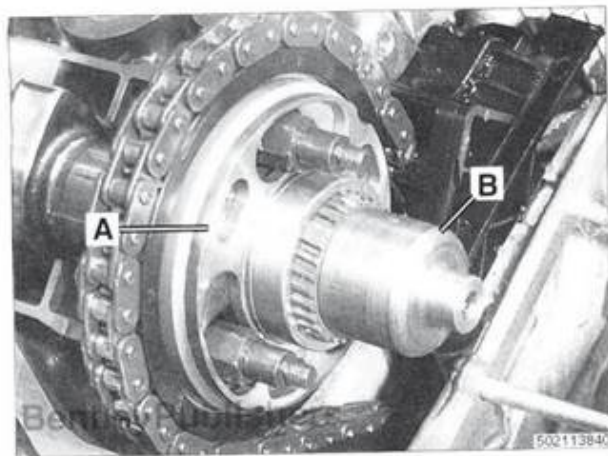
- Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (A), and splined shaft (B).

CAUTION—

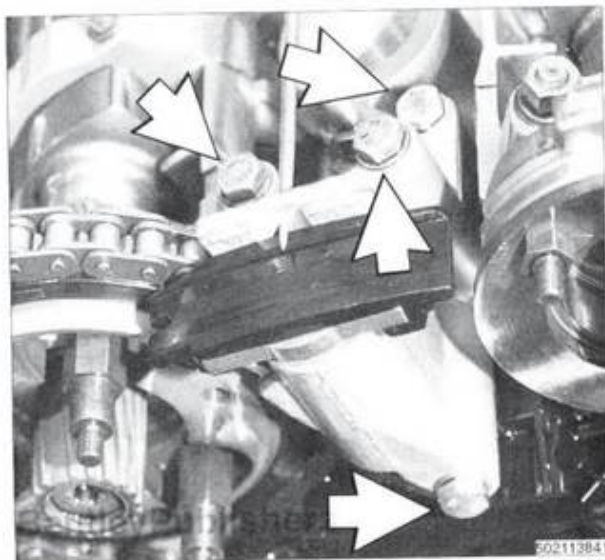
- Intake and exhaust camshaft splined shafts share the same part number. Be sure to mark splined shafts so they can be reinstalled in their original positions.

117-38 Camshaft Timing Chain

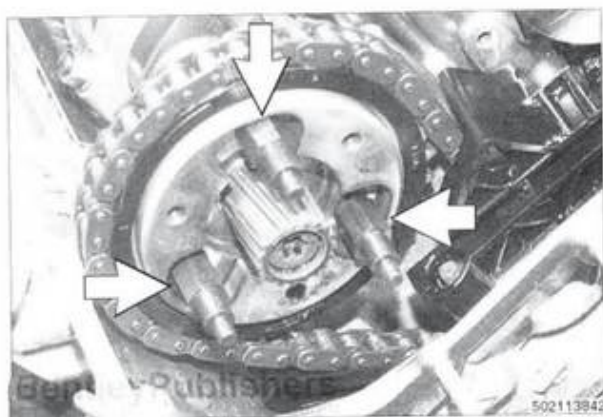
Camshafts, removing (M54 engine)



Remove exhaust camshaft splined sleeve (A) and shaft (B).



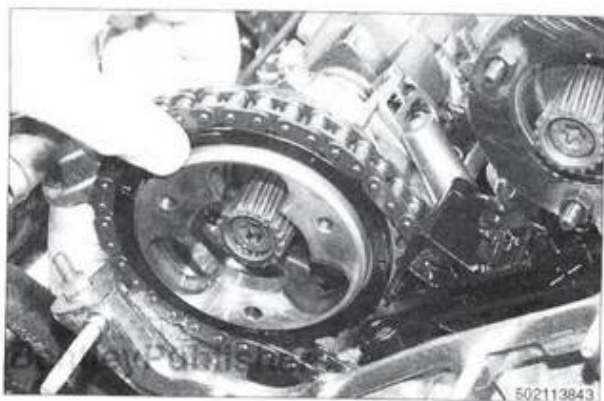
Remove secondary chain tensioner mounting bolts (arrows) and remove tensioner with retaining pin in place.



Remove sprocket mounting studs (arrows) from exhaust camshaft.

Camshaft Timing Chain 117-39

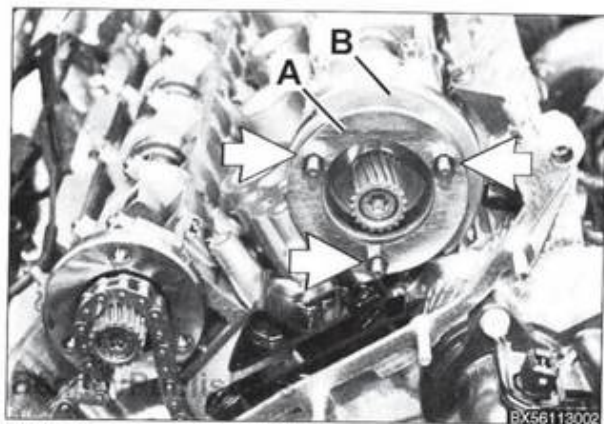
Camshafts, removing (M54 engine)



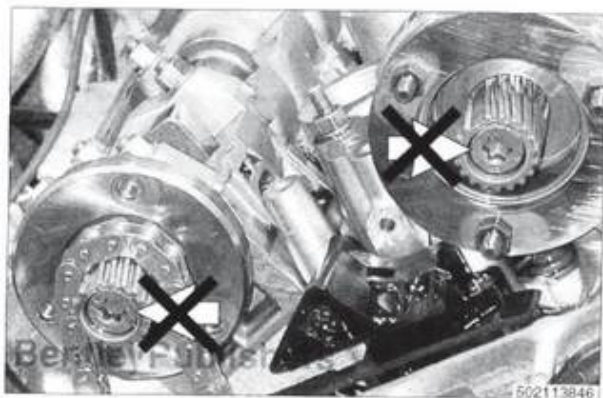
- ◀ Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.



- ◀ Place timing chain on end of exhaust camshaft.



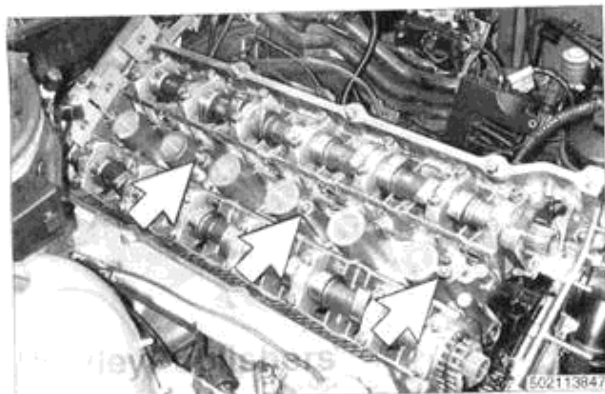
- ◀ Remove locating studs (**arrows**) from intake camshaft. Lift off intake camshaft thrust spacer (**A**) and impulse wheel (**B**).



- ◀ Do not remove Torx® screws (**arrows**) from camshafts.

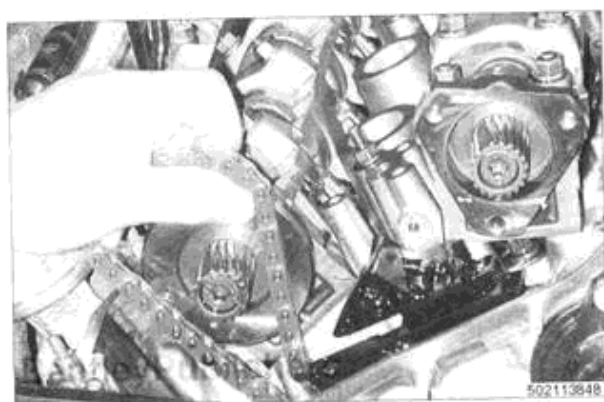
117-40 Camshaft Timing Chain

Camshafts, removing (M54 engine)



➤ Remove cylinder head cover mounting studs (**arrows**) from center of cylinder head.

— Remove crankshaft locking tool.

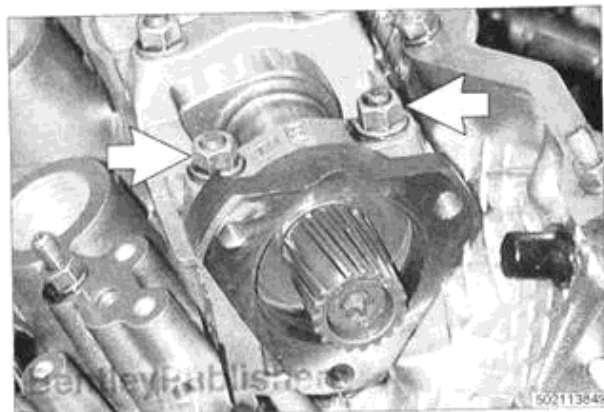


➤ Lift primary chain and hold under tension. Use crankshaft vibration damper bolt to rotate engine in direction opposite to normal rotation (counterclockwise) approximately 30°.

CAUTION—

• By turning crankshaft 30° counterclockwise, pistons are moved away from top dead center. This prevents piston-to-valve interference during camshaft servicing.

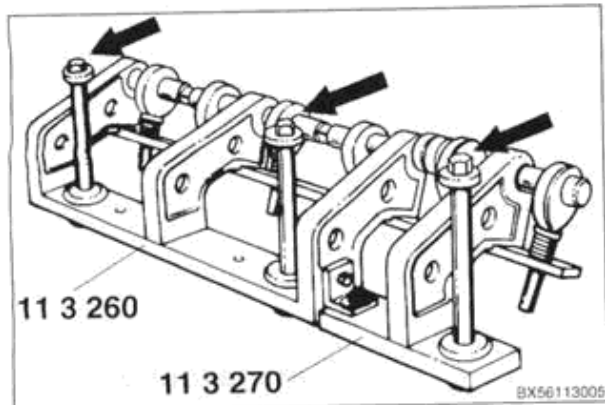
— Remove camshaft locking tools (BMW special tool set 11 3 240) from rear of cylinder head.



➤ Remove intake camshaft bearing cap 1 fasteners (**arrows**). Remove bearing cap.

CAUTION—

• Do not remove camshaft bearing caps 2 - 6 at this time.



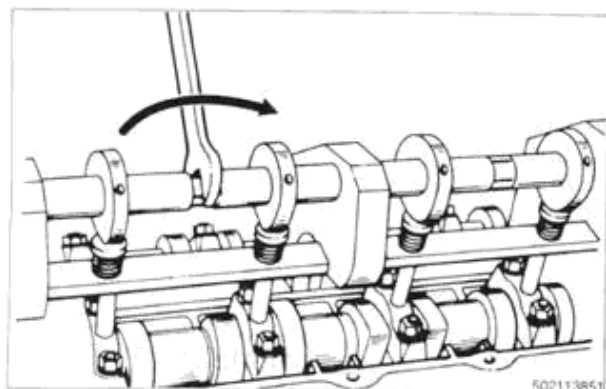
➤ Fit BMW special tools 11 3 260 and 11 3 270 to cylinder head and screw long bolts (**arrows**) into spark plug threads. Align tensioning pins on tool with bearing caps on camshaft.

CAUTION—

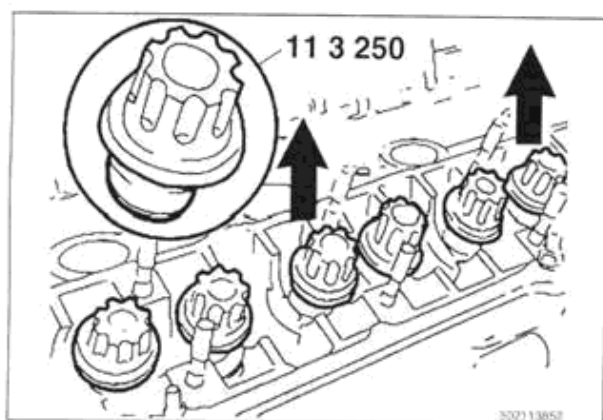
• Do not overtighten bolts in spark plug holes.

Camshaft Timing Chain 117-41

Camshafts, installing (M54 engine)



- Rotate eccentric shaft of special tool (**arrow**) to pretension intake camshaft bearing caps. Remove remaining intake camshaft bearing cap fasteners.
- Slowly release tension on eccentric shaft and remove BMW special tools. Remove bearing caps and set aside in order. Remove camshaft and store safely.
- Repeat procedure for exhaust camshaft.

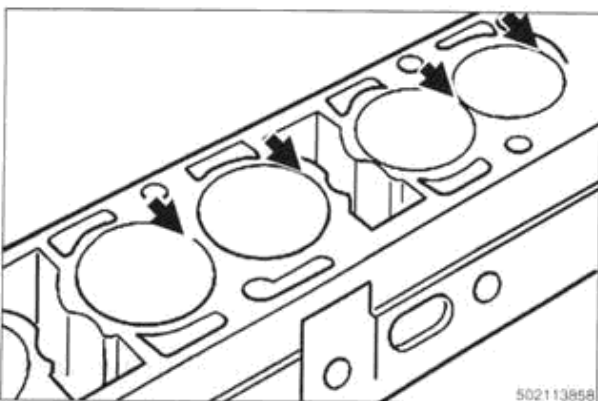


- If cylinder head is being removed, secure hydraulic lifters in lifter bores using BMW special tool set 11 3 250, or remove lifters using a magnetic pick-up tool. With lifters secure or removed, lift out camshaft bearing carriers from cylinder head.

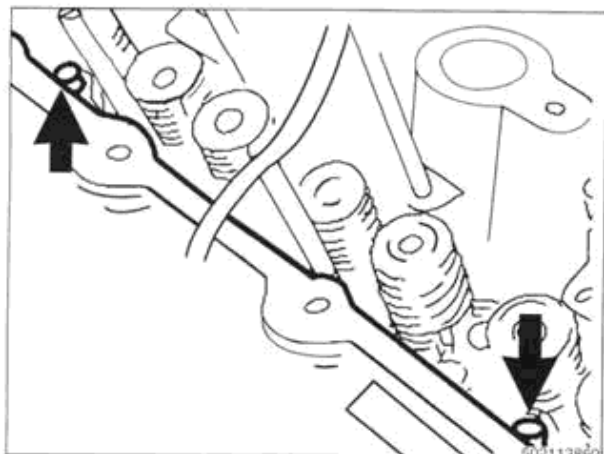
CAUTION—

- Do not let hydraulic lifters fall out as camshaft carrier is removed.
- Mark hydraulic lifters so that they can be reinstalled in their original lifter bores.
- Store hydraulic lifters in an upright position.

Camshafts, installing (M54 engine)



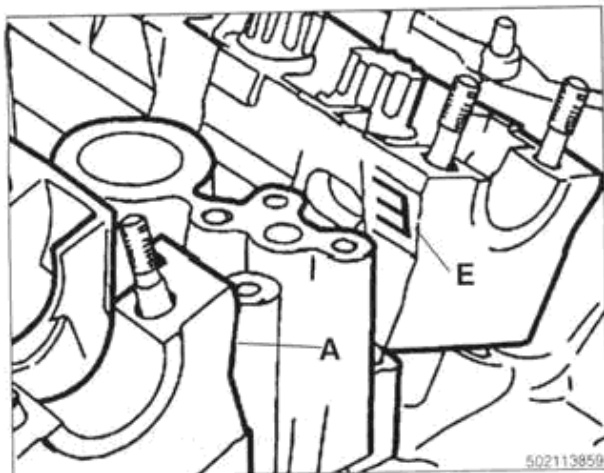
- Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters and friction washers with assembly lubricant before installation.
- Before installing camshaft carriers, examine hydraulic lifter bore bearing points (**arrows**) on underside of camshaft carriers for signs of wear.



- Center camshaft carrier with hydraulic lifters on pins (**arrows**) at bearing positions 2 and 7.

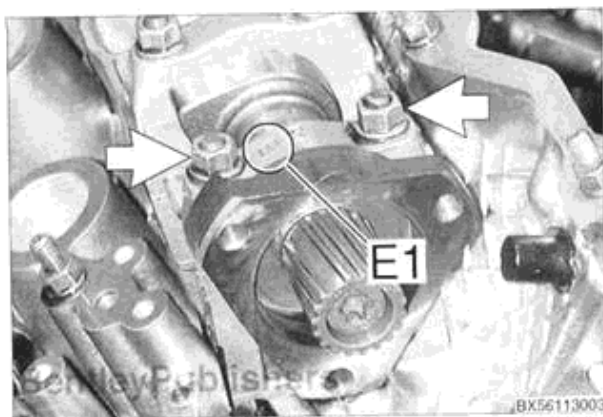
117-42 Camshaft Timing Chain

Camshafts, installing (M54 engine)



➤ Note marks on camshaft carriers: **E** for intake side and **A** for exhaust side.

- Lift timing chain and place exhaust camshaft on exhaust camshaft carrier. Place intake camshaft on intake camshaft carrier.

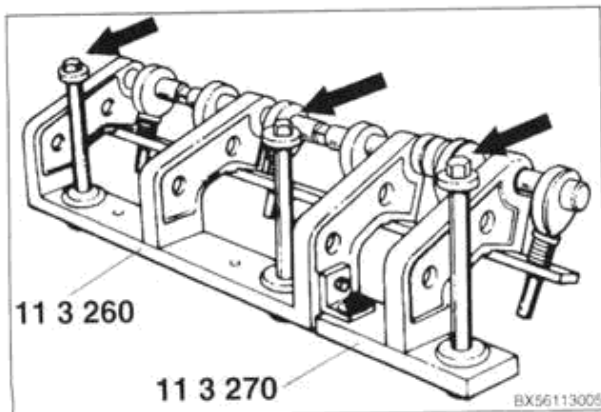


➤ Place bearing caps on camshafts and install retaining nuts (**arrows**) finger tight.

- Note that each bearing cap is marked (**inset**):
E1 to E7 for intake (front to rear)
A1 to A7 for exhaust (front to rear)

CAUTION—

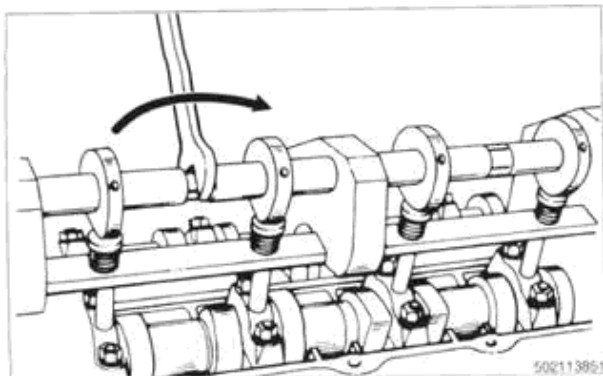
- Make sure the crankshaft, which was rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before reinstalling the camshafts. This ensures that pistons are out of TDC position and prevents piston-to-valve interference when the camshafts are installed.



➤ Fit BMW special tools 11 3 260 and 11 3 270 to cylinder head and screw long bolts (**arrows**) into spark plug threads. Align tensioning pins on tool with bearing caps on intake camshaft.

CAUTION—

- Do not overtighten bolts in spark plug holes.



➤ Rotate eccentric shaft of special tool (**arrow**) to pretension bearing caps. Torque bearing cap nuts.

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 special tools.

Camshaft Timing Chain 117-43

Camshafts, installing (M54 engine)

- Repeat procedure for exhaust camshaft.

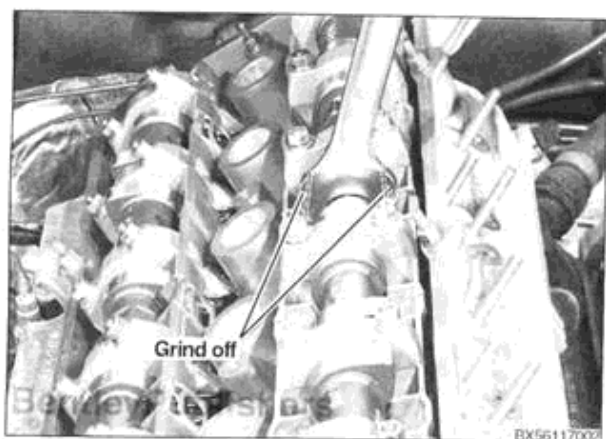
CAUTION—

- After the camshafts are installed, a minimum waiting time is required for the hydraulic lifters to bleed down before bringing the crankshaft and pistons back to TDC. When the camshafts are removed, the hydraulic lifters may expand. This expansion can cause increased valve lift when camshafts are bolted down, possibly resulting in piston-to-valve interference.

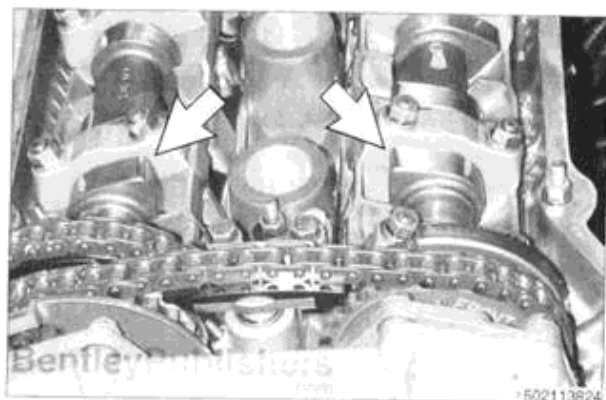
Hydraulic lifter bleed down waiting times

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

- ◀ In procedure steps that follow, use 27 mm open-end wrench to rotate camshaft into position. If necessary, grind off outer edges of wrench jaws to prevent damage to cylinder head.



- ◀ Rotate camshafts until intake and exhaust lobes for cylinder 1 face each other (arrows).

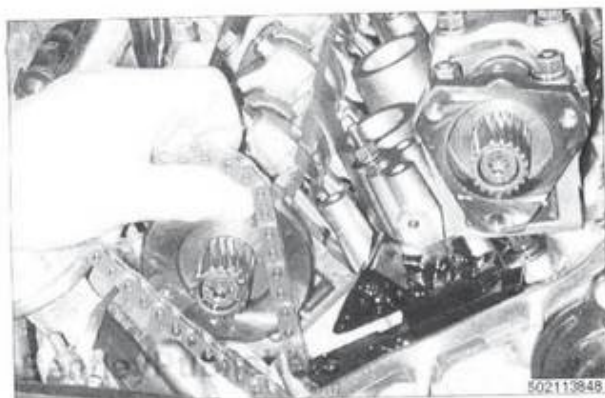


- ◀ Secure camshafts in TDC position using BMW camshaft TDC tools 11 3 241. Align camshafts so that camshaft TDC tools rest solidly on cylinder head upper surface. Lock down with special tool 11 3 244 bolted to a spark plug bore.

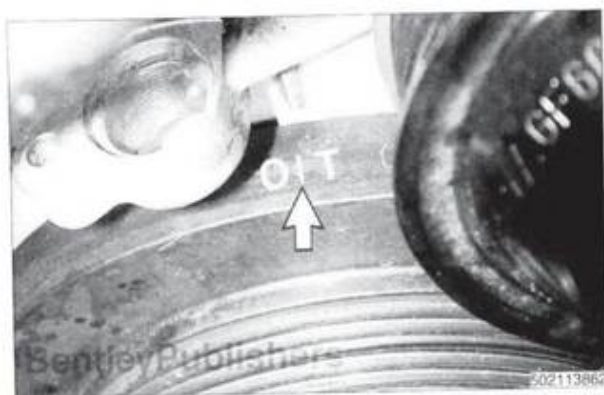


117-44 Camshaft Timing Chain

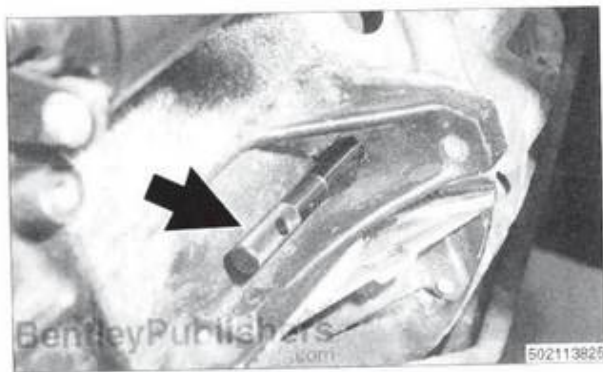
Camshafts, installing (M54 engine)



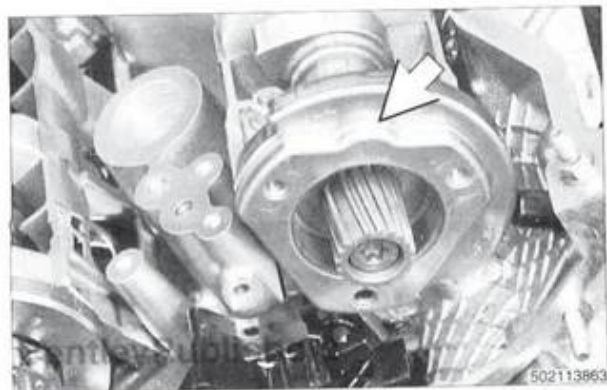
➤ Lift timing chain and hold under tension.



