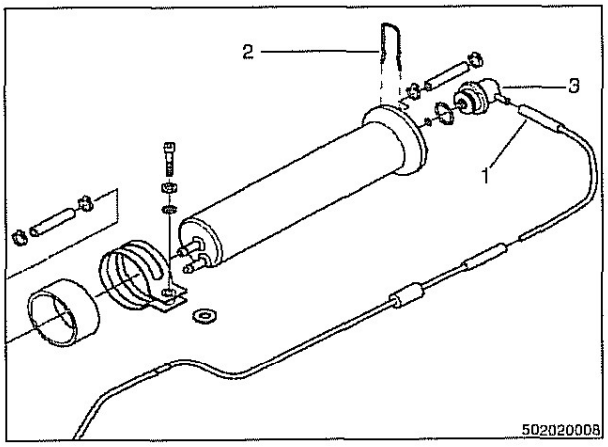
– When replacing fuel filter:
  - Use appropriate hose clamping device to clamp off filter inlet and outlet hoses to lessen fuel spillage.
  - *Loosen center clamping* bracket and hose clamps on either end of filter.
  - Note arrow or markings indicating direction of flow on new filter.
  - Install new filter using new hose clamps.

– Drain fuel filter from inlet side into a container and inspect drained fuel. Check for rust, moisture and contamination.



If fuel filter is equipped with fuel pressure regulator:
- Remove vacuum hose (**1**).
- *Pull out locking clip* (**2**).
- Remove fuel pressure regulator (**3**).
- Install pressure regulator in new filter.

> ***CAUTION—***
> - *Clean thoroughly around the filter connections before removing them.*
> - *After assembly, check filter connections carefully for leaks before installing cover.*

NOTE—
Additional information about the fuel filter assembly is in ***160 Fuel Tank and Fuel Pump.***

Fuel tank and fuel lines, inspecting

Inspect the fuel tank, fuel lines, and fuel system for damage or leaks. Check for fuel leaks in the engine compartment or fuel odors in the passenger compartment. Check for any evaporative emissions hoses that may have become disconnected, checking carefully at charcoal canister and evaporative emissions purge system. See **130 Fuel Injection** and **160 Fuel Tank and Fuel Pump** for component locations and additional information.

> ***WARNING—***
> *When checking for fuel leaks, the engine must be cold. A hot exhaust manifold or exhaust system could cause the fuel to ignite or explode causing serious personal injury. Ventilate the work area and clean up spilled fuel immediately.*

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Suspension, front, inspecting

Inspection of the front suspension and steering includes a check of all moving parts for wear and excessive play. Inspect ball joint and tie-rod rubber seals and boots for cracks or tears that could allow the entry of dirt, water, and other contaminants. See **310 Front Suspension.**

Suspension, rear, inspecting

Differential and rear drive axle service consists of checking and changing the gear oil, inspecting for leaks, and checking the drive axle CV joint boots for damage.

The areas where leaks are most likely to occur are around the drive shaft and drive axle mounting flanges. For more information on identifying oil leaks and their causes, see **330 Rear Suspension** and **331 Final Drive.**

Tires, checking inflation pressure

Correct tire pressures are important to handling and stability, fuel economy, and tire wear. Tire pressures change with temperature. Pressures should be checked often during seasonal temperature changes. Correct inflation pressures can be found on the driver's door pillar and in the owner's manual. Note that tire pressures should be higher when the car is more heavily loaded.

> ***WARNING—***
> *Do not inflate any tire to a pressure higher than the tire's maximum inflation pressure listed on the sidewall. Use care when adding air to warm tires. Warm tire pressures can increase as much as 4 psi (0.3 bar) over their cold pressures.*

Tires, rotating

BMW does not recommend tire rotation. Due to the car's suspension design, the front tires begin to wear first at the outer shoulder and the rear tires begin to wear first at the middle of the tread or inner shoulder. Rotating the tires may adversely affect road handling and tire grip.

Transmission service, automatic

The automatic transmissions installed in E39 models are filled with special automatic transmission fluid. The transmission lubricant type can be found on the "type-plate" on the side of the transmission. The recommended lubricants are listed earlier in this repair group. See **Fluids and lubricants.** If in doubt, consult an authorized BMW dealer for alternate

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fluid use and the most-up-to-date information regarding transmission operating fluids.

The automatic transmission is not equipped with a dipstick. Therefore, checking the ATF level is an involved procedure which includes measuring and maintaining a specified ATF temperature during the checking procedure.

For more complete ATF service information, including checking ATF level and ATF filter replacement procedures, see **240 Automatic Transmission**.

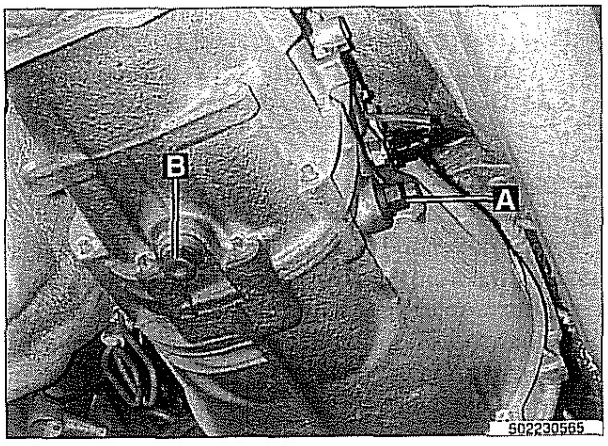
Transmission service, manual

Manual transmission service consists of inspecting for leaks and checking the fluid. Evidence of transmission leaks is likely to be seen around the driveshaft mounting flange and at the bottom of the bellhousing.

NOTE—
*For more information on identifying oil leaks and their causes, see **230 Manual Transmission** and **210 Clutch**.*

Transmission fluid, checking and filling (manual transmission)

The manual transmission installed in the E39 models is filled with a special lifetime fluid (MTF-LT-1). This oil ordinarily does not need to be changed.



Check manual transmission oil level at transmission filler plug (**A**). Make sure car is on level surface.

NOTE—
*Transmission fluid level checking and replacement procedures are covered in **230 Manual Transmission.***

Wheels, aligning

BMW recommends checking the front and rear alignment once a year and whenever new tires are installed.

