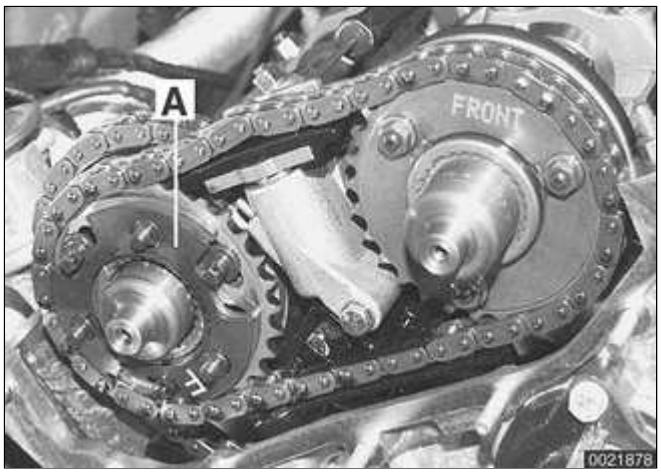
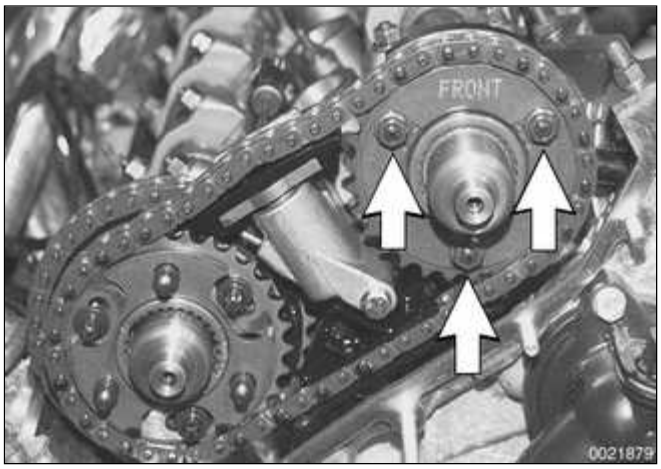
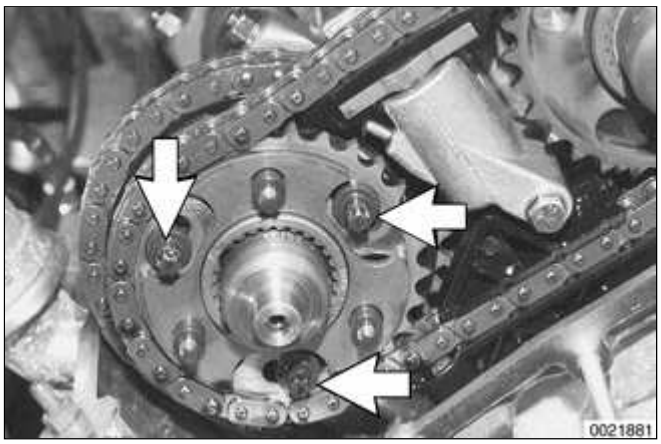


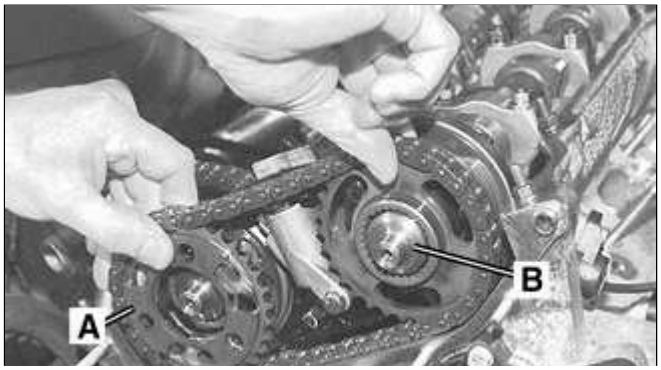
- Remove spring plate (**A**).



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



- Remove torx screws from exhaust camshaft sprocket (**arrows**).

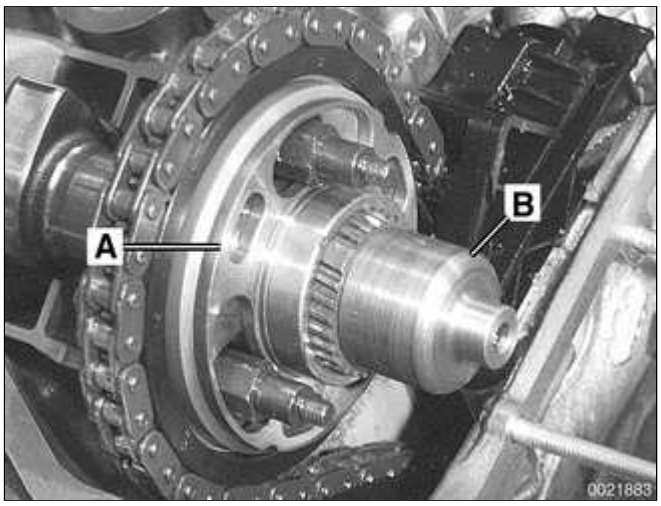


- Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (**A**) and splined shaft (**B**).

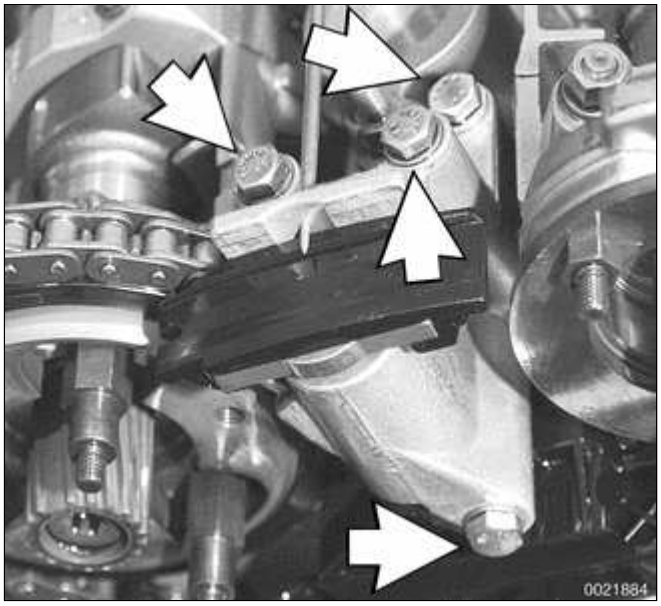
CAUTION!

Splined shafts for both intake and exhaust camshafts share the same part number. Remove and mark used

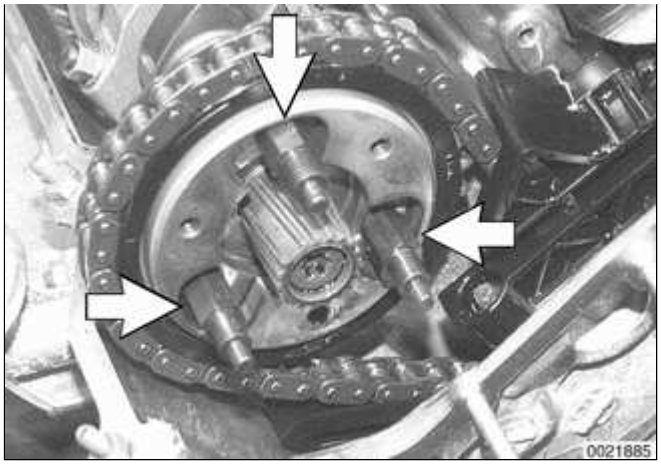
splined shafts in order to reinstall in original locations.



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

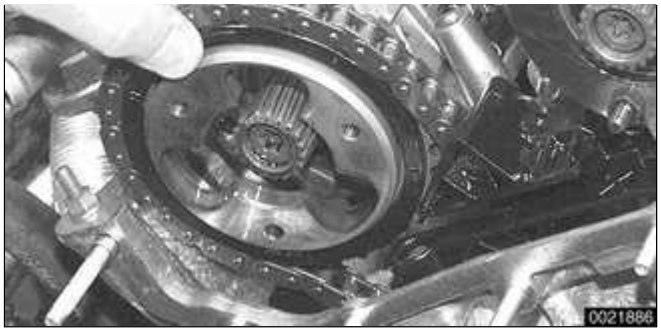


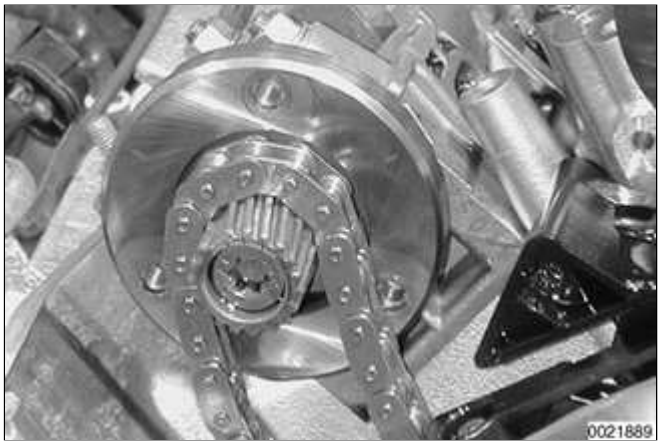
- Remove secondary chain tensioner mounting bolts (**arrows**). Remove tensioner while keeping locking pin in place.



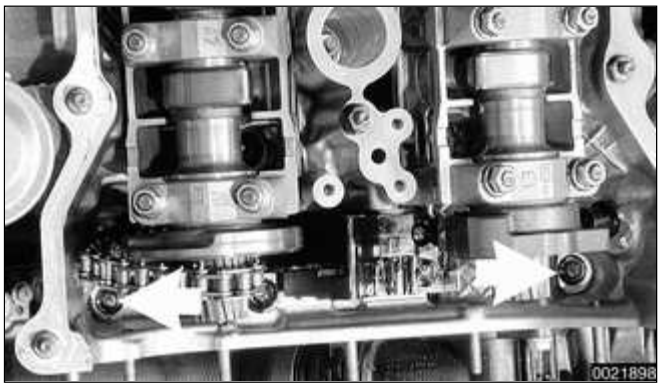
- Remove primary chain sprocket mounting studs (**arrows**) on exhaust camshaft.

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

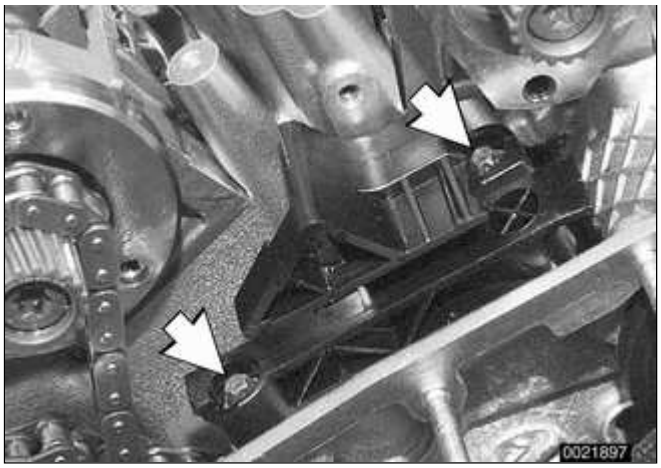




- Set timing chain on exhaust camshaft end.



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



- Remove secondary chain lower guide bolts (**arrows**). Remove chain guide.

Note:

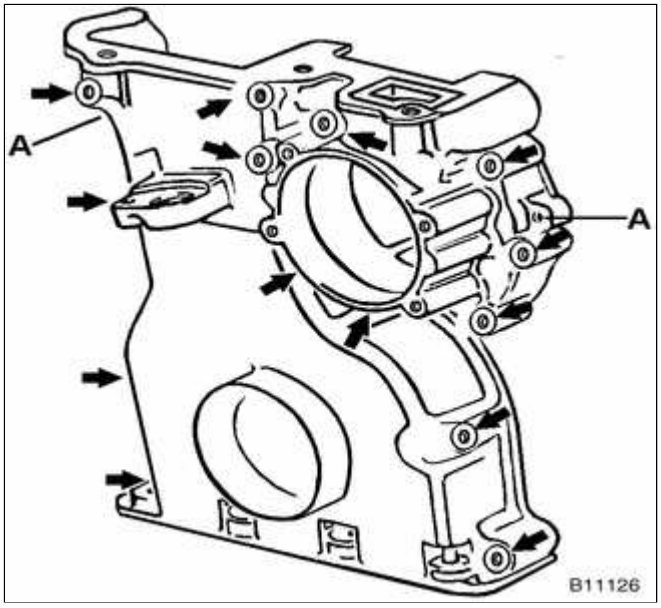
Bolt on intake camshaft side is long and extends into timing chain cover.

- Remove crankshaft hub center bolt and remove crankshaft hub (to 1/2000 models) or vibration damper (models from 1/2000).

CAUTION!

The crankshaft must not be allowed

to rotate when the timing chains are loosened or removed. The pistons can contact the valves.



- Using a drift of less than 5 mm diameter, drive two locating dowels (**A**) in left and right sides of lower timing chain cover toward rear of car. Remove cover mounting bolts (**arrows**) and carefully lift cover off.

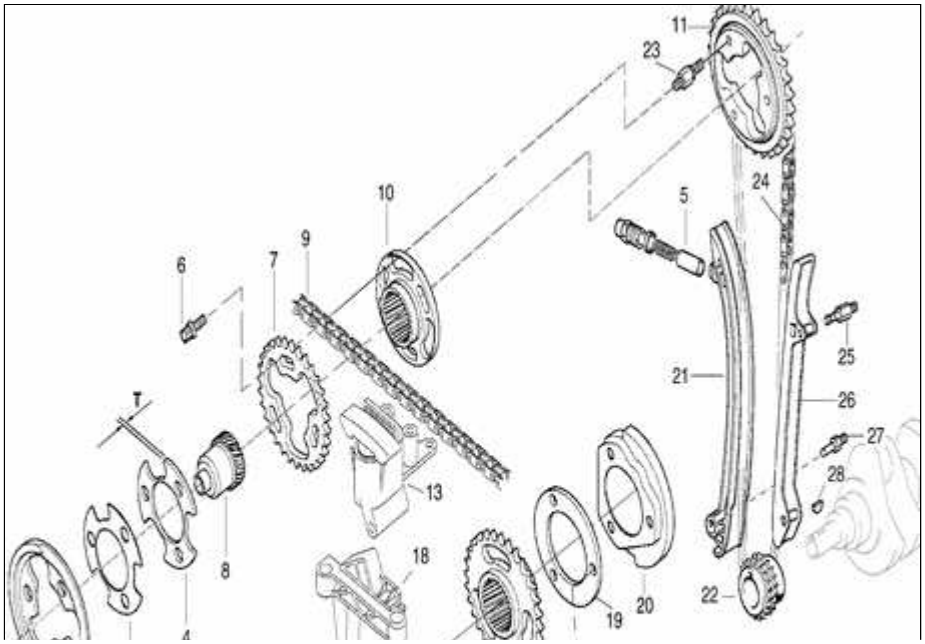
CAUTION!

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.

Note:

- *The chain cover can be removed with the coolant pump installed.*
- *Use care when removing the cover from the coolant pipe at rear.*

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



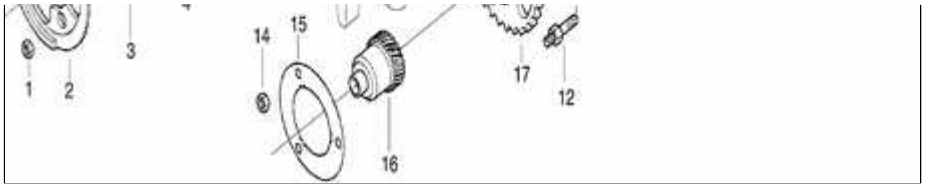
Double VANOS components (M52 TU, M54 engine)

1 - Impulse wheel mounting nut

2 - Camshaft impulse wheel (exh.)

3 - Spring plate

4 - Thrust spacer (T = 3.5 mm)



5 - **Primary chain tensioner**

6 - **Torx screw**

7 - **Exhaust secondary sprocket**

8 - **Splined shaft**

9 - **Secondary timing chain**

10 - **Splined sleeve**

11 - **Primary sprocket**

12 - **Threaded stud**

13 - **Secondary chain tensioner**

14 - **Sprocket mounting nut**

15 - **Spring plate**

16 - **Splined shaft**

17 - **Intake camshaft sprocket**

18 - **Secondary chain lower guide**

19 - **Thrust spacer**

20 - **Camshaft impulse wheel (intake)**

21 - **Chain tensioner rail**

22 - **Crankshaft sprocket**

23 - Threaded stud

24 - Primary chain

25 - Threaded stud

26 - Guide rail

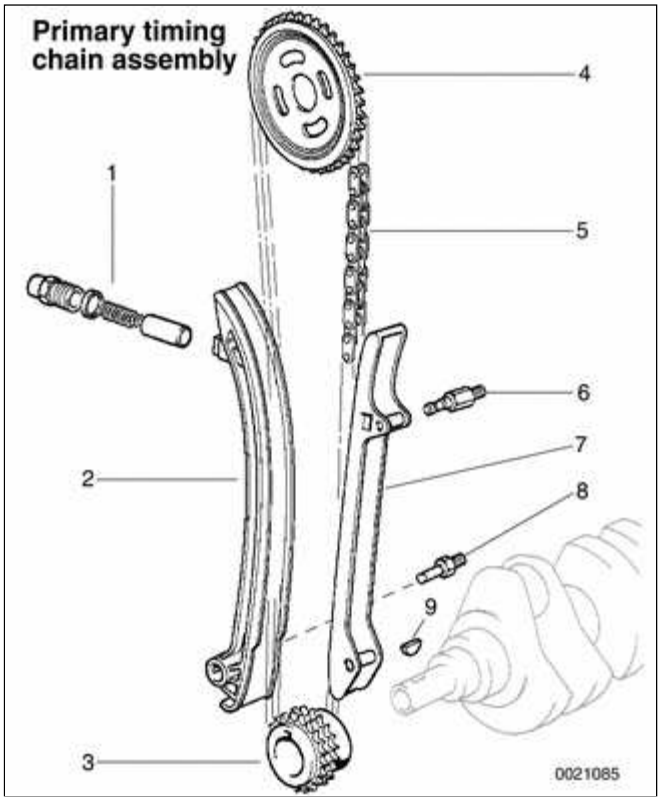
27 - Threaded stud

28 - Woodruff key

Camshaft timing chains, Installing

CAUTION!