➤ While maintaining tension on timing chain, use crankshaft vibration damper bolt to rotate crankshaft in direction of rotation (clockwise) until cylinder 1 is at TDC position. **O/T (arrow)** on front pulley lines up with boss on lower timing chain cover.



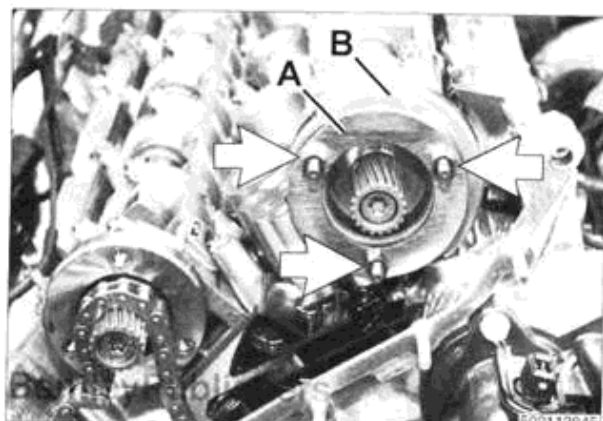
➤ Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



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

Camshaft Timing Chain 117-45

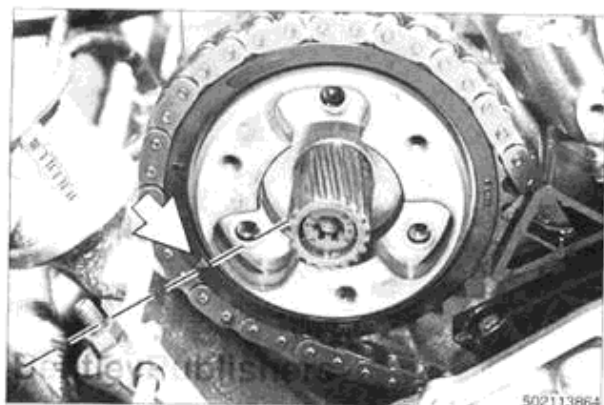
Camshafts, installing (M54 engine)



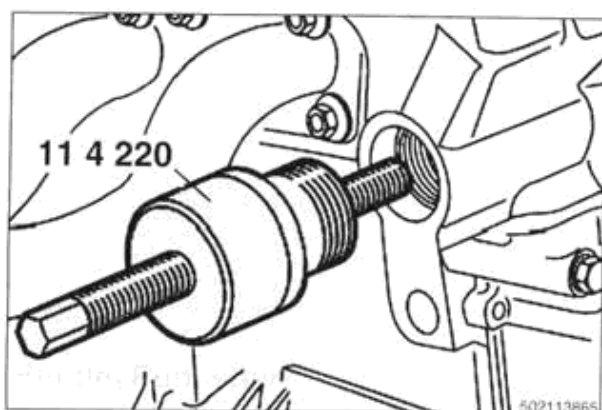
- Fit thrust spacer (A) to intake camshaft (B) and tighten down with threaded locating studs. Place longer threaded end of studs into camshaft (arrows).

Tightening torque

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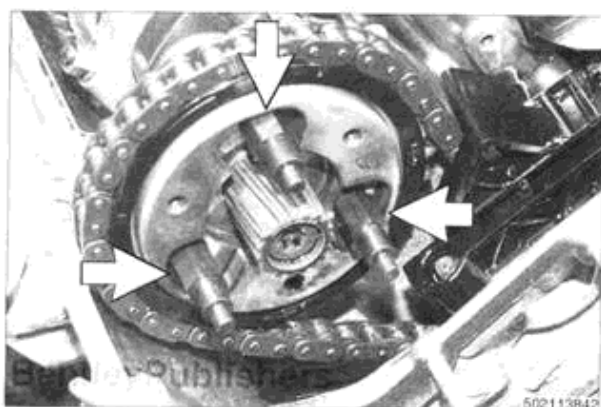
- Fit primary sprocket to primary timing chain and install on exhaust camshaft so that pointer on sprocket (arrow) lines up with cylinder head sealing surface (dashed line).



- Insert BMW special tool 11 4 220 into timing chain tensioner bore and bring center spindle into contact with tensioning rail. Tighten until slack is removed, but do not pretension timing chain.

NOTE—

- BMW special tool 11 4 220 is an adjustable dummy tensioner and simulates the function of the primary chain tensioner.
- Make sure that arrow on upper primary sprocket still lines up with upper edge of cylinder head. Reposition sprocket if necessary.



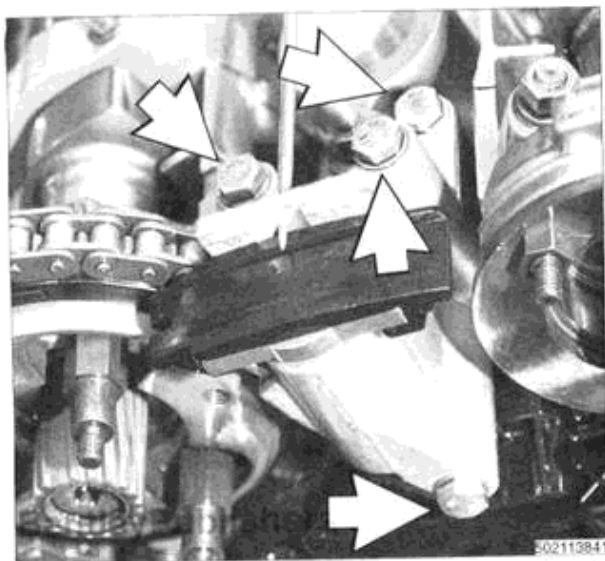
- Insert and tighten down threaded locating studs (arrows) in end of exhaust camshaft. Note installed position of studs.

Tightening torque

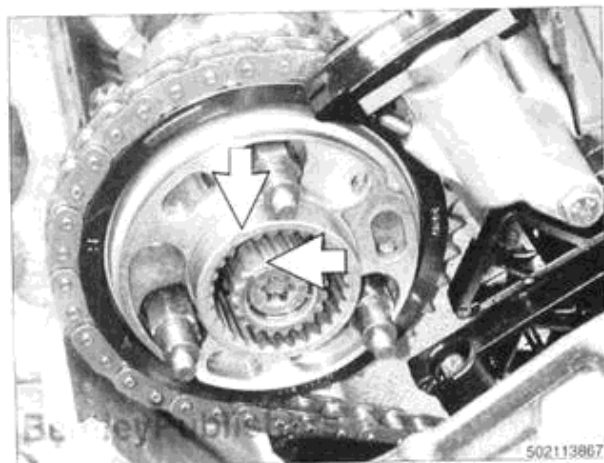
Exhaust camshaft locating stud	20 Nm (15 ft-lb)
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117-46 Camshaft Timing Chain

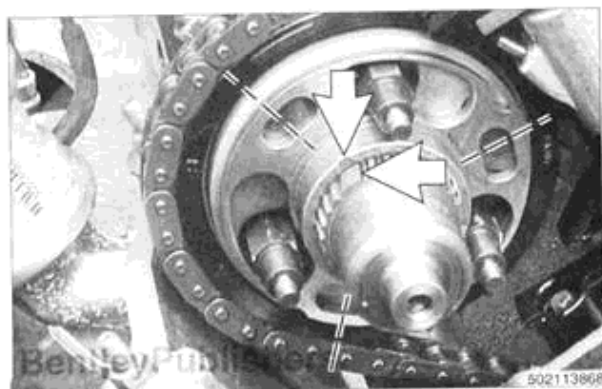
Camshafts, installing (M54 engine)



- Install secondary chain tensioner on cylinder head (**arrows**). Keep tensioner compressed using BMW special tool 11 3 291 or suitable pin tool.



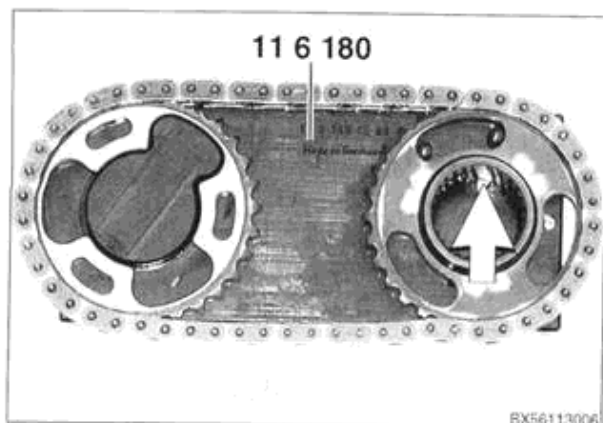
- Install exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



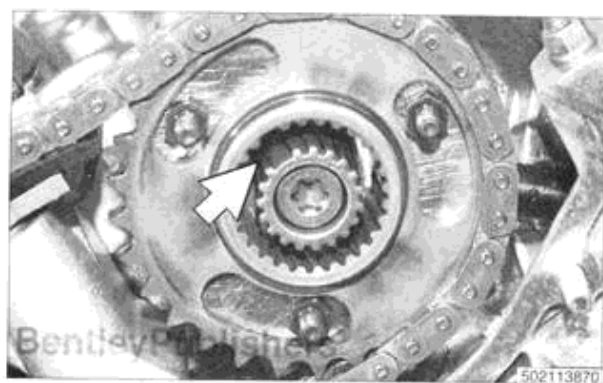
- Slide splined shaft on exhaust camshaft. Be sure that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).
- Push splined shaft in further to rotate splined sleeve until three threaded holes in primary chain sprocket are centered in splined sleeve slots (**dashed lines**).

Camshaft Timing Chain 117-47

Camshafts, installing (M54 engine)



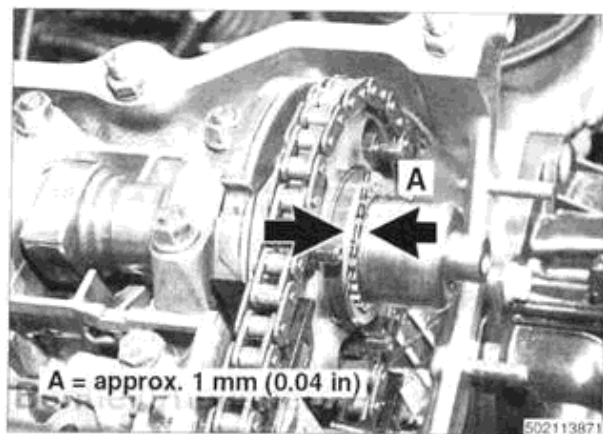
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.



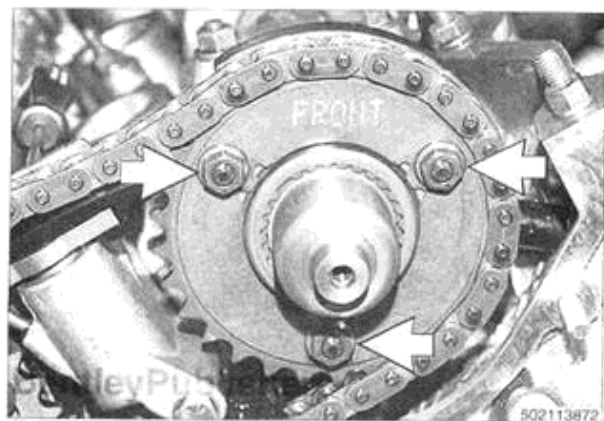
- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (**arrow**).

CAUTION—

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



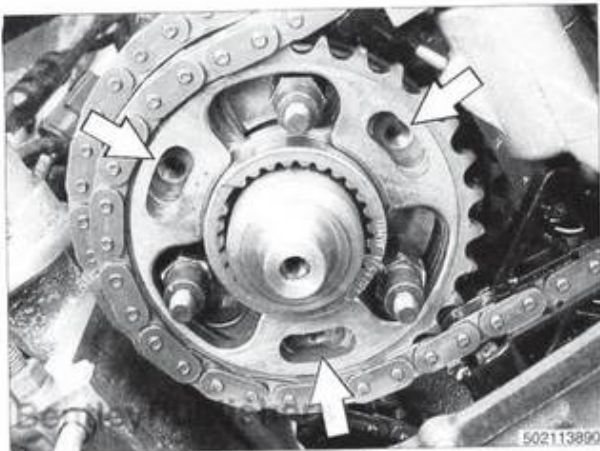
- Align locating tooth of splined shaft with gaps on camshaft and sprocket. Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in) of splines (**arrows**) are visible.



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

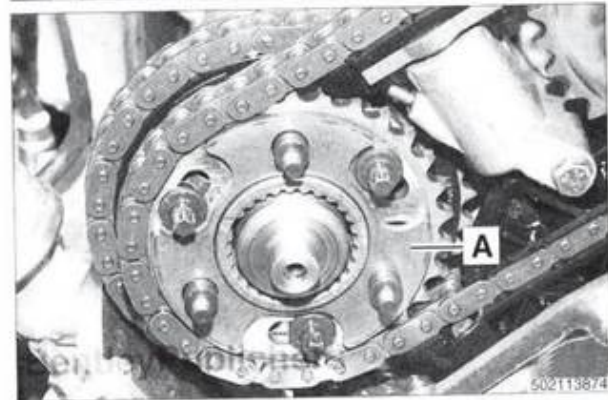
117-48 Camshaft Timing Chain

Camshafts, installing (M54 engine)

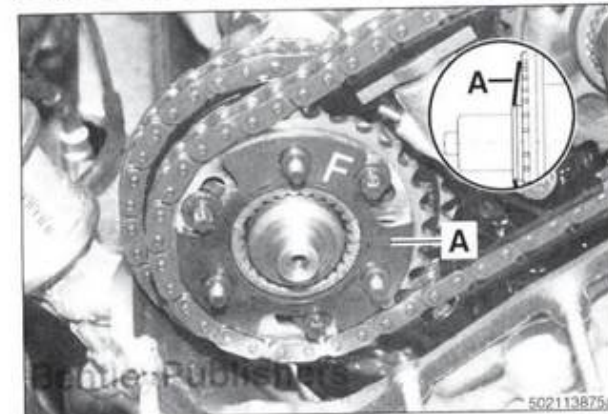


Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft assembly.

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



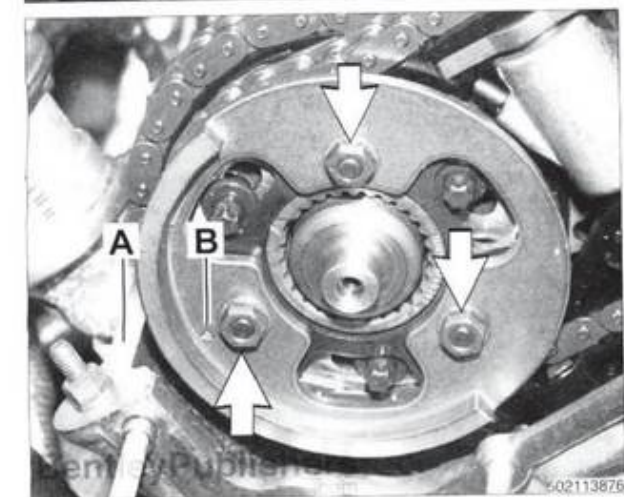
Fit thrust spacer (**A**) on exhaust camshaft.



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 as shown in inset: convex side facing forward.



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

Camshaft Timing Chain 117-49

Camshafts, installing (M54 engine)



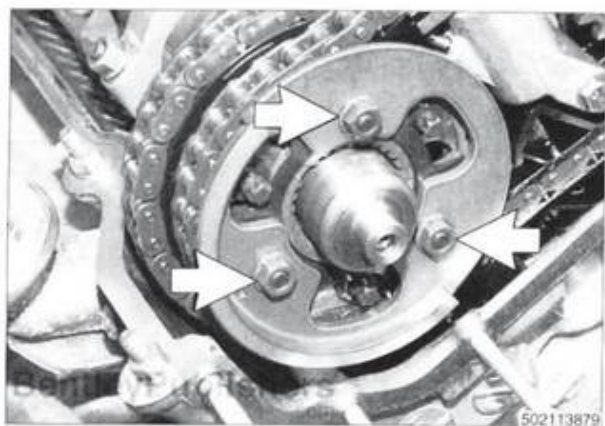
- Pull out exhaust camshaft splined shaft to stop (**arrow**).
- Press down on secondary chain tensioner and remove tensioner lock-down tool.



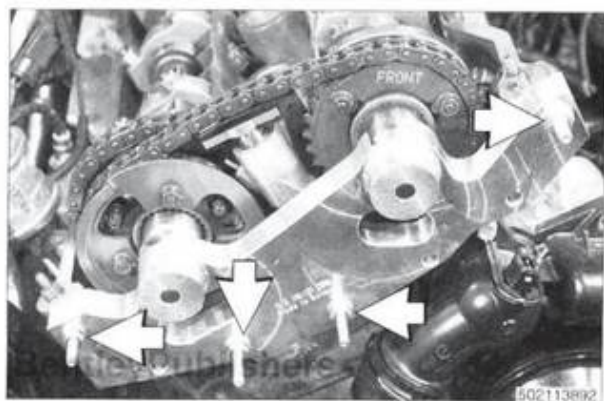
- Preload primary chain:
 - Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

Tightening torque

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



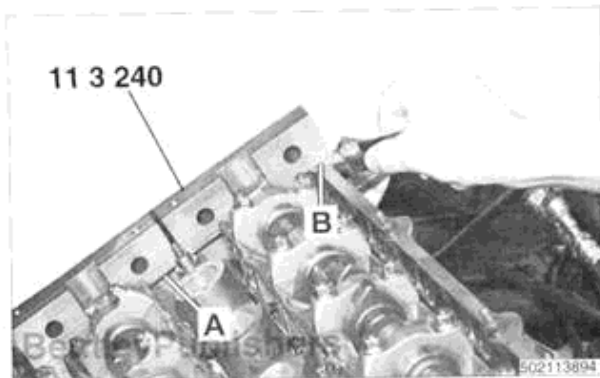
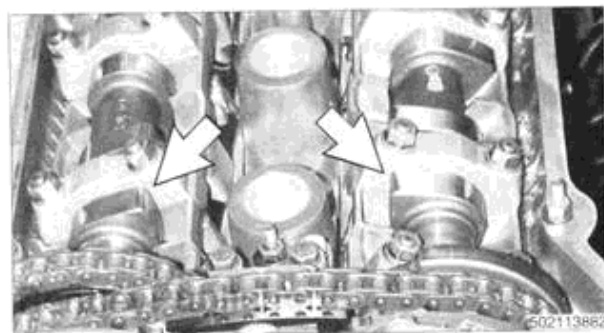
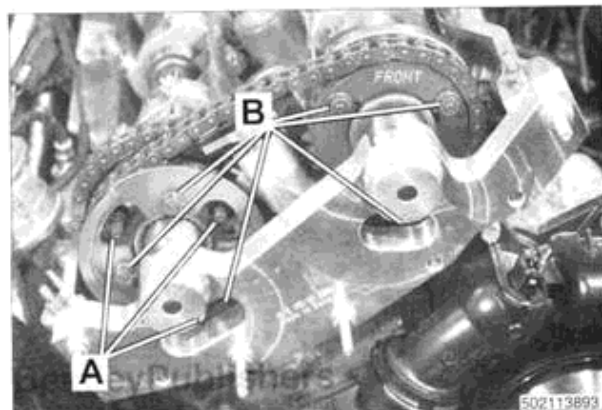
- Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Install nuts (**arrows**) finger tight, then tighten down uniformly until special tool is in full contact with cylinder head.

CAUTION—

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

117-50 Camshaft Timing Chain

Camshafts, installing (M54 engine)



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 wheel to camshaft— (initial torque)	5 Nm (44 in-lb)
Sprocket assembly wheel to camshaft	20 Nm (15 ft-lb)
• M7 torx screws (A)	10 Nm (8 ft-lb)
• M6 mounting nuts (B)	

- Remove crankshaft locking tool so that crankshaft is no longer secured in TDC position.
- 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 set 11 3 240 over camshafts and measure clearances.
 - Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS splines, when 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.
 - Otherwise, reset camshaft timing. See **Camshaft timing, checking and adjusting (M54 engine)** in this repair group.

CAUTION—

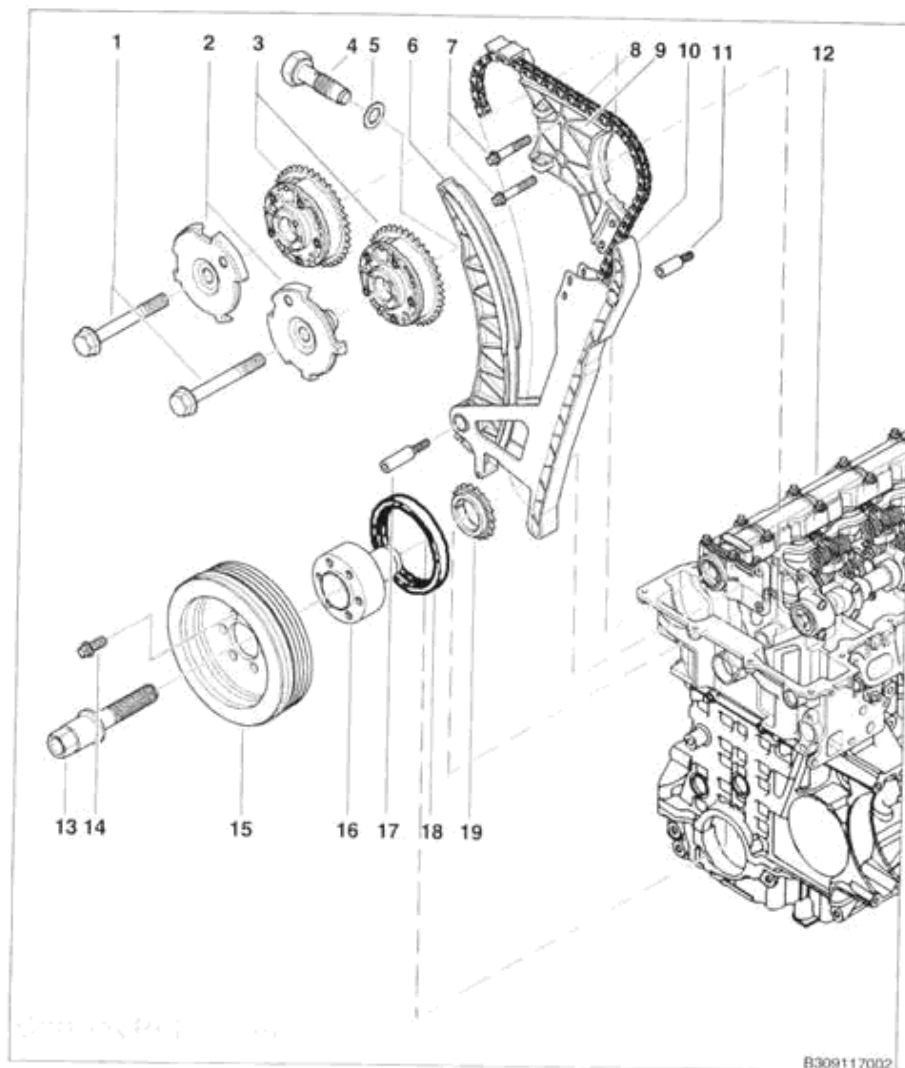
- If the exhaust side of the tool (A) is not flush with the cylinder head, camshaft timing is incorrect. Reset camshaft timing.

- Remove BMW special tool 11 6 150 from front of cylinder head.
- Reinstall VANOS unit. See **Double VANOS unit, installing (M54 engine)** in this repair group.
- Remove camshaft and crankshaft locking tools.
- Reassemble engine. Be sure to top off and bleed cooling system

TIMING CHAIN SERVICE (N52 ENGINE, N54 ENGINE)

Camshaft timing chain components (N52, N54 engine)

Camshaft timing chain, vibration damper (front pulley) and associated components of N52 and N54 engines are similar.



1. VANOS unit mounting bolt (M10 x 94 mm)
 - Replace with new
 - Tighten in 2 stages
 - Stage 1: 20 Nm (15 ft-lb)
 - Stage 2: Additional 180°
2. Camshaft impulse wheel
3. VANOS unit
 - Different intake and exhaust adjustment units
4. Chain tensioner (M22 x 1.5)
 - Tighten to 55 Nm (41 ft-lb)
5. Sealing O-ring
6. Chain tensioner rail
7. Chain assembly mounting bolts (M6 x 35 mm Torx)
 - Tighten to 8.5 Nm (6 ft-lb)
8. Timing chain
9. Chain assembly
10. Chain guide
11. Chain guide mounting bolt (M7)
 - Tighten to 14 Nm (10 ft-lb)
12. Cylinder head with camshafts
 - N52 cylinder head illustrated
13. Vibration damper hub mounting bolt (M16 x 80 mm)
 - Replace with new
 - Tighten in 2 stages
 - Stage 1: 100 Nm (74 ft-lb)
 - Stage 2: Additional 360°
14. Vibration damper mounting bolt (M8 x 16 mm Torx)
 - Tighten to 35 Nm (26 ft-lb)
15. Vibration damper (front pulley)
16. Vibration damper hub
17. Chain tensioner rail mounting bolt (M8)
 - Tighten to 20 Nm (15 ft-lb)
18. Crankshaft front seal
19. Crankshaft sprocket

117-52 Camshaft Timing Chain

Camshaft timing chain, removing and installing (N52, N54 engine)

Camshaft timing chain, removing and installing (N52, N54 engine)

When removing and installing the camshaft timing chain, special tools and procedures are required to remove and install VANOS units and to time camshafts. Read the entire procedure before beginning repairs.