NOTE—
*See **320 Steering and Wheel Alignment** for a more detailed discussion of alignment requirements and specifications.*

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BODY AND INTERIOR MAINTENANCE

Body and hinges, lubricating

Door locks and lock cylinders can be lubricated with an oil that contains graphite.

Body and door hinges, hood latch and door check rods should be lubricated with SAE 30 or SAE 40 engine oil. Lubricate seat runners with multipurpose grease. Do not apply any oil to rubber parts. If door weather-strips are sticking, lubricate them with silicone spray or talcum powder. The hood release cable should be lubricated as well.

The use of winter lock deicer sprays should be kept to an absolute minimum, as the alcohol in the deicer will wash the grease out of the lock assemblies and may cause locks to corrode internally or to become difficult to operate.

Exterior washing

The longer dirt is left on the paint, the greater the risk of damaging the glossy finish, either by scratching or by the chemical effect dirt particles may have on the painted surface.

Do not wash the car in direct sunlight. If the engine hood is warm, allow it to cool. Beads of water not only leave spots when dried rapidly by the sun or heat from the engine, but also can act as small magnifying glasses and burn spots into the finish. Wash the car with a mixture of lukewarm water and a car wash product. Rinse using plenty of clear water. Wipe the body dry with a soft cloth towel or chamois to prevent water-spotting.

Interior care

Dirt spots can usually be removed with lukewarm soapy water or a dry foam cleaner. Use spot remover for grease and oil spots. Do not pour the liquid directly on the carpet or fabric, but dampen a clean cloth and rub carefully, starting at the edge of the spot and working inward. Do not use gasoline, naphtha, or other flammable substances.

Leather upholstery and trim

Leather upholstery and trim should be periodically cleaned using a slightly damp cotton or wool cloth. The idea is to get rid of the dirt in the creases and pores that can cause brittleness and premature aging. On heavily soiled areas, use a mild detergent (such as Woolite®) or other specially formulated leather cleaners. Dry the trim and upholstery completely

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using a soft cloth. Regular use of a good quality leather conditioner will reduce drying and cracking of the leather.

Polishing

Use paint polish only if the finish assumes a dull look after long service. Polish can be used to remove tar spots and tarnish, but afterwards a coat of wax should be applied to protect the clean finish. Do not use abrasive polish or cleaners on aluminum trim or accessories.

Seat belts

Dirt and other abrasive particles will damage seat belt webbing. If it is necessary to clean seat belts, use a mild soap solution. Bleach and other strong cleaning agents may weaken the belt webbing and should be avoided.

> ***WARNING —***
> *Do not clean the seat belt webbing using dry cleaning or other chemicals. Allow wet belts to dry before allowing them to retract.*

The condition of the belt webbing and the function of the retractor mechanisms should be inspected. See **720 Seat Belts** for seat belt inspection information.

Special cleaning

Tar spots can be removed with a bug and tar remover. Never use gasoline, kerosene, nail polish remover, or other unsuitable solvents. Insect spots also respond to tar remover. A bit of baking soda dissolved in the wash water will facilitate their removal. This method can also be used to remove tree sap spots.

Washing chassis

Periodic washing of the underside of the car, especially in winter, will help prevent accumulation of road salt and rust. The best time to wash the underside is just after the car has been driven in wet conditions. Spray the chassis with a powerful jet of water. Commercial or self-service car washes may not be best for this, as they may recycle the salt-contaminated water.

Waxing

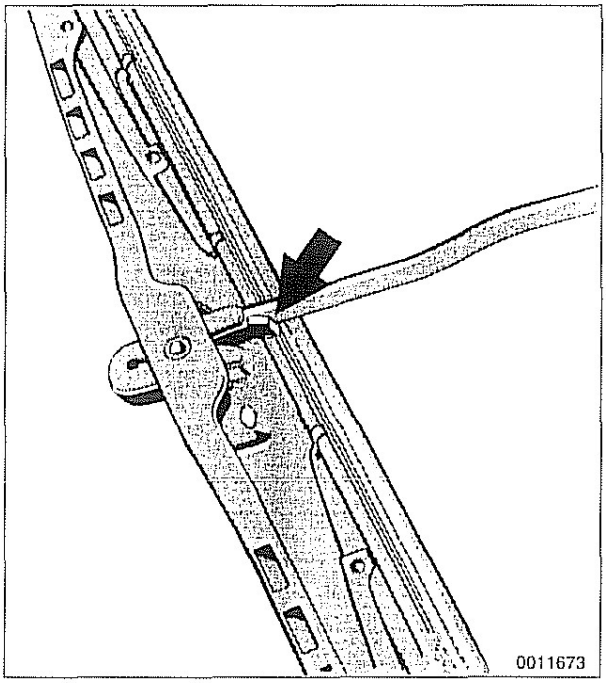
For a long-lasting, protective, and glossy finish, apply a hard wax after the car has been washed and dried. Use carnauba or synthetic based products. Waxing is not needed after every washing. You can tell when waxing is required by look-

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ing at the finish when it is wet. If the water coats the paint in smooth sheets instead of forming beads that roll off, a new coat of wax is needed. Wax should not be applied to black trim pieces, rubber, or other plastic parts.

Windshield wiper blade maintenance

Common problems with the windshield wipers include streaking or sheeting, water drops after wiping, and blade chatter. Streaking is usually caused when wiper blades are coated with road film or car wash wax. Clean the blades using soapy water. If cleaning the blades does not cure the problem, they should be replaced. BMW recommends replacing the wiper blades twice a year, before and after the cold season.



➢ To replace wiper blade, depress retaining tab (**arrow**) and slide blade out of arm.

– Check tension spring that forces wiper against glass. Replace wiper arm if spring tension is weak.

Drops that remain behind after wiping are caused by oil, road film, or diesel exhaust coating the windshield. Use an alcohol or ammonia solution or a nonabrasive cleanser to clean the windshield.

Wiper blade chatter may be caused by dirty or worn blades, by a dirty windshield, or by bent or twisted wiper arms. Clean the blades and windshield as described above. Adjust the wiper arm so that there is even pressure along the blade, and so that the blade is perpendicular to the windshield at rest. Lubricate the wiper linkage with a light oil. The linkage is located under the hood on the driver's side. If the problem persists, the blades are excessively aged or worn and should be replaced. See **611 Wipers and Washers** for more information.