The procedure outlined below assumes that the camshafts and the crankshaft are locked in the TDC installation position with special locking tools as shown earlier.



Inspect timing chain sprockets. Inspect guide rail and tensioner rail for deep grooves caused by chain contact. Replace any part that is worn or damaged.

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

Note:

If any sprockets are being replaced due to wear, the chain should also be replaced. If the crankshaft sprocket requires replacement, the oil pump drive sprocket and chain must be removed. See ⇒ 119 Lubrication System for oil pump removal information.

- Install primary timing chain to crankshaft sprocket and hang

upper end from exhaust camshaft.

- If necessary, replace crankshaft seal as described earlier.

- To install lower timing case cover:

- Clean cover and cylinder block sealing surfaces.

- Use new gaskets and coolant pipe O-ring.

- Drive timing cover dowels in 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 to engage dowels.

- Install all bolts hand tight, including two Torx bolts from above.

- Install secondary chain lower guide.

- Drive dowels in flush to front of cover.

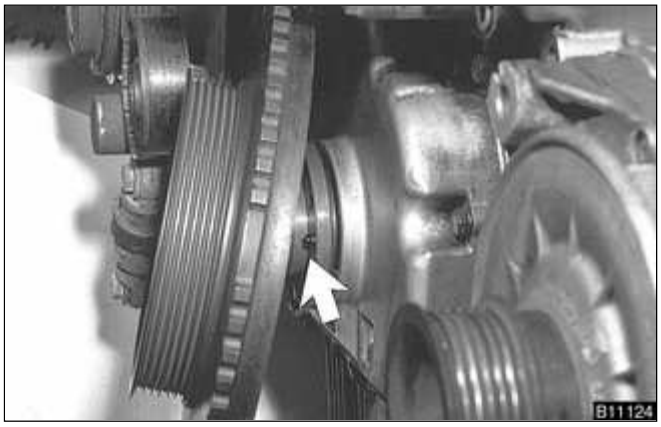
- Tighten cover mounting bolts alternately and in stages.

Tightening torques

Tightening torques	
Lower timing cover to cylinder block (M6)	10 Nm (89 in-lb)

- Install oil pan with new gasket. See ⇒ 119 Lubrication System.

Tightening torque	
Oil pan to engine block (M6)	
8.8 grade	10 Nm (89 in-lb)
10.9 grade	12 Nm (9 ft-lb)

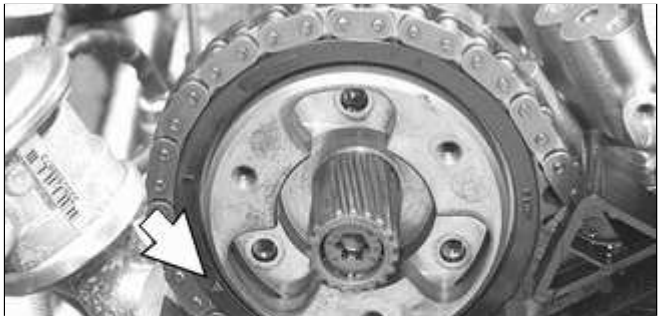


- Install crankshaft hub or vibration damper to crankshaft. Install crankshaft center bolt finger tight. Make sure hub is fully seated, noting alignment dowel (**arrow**), where applicable.

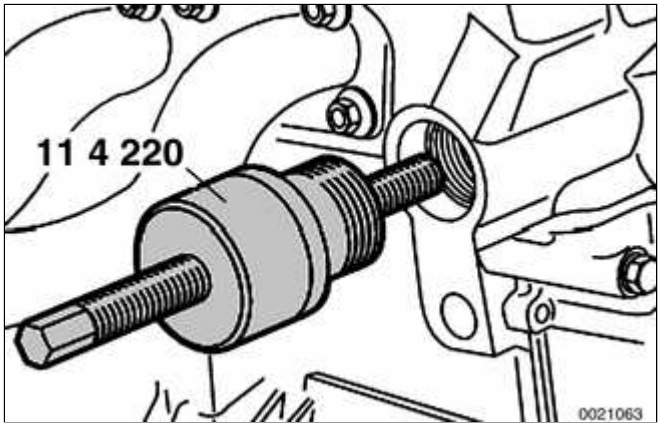
Note:

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

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



- Fit top sprocket to primary timing chain and install on exhaust camshaft so that pointer (**arrow**) on sprocket lines up with cylinder head sealing surface.

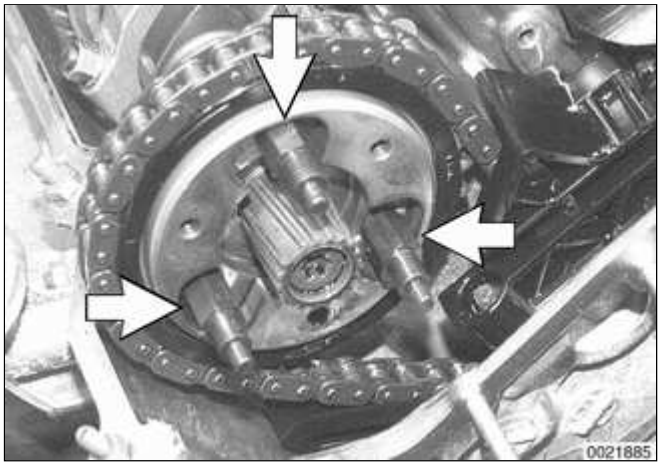


- Insert BMW special tool 11 4 220 in cylinder head and screw in adjustment screw by hand just until it contacts tensioning rail.

Note:

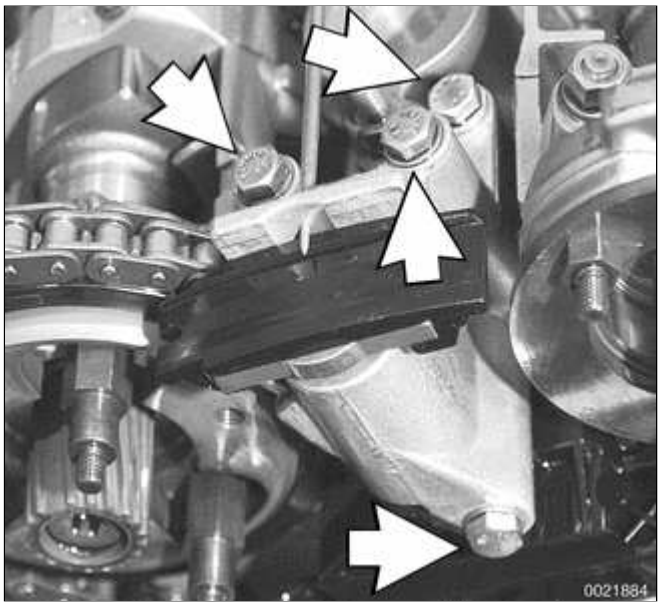
BMW special tool 11 4 220 is a dummy primary chain tensioner and simulates the function of the tensioner.

  - Make sure arrow on top primary sprocket is still lined up with upper edge of cylinder head. Reposition sprocket if necessary.



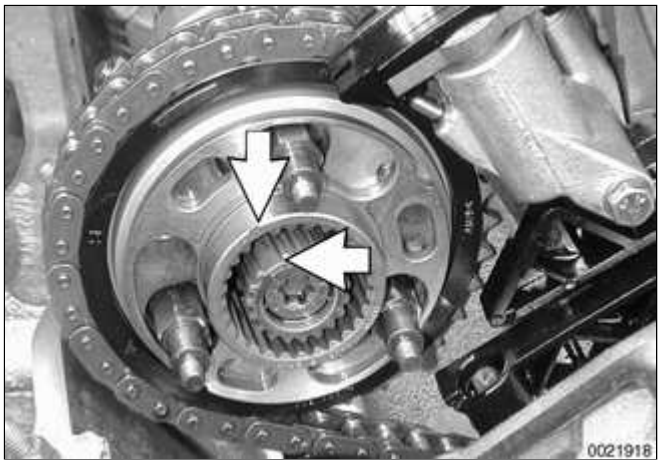
- Install and tighten down threaded locating studs (**arrows**) in end of exhaust camshaft.

Tightening torques	
Exhaust camshaft locating stud	20 Nm (15 ft-lb)

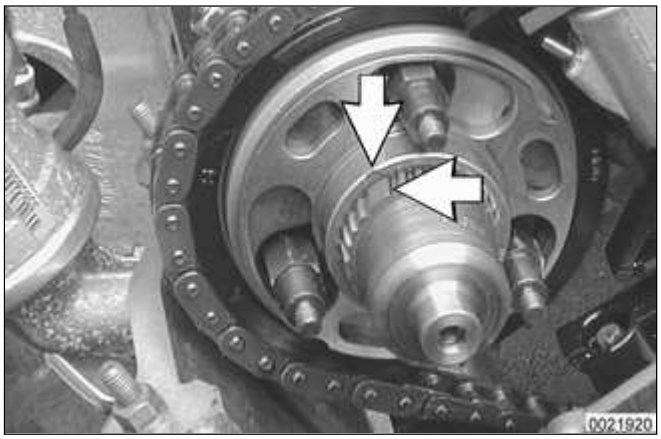


- Install secondary chain tensioner on cylinder head.

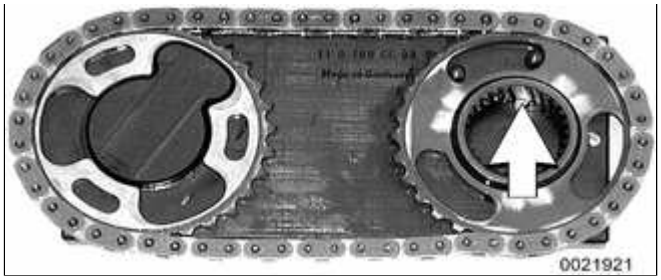
  - Make sure tensioner is locked in compressed position as described earlier.



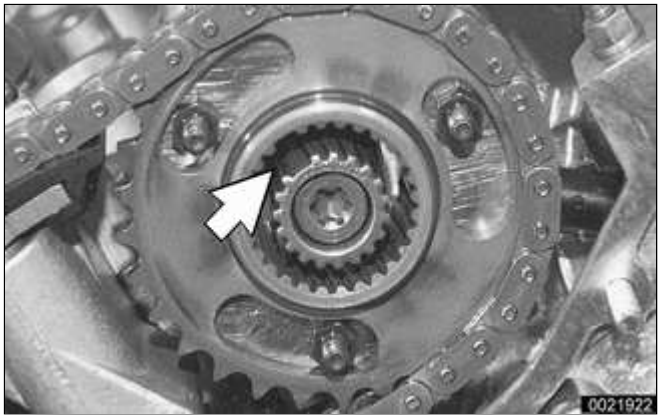
- Fit exhaust camshaft splined sleeve, aligning gap in sleeve splines with corresponding gap on camshaft splines (**arrows**).



- Slide splined shaft onto exhaust camshaft, aligning larger tooth with corresponding gap of splined sleeve.
  - Slide splined shaft in further until 3 small slots in splined sleeve are centered on 3 threaded holes in sprocket.



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

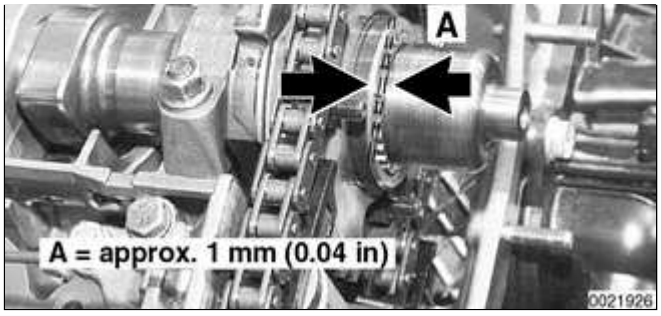


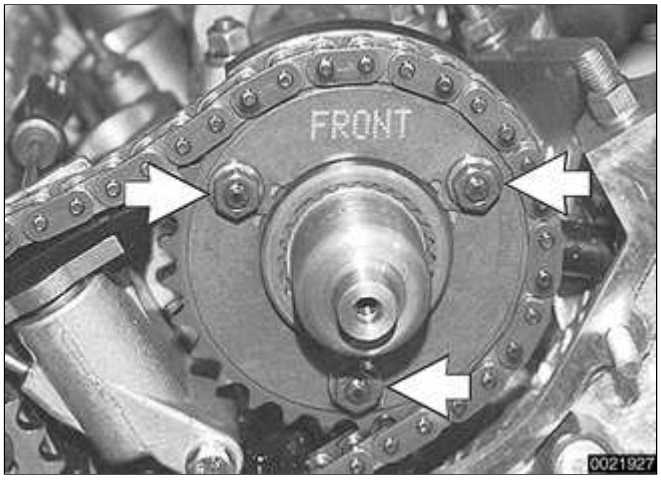
- Carefully remove chain and sprockets from tool and slide onto camshafts. Align gap in intake sprocket splines with corresponding gap in camshaft splines (**arrow**).

CAUTION!

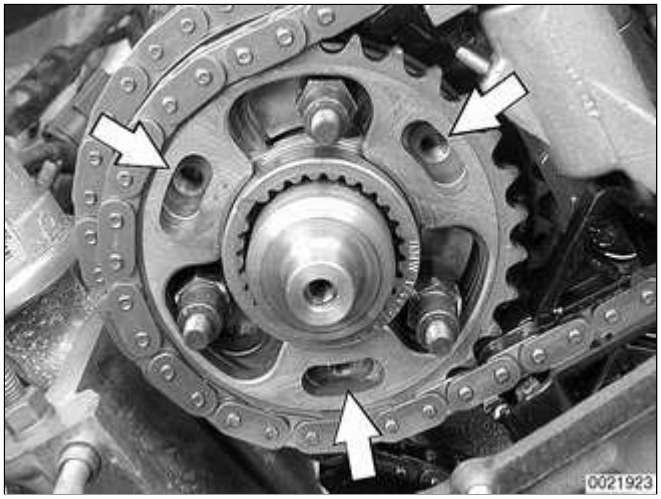
Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.

- Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines can still be seen.

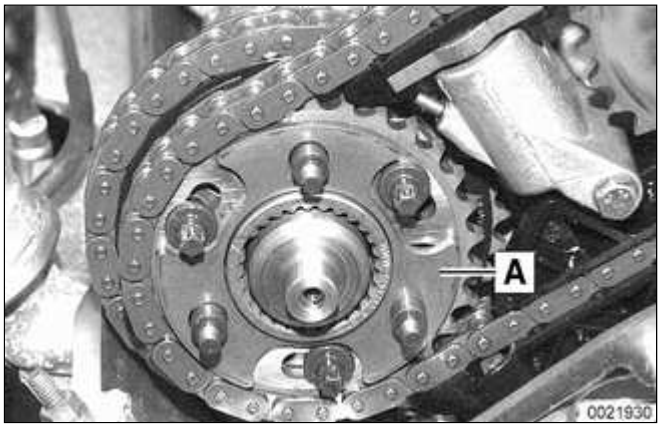




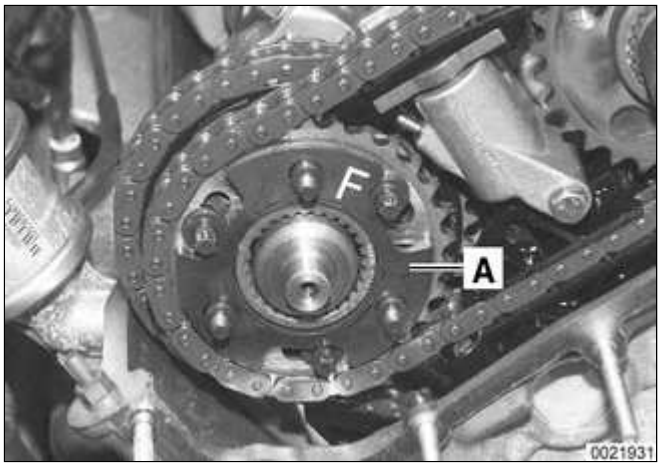
- Install intake camshaft spring plate so that FRONT mark is visible. Install mounting nuts (**arrows**) finger tight.