WARNING—

- To avoid personal injury, be sure the engine is cold before beginning the procedure.

CAUTION—

- Disassembly, removal and assembly of camshafts or VANOS units without special tools poses the risk of damage or breakage: Valves may be bent by contact with the piston crowns.
- Throughout this procedure, unless otherwise specified, crankshaft and camshafts remain locked against rotation using BMW special tools.

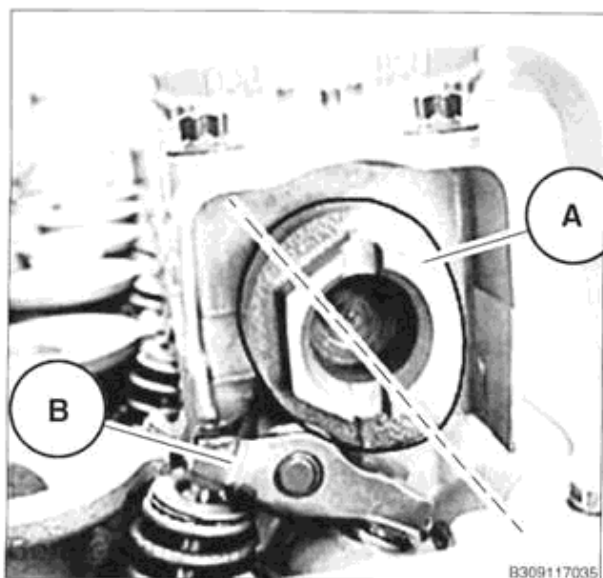
- Use scan tool to read out and record ECM fault memory.
- Switch ignition OFF and remove key.
- Remove upper and lower cabin microfilter housings. See **640 Heating and Air-conditioning**.
- Remove strut tower brace.
- Remove ignition coil cover (upper engine cover). See **020 Maintenance**.
- Detach ignition coil connectors. Lift ignition coil harness off cylinder head cover and set aside.
- Remove ignition coils. See **120 Ignition System**.
- Remove cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove spark plugs.

◀ N52 engine: Using vibration damper bolt, rotate crankshaft to place cylinder 1 in TDC firing position. In this position, cylinder 1 intake camshaft lobe points upward at an angle (dashed line).



Camshaft Timing Chain 117-53

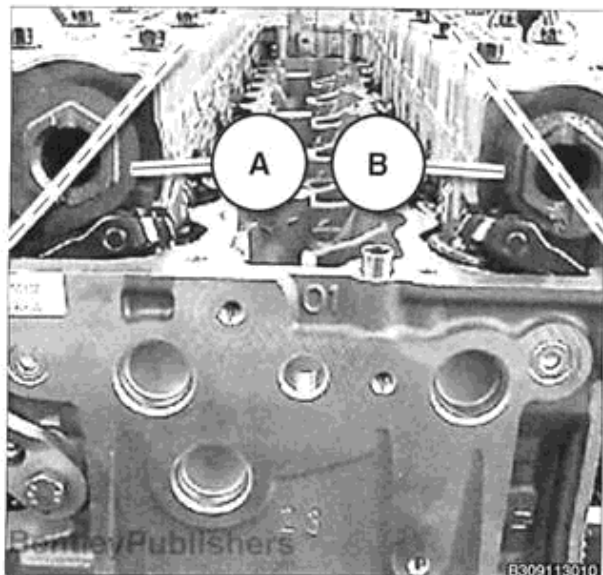
Camshaft timing chain, removing and installing (N52, N54 engine)



- ◀ N52 engine: Cylinder 1 in TDC firing position: Cylinder 6 exhaust camshaft lobe (A) points downward at an angle (dashed line). Cam follower (B) is not actuated.

NOTE—

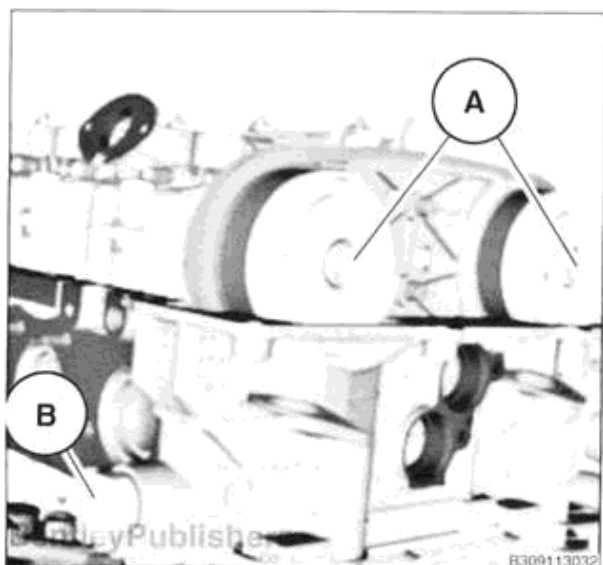
- Use a mirror to check exhaust camshaft lobe position.



- ◀ N54 engine: Using vibration damper bolt to rotate crankshaft, place cylinder 1 in TDC firing position. In this position, lobes for cylinder 6 (rear of engine) intake and exhaust camshafts (A, B) point away from each other and down. Cylinder 6 camshaft lobes do not contact roller cam followers.

NOTE—

- Use a mirror to check cylinder 6 cam lobe positions.



- ◀ Working at right front of cylinder head, remove timing chain tensioner (B). Be prepared to catch dripping oil with a shop towel. Do not allow oil to contaminate accessory belt.

- Raise vehicle and support safely.

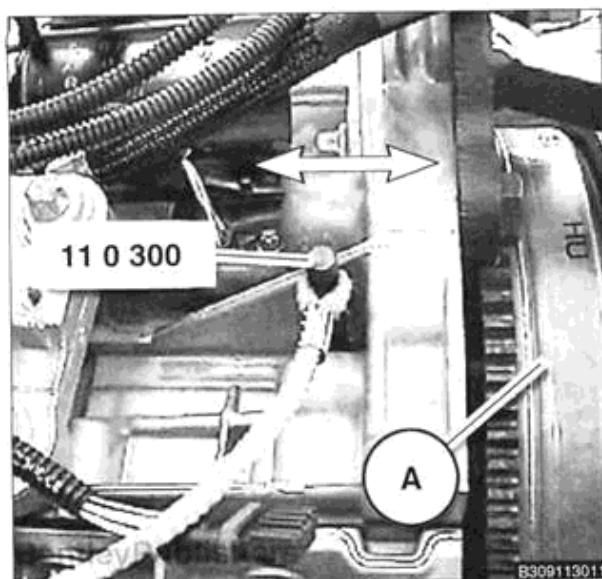
WARNING—

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove engine compartment splash shield. See 020 Maintenance.
- Remove engine accessory belt. See 020 Maintenance.
- Remove vibration damper (front pulley). See Vibration damper, removing and installing (N52, N54 engine) in this repair group.
- Remove crankshaft front seal. See 119 Lubrication System.

117-54 Camshaft Timing Chain

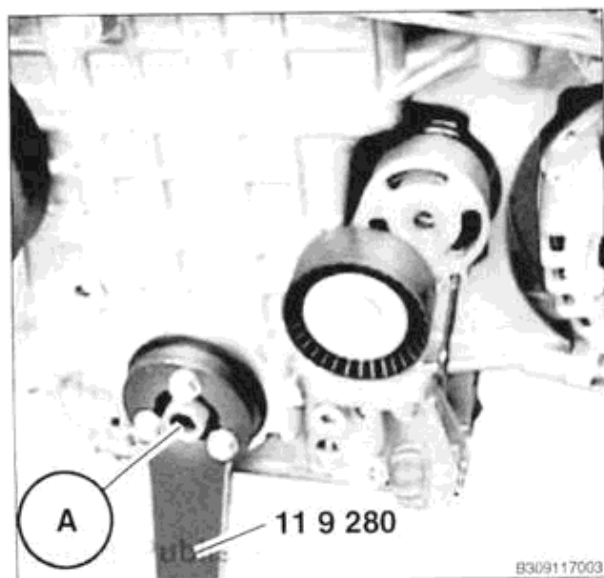
Camshaft timing chain, removing and installing (N52, N54 engine)



Working underneath engine, slide out protective plug at lower left of engine bell housing flange. Install BMW special tool 11 0 300 (crankshaft locking tool) through bell housing flange port into flywheel (A) hole. If necessary, rock flywheel slightly back and forth to line up holes with tool. This locks crankshaft at TDC.

CAUTION—

- Models with automatic transmission: In the flywheel (torque plate), a short distance before the bore for TDC position, there is a large bore which can be confused with the special tool bore. If the flywheel is locked using the correct bore, the engine can no longer be rotated at the vibration damper bolt.
- If special tool 11 0 300 does not slide easily into the bell housing flange bore, sand paint off the tool. Do not enlarge the bore.

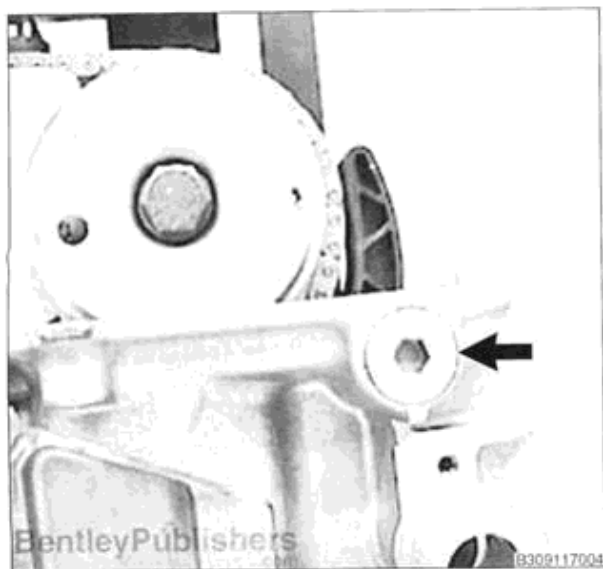


Remove vibration damper hub:

- Bolt BMW special tool 11 9 280 (counter hold tool) to hub.
- With help of assistant counter holding hub, loosen and remove hub bolt (A). Discard bolt.
- Pull hub off crankshaft, sliding it out of timing chain lower sprocket.

CAUTION—

- Counter hold hub securely. Do not rely on flywheel lock (special tool 11 0 300) to counter hold against crankshaft rotation.

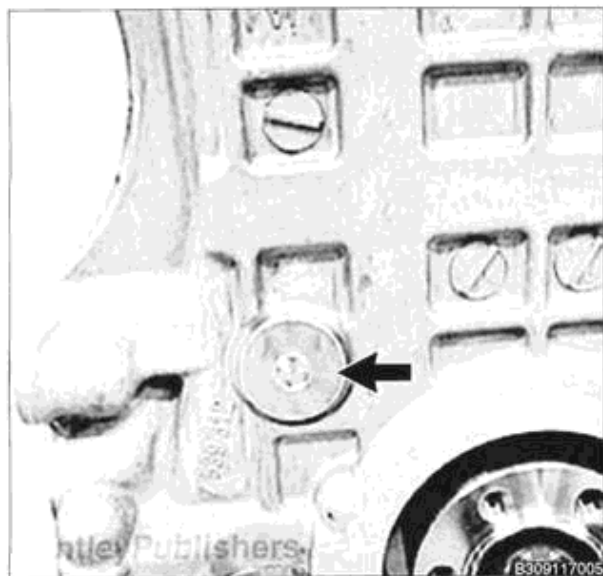


Unscrew plug (arrow) at upper left of timing chain housing.

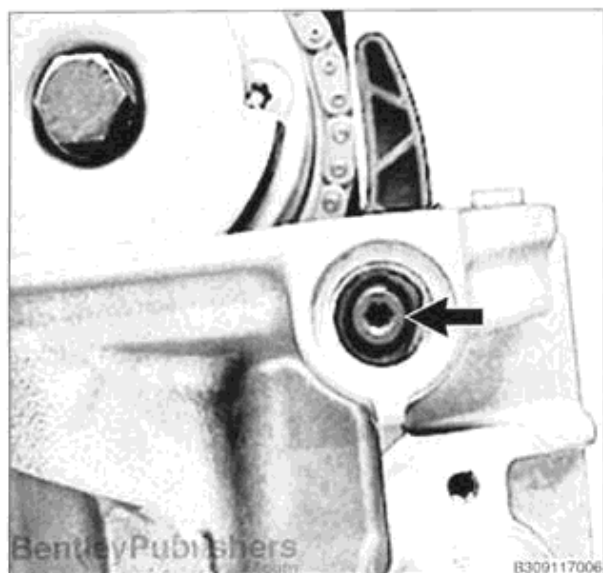
Camshaft Timing Chain 117-55

Camshaft timing chain, removing and installing (N52, N54 engine)

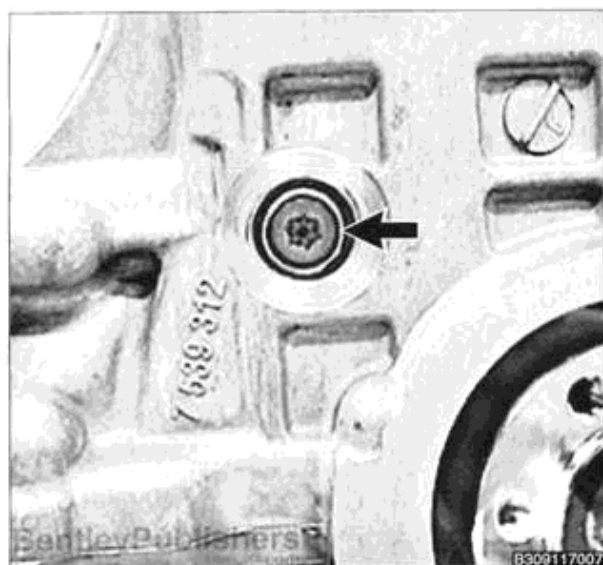
- Unscrew plug (arrow) at lower right of timing chain housing.



- Remove chain guide mounting bolt (arrow) at upper left of timing chain housing.

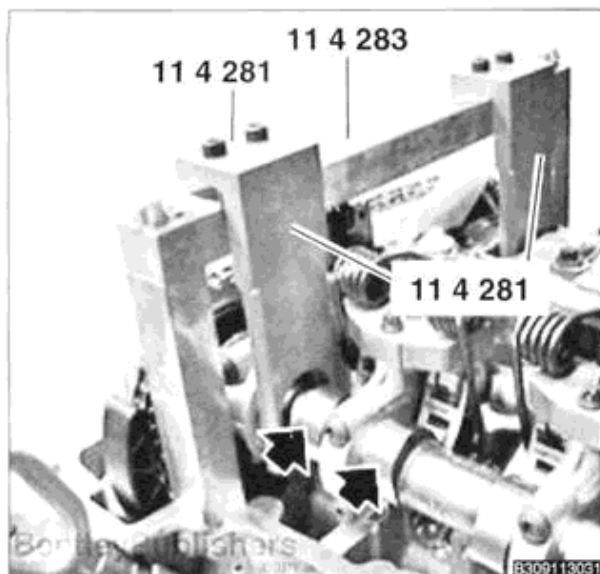


- Remove chain tensioning rail mounting bolt (arrow) at lower right of timing chain housing.

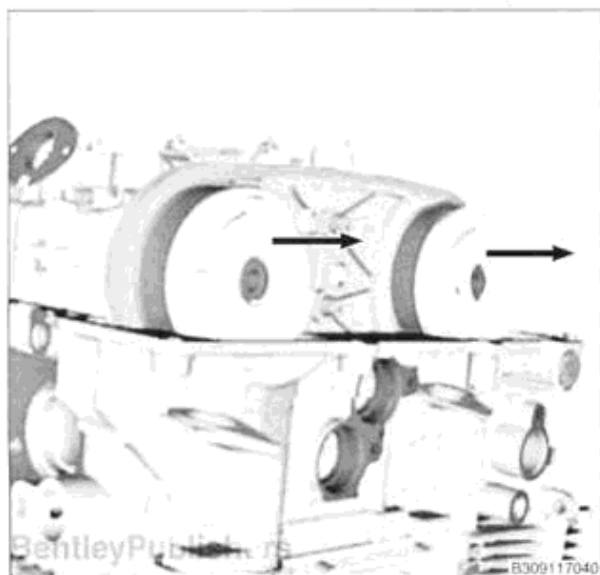


117-56 Camshaft Timing Chain

Camshaft timing chain, removing and installing (N52, N54 engine)



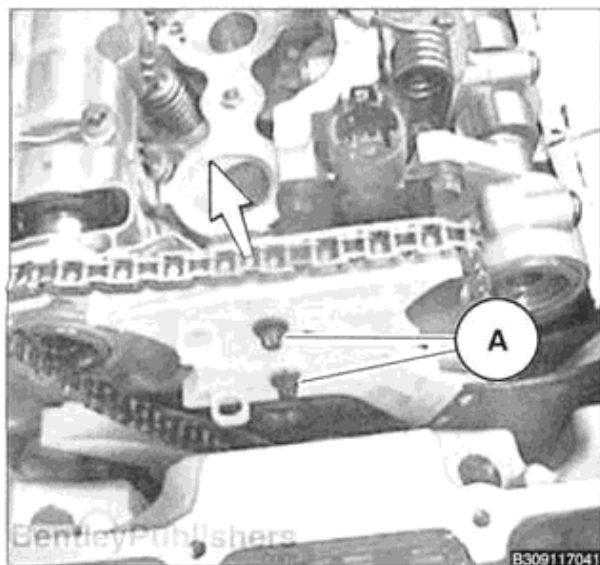
Use BMW special tool set 11 4 280 to lock down camshafts.



- Remove intake and exhaust VANOS units:
- Loosen and remove VANOS unit mounting bolts. Discard bolts.
 - Disengage timing chain from VANOS unit sprockets.
 - Remove VANOS units (**arrows**) and set aside. See **VANOS units, removing and installing (N52, N54 engine)** in this repair group.

NOTE —

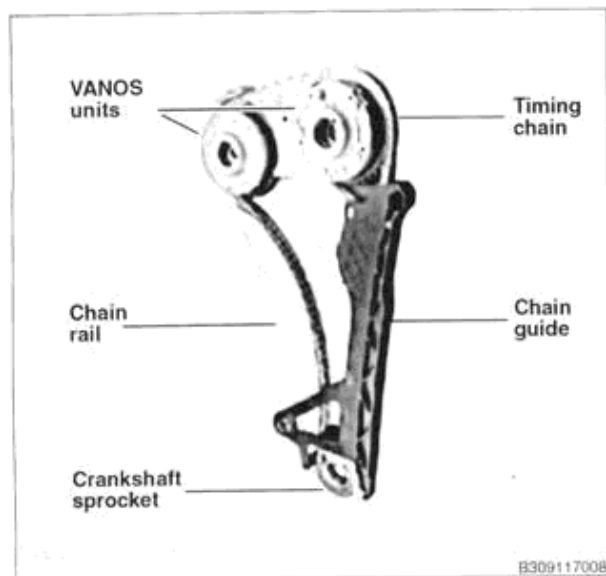
- *Illustration does not show special tool set 11 4 280 in place.*



- Working at front of cylinder head:
- Remove timing chain assembly mounting bolts (**A**).
 - Lift timing chain, timing chain assembly and crankshaft sprocket straight up (**arrow**) out of timing chain housing.

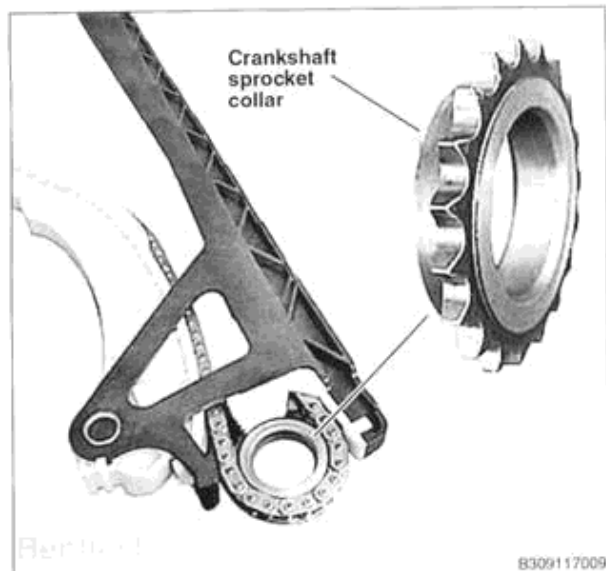
Camshaft Timing Chain 117-57

Camshaft timing chain, removing and installing (N52, N54 engine)



Chain, chain assembly and crankshaft sprocket. VANOS units shown installed on assembly for purposes of illustration.

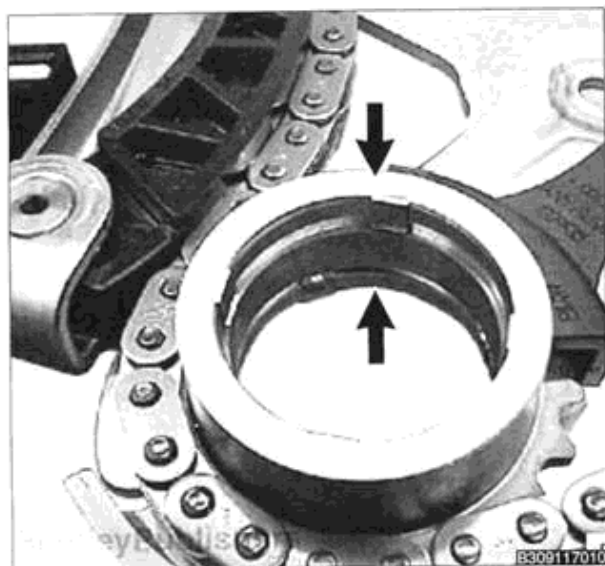
- Disengage timing chain from guide and rail assembly and crankshaft sprocket and fit new chain.



Fit crankshaft sprocket to chain in orientation shown, with collar pointing to engine.

CAUTION—

- Incorrect sprocket assembly results in engine damage.



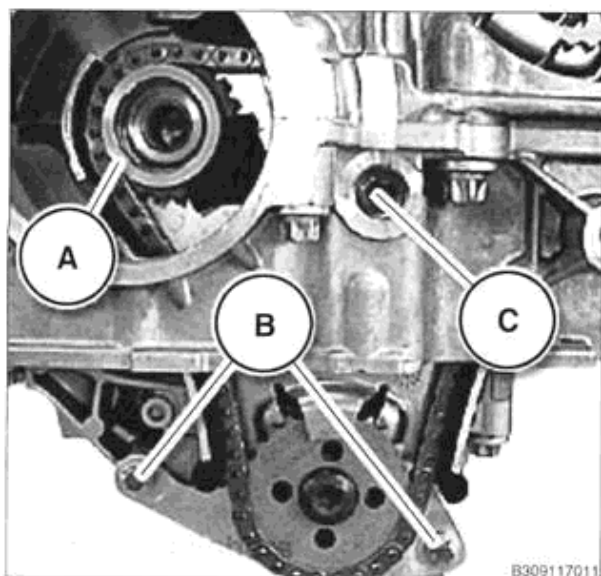
N54 engine: Note that friction plates (arrows) are fitted between timing chain sprocket and oil pump drive sprocket.

CAUTION—

- If N54 engine is operated without friction plates, engine damage results.

117-58 Camshaft Timing Chain

Camshaft timing chain, removing and installing (N52, N54 engine)



- ⚠ N54 engine: Make sure oil pump drive sprocket friction plate (A) is in correct position.

NOTE—

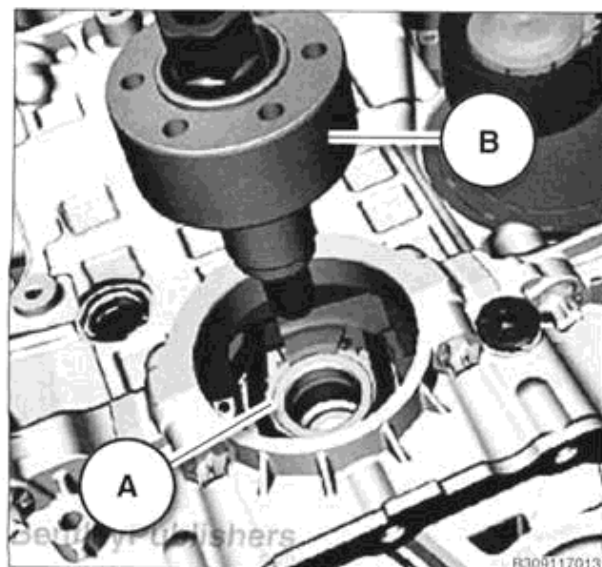
• B and C are oil pump and oil pump chain guide mounting bolts.