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100 Engine-General

General 100-2
Engine identifying features 100-3

Driveability Troubleshooting 100-4
System voltage 100-5
Main grounds 100-5

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GENERAL

This section covers system descriptions and general information on engines and engine management systems. Also covered is basic engine troubleshooting.

For specific repair procedures, refer to the appropriate repair group:

- **110 Engine Removal and Installation**
- **113 Cylinder Head Removal and Installation**
- **116 Cylinder Head and Valvetrain**
- **117 Camshaft Timing Chain**
- **119 Lubrication System**
- **120 Ignition System**
- **130 Fuel Injection**
- **170 Radiator and Cooling System**

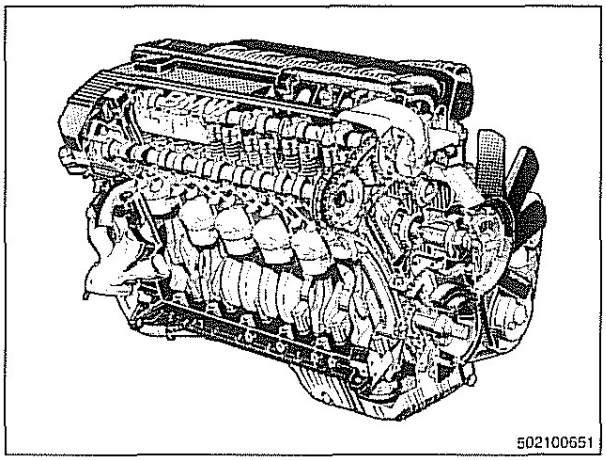
E39 models are fitted with a variant of either an inline 6–cylinder or a V-8 engine. See **Table a.**

Table a. Engine specifications

Model	Engine code, type	Displacement cc (cu. in.)	Engine management	Bore, Stroke mm (in.)	Compression ratio	Torque lb-ft / rpm	Horsepower (SAE) / rpm
528i 1997 - 1998	M52 6–cylinder	2793 (170.4)	Siemens MS 41.1	84 (3.307) 84 (3.307)	10.2 : 1	206 / 3,950	190 / 5,300
528i 1999 - 2000	M52 TU 6–cylinder	2793 (170.4)	Siemens MS 42.0	84 (3.307) 84 (3.307)	10.2 : 1	206 / 3,950	193 / 5,500
525i 2001 - 2002	M54 6–cylinder	2494 (152.2)	Siemens MS 43.0	84 (3.307) 75 (2.953)	10.5 : 1	175 / 3,500	184 / 6,000
530i 2001 - 2002	M54 6–cylinder	2979 (181.8)	Siemens MS 43.0	84 (3.307) 89.6 (3.528)	10.2 : 1	214 / 3,500	225 / 5,900
540i 1997	M62 V–8	4398 (268.4)	Bosch M 5.2	82.7 (3.26) 92 (3.62)	10.0 : 1	310 / 3,900	282 / 5,700
540i 1998	M62 V-8	4398 (268.4)	Bosch M 5.2.1	82.7 (3.26) 92 (3.62)	10.0 : 1	310 / 3,900	282 / 5,700
540i 1999 - 2002	M62 TU V-8	4398 (268.4)	Bosch ME 7.2	82.7 (3.26) 92 (3.62)	10.0 : 1	324 / 3,600	282 / 5,400

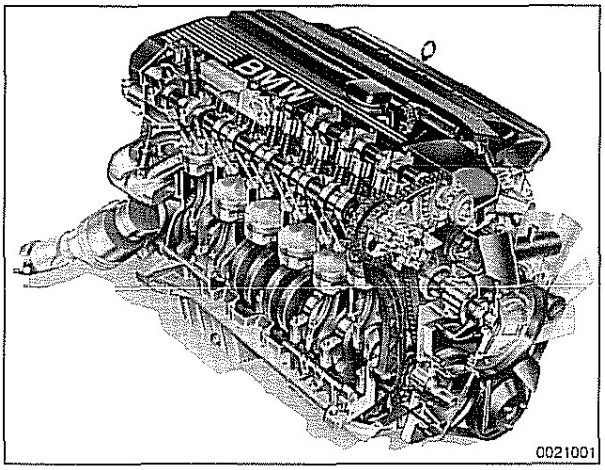
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Engine identifying features

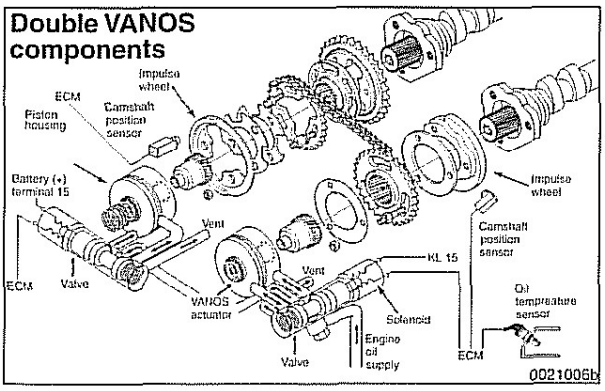


- The M52 engine (MY97-98 528i) used a single on-off variable intake valve timing system (called VANOS). The cylinder block is cast iron and the cylinder head is aluminum. The engine management system is Siemens MS 41.1 and features NGK-type (0-5 volt) oxygen sensors.

NOTE—
VANOS is an acronym based on the German words Variable Nockenwellen Steuerung (variable camshaft timing).



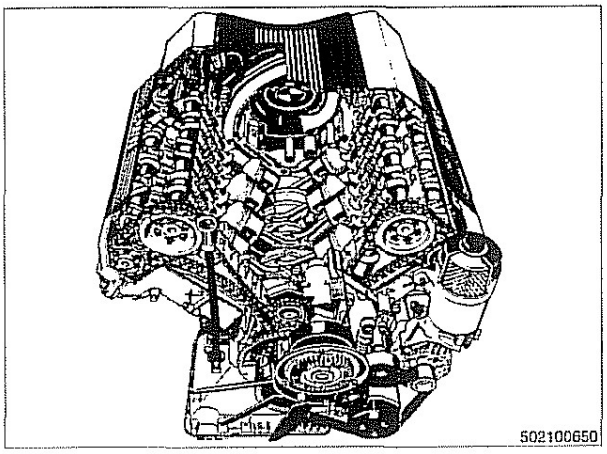
- The M52 TU engine (MY99-00 528i) and the M54 engines (MY01-02 525i/530i) are fitted with double VANOS. The engine blocks are constructed of aluminum alloy with cast iron cylinder sleeves.