- Working at exhaust side, insert sprocket mounting Torx screws into threaded holes (**arrows**).
  - Initially tighten screws to approx. 5 Nm (44 in-lb). Back off half a turn.



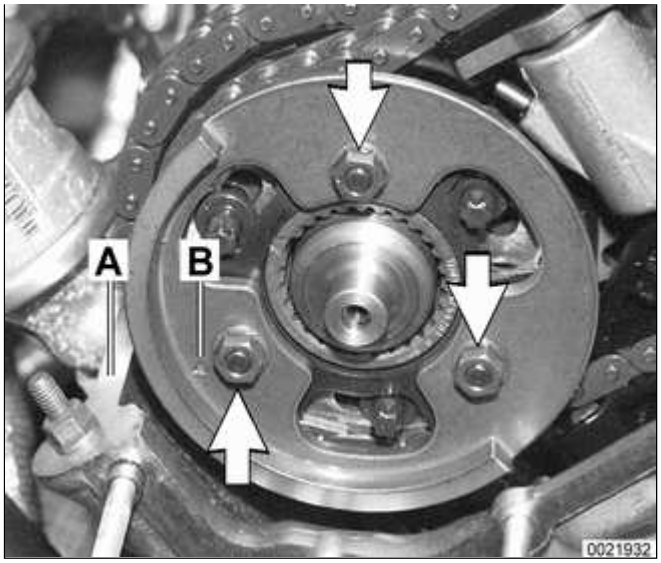
- Fit thrust spacer (**A**) on exhaust camshaft.



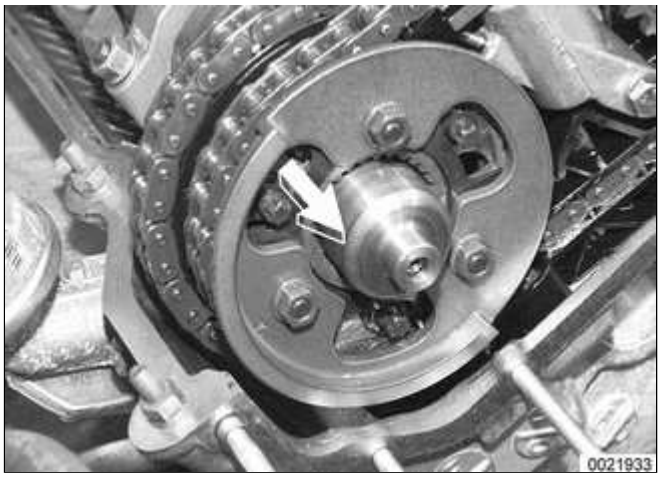
- Install spring plate (**A**) to exhaust camshaft. Make sure that **F** marking is visible.

Note:

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



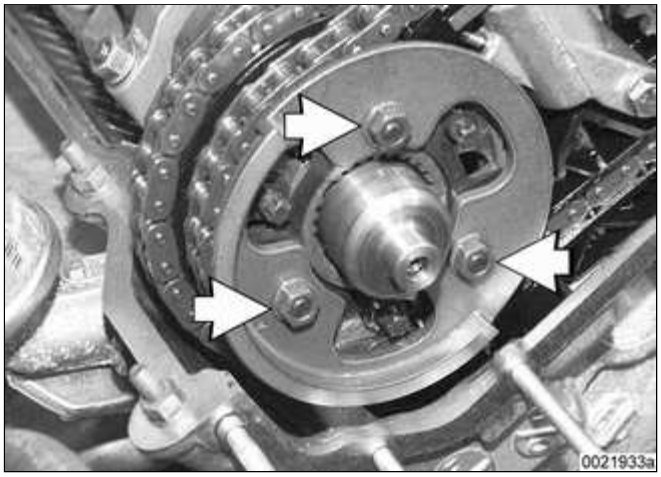
- Install exhaust camshaft impulse wheel, aligning mark (**B**) with top edge of cylinder head (**A**). Install mounting nuts (**arrows**) finger tight.



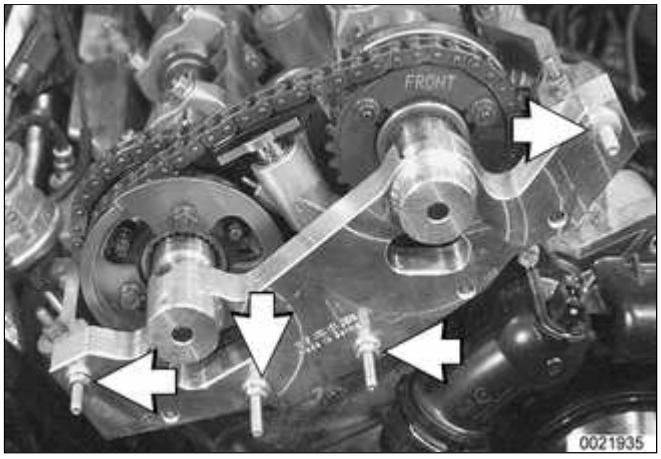
- Pull out exhaust splined shaft until it stops.
  - Press down on secondary chain tensioner and remove tensioner lock-down tool.

- 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)



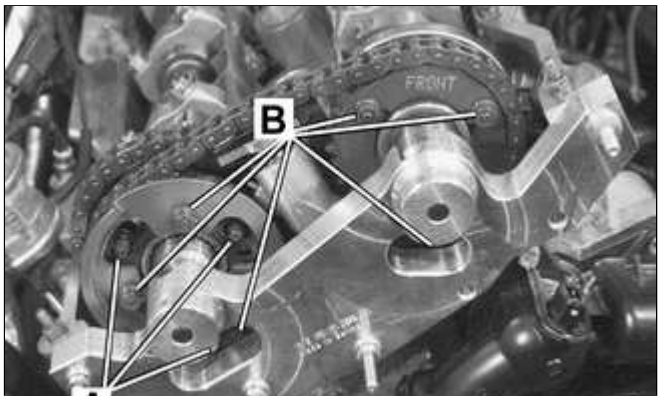
- Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



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

CAUTION!

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



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

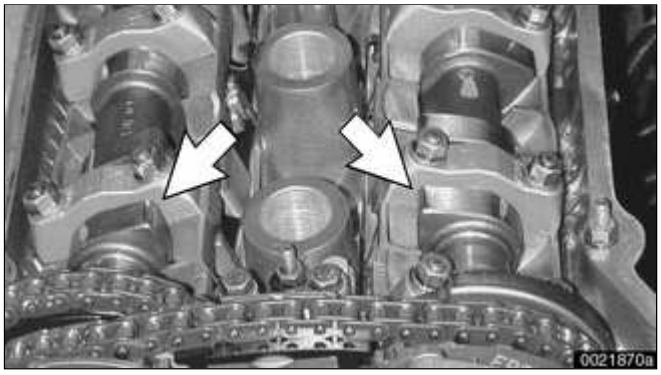
exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).

- Torque down mounting screws (**A**) and nuts (**B**) to final specifications.

Tightening torques	
Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly to camshaft	
M7 Torx screw (**A**)	20 Nm (15 ft-lb)
M6 mounting nut (**B**)	10 Nm (89 in-lb)

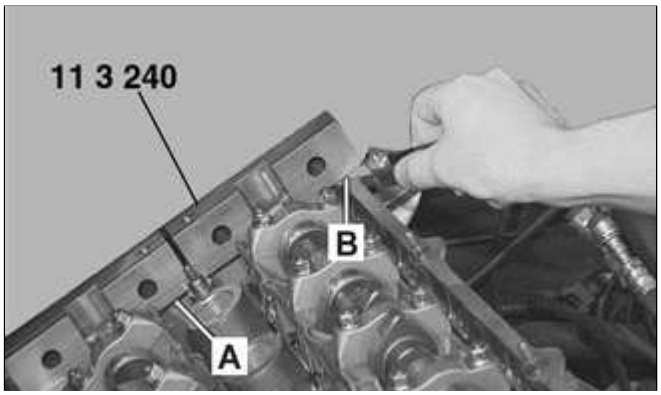
- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer secured.

- Remove camshaft locking tools from rear of camshafts.



- Crank engine over by hand twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face each other.

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



- Place BMW special tool 11 3 240 over camshaft ends and measure clearance of tool to cylinder head surface.

Note:

- *If the exhaust side of the tool is not flush with the head (gap **A**), retime the camshafts as described later in*

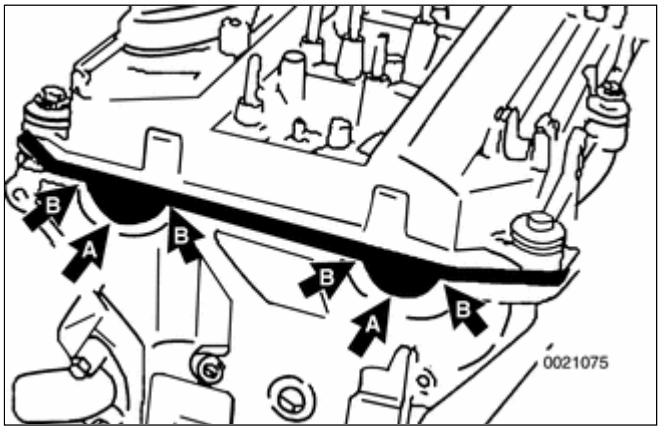
this repair group.

- *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 may be up to 1 mm (0.04 in) above the surface of the cylinder head (gap **B**).This is normal. Otherwise, retime the camshafts as described later in this repair group.*

- Remove VANOS setup bracket from front of cylinder head.

- Install VANOS unit. See ⇒ VANOS control unit, given later.

- 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 (89 in-lb)

- Reassemble remainder of engine:

- Torque crankshaft hub center bolt, using special tools 11 2 150/11 2 410 (to 1/2000) or 11 8 190/11 8 200 (from 1/2000).

CAUTION!

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

- Reinstall air filter housing, engine covers, interior ventilation microfilter housing.

- Secure all coolant hoses, thermostat housing, engine coolant drains.

- Reinstall engine oil drain plug.

- Refill engine oil and coolant before running engine. Check for leaks.

Tightening torques	
Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Radiator cooling fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Vibration damper hub to crankshaft	410 Nm (302 ft-lb)

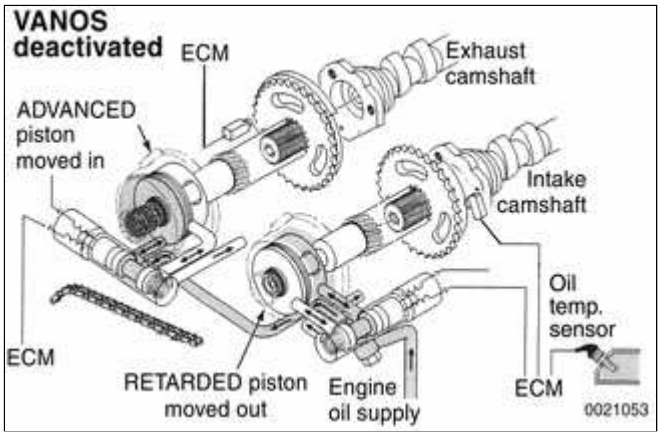
- Use scan tool to check VANOS operation with engine idling.

Vanos

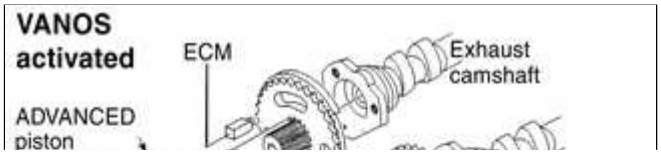
The main components of the double VANOS system are:

- Intake and exhaust camshafts with helical spline inserts
- Camshaft sprockets with adjustable gears
- VANOS actuators (two position piston housing with internal/external helical spline cup)
- Three-way solenoid switching valves
- Camshaft position impulse wheels
- Hall effect camshaft position sensors

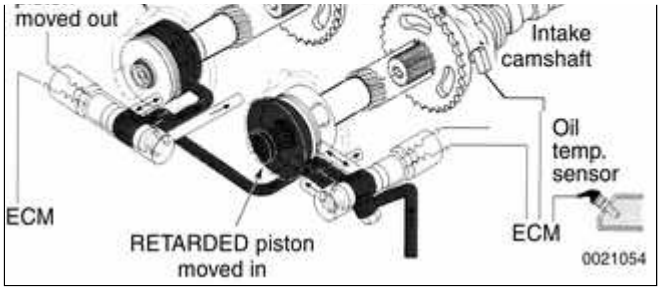
Camshaft position is varied based on engine rpm, throttle position signal, intake air and coolant temperature.



- When engine is started, camshafts are in deactivated position:
  - Intake camshaft is held in RETARDED position by oil pressure.
  - Exhaust camshaft is held in ADVANCED position by preload spring and oil pressure.



- Within 2 - 5 seconds (50 engine revolutions), the ECM begins monitoring and controlling camshaft



positions.

The Double VANOS system allows full variability of camshaft timing up to the limits of the system. When the ECM detects that the camshafts are in optimum position, the solenoids are modulated at approximately 100 - 220 Hz to maintain oil pressure on both sides of the actuator pistons to maintain timing.

In models with DME MS 43.0 (model year 2001), the engine control module (ECM) detects camshaft position before the engine starts, thereby adjusting camshaft timing immediately upon start-up

Note:

- *BMW does not provide diagnostic information or specifications for the Double VANOS system. VANOS system troubleshooting and diagnostics is best accomplished using a scan tool.*

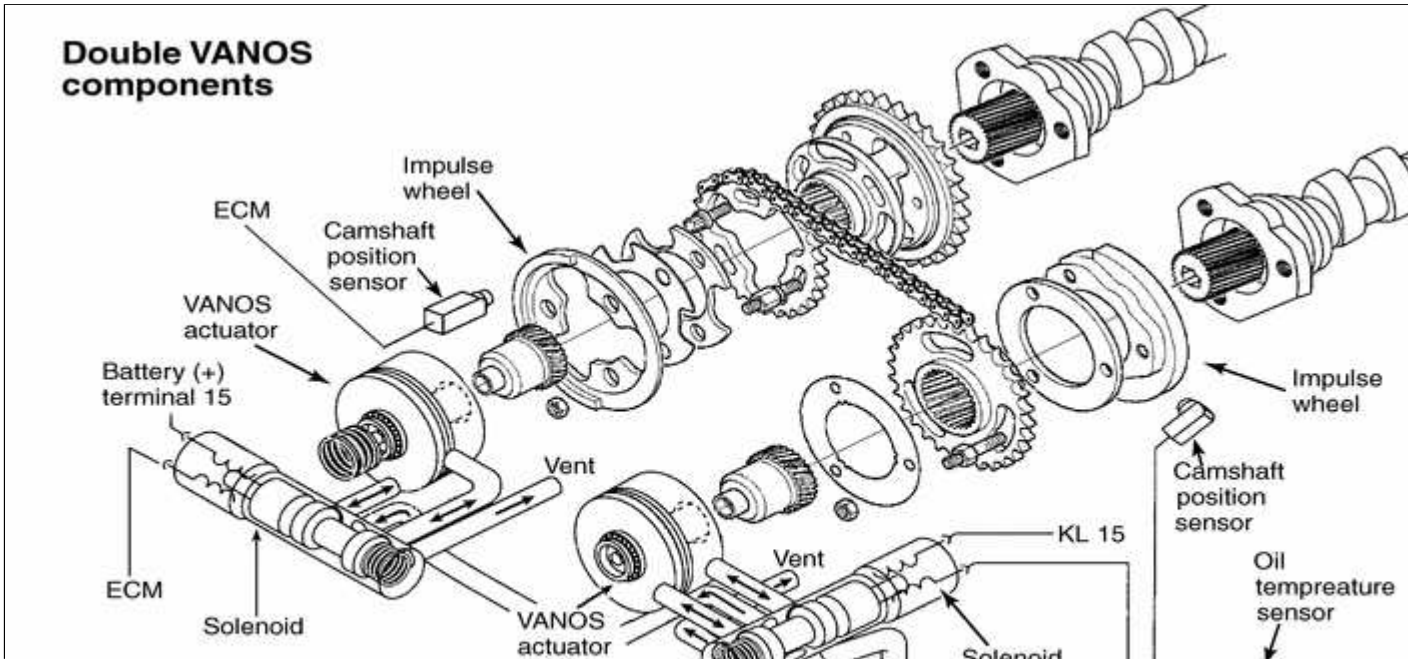
- *Diagnostic Trouble Codes (DTCs) pertaining to the VANOS system are listed in ⇒ Table a. See also ⇒ OBD On Board Diagnostics at the back of this manual.*