- Pull timing chain taut until sprocket engages chain guide. Install timing chain and chain assembly in chain housing in this position, holding chain under tension at all times.
- Install and torque timing chain assembly, rail and guide bolts.

Tightening torques

Timing chain guide to cylinder head (M7)	14 Nm (10 ft-lb)
Timing chain assembly to cylinder head (M6 x 35 mm Torx)	8.5 Nm (6 ft-lb)
Timing chain rail to crankcase (M8)	20 Nm (14 ft-lb)

- ⚠ N54 engine: Slide friction plate (arrow) on vibration damper hub shaft prior to inserting hub in crankcase bore.



- ⚠ Line up timing chain and oil pump chain sprockets (A) inside crankcase bore, then insert vibration damper hub (B), sliding it through chain sprockets. Using new vibration damper bolt, attach hub finger tight to crankshaft.

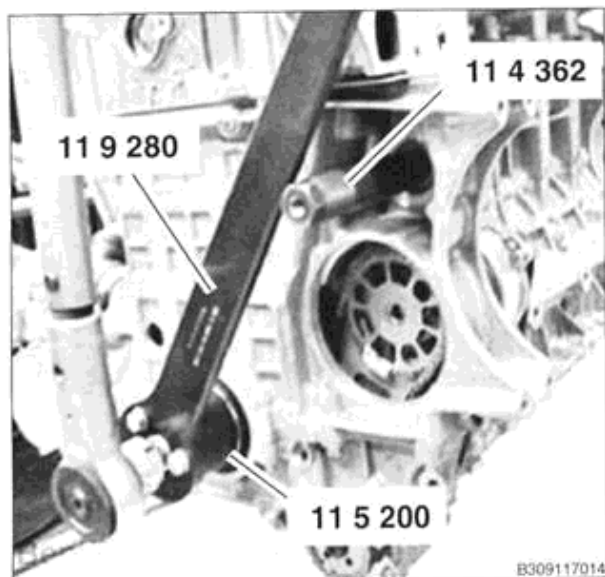
- To achieve final torque on vibration damper hub, follow one of several alternative procedure steps for preventing crankshaft rotation recommended by BMW.

CAUTION—

• Do not rely on flywheel lock (special tool 11 0 300) to counter hold against crankshaft rotation.

Camshaft Timing Chain 117-59

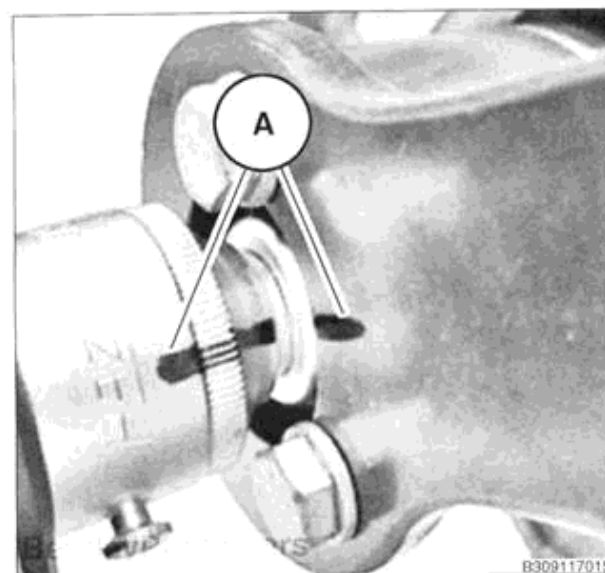
Camshaft timing chain, removing and installing (N52, N54 engine)



- Remove belt tensioner and screw in special tool 11 4 362.
- Bolt special tool 11 5 200 to vibration damper hub.
- Bolt special tool 11 9 280 to tool 11 5 200. Rest tool 11 9 280 against tool 11 4 362.
- Tighten to initial tightening torque.

Tightening torque

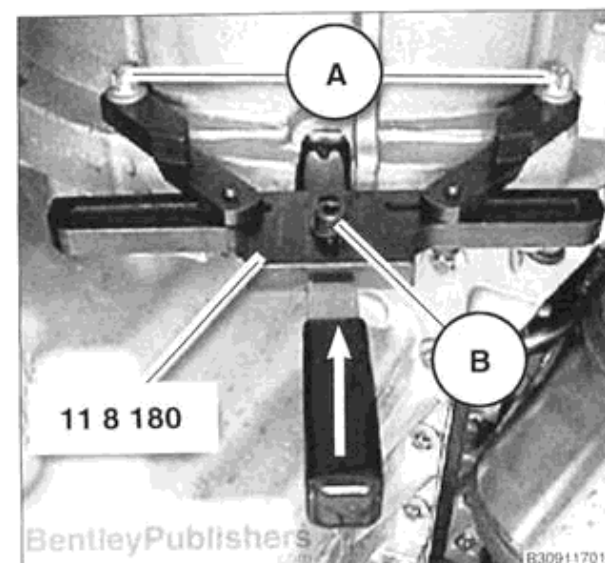
Vibration damper hub to crankshaft	100 Nm (74 ft-lb)
• Stage 1	



- Mark special tool 11 9 280 and socket wrench with paint (A).
- Tighten hub bolt to final torque with assistant helping to counter hold tool 11 9 280.

Tightening torque

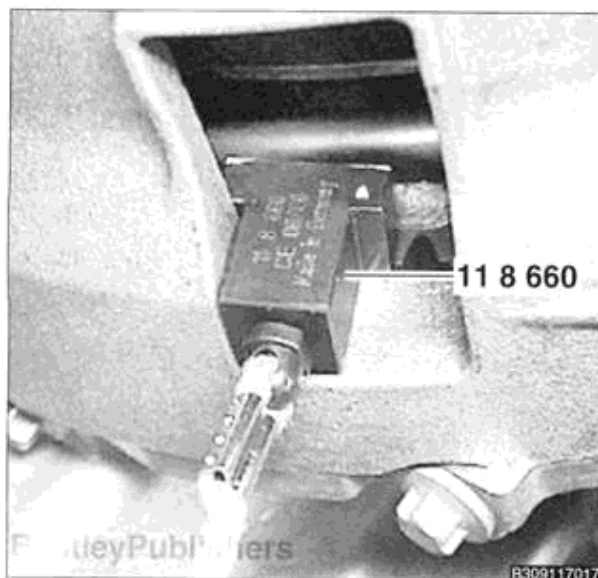
Vibration damper hub to crankshaft	Additional 360°
• Stage 2	



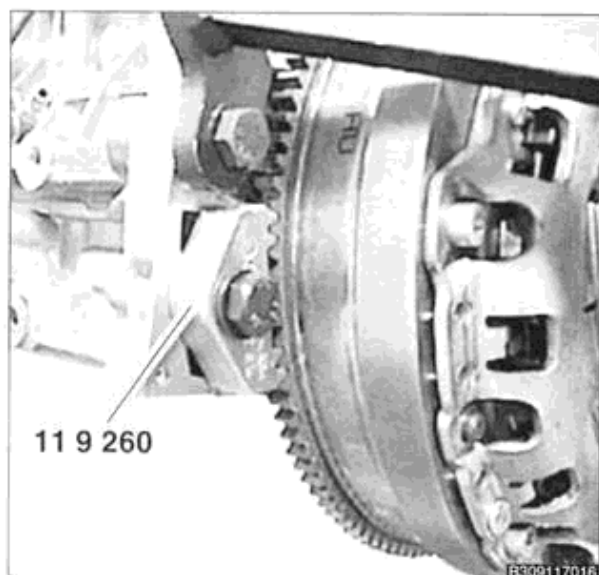
- Alternate method for manual transmission vehicle:
- Mount special tool 11 8 180 on transmission using bolts A.
- Slide lock handle up (arrow) and tighten bolt B.

117-60 Camshaft Timing Chain

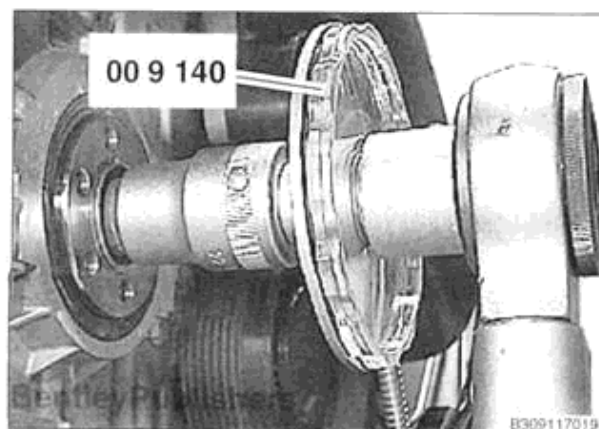
Camshaft timing chain, removing and installing (N52, N54 engine)



- ◀ Alternate method for automatic transmission vehicle:
- Secure flywheel with special tool 11 8 660 through transmission bell housing opening.



- ◀ Alternate method if transmission is removed:
- Secure flywheel with special tool 11 9 260.



- ◀ Use angle protractor (BMW special tool 00 9 140 or equivalent) to torque hub bolt.

Tightening torque

Vibration damper hub to crankshaft

- Stage 1
- Stage 2

100 Nm (74 ft-lb)
Additional 360°

- Install crankshaft front seal. See **119 Lubrication System**.

Camshaft Timing Chain 117-61

Camshaft timing, adjusting (N52, N54 engine)



- Use new bolts to reattach VANOS units. Note that exhaust and intake units are different and so marked. Camshaft sensor impulse wheel for intake and exhaust are the same. See **VANOS units, removing and installing (N52, N54 engine)** in this repair group.

Tightening torque

VANOS unit to camshaft
(use new M10 x 94 mm bolt):

- Stage 1
- Stage 2

20 Nm (15 ft-lb)
additional 180°

- Install chain tensioner. See **Timing chain tensioner (N52, N54 engine)** in this repair group.

CAUTION—

- If chain tensioner is reused, drain its oil chamber. Place tensioner on level working surface and compress slowly. Repeat twice.
- No sealing ring is fitted to chain tensioner at the factory. When reassembling engine, be sure to use new sealing O-ring.

Tightening torque

Timing chain tensioner to cylinder head
(M22 x 1.5) (use new sealing O-ring)

55 Nm (41 ft-lb)

- Remove crankshaft and camshaft locking tools and rotate engine 2 full revolutions. Then check and, if necessary, reset camshaft timing. See **Camshaft timing, adjusting (N52, N54 engine)** in this repair group.

CAUTION—

- Remove crankshaft and camshaft locking tools before rotating or starting engine.

- Reassemble engine.

Camshaft timing, adjusting (N52, N54 engine)

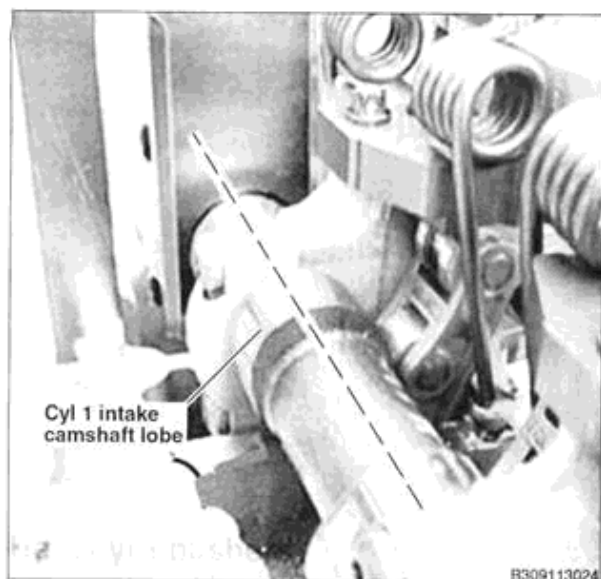
WARNING—

- To avoid personal injury, be sure the engine is cold before beginning the procedure.

- Use scan tool to read out and record ECM fault memory.
- Switch ignition OFF and remove key.
- Remove upper and lower cabin microfilter housings. See **640 Heating and Air-conditioning**.
- Remove strut tower brace.
- Remove ignition coil cover (upper engine cover). See **020 Maintenance**.
- Detach ignition coil connectors. Lift ignition coil harness off cylinder head cover and set aside.

117-62 Camshaft Timing Chain

Camshaft timing, adjusting (N52, N54 engine)



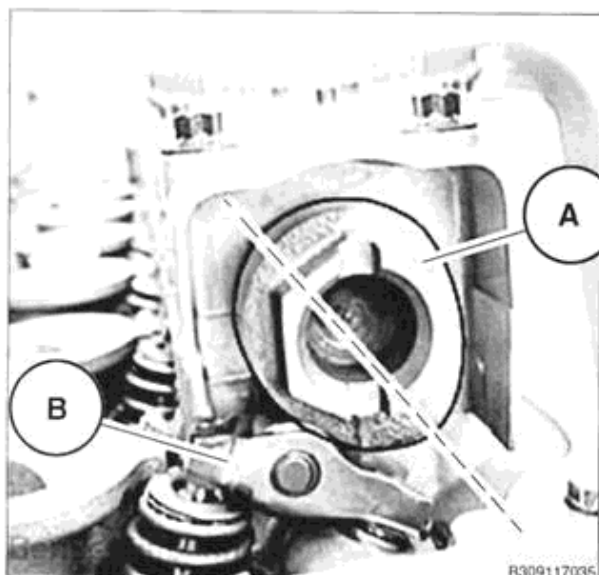
- Remove ignition coils. See **120 Ignition System**.
- Remove cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Raise vehicle and support safely.

WARNING —

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove engine compartment splash shield. See **020 Maintenance**.

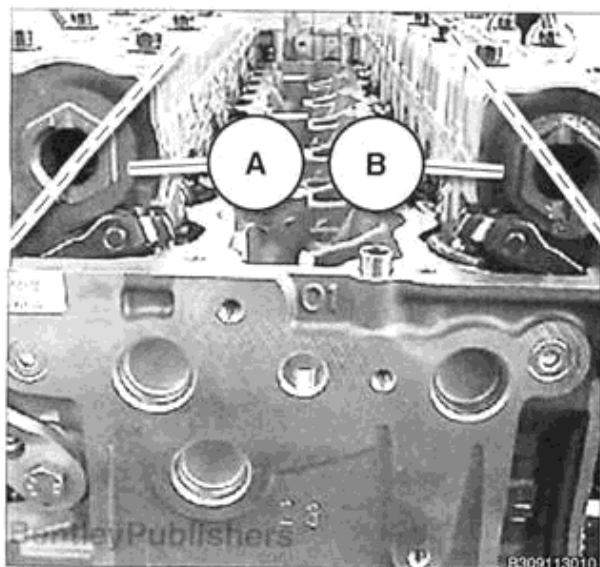
- N52 engine: Using vibration damper bolt, rotate crankshaft to place cylinder 1 in TDC firing position. In this position, cylinder 1 intake camshaft lobe points upward at an angle (**dashed line**).



- N52 engine: Cylinder 1 in TDC firing position: Cylinder 6 exhaust camshaft lobe (A) points downward at an angle (**dashed line**). Cam follower (B) is not actuated.

NOTE —

- Use a mirror to check exhaust camshaft lobe position.



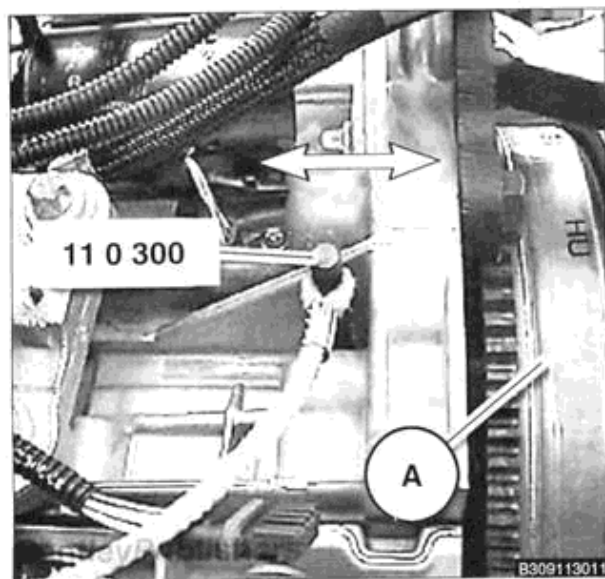
- N54 engine: Using vibration damper bolt to rotate crankshaft, place cylinder 1 in TDC firing position. In this position, lobes for cylinder 6 (rear of engine) intake and exhaust camshafts (A, B) point away from each other and down. Cylinder 6 camshaft lobes do not contact roller cam followers.

NOTE —

- Use a mirror to check cylinder 6 cam lobe positions.

Camshaft Timing Chain 117-63

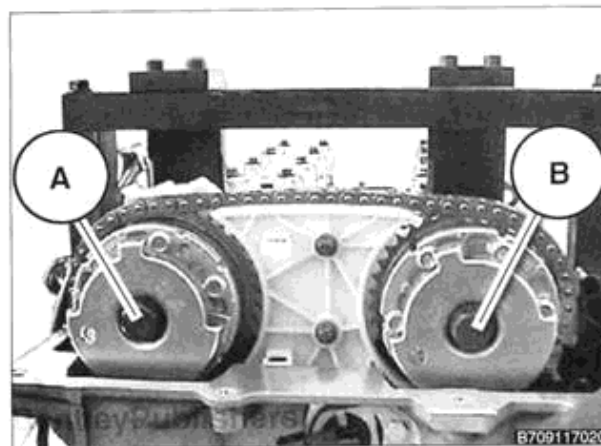
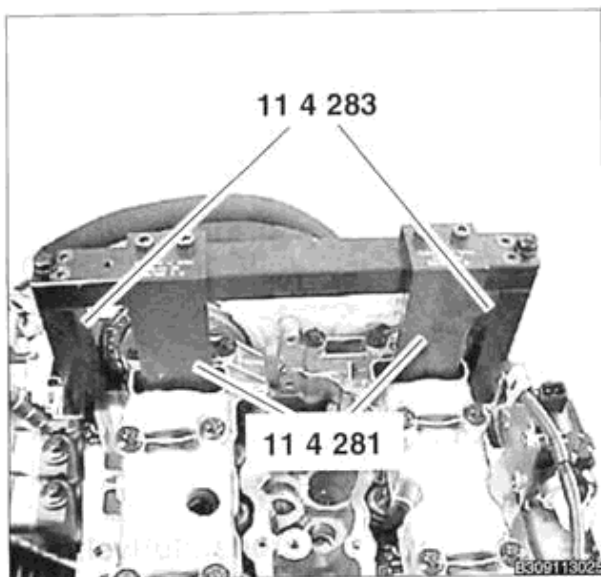
Camshaft timing, adjusting (N52, N54 engine)



- Working underneath engine, slide out protective plug at lower left of engine bell housing flange. Install BMW special tool 11 0 300 (crankshaft locking tool) through bell housing flange port into flywheel (A) hole. If necessary, rock flywheel slightly back and forth to line up holes with tool. This locks crankshaft at TDC.

CAUTION—

- Models with automatic transmission: In the flywheel (torque plate), a short distance before the bore for TDC position, there is a large bore which can be confused with the special tool bore. If the flywheel is locked using the correct bore, the engine can no longer be rotated at the vibration damper bolt.
- If special tool 11 0 300 does not slide easily into the bell housing flange bore, sand paint off the tool. Do not enlarge the bore.

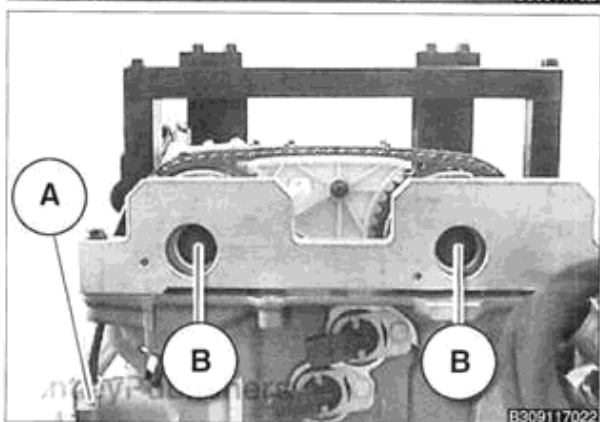
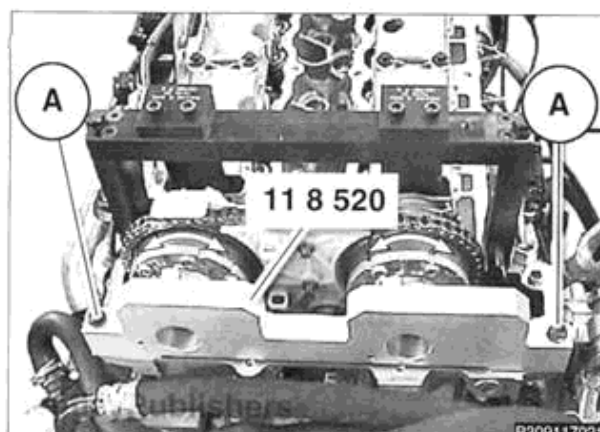


- Use BMW special tool set 11 4 280 to lock down camshafts.
- With crankshaft locked, if special tool 11 4 281 fits, camshaft timing is correct. Remove special tools and reassemble engine.
 - If special tool 11 4 281 does not fit, use hexagon casting at rear of camshafts to rotate camshafts until tool fits. Proceed with camshaft timing procedure below.

- Working at front of camshafts:
- Loosen exhaust and intake camshaft adjustment (VANOS) unit mounting bolts (A, B).
 - Discard bolts and replace with new.
 - Tighten bolts finger tight.

117-64 Camshaft Timing Chain

Timing chain tensioner (N52, N54 engine)



- Install BMW special tool 11 8 520.
 - Place tool up against VANOS unit sensor gears.
 - Rotate sensor gears (**arrows**) until locating pins on tool line up with bores in sensor gears.
 - Push tool firmly against sensor gears and lock down with M6 x 45 mm bolts (**A**).

- Working at front of cylinder head:
 - Remove timing chain tensioner (**A**). Be prepared to catch dripping oil. Do not allow oil to contaminate accessory belt.
 - Screw BMW special tool 11 9 340 (dummy chain tensioner) into cylinder head.
 - Using BMW special tool 00 9 250 (low torque torque-wrench), rotate stud of special tool 11 9 340 to pretension timing chain to 0.6 Nm (5.3 in-lb).
 - Tighten VANOS unit mounting bolts (**B**).

Tightening torque

VANOS unit to camshaft:

- Stage 1
- Stage 2

20 Nm (15 ft-lb)
additional 180°

- Remove special tools and assemble engine. Reinstall chain tensioner using new sealing O-ring. See **Timing chain tensioner (N52, N54 engine)** in this repair group.

Tightening torque

Timing chain tensioner to cylinder head
(M22 x 1.5) (use new sealing O-ring)

55 Nm (41 ft-lb)

Timing chain tensioner (N52, N54 engine)

The timing chain tensioner is screwed into the right front of the cylinder head. When it is removed be sure to catch any dripping oil in a shop towel. Do not allow oil to contaminate accessory belt.

- If chain tensioner is reused, drain its oil chamber. Place tensioner vertically on level working surface and compress slowly (**arrow**). Repeat twice.

CAUTION—

- No sealing ring is fitted to chain tensioner at the factory. When reassembling engine, be sure to use new sealing O-ring.

Tightening torque

Timing chain tensioner to cylinder head
(M22 x 1.5) (use new sealing O-ring)

55 Nm (41 ft-lb)



VANOS UNITS (N52, N54 ENGINE)

VANOS units, removing and installing (N52, N54 engine)

Special tools and procedures are required to remove and install VANOS units and to time camshafts. Read the entire procedure before beginning repairs.

WARNING—

- To avoid personal injury, be sure the engine is cold before beginning the procedure.

CAUTION—

- Disassembly, removal and assembly of VANOS units without special tools poses the risk of damage or breakage: Valves may be bent by contact with the piston crowns.
- Throughout this procedure, unless otherwise specified, crankshaft and camshafts remain locked against rotation using BMW special tools.
- Keep VANOS components free of silicone sealant. A small amount of silicone introduced into VANOS actuator or solenoid can set faults.

- Use scan tool to read out and record ECM fault memory.
- Switch ignition OFF and remove key.
- Remove upper and lower cabin microfilter housings. See **640 Heating and Air-conditioning**.
- Remove strut tower brace.
- Remove ignition coil cover (upper engine cover). See **020 Maintenance**.
- Detach ignition coil connectors. Lift ignition coil harness off cylinder head cover and set aside.
- Remove ignition coils. See **120 Ignition System**.
- Remove cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Raise vehicle and support safely.