- The double VANOS (variable camshaft control) system incorporates true variable control of both the intake and exhaust camshafts, as compared to the single VANOS system on the M52 engine (on/off control of the intake camshaft only).

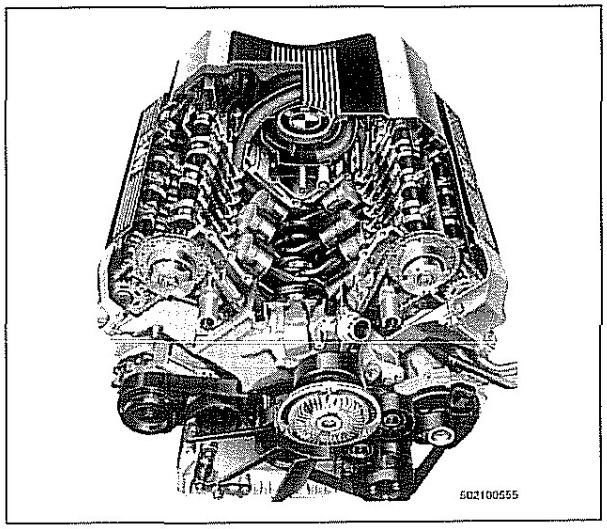
The M54 engines use a fully electronic throttle control (drive by wire). There is no accelerator cable connecting the throttle pedal to the throttle housing in these cars.

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The M62 90° V8 engine uses four valves per cylinder, double overhead camshafts and light alloy cylinder head and cylinder block engine construction.

On 1997 and 1998 540i models, Bosch engine management systems are utilized. **Table a** lists engine management system applications.

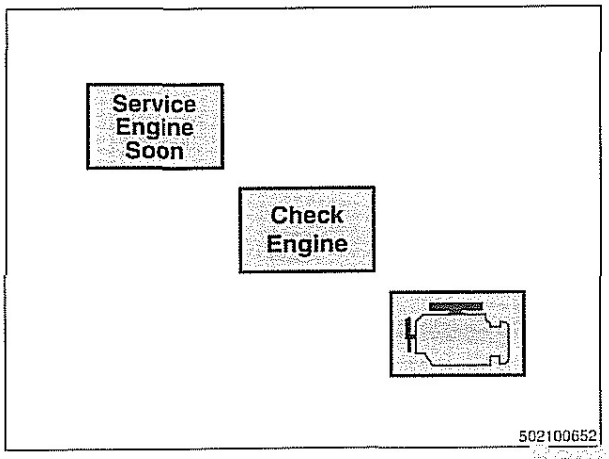


For the 1999 model year, the M62 TU VANOS engine was introduced to the 540i models. This engine is primarily a carryover from the earlier M62 engine, but contains many unique identifying components and technology:

- Variable camshaft timing (VANOS) for the intake valves.
- Bosch ME 7.2 engine management system with electronic throttle control. There is no accelerator cable connecting the throttle pedal to the throttle housing in these cars.
- Compact water-cooled generator (alternator).

DRIVEABILITY TROUBLESHOOTING

E39 vehicles are equipped with sophisticated self-diagnostic engine management systems. These systems monitor and store diagnostic fault information. If the malfunction indicator lamp (MIL) illuminates, the first diagnostic test should be to connect a dedicated scan tool for BMW automobiles and interrogate the fault memory.



If the malfunction indicator light (MIL) comes on or flashes, it indicates that an emissions-related fault has occurred and that fault information is stored in memory within the ECM.

The MIL in E39 cars displays one of these warning graphics in the instrument cluster.

The diagnostic capabilities of these systems have the potential to save hours of diagnostic time and prevent incorrect component replacement. See **OBD On-Board Diagnostics**.

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Two common causes of driveability problems are incorrect system voltage and bad grounds.

System voltage

Digital motor electronics (DME) requires that the system (battery) voltage be maintained within a narrow range of DC voltage. DC voltage levels beyond or below the operating range, or any A/C voltage in the electrical system can cause havoc. When troubleshooting an illuminated MIL, make sure the battery is fully charged and capable of delivering all its power to the electrical system. An undercharged battery can amplify A/C alternator output ripple.

To make a quick check of the battery charge, measure the voltage across the battery terminals with all cables attached and the ignition off. A fully charged battery will measure 12.6 volts or slightly more, compared to 12.15 volts for a battery with a 25% charge.

The DME system operates at low voltage and current levels, making it sensitive to small increases in resistance. The electrical system is routinely subjected to corrosion, vibration and wear, so faults or corrosion in the wiring harness and connectors are not uncommon. Check the battery terminals for corrosion or loose cable connections. See **121 Battery, Starter, Alternator** for additional information.

If a battery cable connection has no visible faults but is still suspect, measure the voltage drop across the connection. A large drop indicates excessive resistance, meaning that the connection is corroded, dirty, or damaged. Clean or repair the connection and retest.

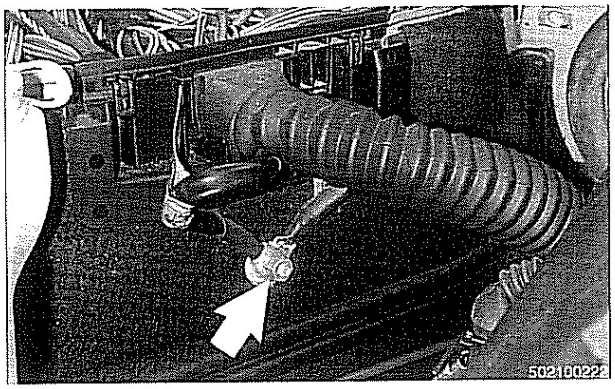
NOTE—
*For instructions on conducting a voltage drop test and other general electrical troubleshooting information, see **600 Electrical System–General.***

Visually inspect all wiring, connectors, switches and fuses in the system. Loose or damaged connectors can cause intermittent problems, especially the small terminals in the ECM connectors. Disconnect the wiring harness connectors to check for corrosion, and use electrical cleaning spray to remove contaminants.

Main grounds

Good grounds are critical to proper DME operation. If a ground connection has no visible faults but is still suspect, measure the voltage drop across the connection. A large voltage drop means high resistance. Clean or repair the connection and retest.