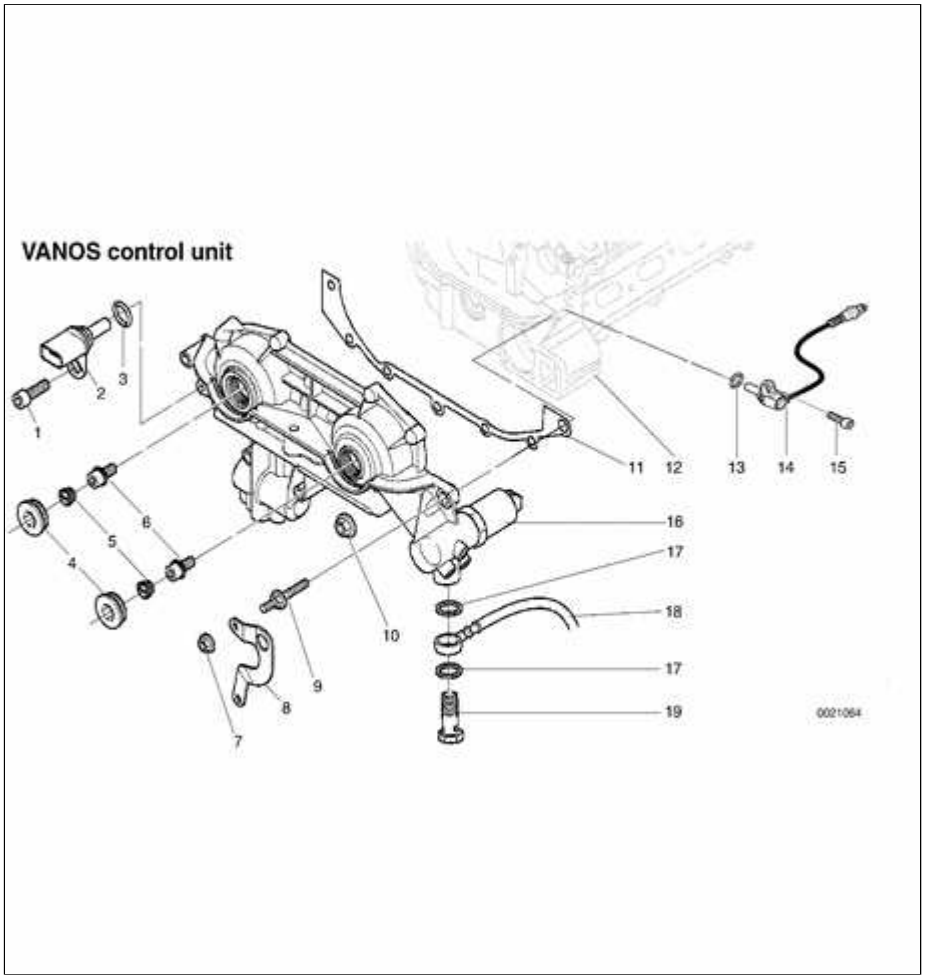
- *Elevated oil temperatures can cause VANOS to deactivate. Oil that is too thick (high viscosity) may cause a DTC to be set in the ECM. If VANOS is deactivated (limp-home mode), there will be a noticeable loss of power.*

Table a. VANOS fault codes		
BMW code	**P-code**	**Fault description**

Table a. VANOS fault codes		
BMW code	**P-code**	**Fault description**
19	P1529	VANOS solenoid valve activation, exhaust
21	P1525	VANOS solenoid valve activation, intake
103	P1519	VANOS faulty reference value intake
104	P1520	VANOS faulty reference value exhaust
105	P1522	VANOS stuck (Bank 1) intake
106	P1523	VANOS stuck (Bank 2) exhaust

Double VANOS components





VANOS control unit

1 - **Bolt M6**

2 - **Exhaust camshaft position 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**

- CAUTION: left hand thread

- tighten to 10 Nm (89 in-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 (89 in-lb)

11 - **Gasket**

12 - **Cylinder head**

13 - **Sealing ring**

14 - **Intake camshaft sensor**

15 - **Bolt M6**

16 - **VANOS control unit**

17 - **Copper sealing ring**

18 - **VANOS oil feed line**

19 - **Banjo bolt**

- tighten to 32 Nm (24 ft-lb)

VANOS control unit, removing

Note:

If the Double VANOS control unit is being replaced, camshaft timing must be checked as described later in this group. This procedure requires multiple special tools. Be sure to read the procedures through before beginning the repair.

- Working inside trunk, disconnect

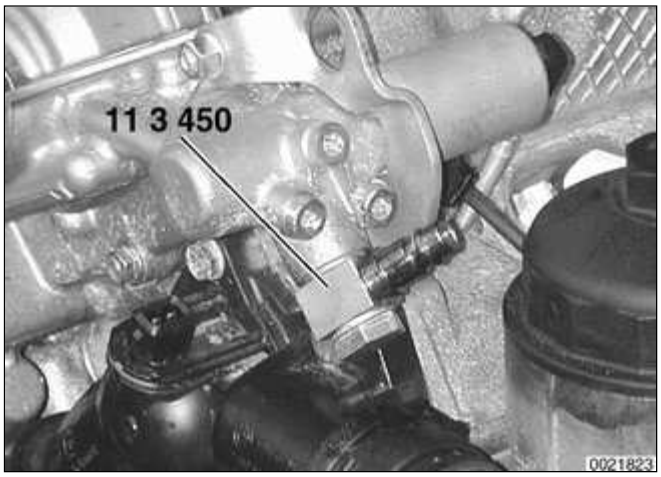
negative (-) battery cable.

CAUTION!

- ***Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.***

- ***Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.***

- Remove complete air filter housing, cylinder head cover, intake camshaft plastic cover and spark plugs, as described earlier in ⇒ Camshaft Timing Chains, Removing.



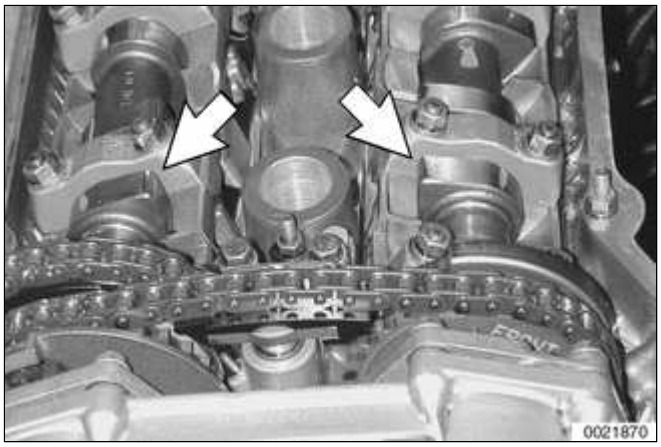
Remove banjo bolt from VANOS unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) to VANOS unit.

CAUTION!

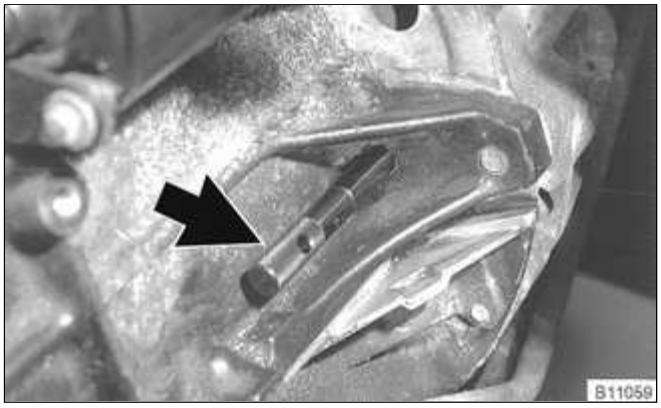
- ***Oil will drain from pressure line. Have a container and rags ready. Do not allow oil to run onto drive belts.***

- ***Cover top of VANOS unit with lint-free shop cloth. Compressed air will force oil to spray out of oil bore on top of unit.***

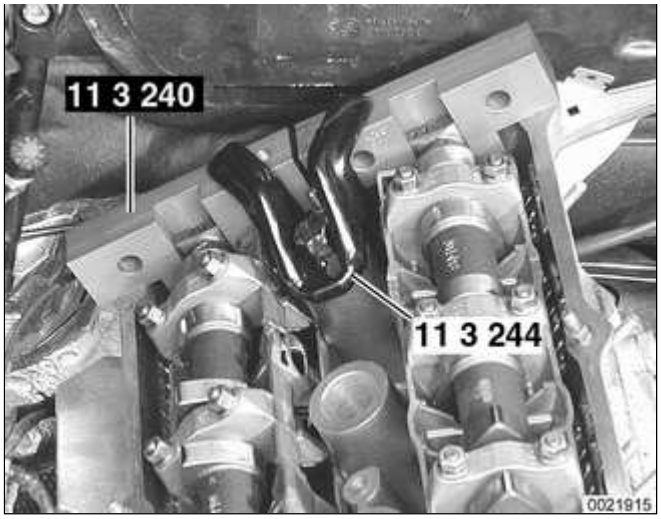
- Connect compressed air line (with line pressure set to 2 - 8 bar or 30 - 110 psi) to air fitting.



- With compressed air line connected, turn engine at least twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face each other.



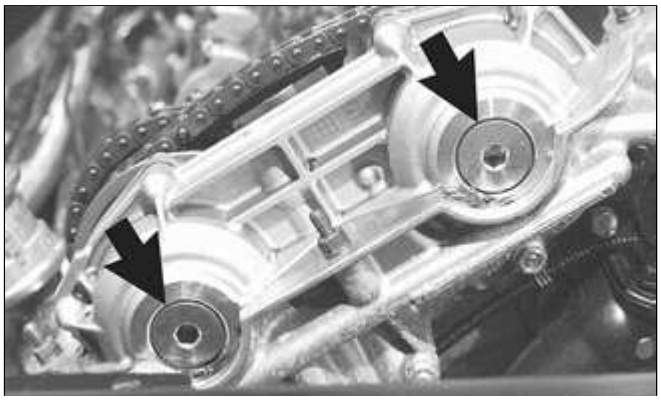
- Remove sealing plug from bore on lower left side of engine block (flywheel end). Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).
  - Unscrew and remove cylinder head cover studs at rear of cylinder head.



- Secure camshafts in TDC position using BMW special tools 11 3 240 ans 11 3 244.
  - Detach compressed air line, leaving compressed air fitting attached to VANOS unit.

Note:

Oil will drain from fittings when air line is removed. Have a container and rags ready. Do not allow oil to run onto drive belts.



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

Note:

Oil will drain from plugs when removed. Have a container and rags ready. Do not allow oil to run onto drive belts.

- Remove sealing caps from inside VANOS unit with BMW special tool 11 6 170, or with short flat nose pliers.

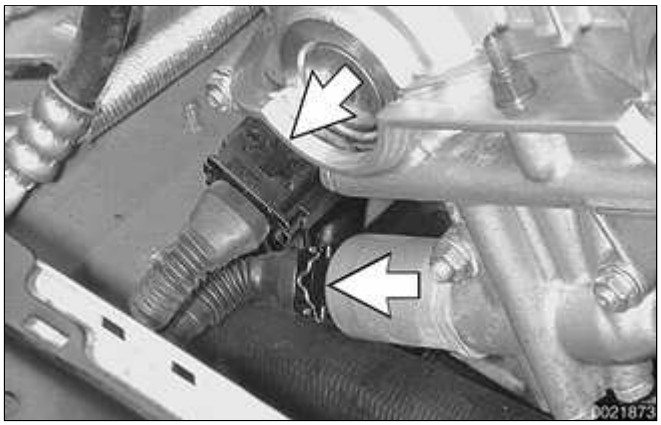
Note:

Additional oil may drain from VANOS unit.

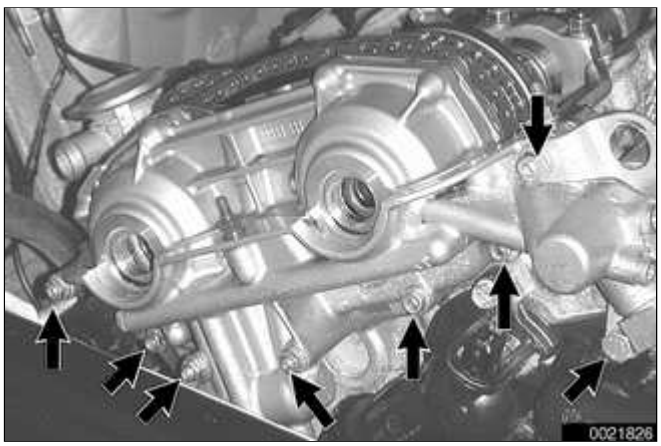
- Remove set screws (left hand thread) on ends of intake and exhaust camshaft hydraulic pistons.

CAUTION!

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



- Disconnect electrical harness connectors from camshaft position sensors and solenoid valves on both exhaust and intake sides of VANOS unit.

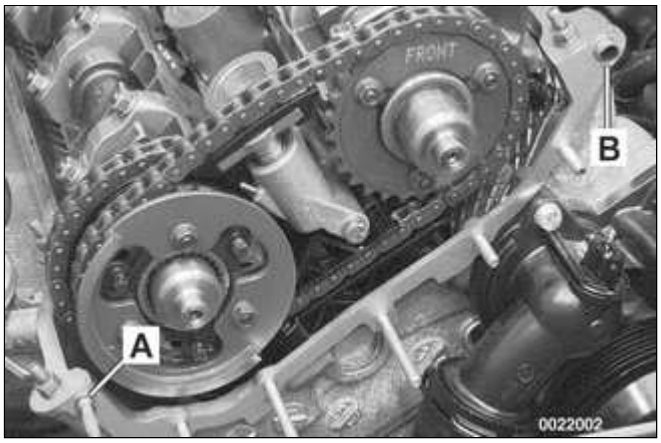


- Remove VANOS unit:
  - Remove fasteners from engine support eye.
  - Remove VANOS mounting nuts (**arrows**) from cylinder head. Slide VANOS unit and metal gasket off.

CAUTION!

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

VANOS control unit, installing



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

CAUTION!

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

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

Note:

- *If the Double VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described later in this group.*

- *If work being carried out has no effect on camshaft timing, it is not necessary to recheck the timing. It is recommended however that the VANOS operation be checked using a compatible scan tool.*

- Using new gasket, install VANOS unit to cylinder head.

- Reinstall engine support eye.

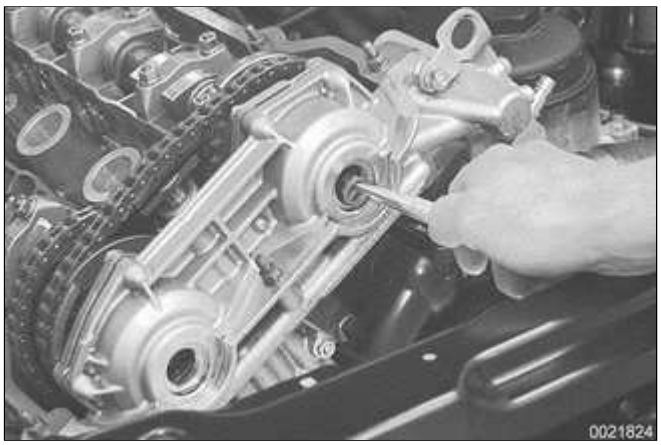
Tightening torque	
VANOS unit to cylinder head	
M6 nut	10 Nm (89 in-lb)
M7 nut	14 Nm (10 ft-lb)

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

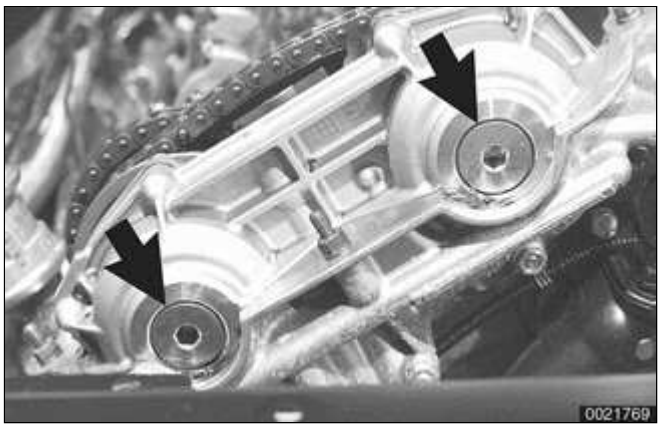
CAUTION!

Set screws have left hand thread. Tighten counterclockwise.

Tightening torque	
Hydraulic piston to splined shaft M6 set screw	10 Nm (89 in-lb)



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



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

Tightening torque	
Sealing plug to VANOS unit	50 Nm (37 ft-lb)

- Remove compressed air fitting from VANOS unit.

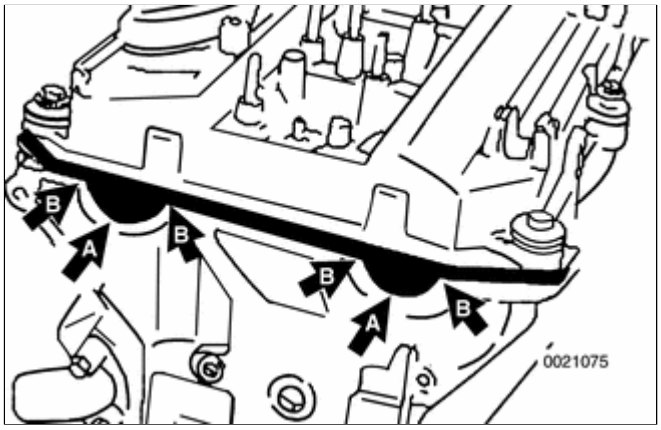
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS unit.

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

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

- Remove BMW special locking tools from rear of cylinder head.

- Remove BMW special locking tool from flywheel and replace dust guard.



Install intake camshaft plastic baffle and then 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.