WARNING—

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

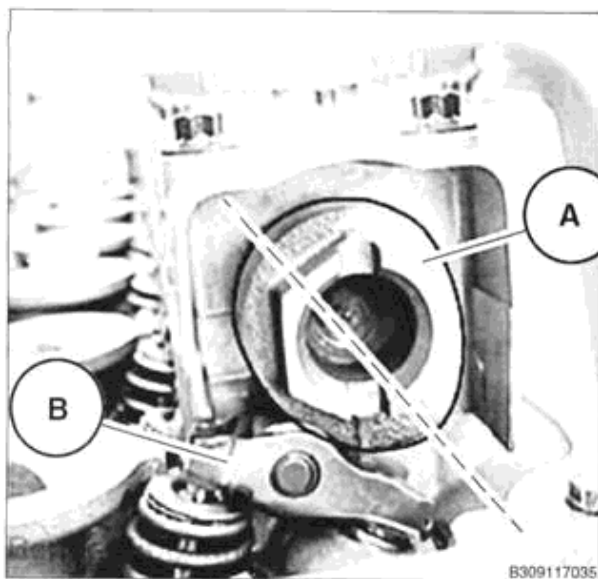
- Remove engine compartment splash shield. See **020 Maintenance**.
- N52 engine: Using vibration damper bolt, rotate crankshaft to place cylinder 1 in TDC firing position. In this position, cylinder 1 intake camshaft lobe points upward at an angle.



Cyl 1 intake camshaft lobe

117-66 Camshaft Timing Chain

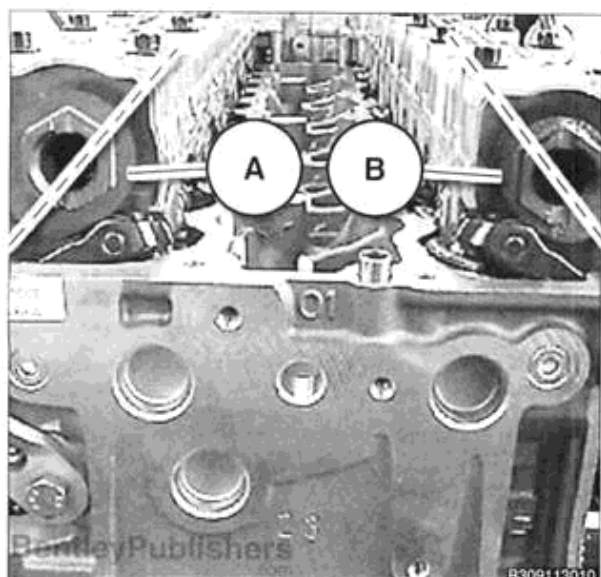
VANOS units, removing and installing (N52, N54 engine)



◀ N52 engine: Cylinder 1 in TDC firing position: Cylinder 6 exhaust camshaft lobe (A) points downward at an angle (dashed line). Cam follower (B) is not actuated.

NOTE—

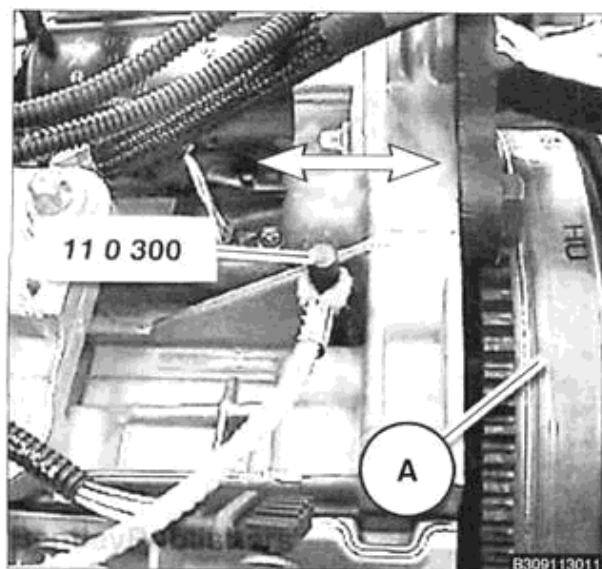
- Use a mirror to check exhaust camshaft lobe position.



◀ N54 engine: Using vibration damper bolt to rotate crankshaft, place cylinder 1 in TDC firing position. In this position, lobes for cylinder 6 (rear of engine) intake and exhaust camshafts (A, B) point away from each other and down. Cylinder 6 camshaft lobes do not contact roller cam followers.

NOTE—

- Use a mirror to check cylinder 6 cam lobe positions.



◀ Working underneath engine, slide out protective plug at lower left of engine bell housing flange. Install BMW special tool 11 0 300 (crankshaft locking tool) through bell housing flange port into flywheel (A) hole. If necessary, rock flywheel slightly back and forth to line up holes with tool. This locks crankshaft at TDC.

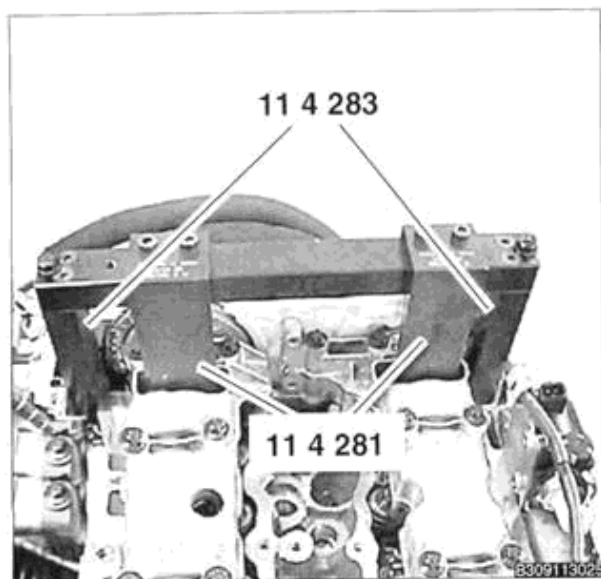
CAUTION—

- Models with automatic transmission: In the flywheel (torque plate), a short distance before the bore for TDC position, there is a large bore which can be confused with the special tool bore. If the flywheel is locked using the correct bore, the engine can no longer be rotated at the vibration damper bolt.
- If special tool 11 0 300 does not slide easily into the bell housing flange bore, sand paint off the tool. Do not enlarge the bore.

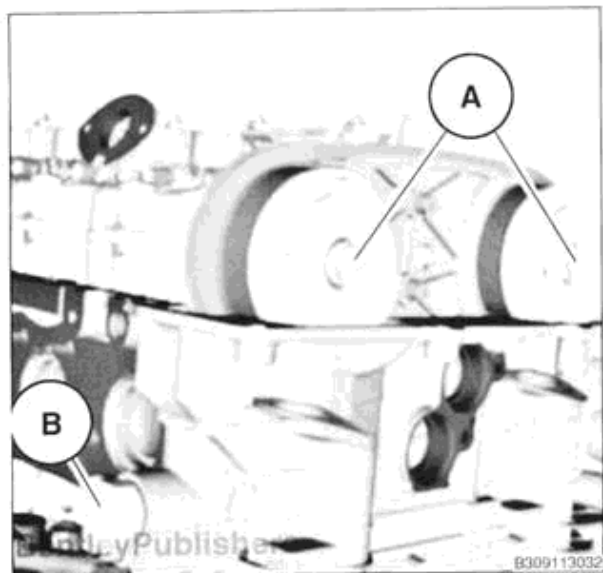
Camshaft Timing Chain 117-67

VANOS units, removing and installing (N52, N54 engine)

Use BMW special tool set 11 4 280 to lock down camshafts.

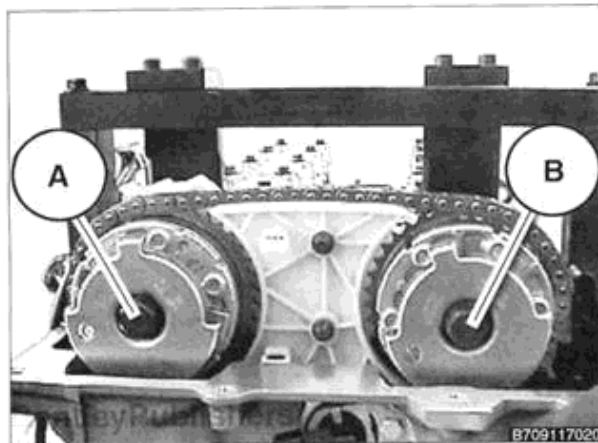


Working at right front of cylinder head, remove timing chain tensioner (B). Be prepared to catch dripping oil with a shop towel. Do not allow oil to contaminate accessory belt.



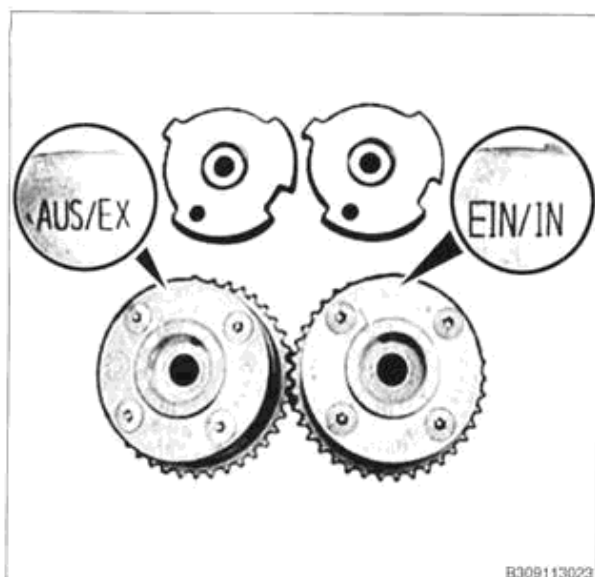
Working at front of camshafts:

- Loosen and remove exhaust and intake VANOS unit mounting bolts (A, B). Discard bolts.
- Disengage timing chain from camshaft adjustment unit sprockets.
- Tilt VANOS units down to remove.



117-68 Camshaft Timing Chain

VANOS units, removing and installing (N52, N54 engine)



B309113023



B309117039

Use new bolts to reattach VANOS units.

- Note that exhaust and intake units are different and so marked.
- Camshaft sensor impulse wheel for intake and exhaust are the same.
- VANOS units and sensor wheels may be installed in any position initially. Finger-tighten mounting bolts for now.

Press chain into chain tensioner rail (**arrow**) by hand to make sure it is routed correctly. (Chain assembly and VANOS units shown removed from engine for purpose of illustration.)

- Adjust camshaft timing. See **Camshaft timing, adjusting (N52, N54 engine)** in this repair group. Then torque VANOS mounting bolts.

Tightening torque

VANOS unit to camshaft (use new M10 x 94 mm bolt):

- Stage 1
- Stage 2

20 Nm (15 ft-lb)
additional 180°

- Install chain tensioner. See **Timing chain tensioner (N52, N54 engine)** in this repair group.

CAUTION—

- If chain tensioner is reused, drain its oil chamber. Place tensioner on level working surface and compress slowly. Repeat twice.
- No sealing ring is fitted to chain tensioner at the factory. When reassembling engine, be sure to use new sealing O-ring.

Tightening torque

Timing chain tensioner to cylinder head (M22 x 1.5) (use new sealing O-ring)

55 Nm (41 ft-lb)

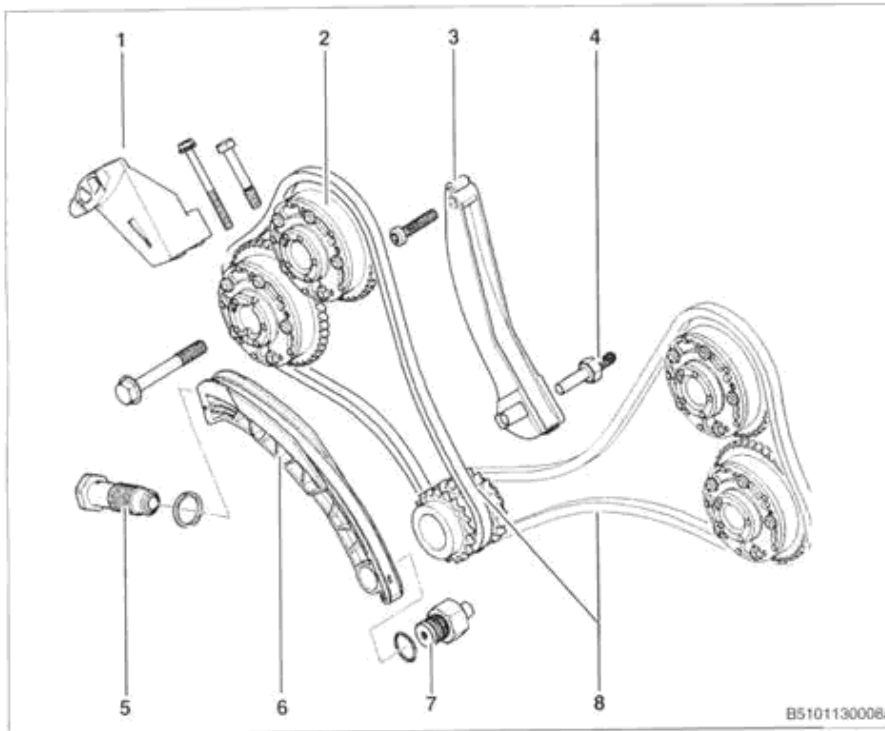
- Reassemble engine.

CAUTION—

- Remove crankshaft and camshaft locking tools before rotating or starting engine.

TIMING CHAIN SERVICE (V8 ENGINE)

Timing chain components (V8 engine)

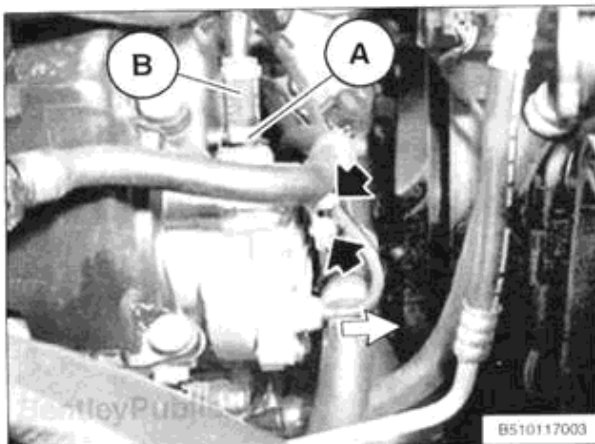


1. Timing chain rail
2. Camshaft adjuster (VANOS) unit
3. Timing chain guide
4. Support stud
5. Timing chain tensioner
6. Timing chain guide
7. Timing chain guide bearing
8. Timing chain

Right camshaft timing, adjusting (V8 engine)

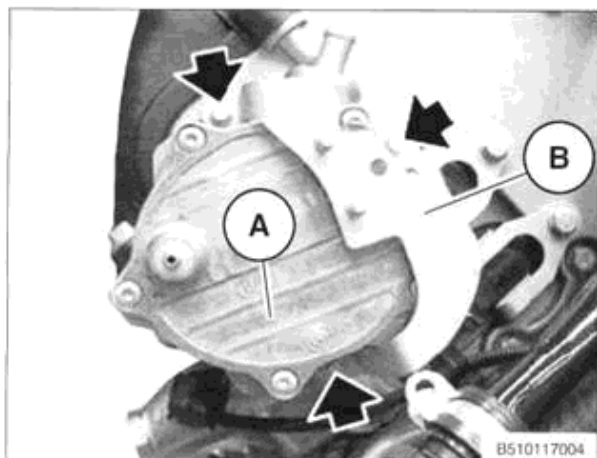
- Remove right side valvetronic motor. See 133 Fuel Injection.
- Remove spark plugs. Plug spark plug bores to prevent debris from entering engine.
- Remove right side cylinder head cover. See 113 Cylinder Head Removal and Installation.
- Remove engine cooling fan and cooling fan shroud. See 170 Radiator and Cooling System.
- Remove air filter housing and ducts. See 133 Fuel Injection.

- Working at front of right cylinder head:
- Remove clamp (A) and remove line (B).
 - Loosen hose clamps (black arrows).
 - Detach vacuum line (white arrow).

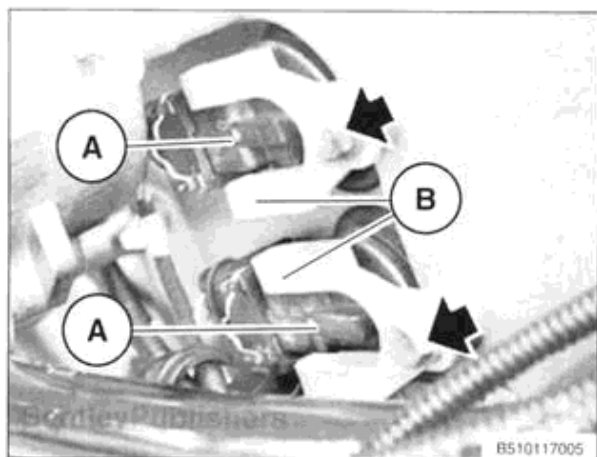


117-70 Camshaft Timing Chain

Right camshaft timing, adjusting (V8 engine)



- Remove vacuum pump fasteners (**arrows**) and vacuum pump (**A**) with bracket (**B**).



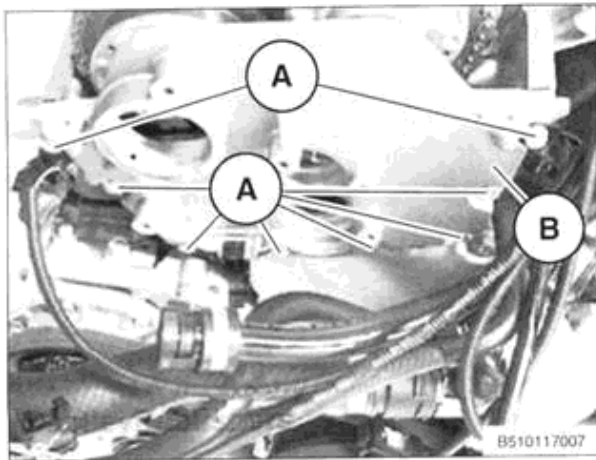
- Disconnect electrical connectors from VANOS adjuster solenoids (**A**). Remove fasteners (**B**), bracket (**arrows**) and remove actuator solenoids (**A**). Discard actuator solenoids O-rings.



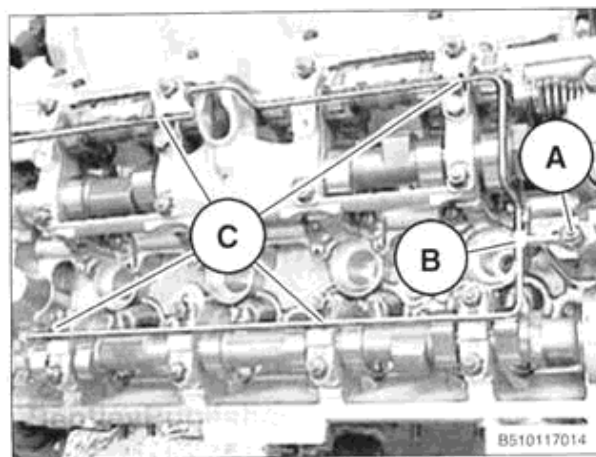
- Remove vacuum lines from bracket (**arrow**).

Camshaft Timing Chain 117-71

Right camshaft timing, adjusting (V8 engine)



- Remove upper timing chain cover fasteners (A) and remove upper cover (B).



- Remove banjo bolt (A). Unclip oil line (B) from retainers (C) and remove.

CAUTION—

- Do not misplace oil line banjo bolt.



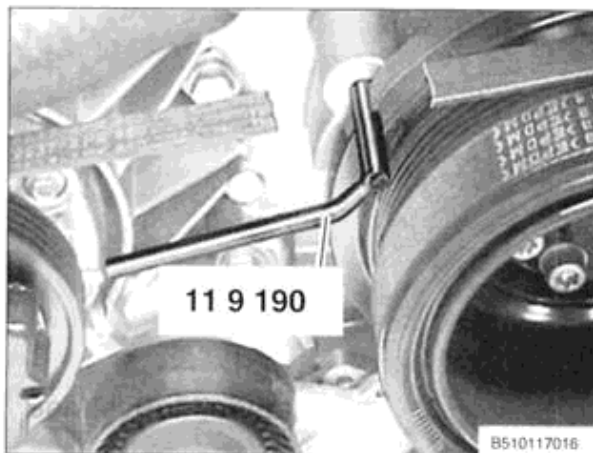
- Using vibration damper center bolt, turn engine in direction of rotation to cylinder 1 TDC position.

NOTE—

- Cylinder 1 exhaust lobe points upwards at an angle.
- Cylinder 1 intake lobe points downwards at an angle.

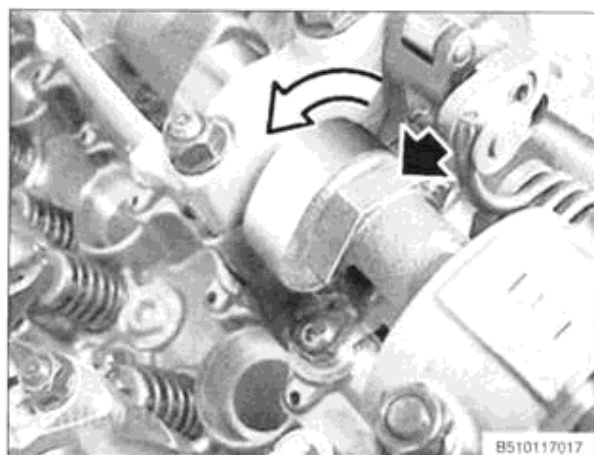
117-72 Camshaft Timing Chain

Right camshaft timing, adjusting (V8 engine)

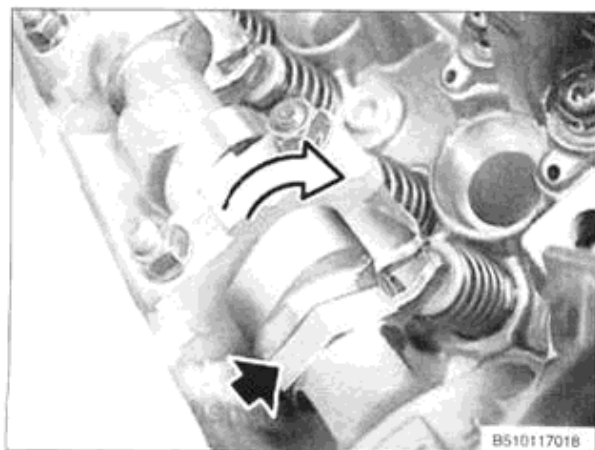


- Using BMW special tool 11 9 190, lock engine in cylinder 1 TDC position.

To avoid incorrect timing adjustment, check VANOS adjustment unit locking using the following steps.



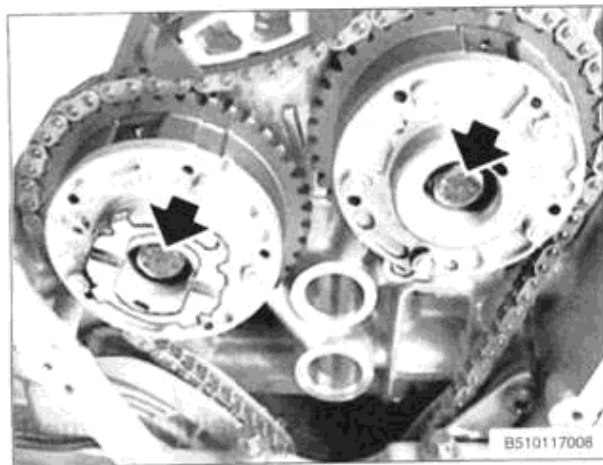
- Grip hexagon (**black arrow**) of intake camshaft and attempt to rotate intake camshaft carefully in direction opposite (**white arrow**) to engine rotation. If there is no fixed connection between intake camshaft and intake VANOS unit, rotate intake camshaft in direction opposite to engine rotation as far as it will go.



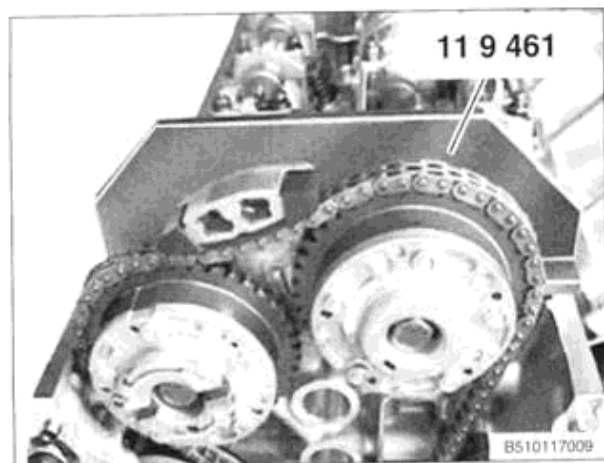
- Grip hexagon (**black arrow**) of exhaust camshaft and attempt to rotate exhaust camshaft carefully in the direction of engine rotation (**white arrow**). If there is no fixed connection between exhaust camshaft and exhaust VANOS unit, rotate exhaust camshaft in the direction of engine rotation as far as it will go.