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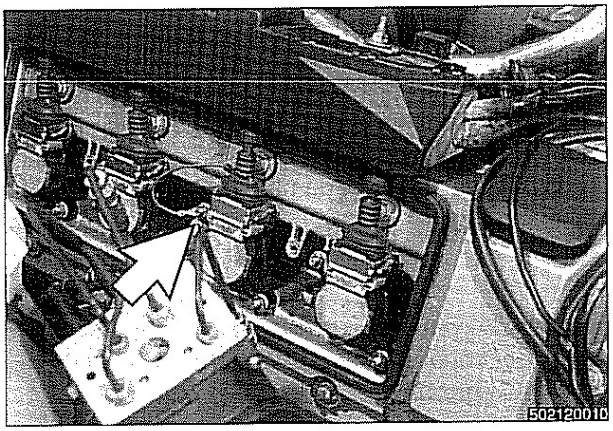


The main grounds for the fuel and ignition circuits of the DME system are illustrated below; see **610 Electrical Component Locations** for additional ground and component locations.

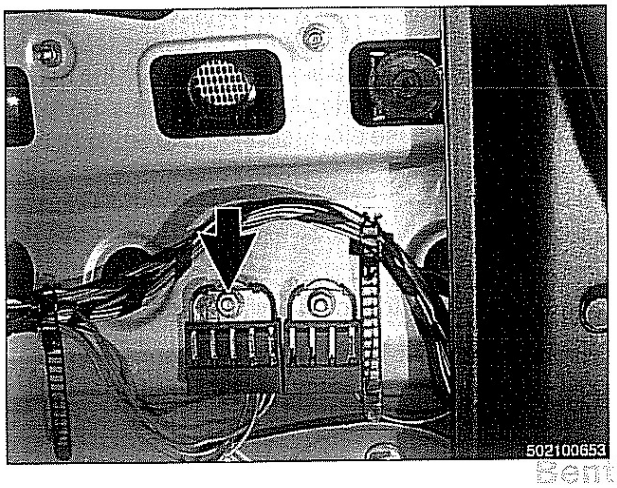
- Ground for engine management system in right rear of engine compartment on E-box bulkhead (**arrow**).



- 6-cylinder models: Grounds for ignition coils (**arrows**).



- V-8 models: Grounds for ignition coils, at cylinders 3 (**arrow**) and 7.



- Fuel pump ground (**arrow**) below right tail light in luggage compartment.

NOTE —
Ground location for sedan shown, wagon models may differ.



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110 Engine Removal and Installation

General 110-2
Special tools 110-2
Engine, Removal and Installation (6–cylinder) 110-3
Engine, Removal and Installation (V–8 models) 110-16

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GENERAL

Engine removal and installation are covered in this repair group.

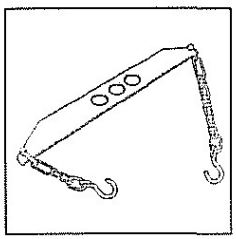
See **100 Engine–General** for engine identification details and engine codes.

Transmission removal is required for all models before the engine can be removed. This is best accomplished with the car raised on an automotive lift. For additional procedures required during engine removal, refer to the following repair groups:

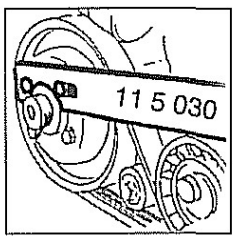
- **020 Maintenance**
- **121 Battery, Alternator, Starter**
- **170 Radiator and Cooling System**
- **180 Exhaust System**
- **230 Manual Transmission**
- **240 Automatic Transmission**
- **410 Fenders, Engine Hood**

Special tools

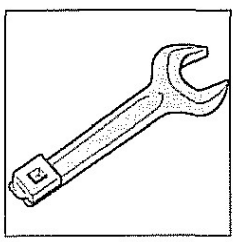
Some special tools are required for engine removal and installation. Be sure to have the necessary equipment on hand before starting the job.



Engine lifting tool
(Tool No. BMW 11 0 000)

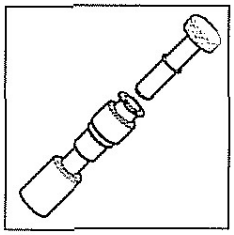


Cooling fan counterhold tool
(Tool No. BMW 11 5 030)

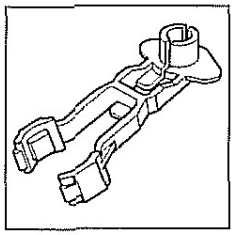


Cooling fan wrench
(Tool No. BMW 11 5 040)

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Fuel line plugs
(Tool No. BMW 13 5 281 / 13 5 282)



Fuel line removal tool
(Tool No. BMW 16 1 050)

CAUTION—
- *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*
- *If the MIL (Malfunction Indicator Light, also may be called "Check Engine" or "Service Engine Soon" light) is illuminated, see **OBD On-Board Diagnostics** for DME fault code information.*
- *If other system faults have been detected, as indicated by an illuminated ABS, SRS or ASC/DSC warning light, see the appropriate repair group in this manual or an authorized BMW dealer for more information on fault codes.*

ENGINE, REMOVAL AND INSTALLATION (6–CYLINDER)

NOTE—
- *Engine removal procedures are similar for all 6–cylinder models. When differences exist, they are noted at the beginning of each step. Engine are referred to by engine code. See **100 Engine-General** for engine code and application information.*
- *Be sure to cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.*
- *The intake manifold must be removed on 6–cylinder models before the engine can be removed.*

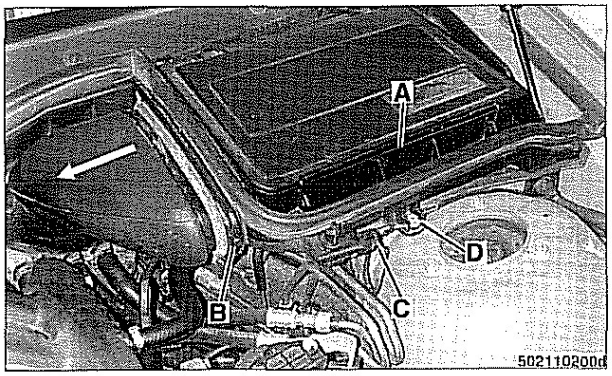
WARNING—
Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