- 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 (89 in-lb)

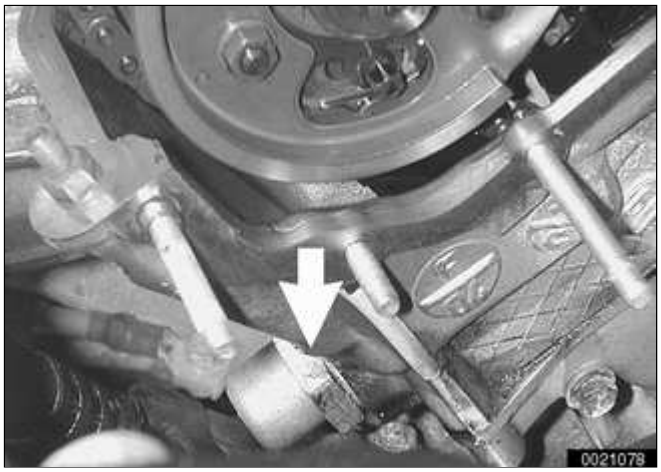
- Remainder of installation is reverse

of removal.

Tightening torques	
Radiator fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

Camshaft timing, adjusting

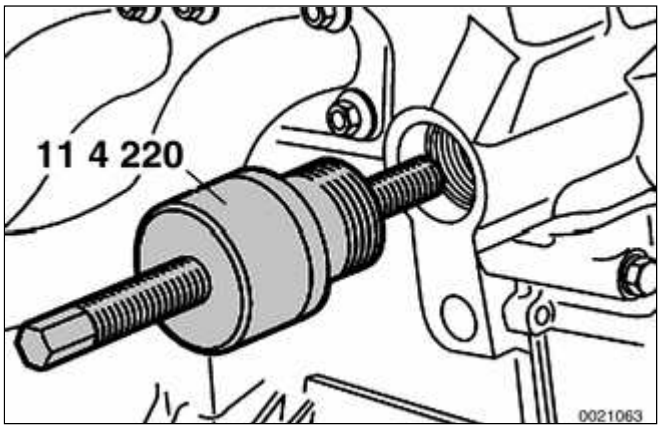
Use this procedure to check and, if necessary, adjust camshaft timing. This procedure assumes that the cylinder head cover and intake camshaft plastic baffle have been removed as described under ⇒ Camshaft Timing Chains, Removing. Also, be sure the cooling fan behind the radiator and the spark plugs have been removed.



- Remove primary camshaft chain tensioner cylinder (**arrow**).

CAUTION!

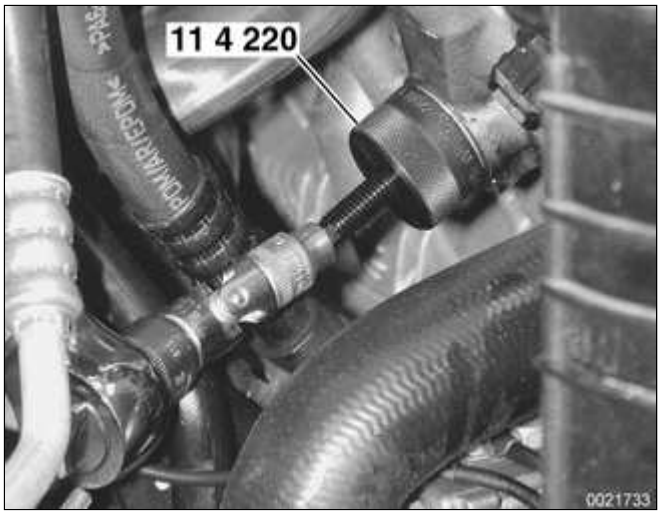
Primary camshaft chain tensioning piston is under spring pressure.



- Insert BMW special tool 11 4 220 in cylinder head and bring adjustment screw into contact with tensioning rail.

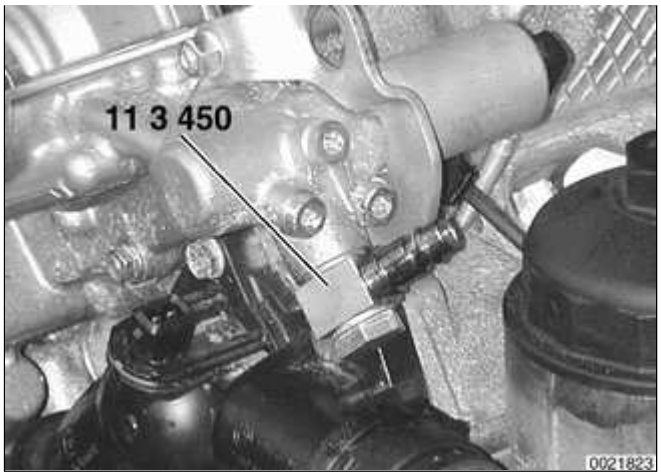
Note:

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

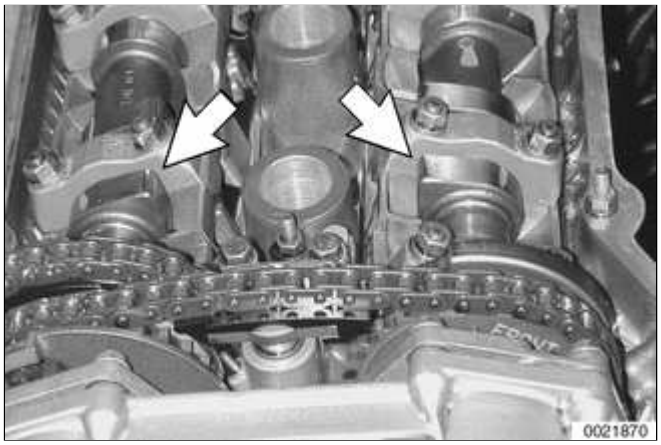


- Unscrew oil pressure pipe from VANOS unit. Remove banjo bolt from oil pressure line and install BMW special tool 11 3 450.

CAUTION!

Cover top of VANOS unit with lint-free shop cloth. Attachment of compressed air line will force oil to spray out of bore.

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



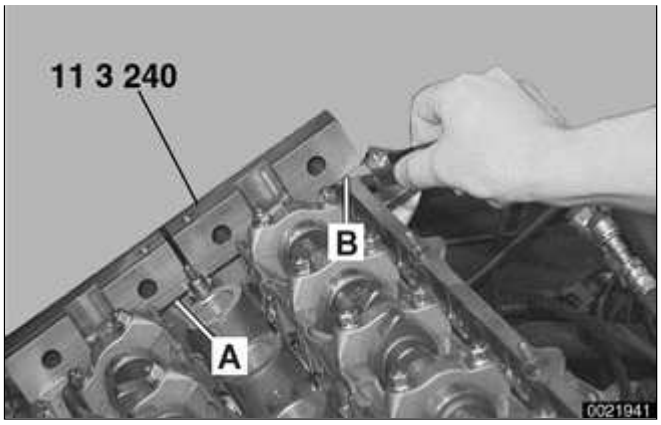
- With compressed air line connected, turn engine at least twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face each other.

CAUTION!

Do not rotate engine counterclockwise to reach the top dead center position. Instead, complete another two complete rotations.

- Remove sealing plug from 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 cylinder head cover studs at rear of cylinder head.

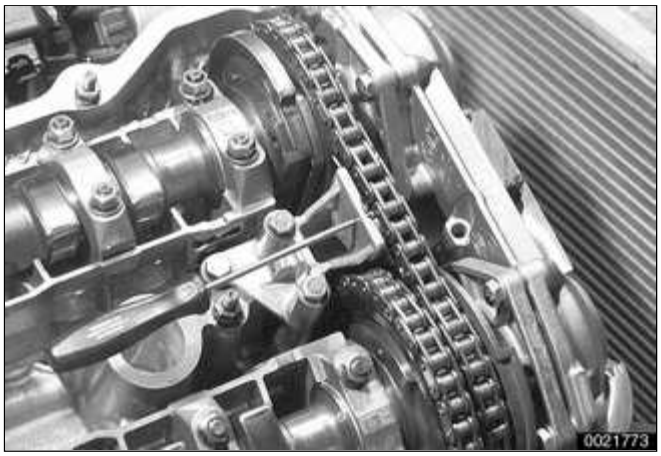


- Place BMW special tool 11 3 240 over camshafts ends and measure clearance of tool to cylinder head surface.

Note:

- *If the exhaust side of the tool (**A**) is not flush with the head, retime the camshafts as described below.*
- *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, retime the engine as described below.*

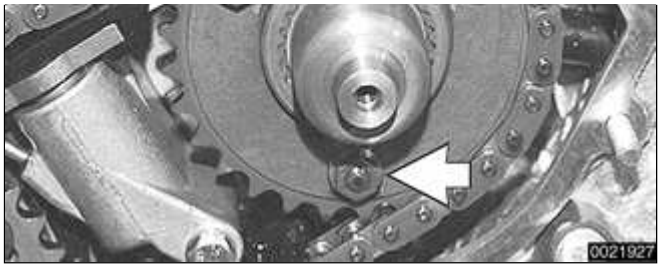
- Remove Double VANOS unit as described earlier.

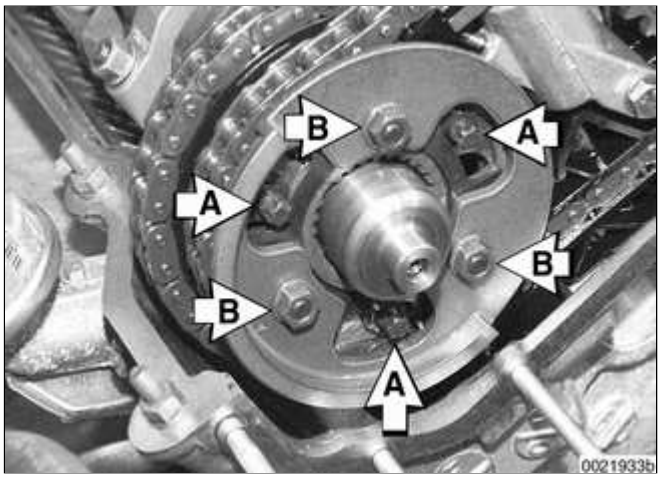


- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or equivalent.

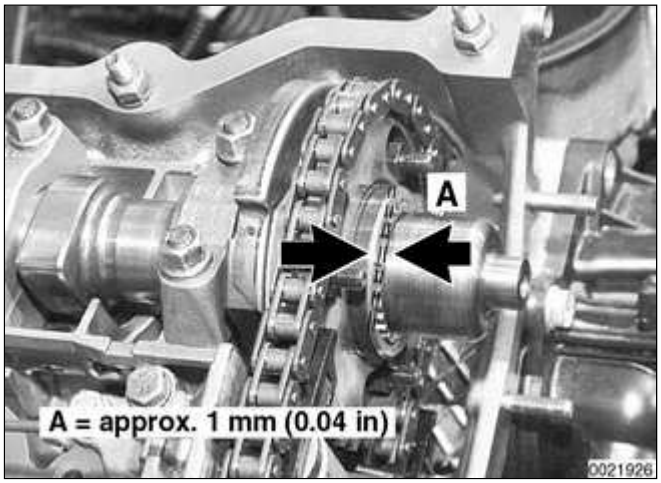
- Make sure primary chain tensioner dummy tool (special tool 11 4 220) is installed in side of cylinder head and just touching tensioning rail. Do not preload chain yet.

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

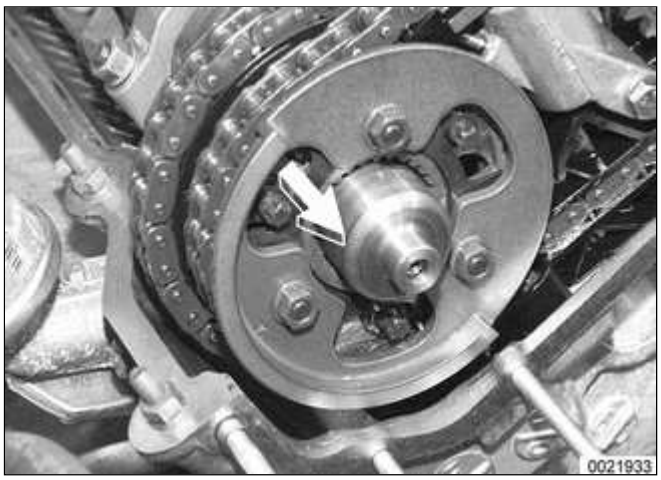




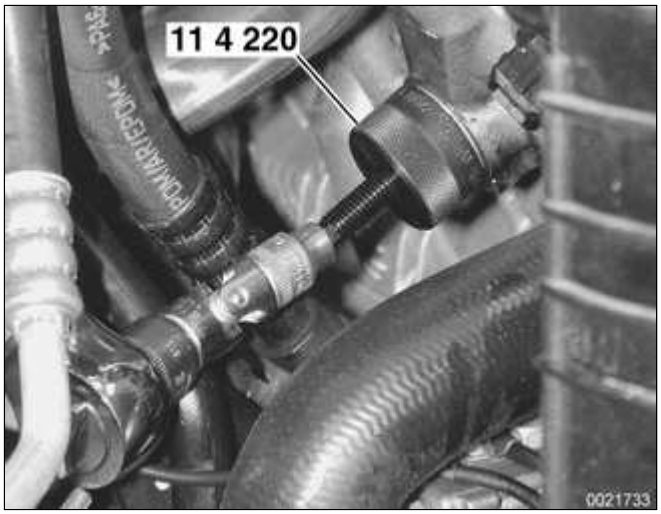
- Loosen exhaust camshaft sprocket mounting bolts (**A**) turn.
  - Loosen exhaust camshaft impulse wheel mounting nuts (**B**) 2 turns.



- Slide out intake camshaft splined shaft until approx. 1 mm (0.04 in) of splines (**arrows**) can be seen.

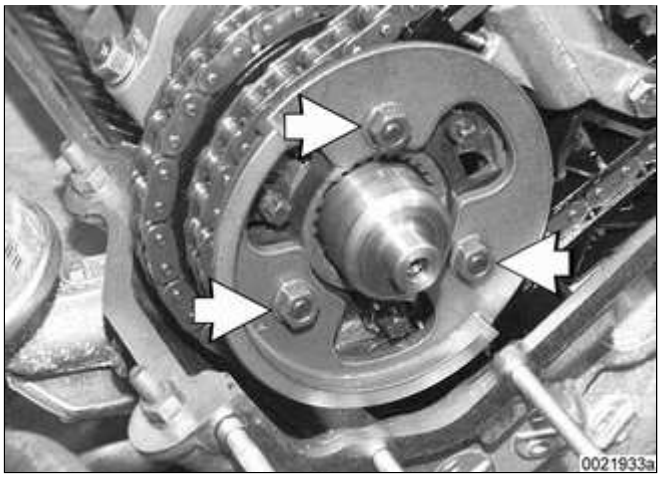


- Pull out exhaust camshaft splined shaft to stop.
  - Make sure camshafts are secured in TDC position using BMW special tools 11 3 240 and 11 3 244.

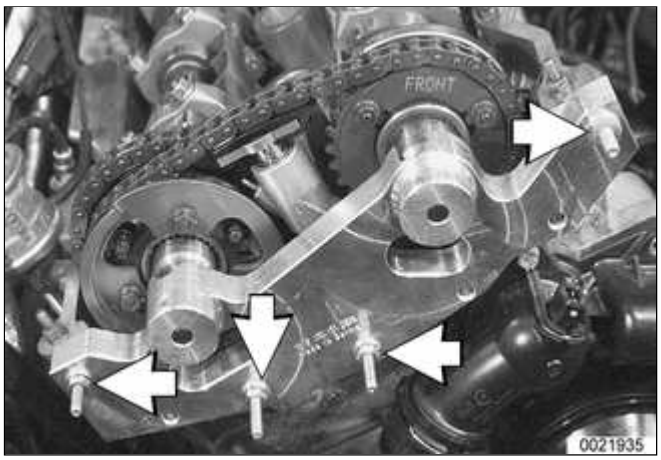


- Preload primary chain tensioning rail:
  - Tighten adjusting screw on BMW special tool 11 4 220.

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



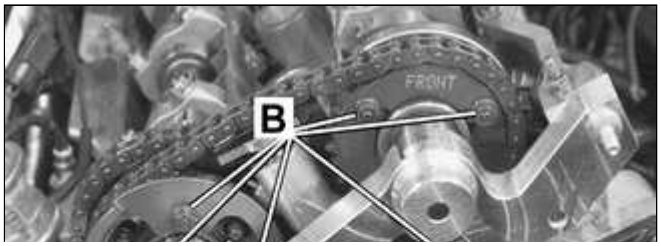
- Preload exhaust camshaft spring plate by pressing on impulse wheel. Tighten mounting nuts (**arrows**) by hand. Do not tighten fully.



- 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 is in full contact with cylinder head.

CAUTION!

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



- Secure camshaft 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.

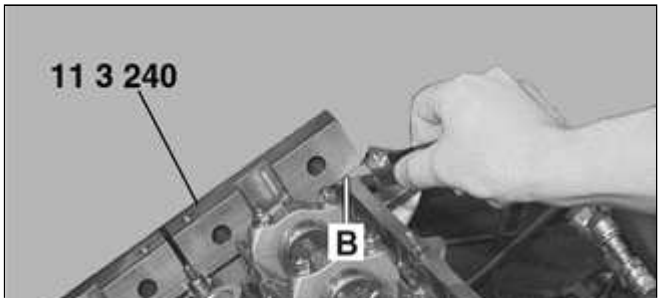
Tightening torques	
Sprocket assembly to camshaft initial torque	5 Nm (44 in-lb)
Sprocket assembly to camshaft	
M7 Torx screw (**A**)	20 Nm (15 ft-lb)
M6 mounting nut (**B**)	10 Nm (89 in-lb)

- Remove flywheel locking tool from transmission bellhousing so that crankshaft is no longer locked.