Camshaft Timing Chain 117-73

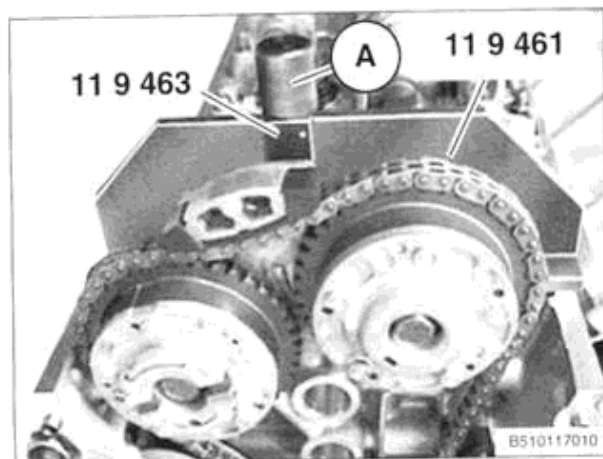
Right camshaft timing, adjusting (V8 engine)



- ◀ Grip each camshaft at hexagon and loosen VANOS adjuster bolts (arrows). Do not remove VANOS adjuster bolts.



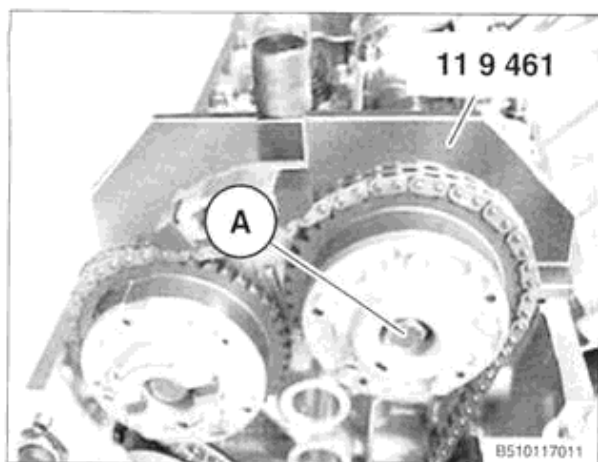
- ◀ Install BMW special tool 11 9 461 on intake camshaft so that it rests flush on cylinder head.



- ◀ Install BMW special tool 11 9 463, secure holder (A) in thread for oil line hand tight.

117-74 Camshaft Timing Chain

Right camshaft timing, adjusting (V8 engine)

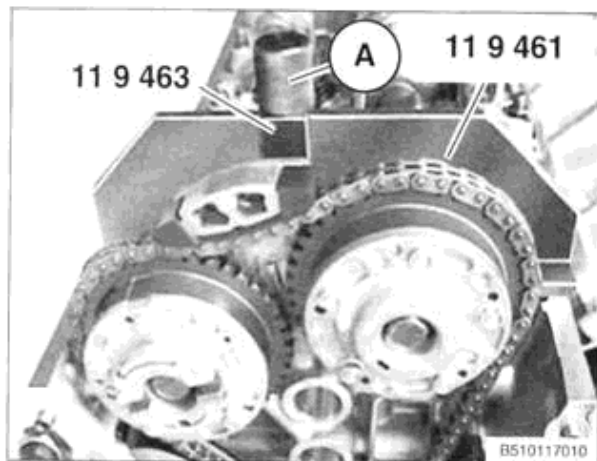


- ◀ Grip intake camshaft at hexagon and tighten intake VANOS adjuster bolt (A).

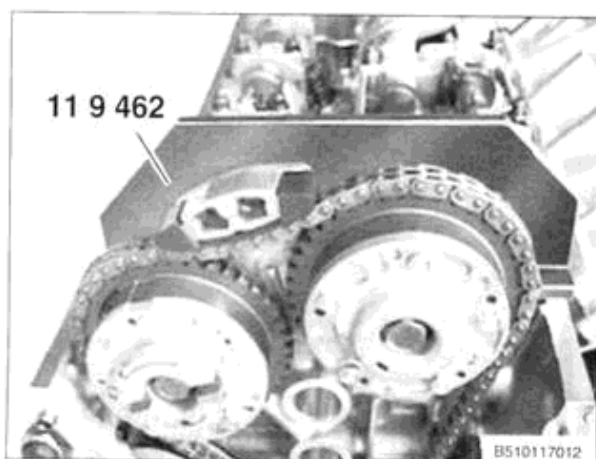
Tightening torque

VANOS adjuster to camshaft
(replace bolt)

80 Nm (59 ft-lb)



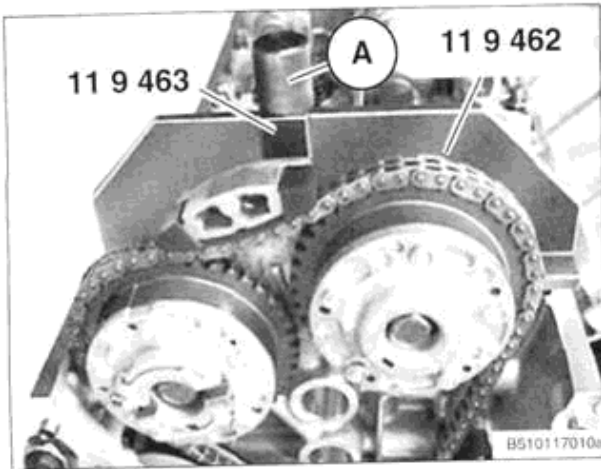
- ◀ Remove holder (A) and BMW special tools 11 9 461, 11 9 463.



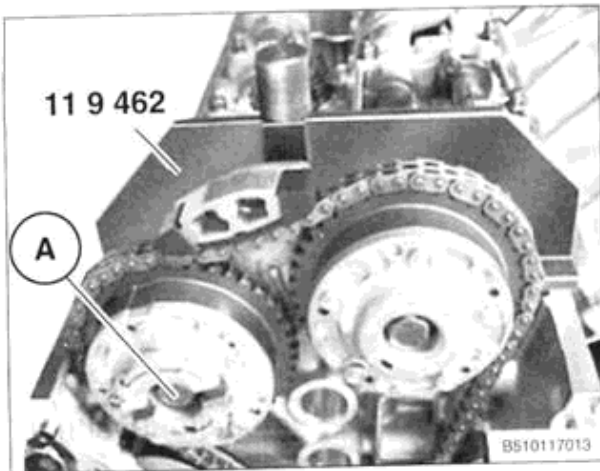
- ◀ Install BMW special tool 11 9 462 on exhaust camshaft so that it rests flush on cylinder head.

Camshaft Timing Chain 117-75

Right camshaft timing, adjusting (V8 engine)



- ◀ Install BMW special tool 11 9 463 and secure holder (A) in oil line thread hand tight.

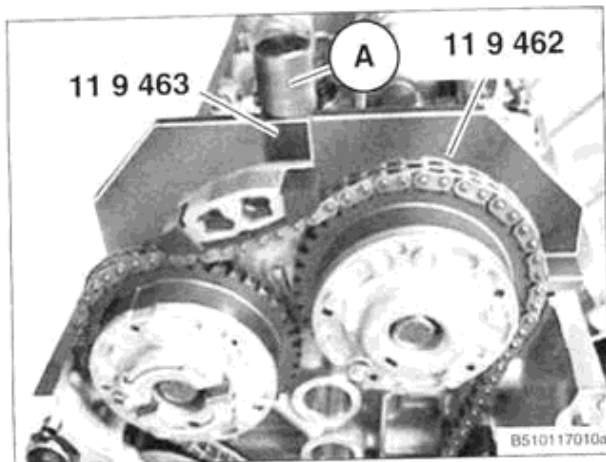


- ◀ Grip exhaust camshaft at hexagon and tighten exhaust VANOS adjuster bolt (A).

Tightening torque

VANOS adjuster to camshaft
(replace bolt)

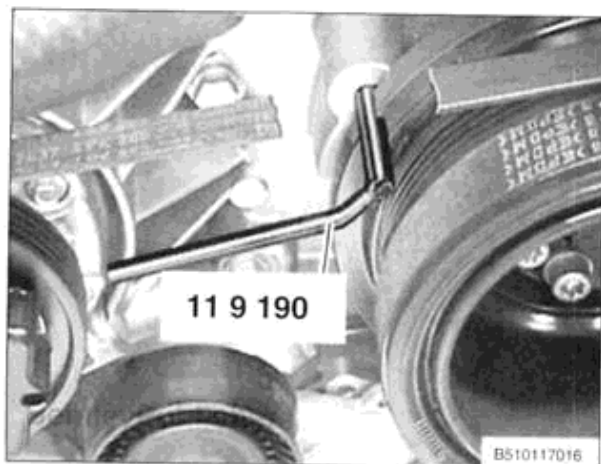
80 Nm (59 ft-lb)



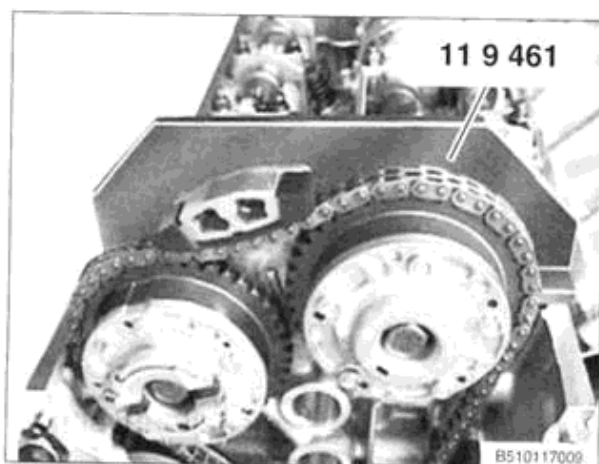
- ◀ Remove holder (A) and BMW special tools 11 9 462, 11 9 463.

117-76 Camshaft Timing Chain

Right camshaft timing, adjusting (V8 engine)



- Remove BMW special tool 11 9 190. Using vibration damper center bolt turn engine 2 full rotations. Using BMW special tool 11 9 190 lock engine in cylinder 1 TDC position.

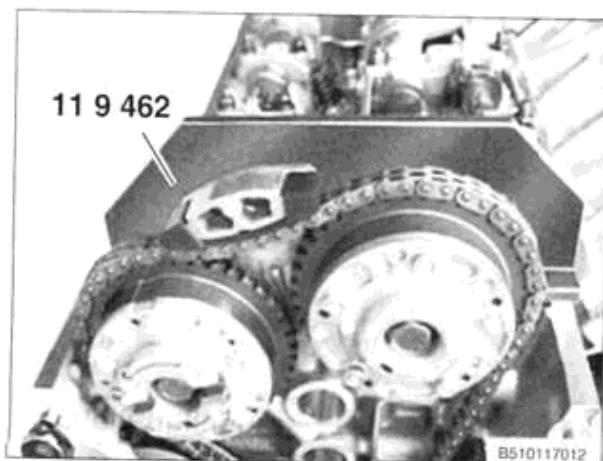


- Place BMW special tool 11 9 461 on intake camshaft and check timing. Timing is correctly adjusted when BMW special tool 11 9 461 rests flat on cylinder head or protrudes by up to 0.5 mm to exhaust side.

NOTE—

- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS units, when the camshaft timing is set correctly, the exhaust side of special tool 11 9 461 may be up to 0.5 mm (0.02 in) above the surface of the cylinder head. This is normal.

- Remove special tool 11 9 461 from inlet camshaft.



- Place BMW special tool 11 9 462 on exhaust camshaft and check timing. Timing is correctly adjusted when BMW special tool 11 9 462 rests flat on cylinder head or protrudes by up to 0.5 mm to exhaust side.

NOTE—

- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS units, when the camshaft timing is set correctly, the exhaust side of special tool 11 9 462 may be up to 0.5 mm (0.02 in) above the surface of the cylinder head. This is normal.

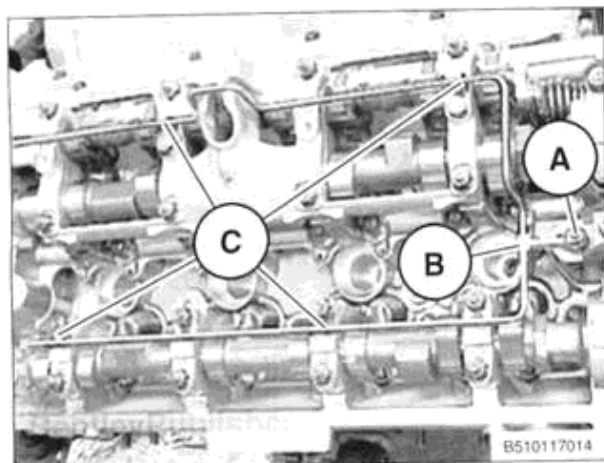
- Remove special tool 11 9 462 from exhaust camshaft.
- Reassemble engine.
- Remember to replace:
 - VANOS unit bolts.
 - VANOS solenoid O-rings.

Camshaft Timing Chain 117-77

Left camshaft timing, adjusting (V8 engine)

Left camshaft timing, adjusting (V8 engine)

- Remove left side valvetronic motor. See **133 Fuel Injection**.
- Remove spark plugs. Plug spark plug bores to prevent debris from entering engine.
- Remove left side cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove engine cooling fan and fan shroud. See **170 Radiator and Cooling System**.
- Remove air filter housing and ducts. See **133 Fuel Injection**.
- Disconnect negative (–) cable from battery.



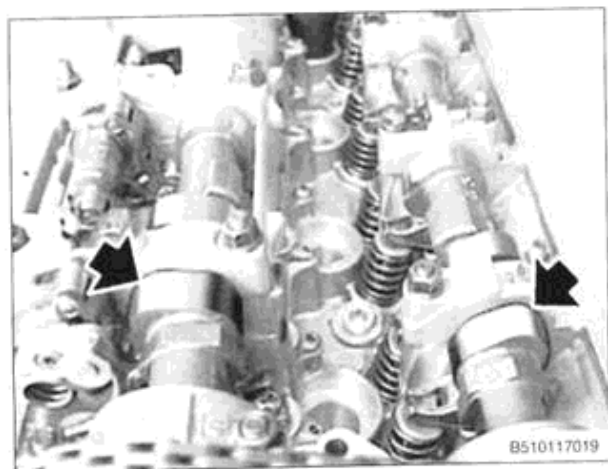
CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove banjo bolt (A). Unclip oil line (B) from retainers (C) and remove.

CAUTION—

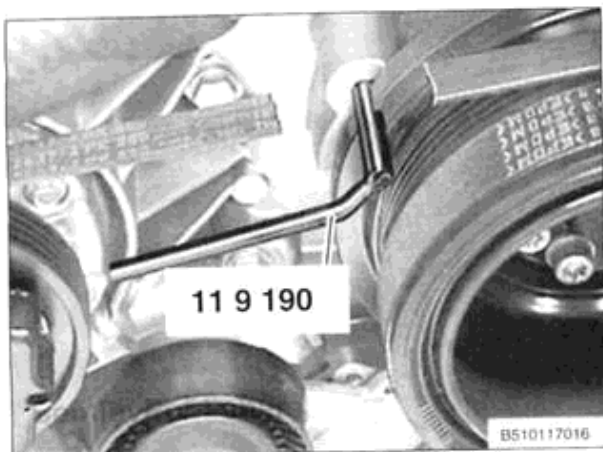
- Do not misplace oil line banjo bolt.



- Using vibration damper center bolt, turn engine in direction of rotation to cylinder 1 TDC position.

NOTE—

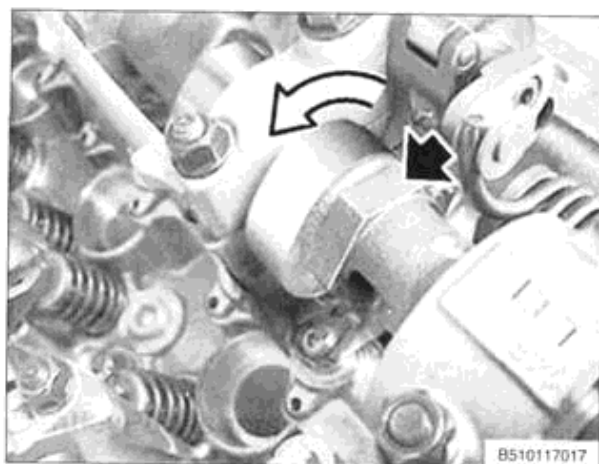
- With cylinder 1 in TDC position, cylinder 5 camshaft intake and exhaust camshaft lobes point upwards at an angle (arrows).



- Using BMW special tool 11 9 190, lock engine in cylinder 1 TDC position.

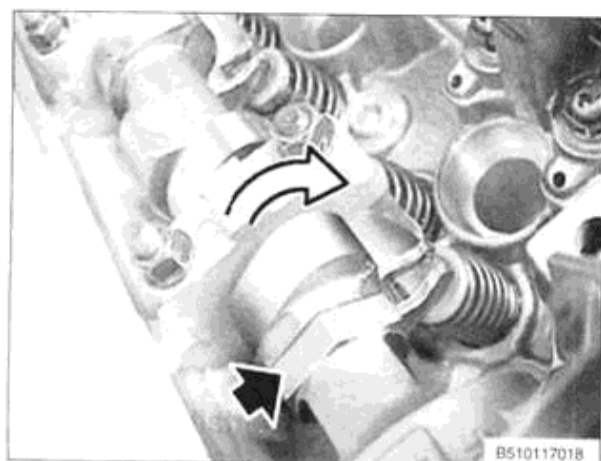
117-78 Camshaft Timing Chain

Left camshaft timing, adjusting (V8 engine)

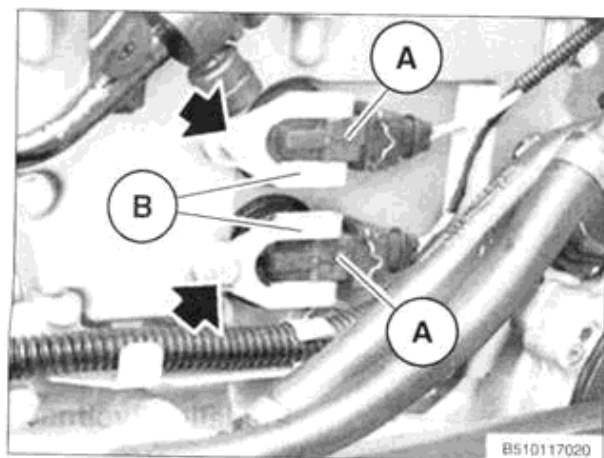


To avoid incorrect timing adjustment, check VANOS adjustment unit locking using the following steps.

- ◀ Grip hexagon (**black arrow**) of intake camshaft and attempt to rotate intake camshaft carefully in direction opposite (**white arrow**) to engine rotation. If there is no fixed connection between intake camshaft and intake VANOS unit, rotate intake camshaft in direction opposite to engine rotation as far as it will go.



- ◀ Grip hexagon (**black arrow**) of exhaust camshaft and attempt to rotate exhaust camshaft carefully in the direction of engine rotation (**white arrow**). If there is no fixed connection between exhaust camshaft and exhaust VANOS unit, rotate exhaust camshaft in the direction of engine rotation as far as it will go.

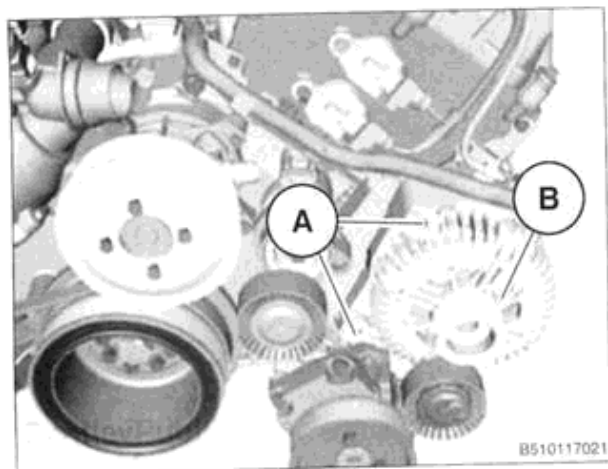


- ◀ Disconnect electrical connectors from VANOS adjuster solenoids (**A**). Remove fasteners (**arrows**), bracket (**B**) and remove actuator solenoids (**A**). Discard actuator solenoids O-rings.

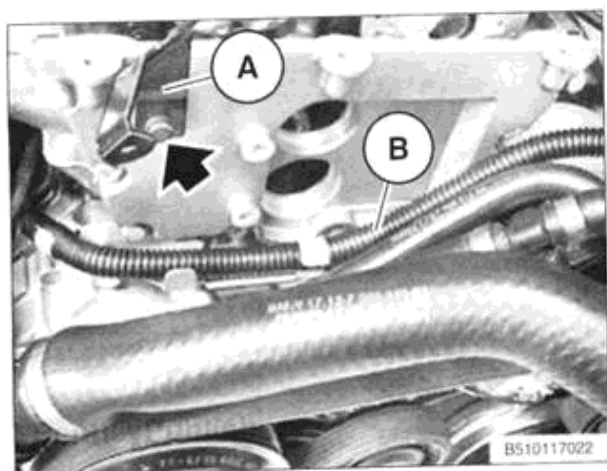
— Remove alternator belt. See **020 Maintenance**.

Camshaft Timing Chain 117-79

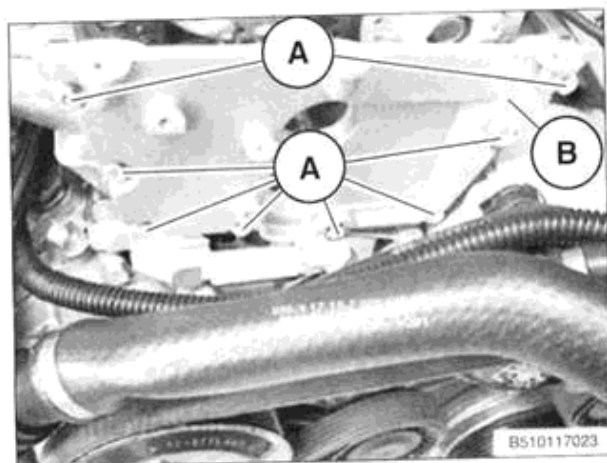
Left camshaft timing, adjusting (V8 engine)



- Remove alternator fasteners (A) and lay alternator (B) aside.



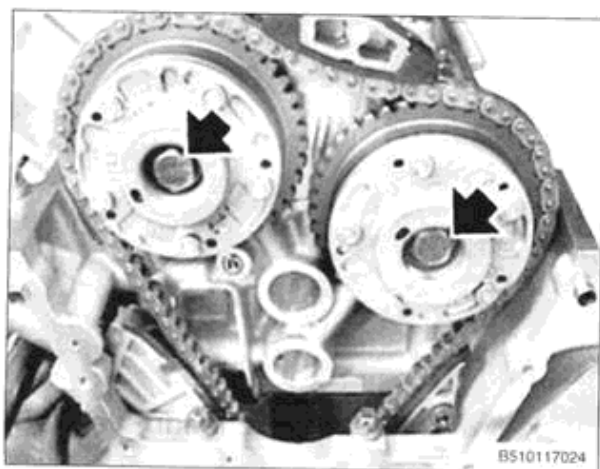
- Remove fastener (arrow) and bracket (A). Unclip wiring harness (B) from bracket.



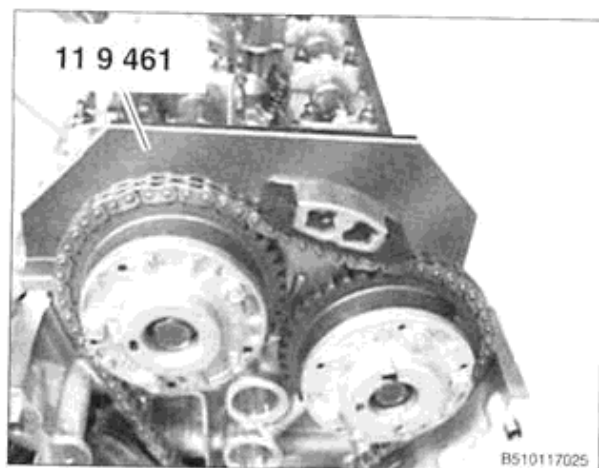
- Remove upper timing chain cover fasteners (A) and remove cover (B).

117-80 Camshaft Timing Chain

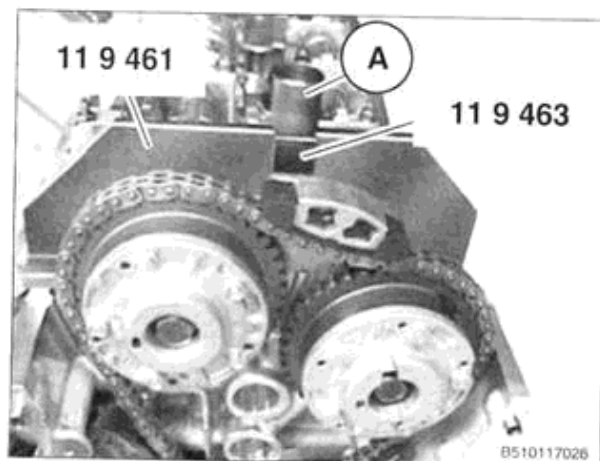
Left camshaft timing, adjusting (V8 engine)



- ◀ Grip each camshaft at hexagon and loosen VANOS adjuster bolts (**arrows**). Do not remove VANOS bolts.