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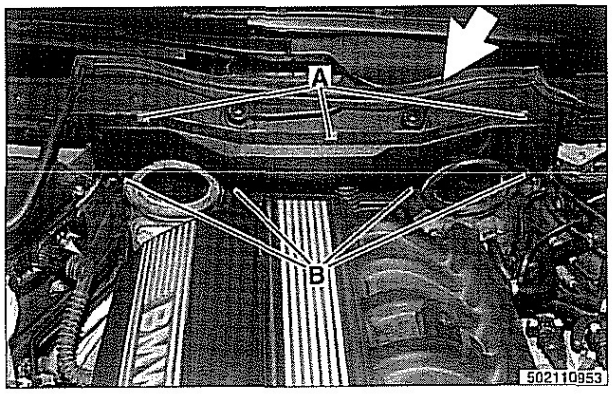
– Disconnect negative (–) cable from battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* ***001 General Cautions and Warnings.***

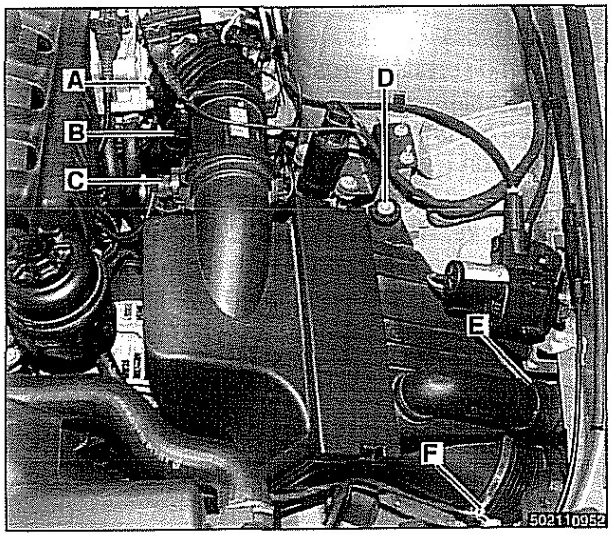
– Remove engine hood, or place in service position. See **410 Fenders, Engine Hood**.



- Remove left and right interior ventilation ducts (left side shown):
  - Release ventilation filter cover latch (**A**) and remove cover.
  - Release plastic locking tab (**B**) or release locking tabs on top of duct (later models).
  - Rotate duct counterclockwise to unlock from bulkhead and remove (**arrow**).
  - Disconnect electrical harness from hood switch (**C**).
  - Release spring lock (**D**).
  - Slide filter housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.

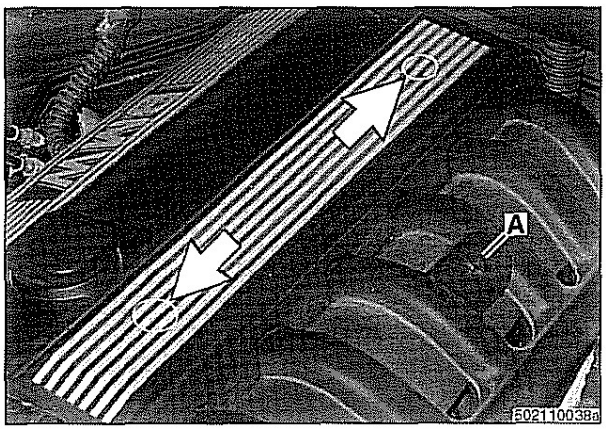


- Remove rear bulkhead panel:
  - Remove rubber sealing gasket (**arrow**).
  - Remove 3 mounting clips (**A**).
  - Remove 4 retaining screws (**B**).
  - Lift off panel.

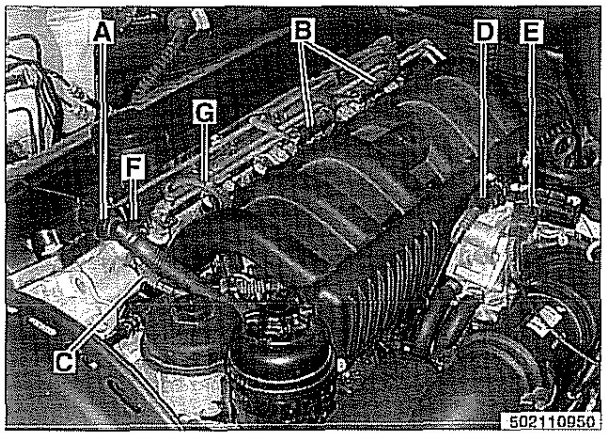


- Remove complete air filter housing:
  - Loosen intake duct hose clamp (**A**) at throttle assembly.
  - Loosen clamp and remove idle control line from intake duct (**B**) and (where applicable) disconnect idle speed control valve electrical harness connector.
  - Disconnect harness connector (**C**) from mass air flow sensor.
  - Remove air filter housing mounting screw (**D**).
  - Disconnect vent tube (**E**).
  - Loosen air intake duct clamp (**F**).
  - Carefully lift air filter housing out of engine bay.

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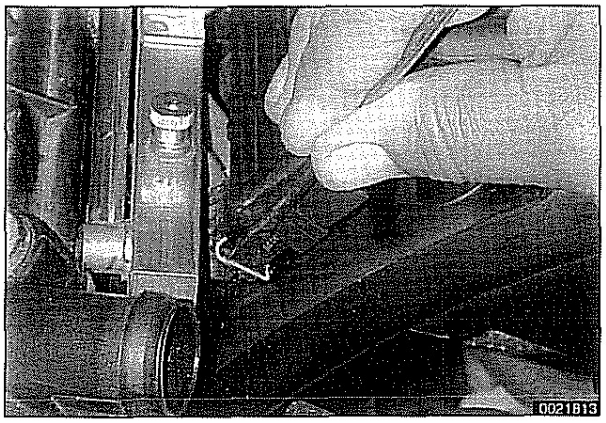


- Remove positive battery cable and intake manifold cover:
  - Remove protective cover from positive (+) jump start post (**A**).
  - Loosen and remove battery lead mounting nut.
  - Remove lead and push down through intake manifold.
  - Remove trim covers (**arrows**) from fuel injector cover.
  - Remove cover hold down bolts and lift off cover.