- Remove camshaft locking tools from rear of cylinder head.

- 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 11 3 240 over camshaft ends and measure clearance of tool to cylinder head surface.

Note:

- *If the exhaust side of the tool (A) is*

not flush with the head, camshaft timing is incorrect. Repeat camshaft timing procedure.

- *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 procedure.*

- Remove camshaft locking tools from rear of camshafts.

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

Tightening torque	
Primary chain tensioner cylinder to cylinder head	70 Nm (52 ft-lb)

- Remove flywheel locking tool from transmission bellhousing Reinstall sealing plug.

- Remove VANOS setup bracket from front of cylinder head.

- Install VANOS control unit as described earlier in this group.

- Remove compressed air fitting (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 engine assembly is reverse of disassembly.

Tightening torques	
Radiator cooling fan (viscous clutch) to coolant pump	40 Nm (30 ft-lb)
Cylinder head cover to cylinder head	10 Nm (89 in-lb)
Spark plug to cylinder head	25 Nm (18 ft-lb)

General

This repair group covers lubrication system troubleshooting as well as oil pan removal and oil pump replacement.

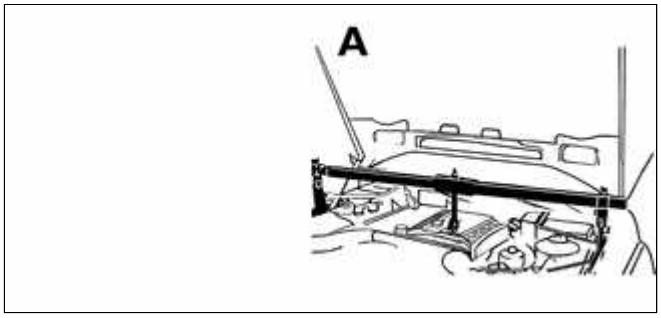
Special tools

The engine needs to be properly supported while the front suspension subframe is removed to access the lubrication system. If BMW special tools 00 0 200 / 00 0 208 are not available, a device to support the weight of the engine from above would be suitable.

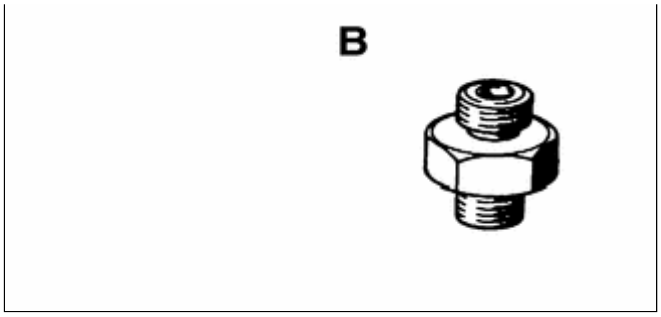
A standard oil pressure gauge may be used for measuring oil pressure. If the BMW DIS tester system is to be used, a special adapter is needed.

Note:

Oil change procedure and oil filter replacement are covered in ⇒ 020 Maintenance



- Engine support bracket BMW 00 0 200/00 0 208



- Adapter for BMW oil pressure gauge BMW 11 4 050

Engine lubrication

Oil pressure is generated by a gear-type pump bolted to the bottom of the engine block. The oil pump is chain driven off the front of the crankshaft.

Oil passages in the cylinder block and cylinder head connect the oil pump to components such as camshafts, crankshaft and valve lifters.

Engine oil capacity (includes filter replacement)	
Rear wheel drive	6.5 liters (6.9 qt.)
All wheel drive	7.5 liters (7.9 qt.)

Troubleshooting

The oil pressure warning system consists of an oil pressure switch mounted in the oil circuit and an instrument panel warning light. Other safety features include:

- Oil level warning system
- A filter bypass to provide lubrication should the oil filter become clogged
- An oil pump pressure relief valve to prevent excessive system pressure

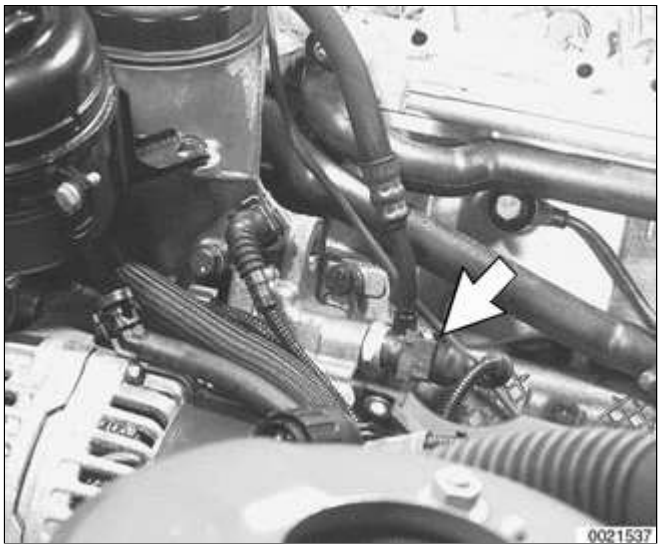
CAUTION!

If the red oil pressure warning light comes on or flashes on while driving, always assume that the oil pressure is low.

Oil pressure, checking

In some engines access to the oil pressure warning switch port may be extremely restricted.

- Unscrew oil filter cap in order to allow engine oil to drain back down into oil pan.



➢ Disconnect harness connector from oil pressure switch (**arrow**) and remove switch.

CAUTION!

Running the engine with the oil pressure switch disconnected may set a fault code (DTC).

Note:

- *Thoroughly clean around the oil pressure switch before removing it.*
- *Be prepared to catch leaking oil with a shop towel.*

Component location	
Oil pressure switch	base of oil filter housing

- Install pressure gauge in place of switch.
- With gauge installed, start engine and allow to reach operating temperature. Check oil pressure both cold and hot.

Note:

For the most accurate test results, the engine oil and filter should be new. The

oil should be the correct grade.

Oil pressure	
Idle (minimum)	0.5 bar (7 psi)
Regulated pressure (elevated engine speed)	4.0 bar (59 psi)

- Remove pressure gauge and reinstall pressure switch.

Tightening torque	
Oil pressure switch to oil filter housing	27 Nm (20 ft-lb)

If testing shows low oil pressure, one or more of the following conditions may be indicated:

- Worn or faulty oil pump
- Worn or faulty engine bearings
- Severe engine wear

All of these conditions indicate the need for major repairs.

Oil pressure warning system, testing

When the ignition is turned on, the oil pressure warning light comes on. When the engine is started and the oil pressure rises slightly, the oil pressure switch opens and the warning light goes out. Make sure the oil level is correct before making tests.

- Turn ignition switch on.

- Warning light on instrument panel must light up.

- Remove connector from oil pressure switch.

- Warning light on instrument panel must go out.

CAUTION!

Running the engine with the oil pressure switch disconnected may set a fault code (DTC).

Note:

If the light does not go out, the wiring to the switch is most likely grounded somewhere between the switch terminal and the warning light. See Electrical Wiring Diagrams at rear of manual for electrical schematics.

- If warning light does not light when ignition is on, remove connector from oil pressure switch and use a jumper wire to ground connector terminal to a clean metal surface.

Note:

If the warning light comes on, check the switch as described in the next step. If the warning light does not come on, the wiring to the instrument cluster or to the light itself is faulty.

- To test switch, connect an ohmmeter between terminal in switch body and ground. With engine off, there should be continuity. With engine running, oil pressure should open switch and there should be no continuity.

Replace a faulty switch.

CAUTION!

Keep in mind that low oil pressure may be preventing the switch from turning the light out. If the light remains on while the engine is running, check the oil pressure as described earlier. Do not drive the car until the problem is corrected. The engine may be severely damaged.

Oil Pan

The oil pan removal procedure requires that the engine be supported from above and the front suspension subframe be unbolted and lowered from the chassis.

Oil pan, removing and installing (rear wheel drive models)

- Raise car and place securely on jack stands.

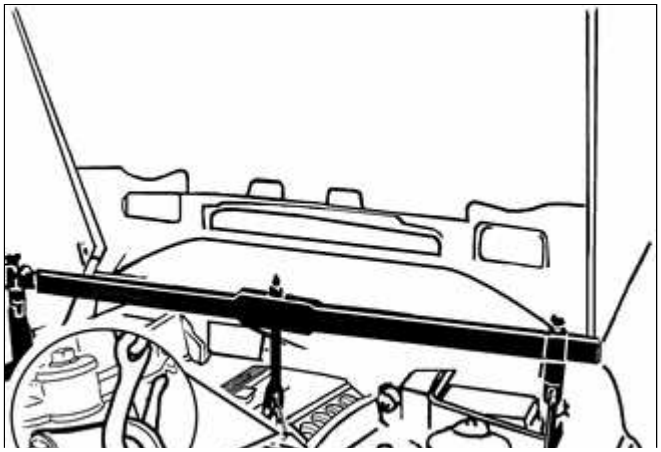
WARNING!

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.

- Remove splash shield from under engine.

- Drain engine oil as described in ⇒ 020 Maintenance

- Remove air filter housing complete with mass air flow sensor.

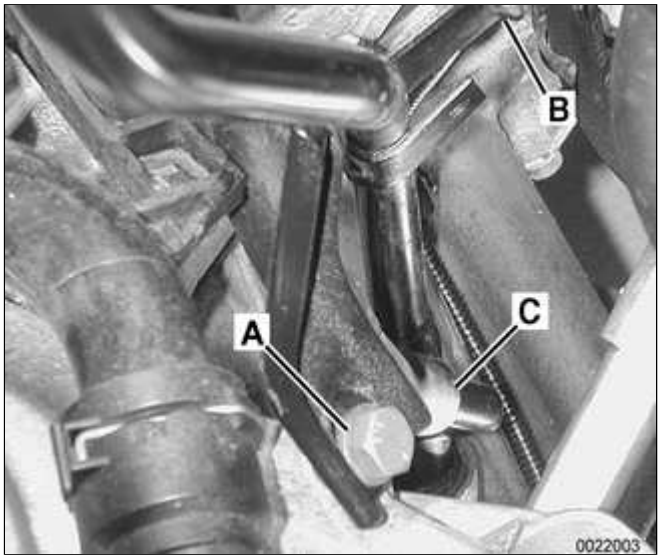


- Install engine lifting equipment at front engine lifting point and raise approximately 5 mm (inch) until engine weight is supported.

- On cars with automatic transmission, remove ATF cooler line brackets from oil pan and from transmission.

Note:

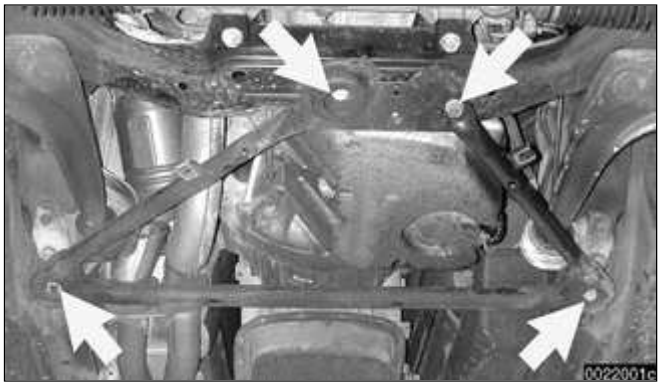
Place drain pan under lines to catch ATF drips.



- Remove oil dipstick guide tube:
  - Detach mounting bolt (**A**) from left engine mounting bracket.
  - Detach fuel lines and wiring harness brackets (**B**).
  - Disconnect oil separator hose (**C**) from base of guide tube and remove tube from oil pan.

Note:

The guide tube is sealed in the block using an O-ring. Check that the O-ring comes out with the tube.



- Working underneath car, remove bolts (**arrow**) and lower reinforcing brace between front suspension subframe and body.

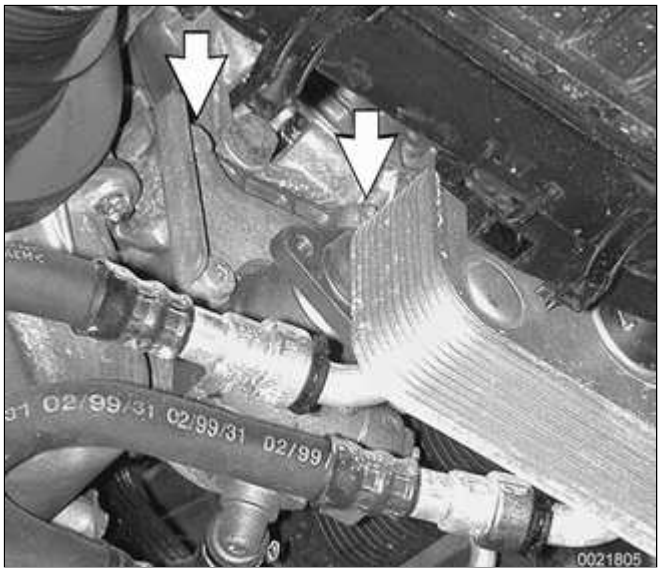
Note:

Reinforcement consists of a triangulated bar for Sedan or Sport Wagon or a reinforced plate for Convertible or Coupe.

- Separate steering column shaft from steering rack at universal joint.

CAUTION!

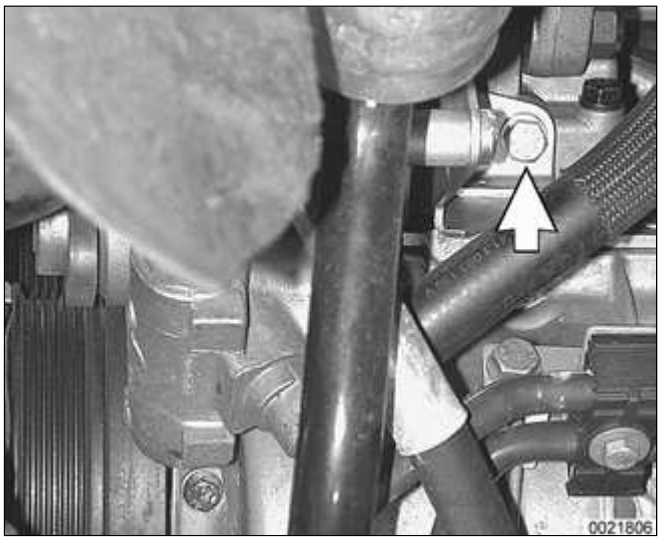
In order to avoid the need for front-end realignment, do not unbolt power steering rack from suspension subframe.



- Remove power steering pump pulley. Remove two mounting bolts from the front (**arrows**)

Note:

Do not detach power steering fluid lines from pump.

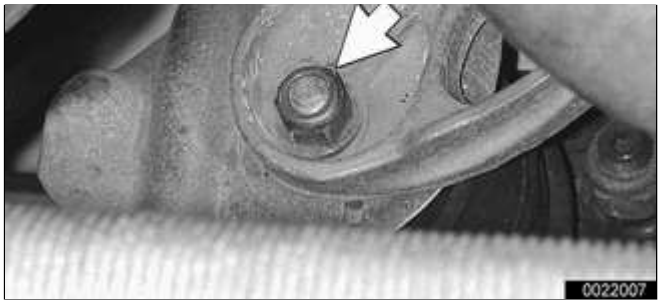


- Remove third power steering mounting bolt (**arrow**) and remove pump from its mounting bracket. Use stiff wire to suspend pump from chassis.

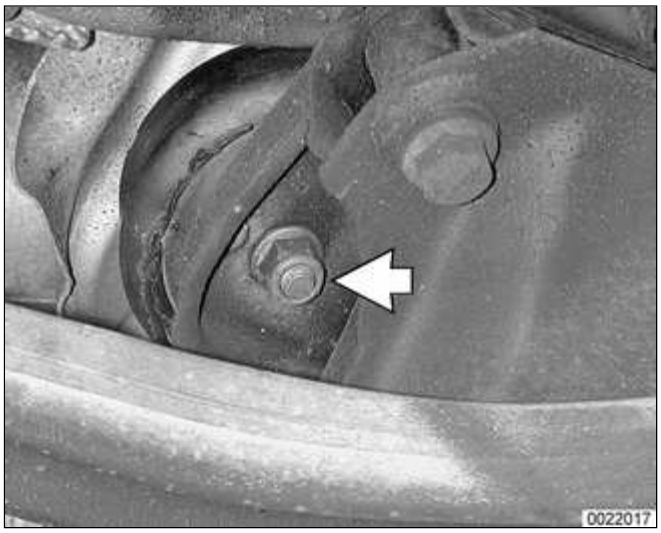
- Detach electrical harness connector (**arrow**) at oil level sensor.

- Loosen top engine mount fasteners (**arrow**).