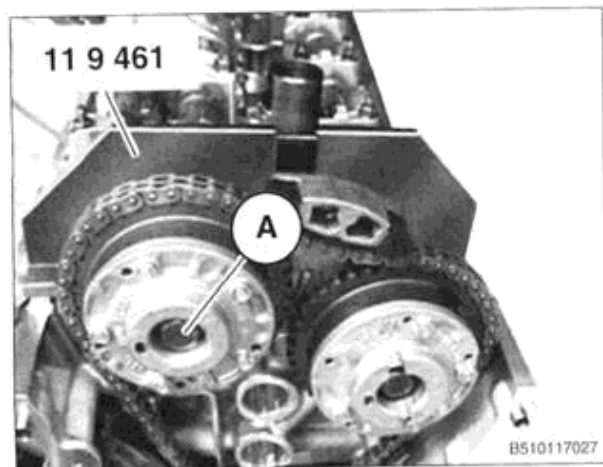
- ◀ Install BMW special tool 11 9 461 on intake camshaft so that it rests flush on cylinder head.



- ◀ Install BMW special tool 11 9 463 and secure holder (**A**) in oil line thread hand tight.

Camshaft Timing Chain 117-81

Left camshaft timing, adjusting (V8 engine)

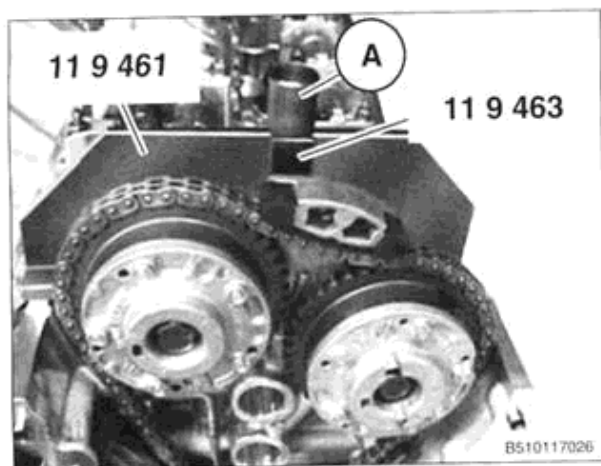


- ◀ Grip intake camshaft at hexagon and tighten intake VANOS adjuster bolt (A).

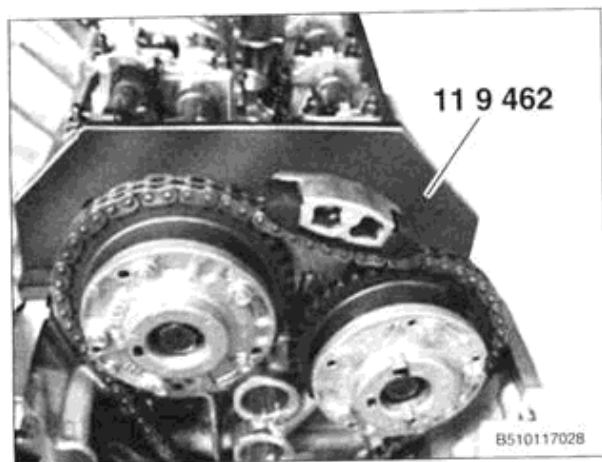
Tightening torque

VANOS adjuster to camshaft
(replace bolt)

80 Nm (59 ft-lb)



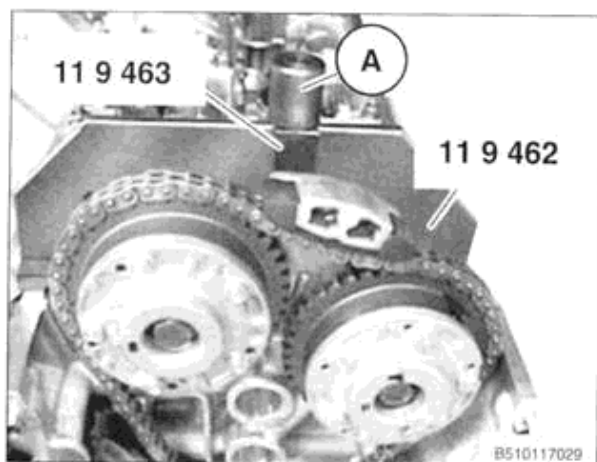
- ◀ Remove holder (A) and BMW special tools 11 9 461, 11 9 463.



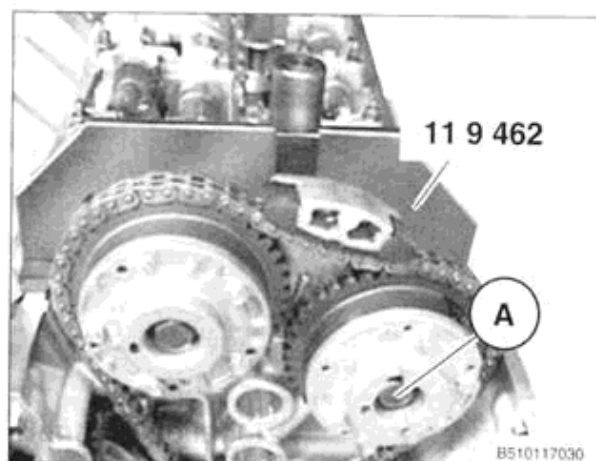
- ◀ Install BMW special tool 11 9 462 on exhaust camshaft so that it rests flush on cylinder head.

117-82 Camshaft Timing Chain

Left camshaft timing, adjusting (V8 engine)



- Install BMW special tool 11 9 463 and secure holder (A) in oil line thread hand tight.

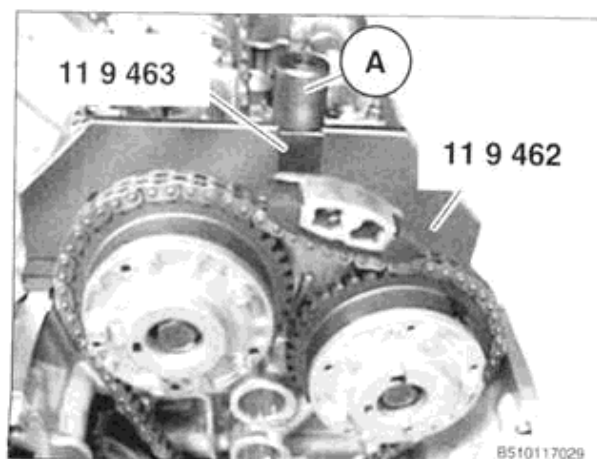


- Grip exhaust camshaft at hexagon and tighten intake VANOS adjuster bolt (A).

Tightening torque

VANOS adjuster to camshaft
(replace bolt)

80 Nm (59 ft-lb)

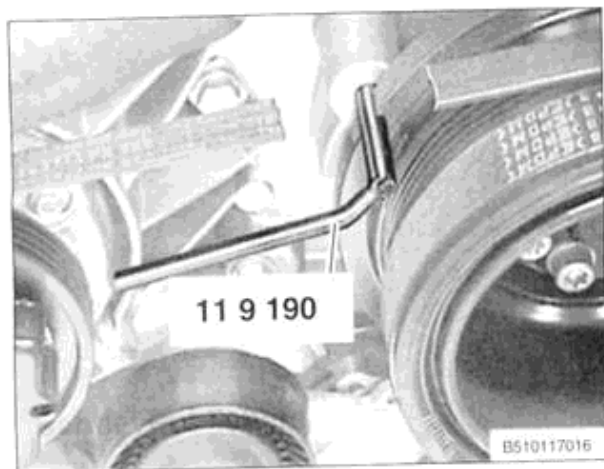


- Remove holder (A) and BMW special tools 11 9 462, 11 9 463.

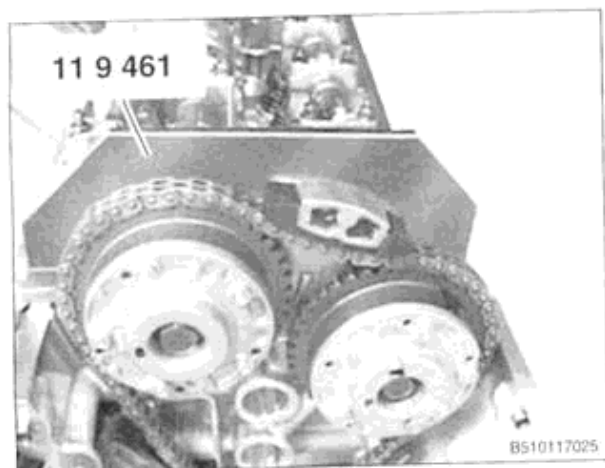
Camshaft Timing Chain 117-83

Left camshaft timing, adjusting (V8 engine)

117



- Remove BMW special tool 11 9 190. Using vibration damper center bolt turn engine 2 full rotations. Using BMW special tool 11 9 190 lock engine in cylinder 1 TDC position.

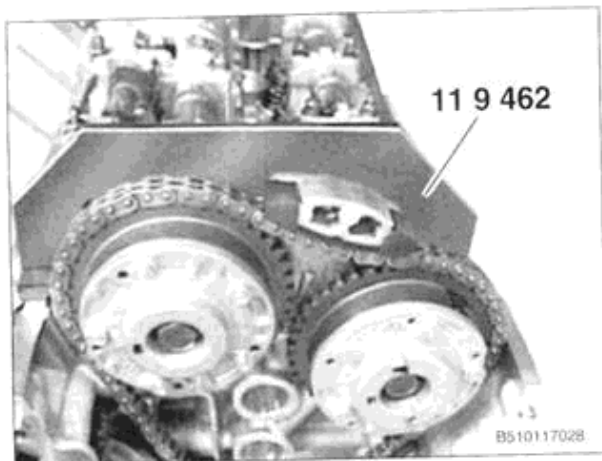


- Place BMW special tool 11 9 461 on intake camshaft and check timing. Timing is correctly adjusted when BMW special tool 11 9 461 rests flat on cylinder head or protrudes by up to 0.5 mm to exhaust side.

NOTE—

- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS units, when the camshaft timing is set correctly, the exhaust side of special tool 11 9 462 may be up to 0.5 mm (0.02 in) above the surface of the cylinder head. This is normal.

- Remove special tool 11 9 461 from inlet camshaft.



- Place BMW special tool 11 9 462 on exhaust camshaft and check timing. Timing is correctly adjusted when BMW special tool 11 9 461 rests flat on cylinder head or protrudes by up to 0.5 mm to exhaust side.

NOTE—

- Due to flexible sprocket design, VANOS unit tolerances and play in the VANOS units, when the camshaft timing is set correctly, the exhaust side of special tool 11 9 462 may be up to 0.5 mm (0.02 in) above the surface of the cylinder head. This is normal.

- Remove special tool 11 9 462 from exhaust camshaft.
- Reassemble engine.
- Remember to replace:
 - VANOS unit bolts.
 - VANOS solenoid O-rings.

117-84 Camshaft Timing Chain

Timing chain tensioner (V8 engine)



Timing chain tensioner (V8 engine)

A timing chain tensioner is screwed into the left front of each cylinder head. When it is removed be sure to catch any dripping oil in a shop towel. Do not allow oil to contaminate accessory belt.

- ⚠ If chain tensioner is reused, drain its oil chamber. Place tensioner vertically on level working surface and compress slowly (arrow). Repeat twice.

CAUTION—

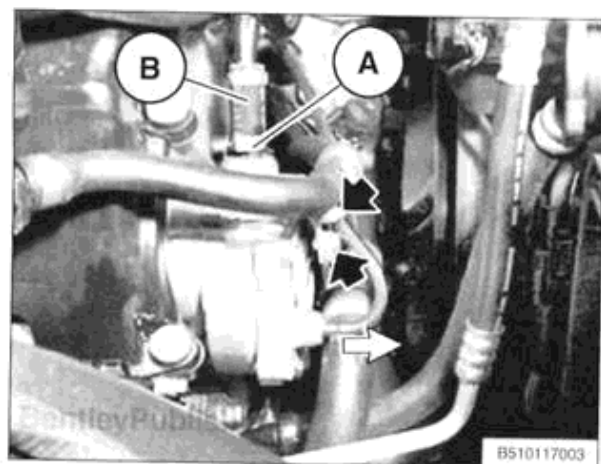
- When reassembling engine, be sure to use new sealing O-ring.

Tightening torque

Timing chain tensioner to cylinder head (M22 x 1.5) (use new sealing O-ring)	65 Nm (48 ft-lb)
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VANOS UNITS (V8 ENGINE)

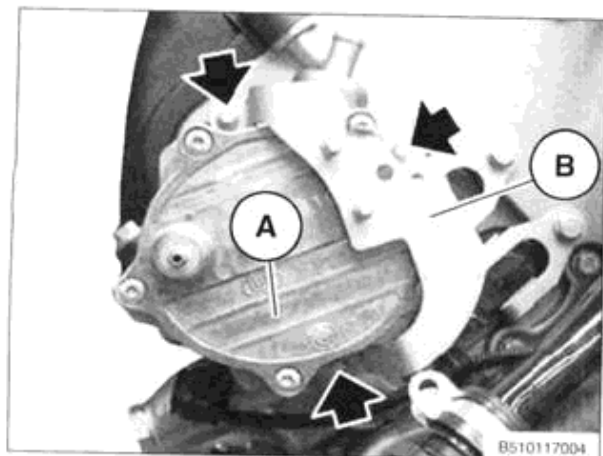
Right VANOS unit, removing (V8 engine)



- Remove right side valvetronic motor. See 133 Fuel Injection.
- Remove spark plugs. Plug spark plug bores to prevent debris from entering engine.
- Remove right side cylinder head cover. See 113 Cylinder Head Removal and Installation.
- Remove engine cooling fan and cooling fan shroud. See 170 Radiator and Cooling System.
- Remove air filter housing and ducts. See 133 Fuel Injection.

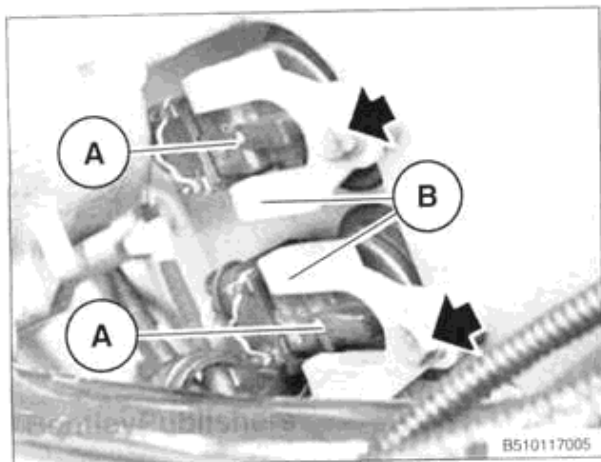
- ⚠ Working at front of right cylinder head:
- Remove clamp (A) and remove line (B).
 - Remove hose clamps (black arrows).
 - Remove vacuum line (white arrow).

- ⚠ Remove vacuum pump fasteners (arrows) and vacuum pump (A) with bracket (B).

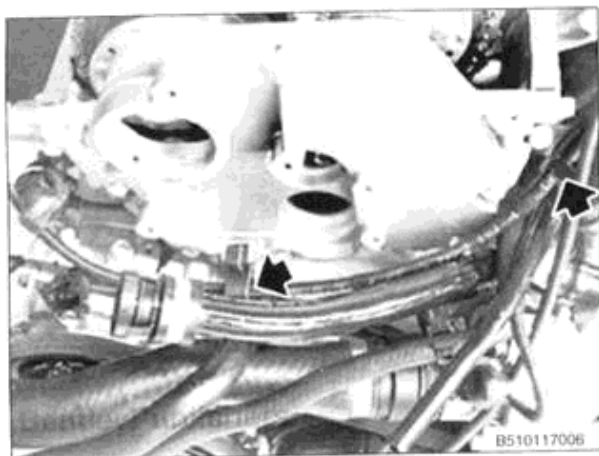


Camshaft Timing Chain 117-85

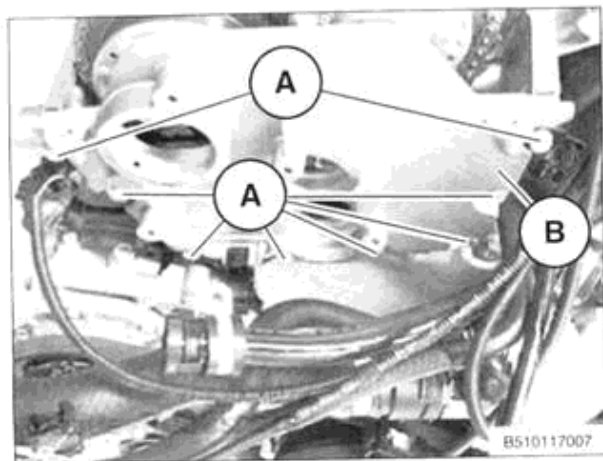
Right VANOS unit, removing (V8 engine)



- ⚡ Disconnect electrical connectors from VANOS adjuster solenoids (A). Remove fasteners (B), bracket (arrows) and remove actuator solenoids (A). Discard actuator solenoids O-rings.



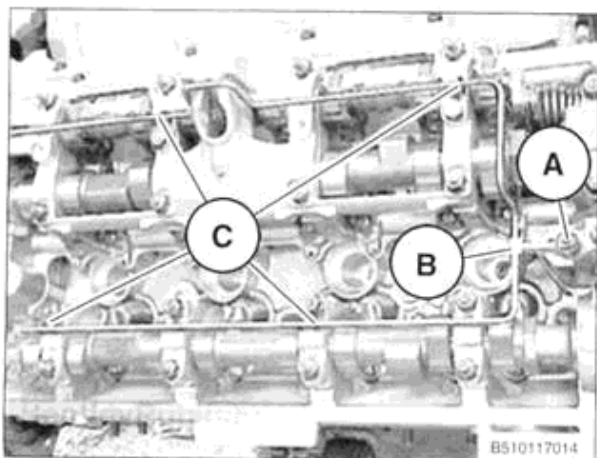
- ⚡ Remove vacuum lines from bracket (arrow).



- ⚡ Remove upper timing chain cover fasteners (A) and remove upper cover (B).

117-86 Camshaft Timing Chain

Right VANOS unit, removing (V8 engine)



- Remove banjo bolt (A). Unclip oil line (B) from retainers (C) and remove.

CAUTION—

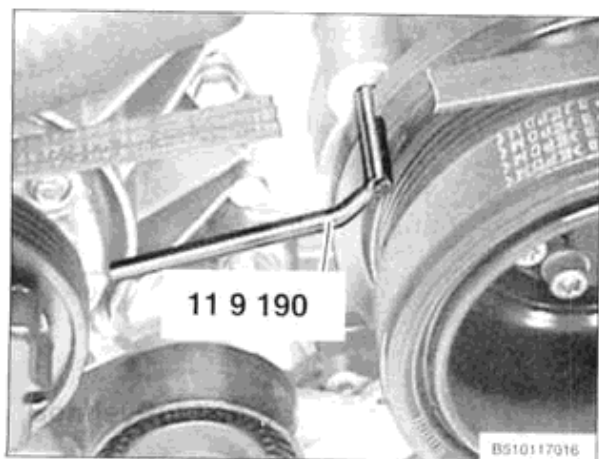
- Do not misplace oil line banjo bolt.



- Using vibration damper center bolt, turn engine in direction of rotation to cylinder 1 TDC position.

NOTE—

- Cylinder 1 exhaust lobe points upwards at an angle.
Cylinder 1 intake lobe points downwards at an angle.



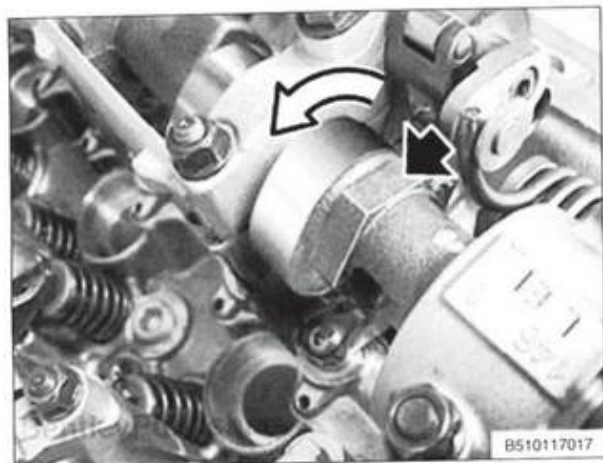
- Using BMW special tool 11 9 190, lock engine in cylinder 1 TDC position.

Camshaft Timing Chain 117-87

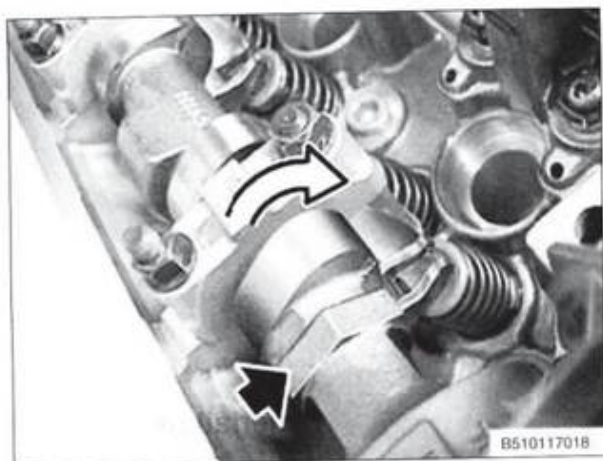
Right VANOS unit, removing (V8 engine)

To avoid incorrect timing adjustment, check VANOS adjustment unit locking using the following steps.

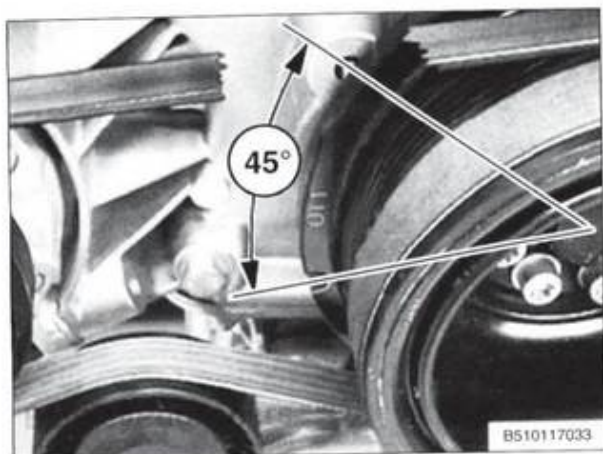
- Grip hexagon (**black arrow**) of intake camshaft and attempt to rotate intake camshaft carefully in direction opposite (**white arrow**) to engine rotation. If there is no fixed connection between intake camshaft and intake VANOS unit, rotate intake camshaft in direction opposite to engine rotation as far as it will go.



- Grip hexagon (**black arrow**) of exhaust camshaft and attempt to rotate exhaust camshaft carefully in the direction of engine rotation (**white arrow**). If there is no fixed connection between exhaust camshaft and exhaust VANOS unit, rotate exhaust camshaft in the direction of engine rotation as far as it will go.

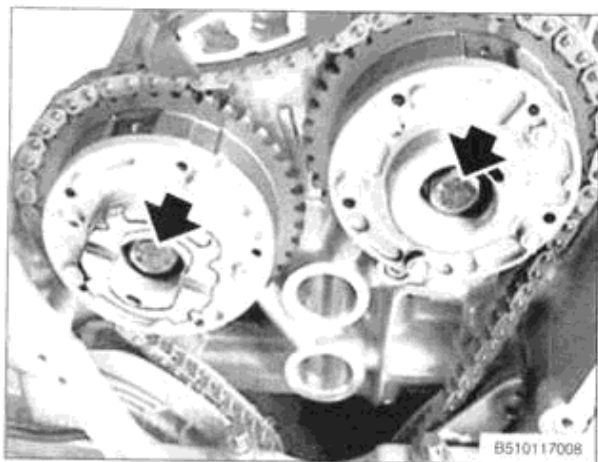


- Using vibration damper center bolt, turn engine in direction opposite to rotation to 45° before cylinder 1 TDC position.



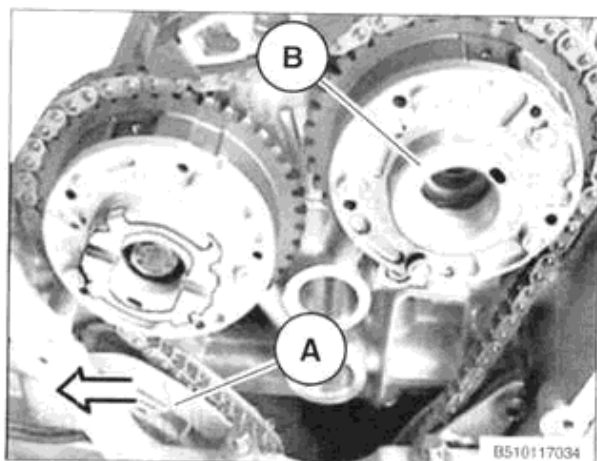
117-88 Camshaft Timing Chain

Right VANOS unit, removing (V8 engine)



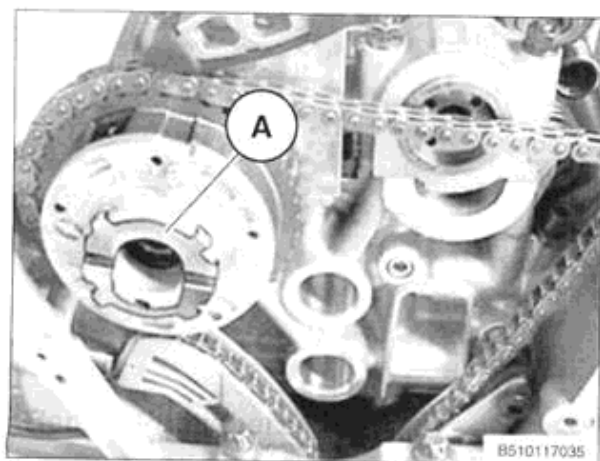
➤ Grip each camshaft at hexagon and loosen VANOS adjuster bolt (arrows). For now, do not remove VANOS bolts.