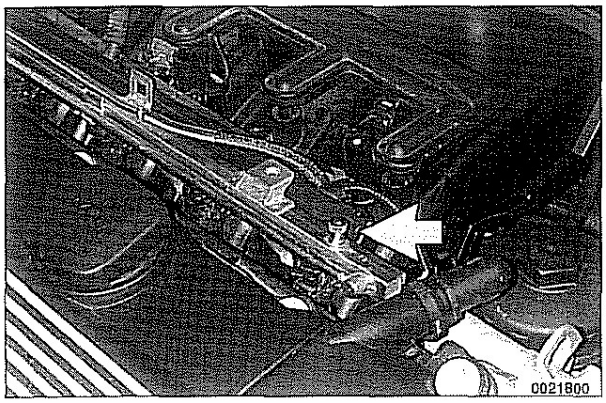
- Working above engine, disconnect the following:
  - Vent line from cylinder head cover (**A**).
  - M52 engine: Oxygen sensor connectors (**B**).
  - Electrical harness connector from intake camshaft VANOS solenoid valve (**C**).
  - M52 engine: Disconnect electrical harness connectors at throttle valve position switch (**D**), ASC valve position switch (**E**), fuel injector harness (**F**) and vent valve (**G**).

> ***CAUTION—***
> *Be sure to mark oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.*



- M52 TU, M54 engine: Disconnect fuel injector electrical connectors from injectors.
  - Use small screwdriver to pry one corner of wire lock clip on fuel injector 1 connector.
  - Repeat for all injectors.
  - Lift off connector loom and lay aside.

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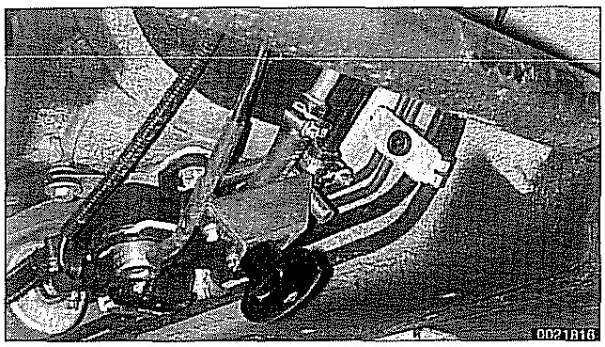
➢ Where applicable, remove schraeder valve cap (**arrow**) from air connection on fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

> ***WARNING —***
> - *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
> - *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

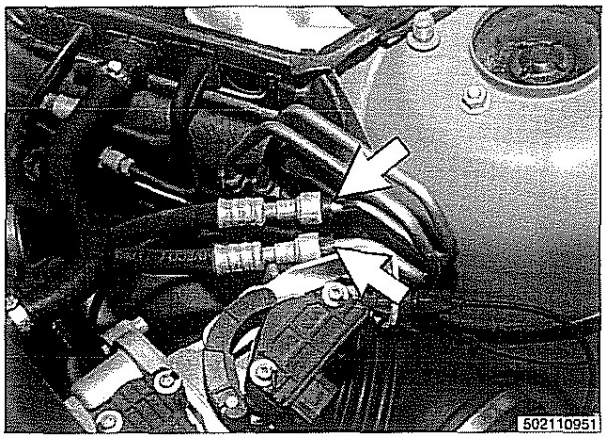
– Raise car and support in a safe manner.

> ***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.*

– Working underneath car, remove protective engine splash guard.



➢ Working beneath car (on left side under driver seat), remove fuel filter cover and clamp fuel hose(s).

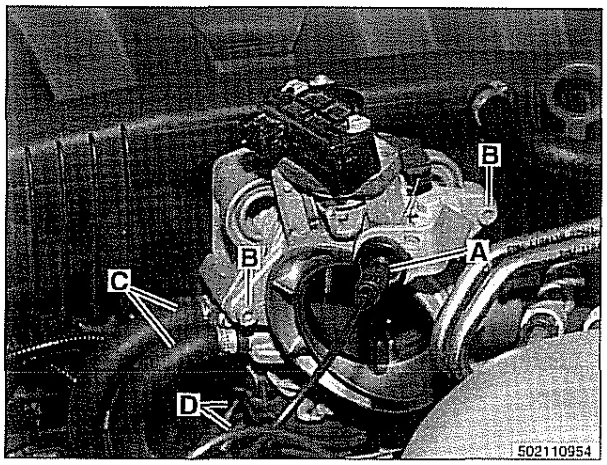


➢ Disconnect fuel lines by sliding locking collar in (**arrows**) and pulling line apart.

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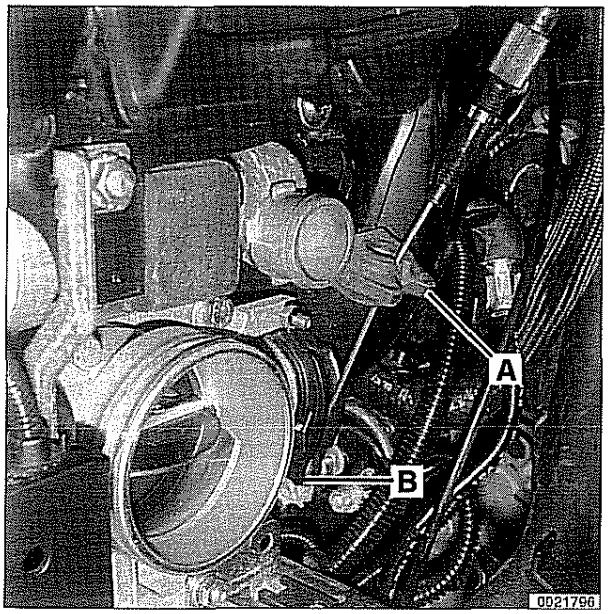
NOTE—
*BMW uses three styles of fuel line connections; a one-time single use clamp, a locking fitting that uses special tool 16 1 050 to release, and a quick release sleeve (**arrow**) that disconnects the line when depressed.*

WARNING—
Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.