Note:



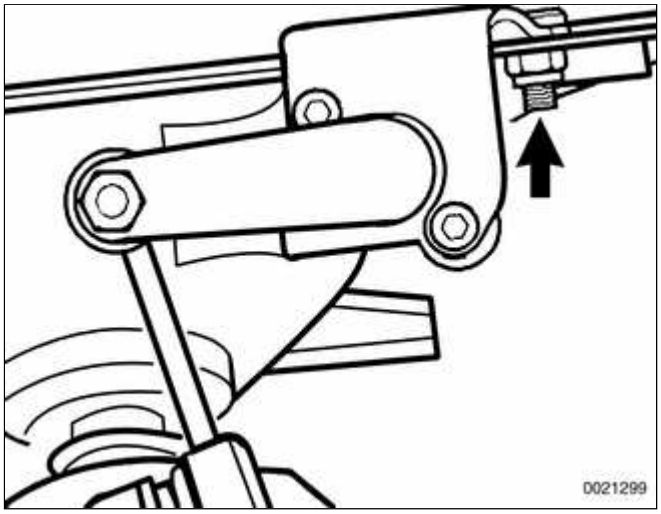
Right side is shown in photo. Left is similar.



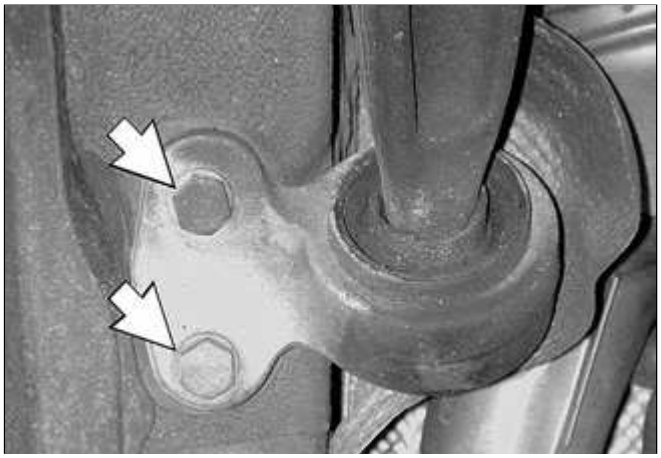
- Loosen lower engine mount fasteners (**arrows**).

Note:

Right side is shown in photo. Left is similar.



- If applicable, remove front ride level sensor mounting bolt (**arrow**) and lay sensor aside.

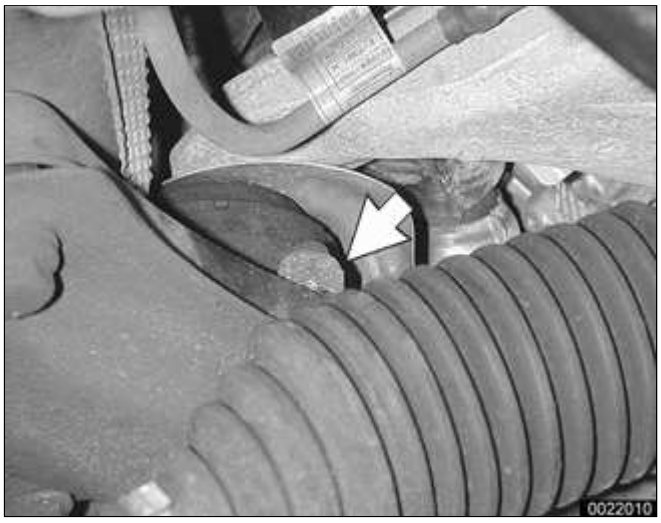


- Remove left and right front control arm bracket bolts (**arrows**) from frame rails.

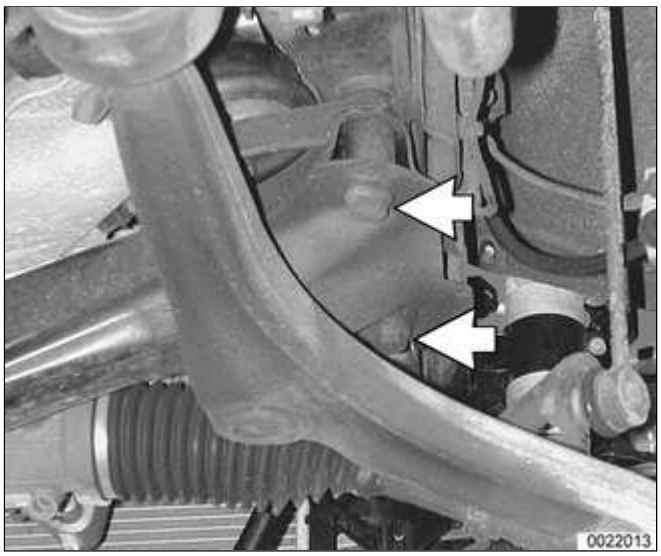
Note:

Right side is shown in photo. Left is similar.

  - Detach left and right stabilizer bar anchors from frame rails.



- Remove left control arm ball joint mounting nut (**arrow**) at front suspension subframe.
  - Drive ball joint out from subframe using soft hammer.
  - Push control arm aside.
  - Repeat for left side.



- Support suspension subframe from below using appropriate jacking equipment. Remove subframe mounting bolts (**arrows**) and lower subframe as far as possible.

Note:

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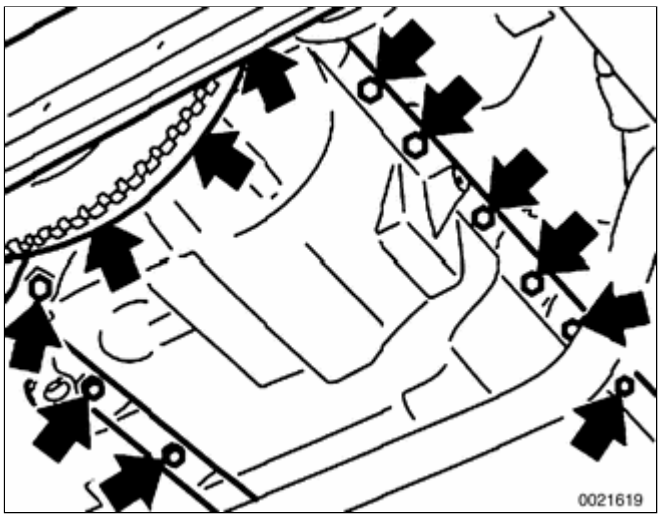
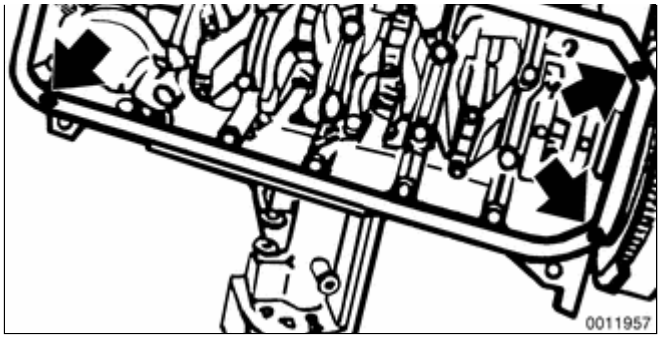


- Remove oil pan screws (**arrows**) at cylinder block and transmission bellhousing. Lower oil pan forward to remove.

CAUTION!

If the oil pan does not separate easily from the engine cylinder block, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.

- When installing oil pan:
  - Thoroughly clean all old gasket



material from mating surfaces and use a new gasket.

- Apply a small amount of non-hardening sealer (3-Bond 1209® or equivalent) to oil pan gasket directly below joints (**arrows**) for end cover and front timing case cover. Apply a bead 3 mm wide by 2 mm high.

- Tighten oil pan bolts to cylinder block evenly all around.

- Tighten transmission bellhousing bolts last.

Tightening torque	
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pan to engine block	
M6, 8.8 grade	10 Nm (89 in-lb)
M6, 10.9 grade	12 Nm (106 in-lb)
Transmission bellhousing to oil pan	
M8 Allen	24 Nm (17 ft-lb)
M8 Torx	21 Nm (15 ft-lb)

- Remainder of installation is reverse of removal.

- Replace self-locking nuts when reinstalling front suspension components.

- Match up key ways while installing steering column shaft. See ⇒ 320 Steering and Wheel Alignment for more specific procedures.

- Use new oil dipstick tube sealing O-ring.
- Fill engine with oil as described in ⇒ 020 Maintenance.
- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning lamp goes out (about 5 seconds).

Note:

BMW does not recommend a front end alignment following this procedure.

Tightening torques	
Control arm ball joint to suspension subframe	90 Nm (66 ft-lb)
Front subframe to frame rails (M12, use new bolts)	
8.8 grade	77 Nm (57 ft-lb)
10.9 grade	110 Nm (81 ft-lb)
12.9 grade	105 Nm (77 ft-lb)
Front end reinforcement to frame rails or suspension subframe (M10, use new bolts)	
Initial torque	59 Nm (44 ft-lb)
Torque angle	90° + 30°
Stabilizer bar to frame rail (M8 nut)	22 Nm (16 ft-lb)
Steering column universal joint clamping screw (M8 bolt, use new bolt)	22 Nm (16 ft-lb)

Oil pan, removing and installing (all wheel drive models)

- Raise car and place securely on jack stands.

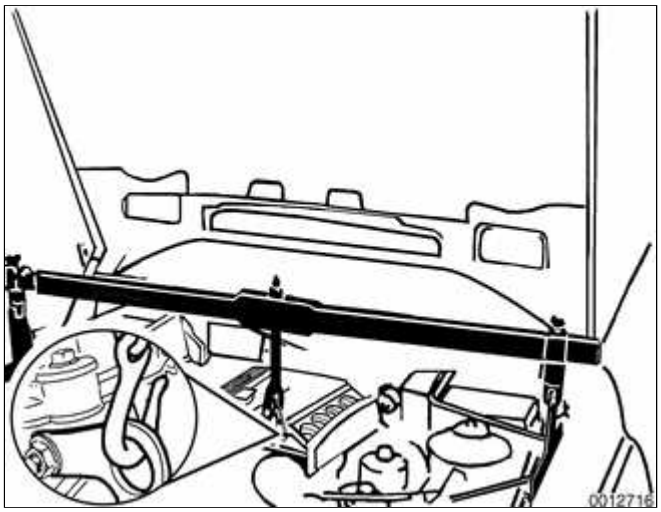
WARNING!

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.

- Remove splash shield from under engine.

- Drain engine oil as described in ⇒ 020 Maintenance

- Remove air filter housing complete with mass air flow sensor.



➢ Install engine lifting equipment at front engine lifting point and raise approximately 5 mm (inch) until engine weight is supported.

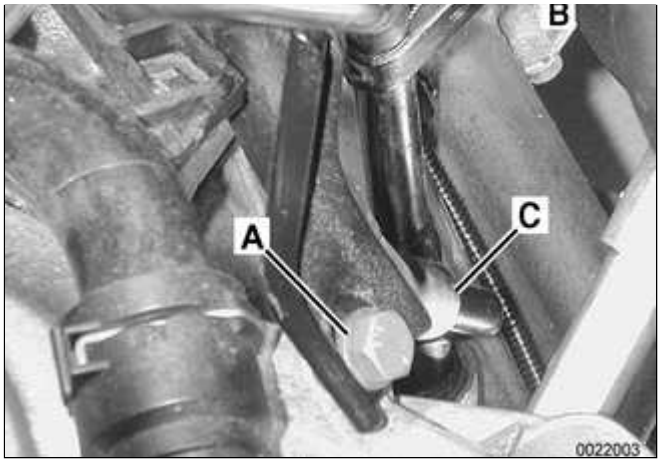
- Remove fuel line clamping brackets from oil pan.

- On cars with automatic transmission, remove ATF cooler line brackets from oil pan and from transmission.

Note:

Place drain pan under lines to catch ATF drips.

➢ Remove oil dipstick guide tube:

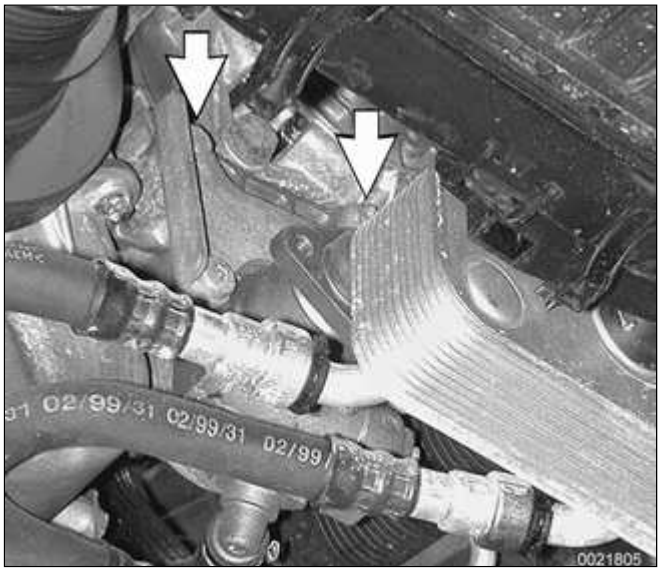


- Detach mounting bolt (**A**) from left engine mounting bracket.
- Detach fuel lines and wiring harness brackets (**B**).
- Disconnect oil separator hose (**C**) from base of guide tube and remove tube from oil pan.

Note:

The guide tube is sealed in the block using an O-ring. Check that the O-ring comes out with the tube.

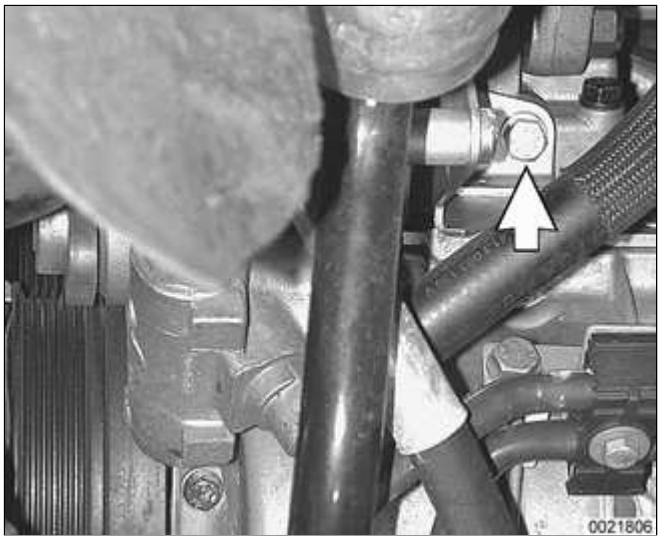
- Separate steering column shaft from steering rack at universal joint. Point wheels straight ahead before disconnecting shaft from rack. See ⇒ 320 Steering and Wheel Alignment.



- Remove power steering pump pulley. Remove two mounting bolts from the front (**arrows**).

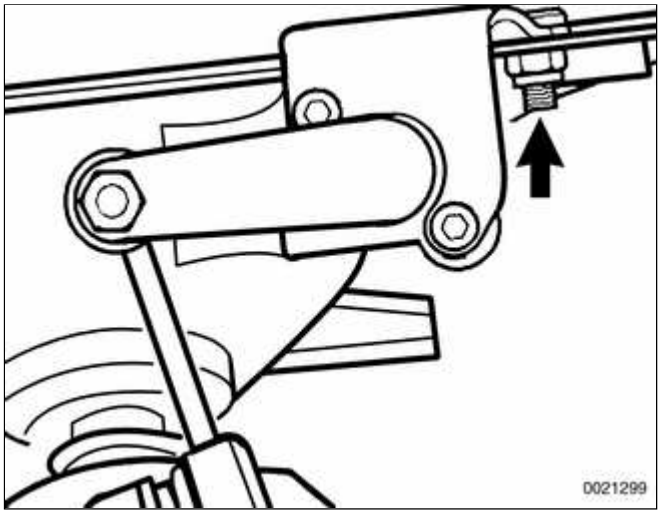
Note:

Do not detach power steering fluid lines from pump.

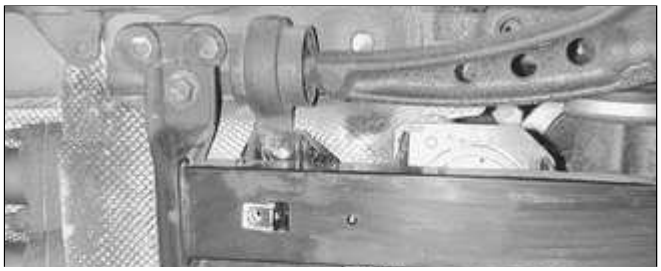


- Remove third power steering mounting bolt (**arrow**) and remove pump from its mounting bracket. Use stiff wire to suspend pump from chassis.

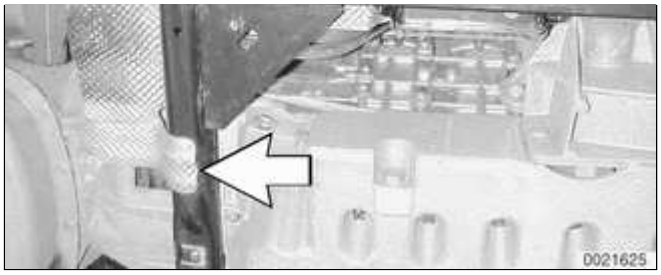
- Detach electrical harness connector at oil level sensor.
    - Remove lower engine mount fasteners.