— Remove intake VANOS adjuster bolt and discard.



➤ Compress tensioner rail (A) several times to remove oil from tensioner. Remove intake VANOS adjuster (B).

— Remove exhaust VANOS adjuster bolt and discard.



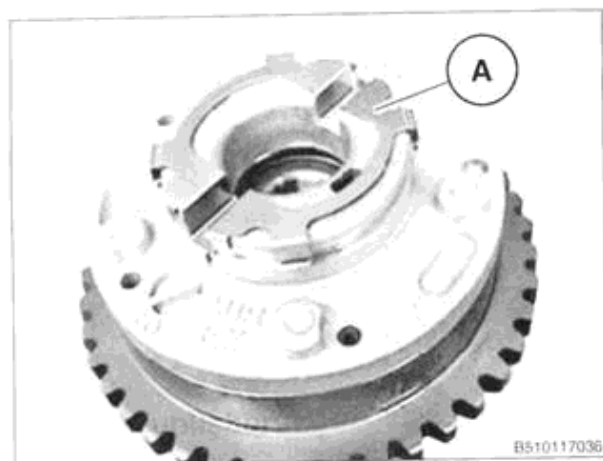
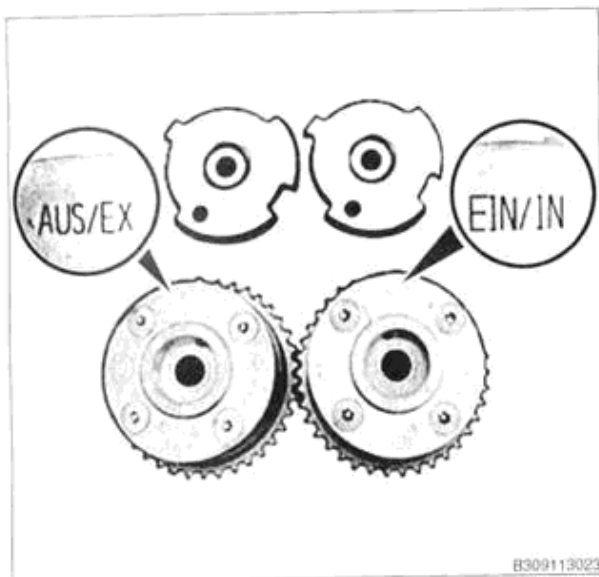
➤ Remove exhaust VANOS adjuster (A). Secure timing chain to prevent it from falling into timing cover.

Camshaft Timing Chain 117-89

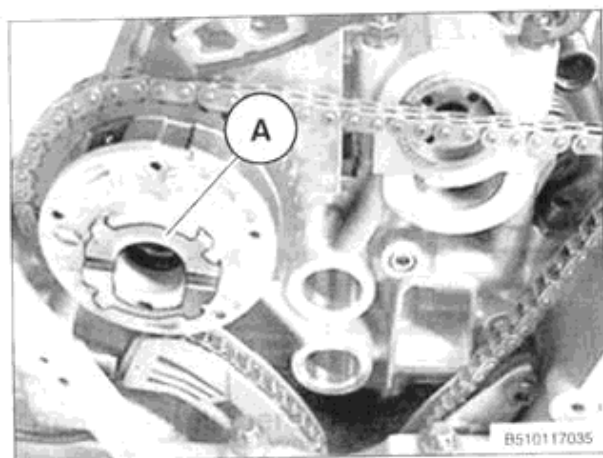
Right VANOS unit, installing (V8 engine)

Right VANOS unit, installing (V8 engine)

- Use new bolts to reattach VANOS units.
- Exhaust and intake units are different and so marked.
 - VANOS units may be installed in any position initially. Finger-tighten mounting bolts for now.



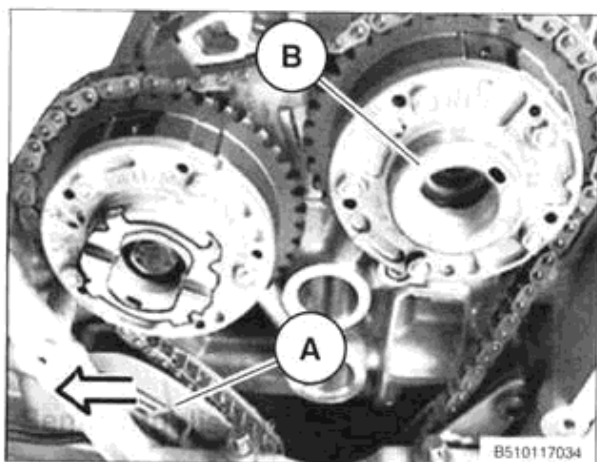
- Exhaust VANOS adjuster has a metal clip (A) for driving vacuum pump.



- Pull timing chain up and place over exhaust VANOS sprockets. Install VANOS adjuster bolt hand tight, then loosen by 1/2 turn.

117-90 Camshaft Timing Chain

Left VANOS unit, removing (V8 engine)



- Compress tensioner rail (A) and place chain over sprockets (B). Install VANOS adjuster bolt hand tight, then loosen by ½ turn

NOTE—

- If tensioner rail cannot be compressed enough to install chain, loosen timing chain tensioner 3 turns.
- Check and adjust camshaft timing. See **Right camshaft timing, adjusting (V8 engine)** in this repair group.
- Reassemble engine.

Tightening torque

VANOS adjuster to camshaft (replace bolt)	80 Nm (59 ft-lb)
Timing chain tensioner to cylinder head	65 Nm (48 ft-lb)

Left VANOS unit, removing (V8 engine)

- Remove left side valvetronic motor. See **133 Fuel Injection**.
- Remove spark plugs. Plug spark plug bores to prevent debris from entering engine.
- Remove left side cylinder head cover. See **113 Cylinder Head Removal and Installation**.
- Remove engine cooling fan and cooling fan shroud. See **170 Radiator and Cooling System**.
- Remove air filter housing and ducts. See **133 Fuel Injection**.
- Disconnect negative (–) cable from battery.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove banjo bolt (A). Unclip oil line (B) from retainers (C) and remove.

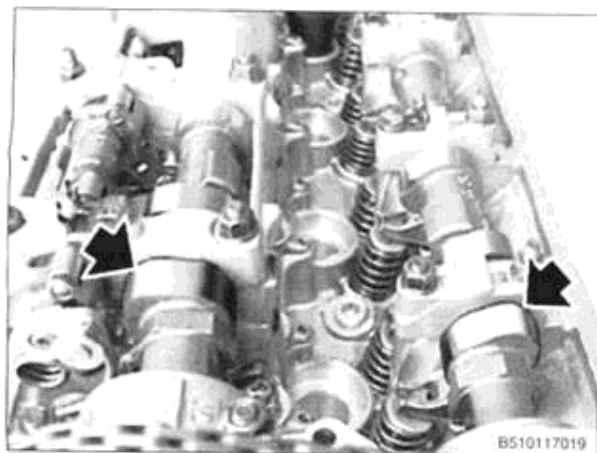
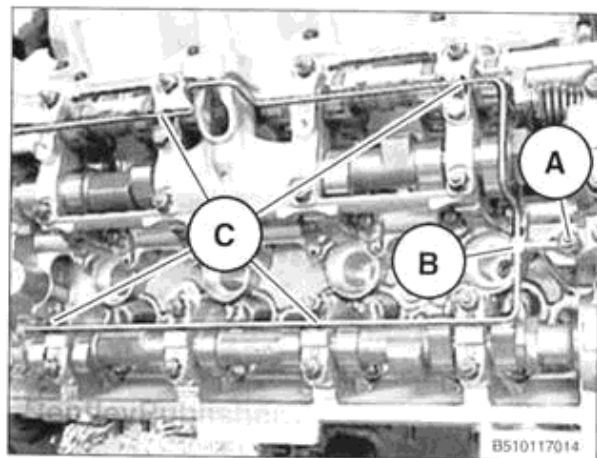
CAUTION—

- Do not misplace oil line banjo bolt.

- Using vibration damper center bolt, turn engine in direction of rotation to cylinder 1 TDC position.

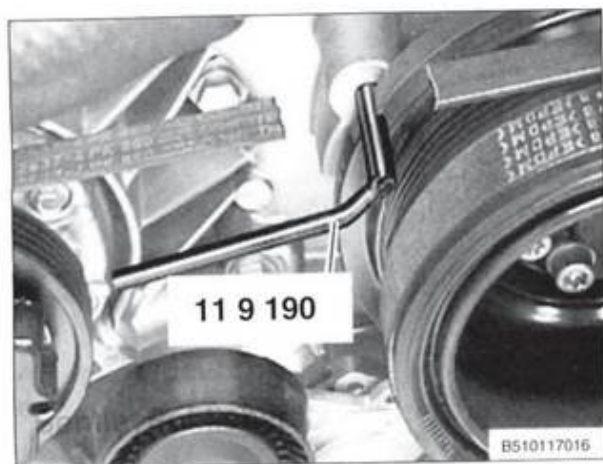
NOTE—

- With cylinder 1 in TDC position, lobes of intake and exhaust camshafts at cylinder 5 point upwards at an angle (arrows).

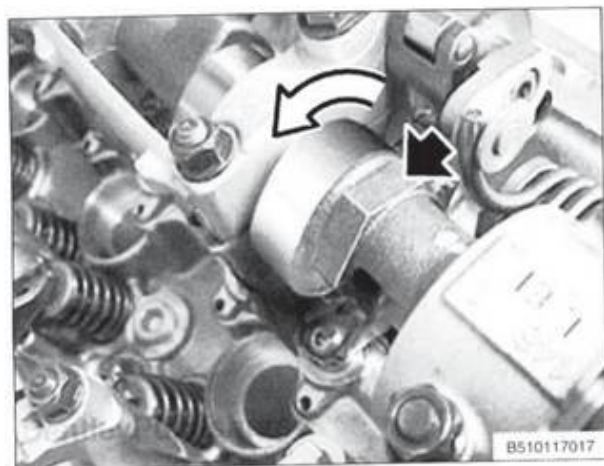


Camshaft Timing Chain 117-91

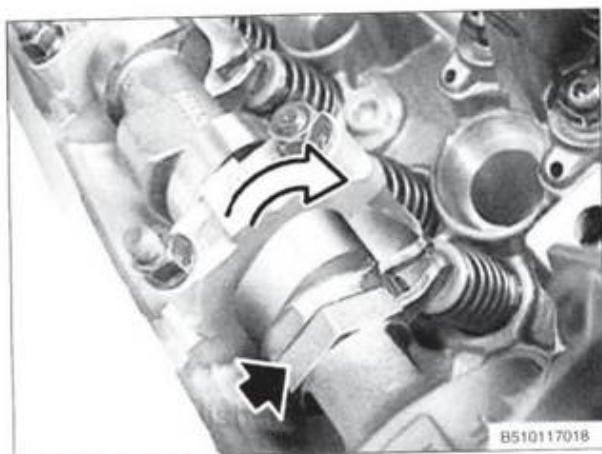
Left VANOS unit, removing (V8 engine)



- Using BMW special tool 11 9 190, lock engine in cylinder 1 TDC position.



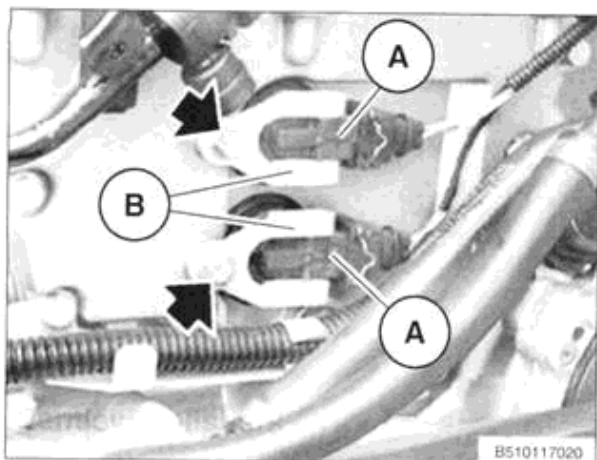
- Grip hexagon (**black arrow**) of intake camshaft and attempt to rotate intake camshaft carefully in direction opposite (**white arrow**) to engine rotation. If there is no fixed connection between intake camshaft and intake VANOS unit, rotate intake camshaft in direction opposite to engine rotation as far as it will go.



- Grip hexagon (**black arrow**) of exhaust camshaft and attempt to rotate exhaust camshaft carefully in the direction of engine rotation (**white arrow**). If there is no fixed connection between exhaust camshaft and exhaust VANOS unit, rotate exhaust camshaft in the

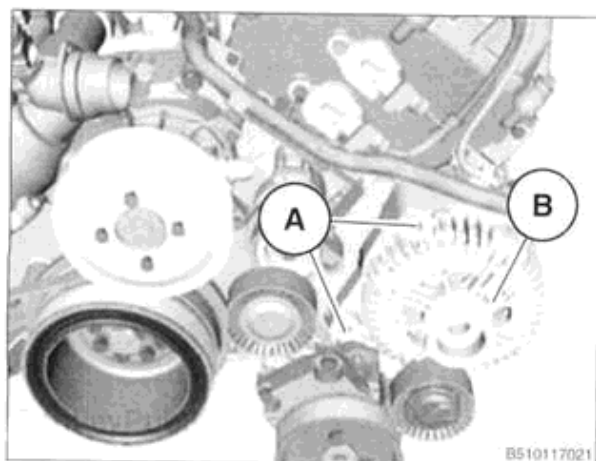
117-92 Camshaft Timing Chain

Left VANOS unit, removing (V8 engine)

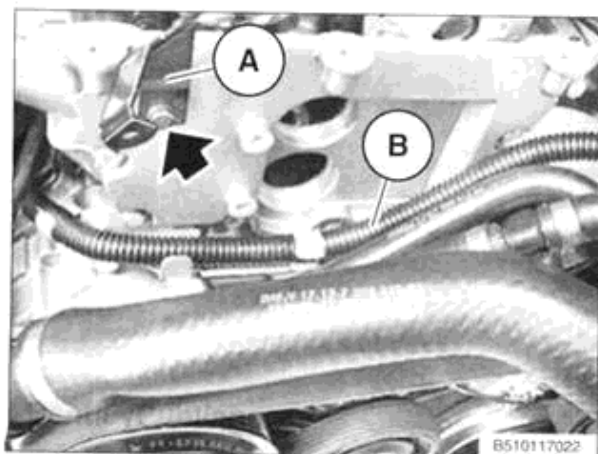


⚡ Disconnect electrical connectors from VANOS adjuster solenoids (A). Remove fasteners (arrows), bracket (B) and remove actuator solenoids (A). Discard actuator solenoids O-rings.

— Remove alternator belt. See **020 Maintenance**.



⚡ Remove alternator fasteners (A) and lay alternator (B) aside.

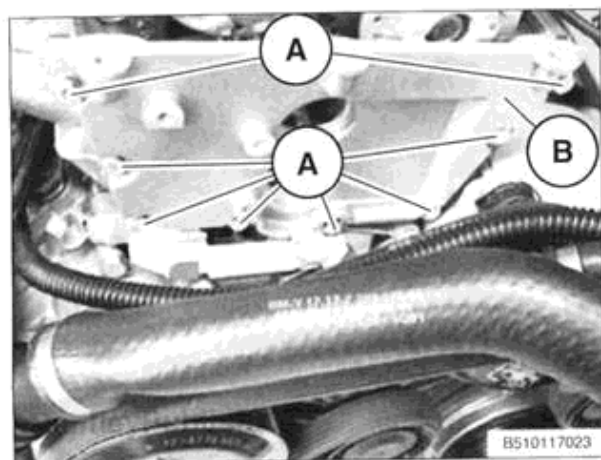


⚡ Remove fastener (arrow) and bracket (A). Unclip wiring harness (B) from bracket.

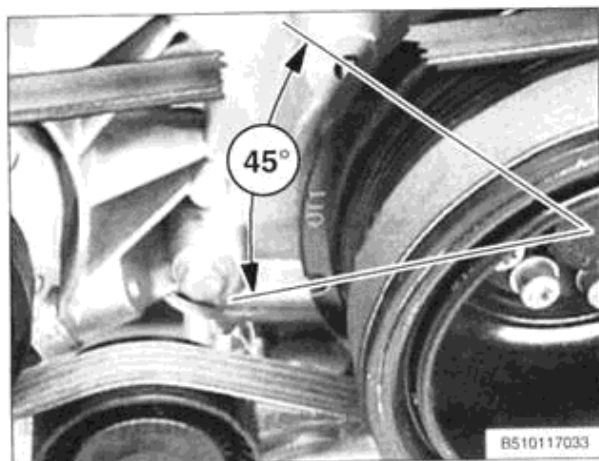
Camshaft Timing Chain 117-93

Left VANOS unit, removing (V8 engine)

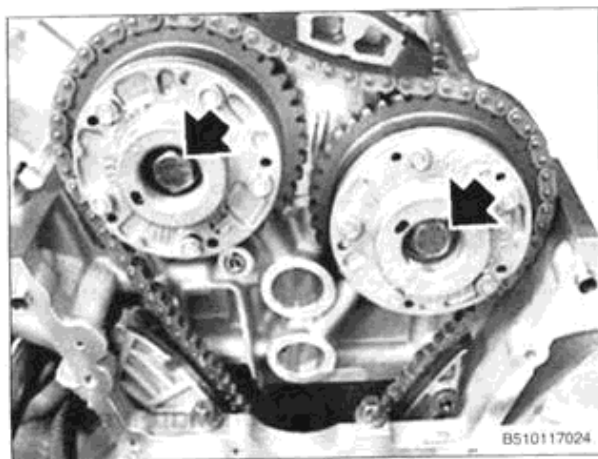
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- Remove upper timing chain cover fasteners (A) and remove cover (B).



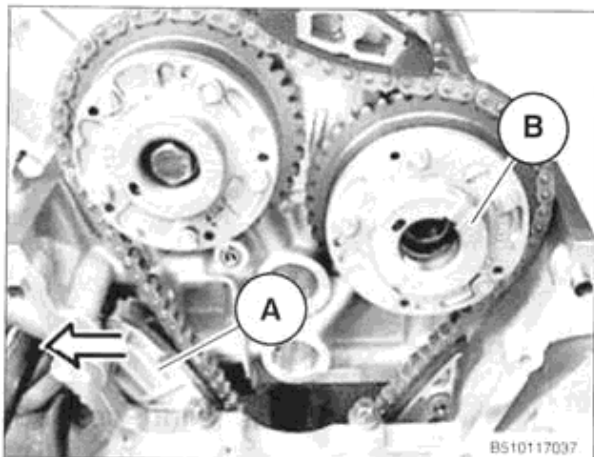
- Using vibration damper center bolt, turn engine in direction opposite to rotation to 45° before cylinder 1 TDC position.



- Grip each camshaft at hexagon and loosen VANOS adjuster bolt (arrows). For now, do not remove VANOS bolts.
- Remove and exhaust VANOS adjuster bolt.

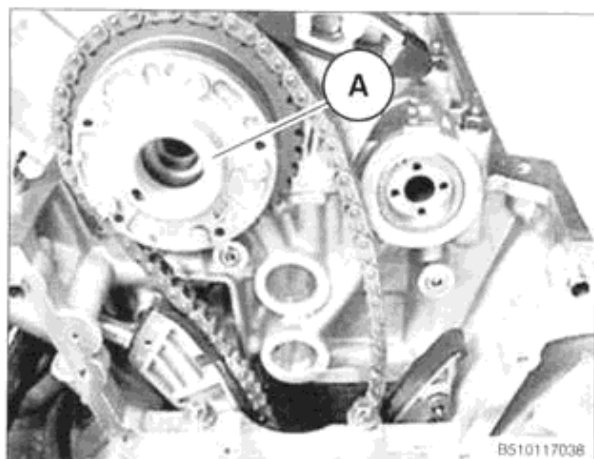
117-94 Camshaft Timing Chain

Left VANOS unit, installing (V8 engine)



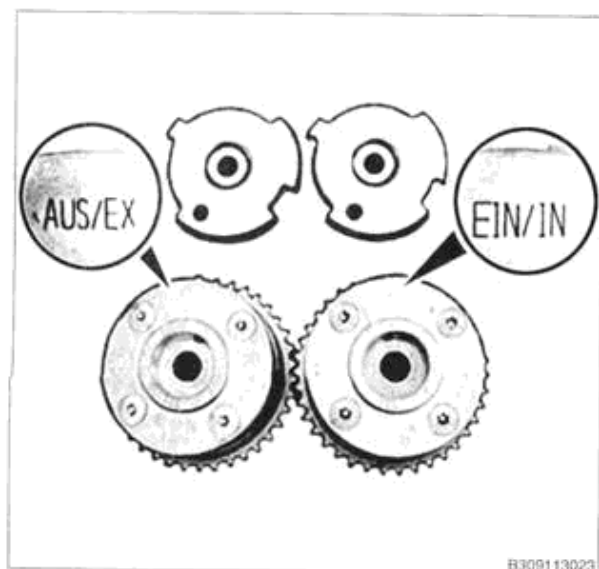
➤ Compress tensioner rail (A) several times to remove oil from tensioner. Remove exhaust VANOS adjuster (B).

— Remove intake VANOS adjuster bolt and discard.



➤ Remove intake VANOS adjuster (A). Secure timing chain to prevent it from falling into timing cover.

Left VANOS unit, installing (V8 engine)

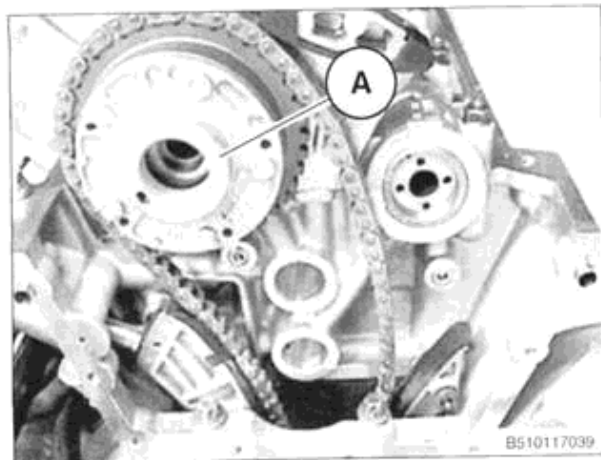


➤ Use new bolts to reattach VANOS units.

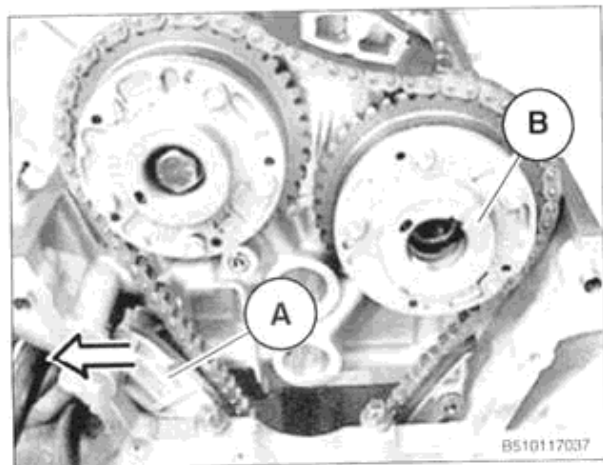
- Exhaust and intake VANOS units are different and so marked.
- VANOS units may be installed in any position initially. Fingertighten mounting bolts for now.

Camshaft Timing Chain 117-95

Left VANOS unit, installing (V8 engine)



- Pull timing chain up and place chain over sprocket (A). Install VANOS adjuster bolt hand tight, then loosen by $\frac{1}{2}$ turn.



- Compress tensioner rail (A) and place chain over sprocket (B). Install VANOS adjuster bolt hand tight, then loosen by $\frac{1}{2}$ turn

NOTE —

- If tensioner rail cannot be compressed enough to install chain remove timing chain tensioner. Remember to replace sealing O-ring.
- Check and adjust camshaft timing. See **Left camshaft timing, adjusting (V8 engine)** in this repair group.
- Reassemble engine.

Tightening torque

VANOS adjuster to camshaft (replace bolt)	80 Nm (59 ft-lb)
Timing chain tensioner	65 Nm (48 ft-lb)