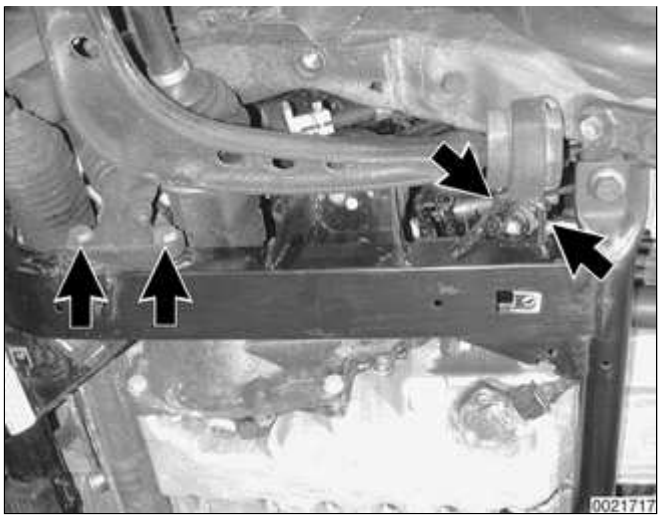


- If applicable, remove front ride level sensor mounting bolt (**arrow**) and lay sensor aside.

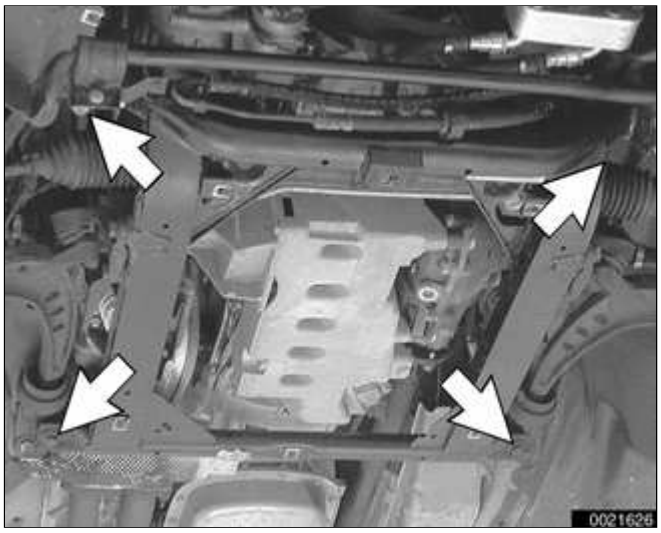


- Working at rear right corner of front subframe, unhook heatshield from subframe (**arrow**).
    - Detach stabilizer bar anchors from frame rails.





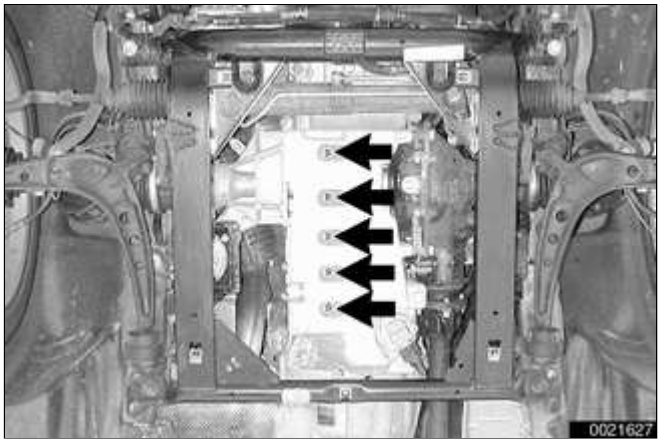
- Remove control arm rear bracket and ball joint mounting bolts (**arrows**) from subframe.
  - Remove control arms and front drive axles as described in ⇒ 310 Front Suspension.
  - Remove front differential and right axle inner bearing pedestal as described in ⇒ 311 Front Axle Final Drive.



- Support subframe while removing four mounting bolts (**arrows**).

CAUTION!

Lower subframe as far as possible without damaging power steering lines. Make sure it is adequately supported throughout the remainder of this procedure.



- Remove oil pan:
  - Remove bellhousing bolts from oil pan.
  - Remove all oil pan periphery bolts.
  - Remove center oil pan bolts (**arrows**).

- Lower oil pan to remove.

CAUTION!

If the oil pan does not separate easily from the engine cylinder block, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.

- When reinstalling oil pan:

- Thoroughly clean all old gasket material from mating surfaces and use a new gasket.

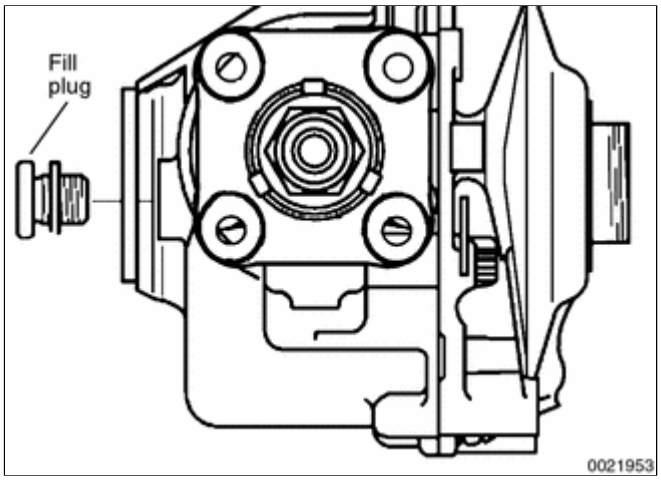
- Apply a small amount of non-hardening sealer (3-Bond 1209® or equivalent) to oil pan gasket directly below joints for end cover and front timing case cover. Apply a bead 3 mm wide by 2 mm high.

- Tighten oil pan bolts to cylinder block evenly all around.

- Tighten transmission bellhousing bolts last.

Tightening torque	
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pan to engine block	
M6, 8.8 grade	10 Nm (89 in-lb)
M6, 10.9 grade	12 Nm (106 in-lb)
M8, 8.8 grade	22 Nm (16 ft-lb)
Transmission bellhousing to oil pan	
M8 Allen	24 Nm (17 ft-lb)

Tightening torque	
M8 Torx	21 Nm (15 ft-lb)



- Reinstall front differential and right axle inner bearing pedestal. See ⇒ 311 Front Axle Final Drive.

  - Fill differential to lower edge of fill plug.

Tightening torques	
Fill or drain plug to front differential	65 Nm (48 ft-lb)
Front differential to oil pan (M10)	45 Nm (33 ft-lb)

- Reinstall front axles, control arms and front steering arms as described in ⇒ 310 Front Suspension.

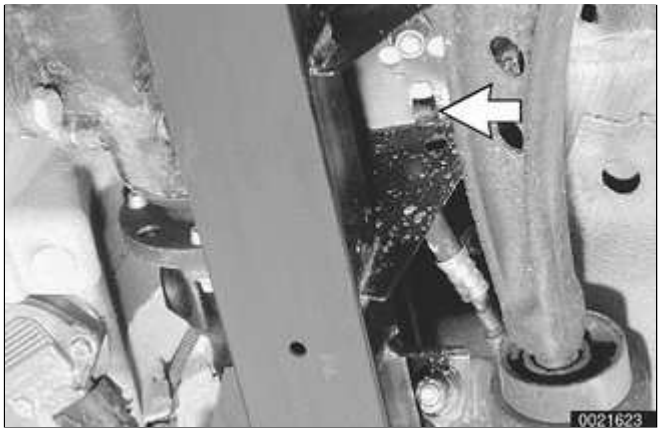
Note:

- *Be sure to replace seals on differential output flanges.*

- *Replace self-locking fasteners when reinstalling front suspension components.*

Tightening torques	
Control arm ball joint bracket to subframe	
M12 bolt	77 Nm (57 ft-lb)
Control arm mounting bracket to subframe	
M10 bolt (always replace)	59 Nm (44 ft-lb)

- When reattaching engine to subframe, be sure that left engine mount locating



tab (**arrow**) is seated correctly in subframe slot.

Tightening torques	
Engine mount to subframe	
M10 self-locking nut	45 Nm (33 ft-lb)
Front of subframe to frame rail (M12 bolt, always replace)	
8.8 grade	77 Nm (57 ft-lb)
10.9 grade	110 Nm (81 ft-lb)
12.9 grade	105 Nm (77 ft-lb)
Rear of subframe to mounting adapter	
M12 bolt (always replace)	110 Nm (81 ft-lb)

- Remainder of installation is reverse of removal.

- Match up key ways while installing steering column shaft. See ⇒ 320 Steering and Wheel Alignment for more specific procedures.

- Use new oil dipstick tube sealing O-ring.

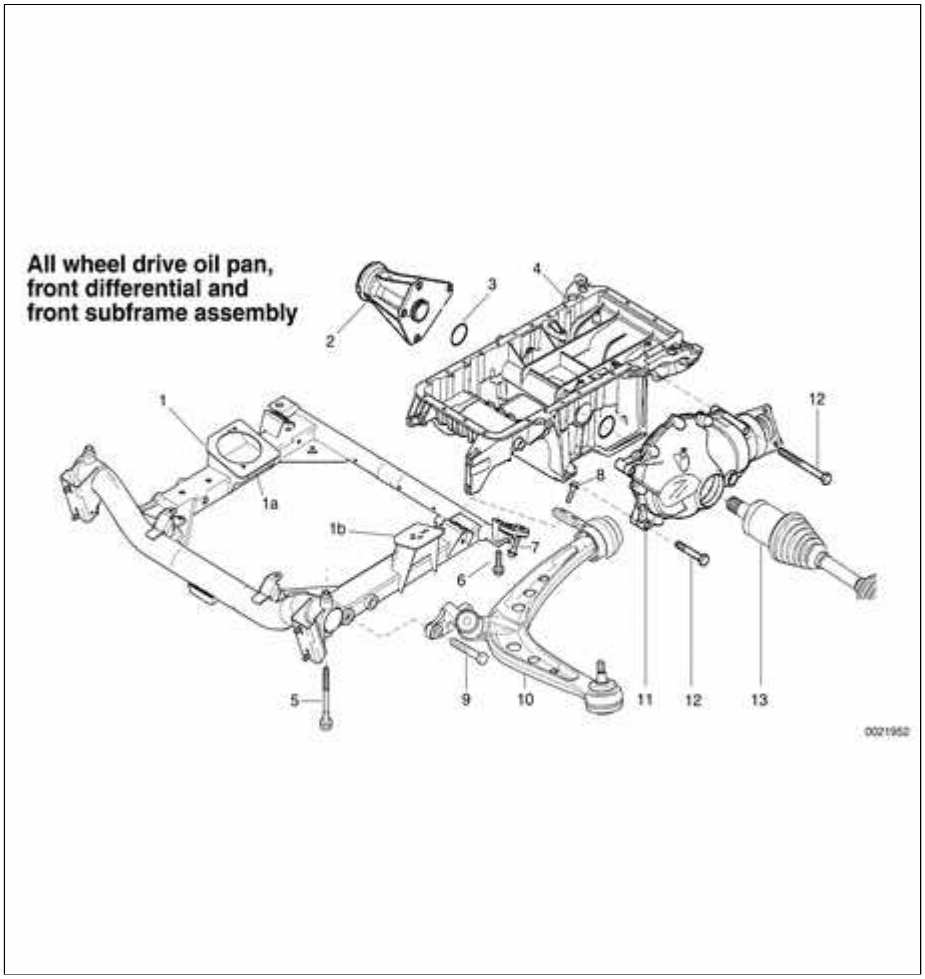
- Fill engine with oil as described in ⇒ 020 Maintenance.

- After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning lamp goes out (about 5 seconds).

Note:

Be sure to align the front end after this procedure.

Tightening torques	
Stabilizer bar to frame rail (M8 nut)	22 Nm (16 ft-lb)
Steering column universal joint clamping screw (M8 bolt, use new bolt)-	22 Nm (16 ft-lb)



All wheel drive oil pan, front differential and front subframe assembly

1 - Front subframe

1a - Right engine mounting point

1b - Left engine mounting point

2 - Right axle inner bearing pedestal

3 - Sealing O-ring

4 - Oil pan

5 - Bolt M12 (always replace) -

- 8.8 grade tighten to 77 Nm (57 ft-lb)
- 10.9 grade tighten to 110 Nm (81 ft-lb)

- 12.9 grade tighten to 105 Nm (77 ft-lb)

6 - **Bolt M12 (always replace)**

- tighten to 110 Nm (81 ft-lb)

7 - **Bolt M10 (always replace)**

- tighten to 59 Nm (44 ft-lb)

8 - **Bolt M10 (always replace)**

- tighten to 59 Nm (44 ft-lb)

9 - **Bolt M12**

- tighten to 77 Nm (57 ft-lb)

10 - **Front control arm with ball joint and rear mounting bracket**

11 - **Front differential**

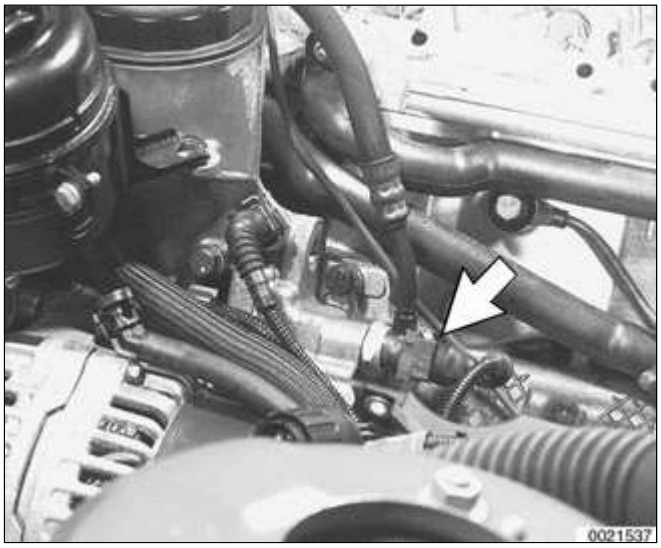
12 - **Bolt M10**

- tighten to 45 Nm (33 ft-lb)

13 - **Left front axle**

Component Replacement

Oil pressure warning switch



- The pressure warning switch is located under the intake manifold, in the rear of the oil filter housing.

Note:

Switch removal may require intake manifold removal.

Tightening torque	
Oil pressure switch to oil filter housing	27 Nm (20 ft-lb)

Oil level warning switch

- The oil level warning switch is located at the bottom of the engine oil pan.

Note:

Anytime the oil level warning switch is removed, be sure to replace the sealing O-ring between switch and oil pan.

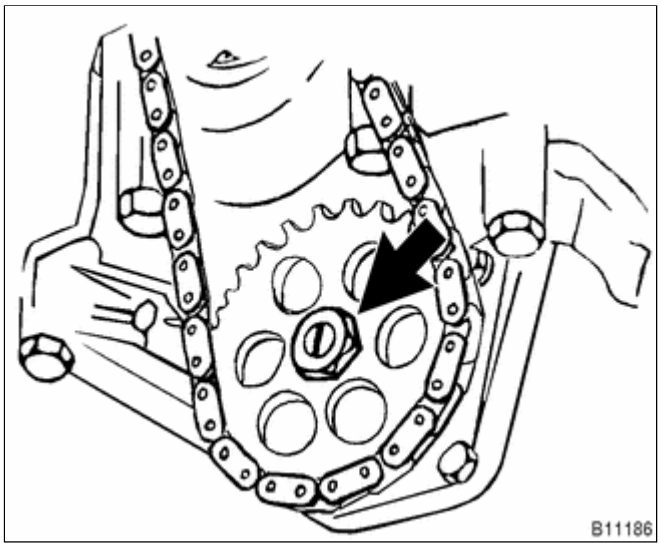
Oil pump, removing and installing

Note:

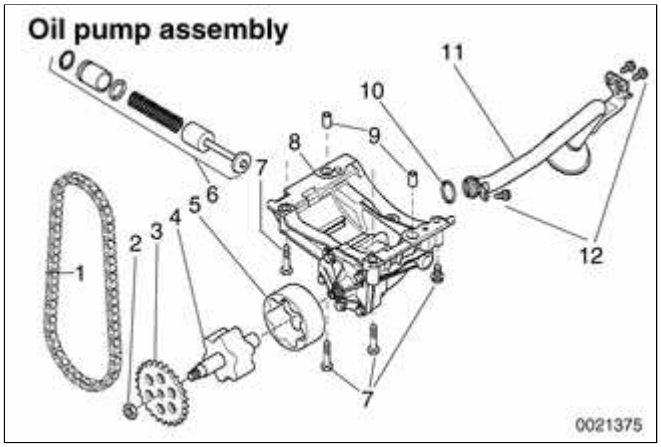
Oil pump removal requires lowering the front suspension subframe to remove the oil pan.

- Drain oil as described in ⇒ 020 Maintenance.

- Remove oil pan as described earlier.



➢ Remove oil pump sprocket mounting nut (left-hand thread) (**arrow**). Lift sprocket off together with drive chain.



➢ Remove mounting bolts from oil pump (**7**) and oil pump pickup tube (**12**). Withdraw pump.

1 - Drive chain

2 - Nut M10x1left-hand thread -tighten to 25 Nm (18 ft-lb)

3 - Oil pump sprocket

4 - Inner rotor

5 - Outer rotor

6 - Oil pressure relief valve assembly

7 - Bolt M8 -tighten to 22 Nm (16 ft-lb)

8 - Oil pump housing

9 - Locating dowels

10 - Sealing O-ring