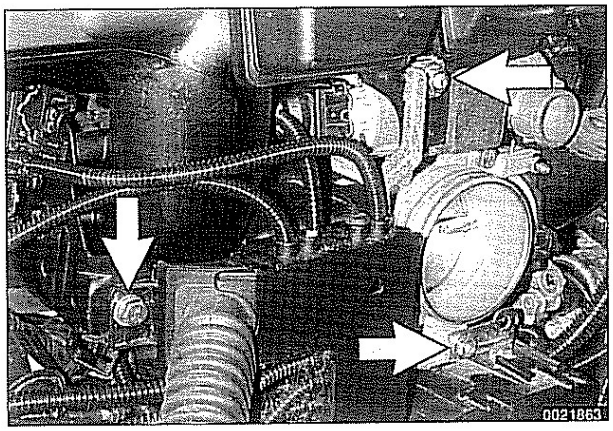
- M52 engine: Remove throttle valve and ASC throttle assemblies.
  - Disconnect ASC throttle cable (**A**).
  - Remove ASC throttle housing mounting fasteners (**B**).
  - Clamp off, disconnect, and plug coolant hoses (**C**).
  - Disconnect throttle and cruise control cables (**D**).
  - Remove throttle housing mounting hardware and throttle valve.

NOTE—
M52 TU, M54 engine: Throttle body is removed with intake manifold.

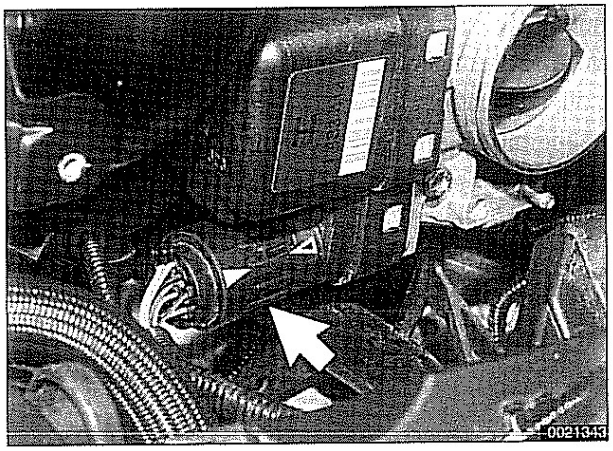


- M52 TU engine: Pull throttle cable out of rubber retainer (**A**) and unlock ball end of cable (**B**) from throttle actuator.

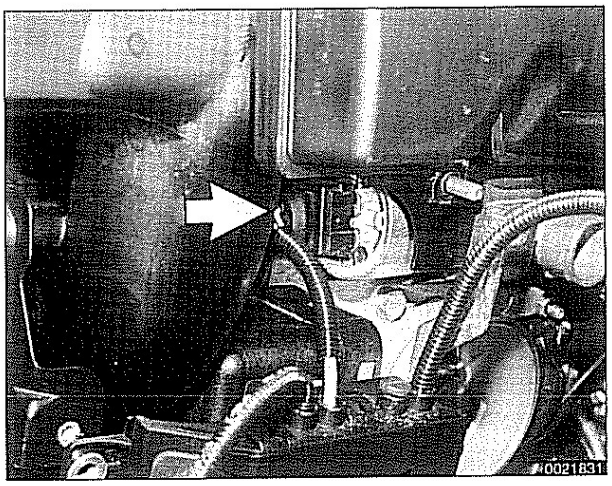
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- M52 TU, M54 engine: Remove fasteners (**arrows**) retaining wiring harness conduit to throttle body.

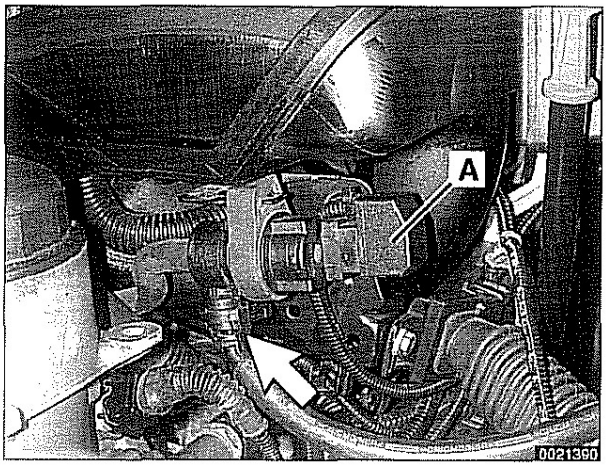


- M52 TU, M54 engine: Working at throttle housing, rotate harness plug (**arrow**) counterclockwise and remove.



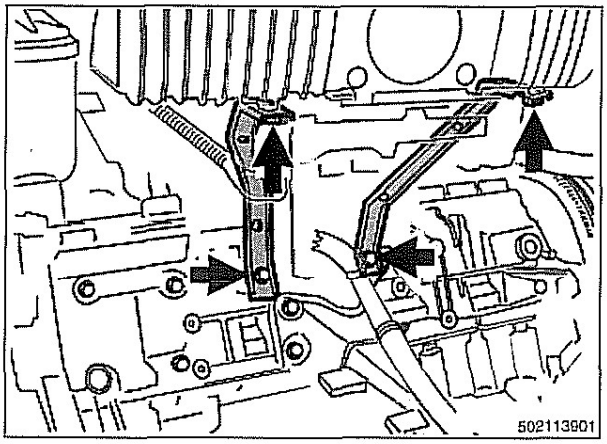
- M52 TU, M54 engine: Disconnect electrical harness connector at idle speed control valve (**arrow**), directly above throttle valve.

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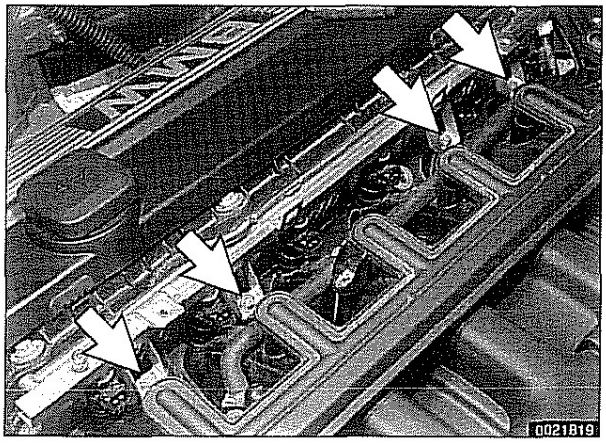


➢ M52 TU, M54 engine: Disconnect electrical harness connector at fuel tank venting valve (**A**). Disconnect vent hose at fitting (**arrow**).

– Working under intake manifold, disconnect the following:
- Engine oil dipstick tube support.
- Oil separator return line from dipstick tube.
- Intake air temperature sensor electrical harness connector (underside of intake manifold near throttle body).
- M52 TU, M54 engine: Resonance valve electrical harness connector.
- M52 engine: Fuel tank vent line and harness.



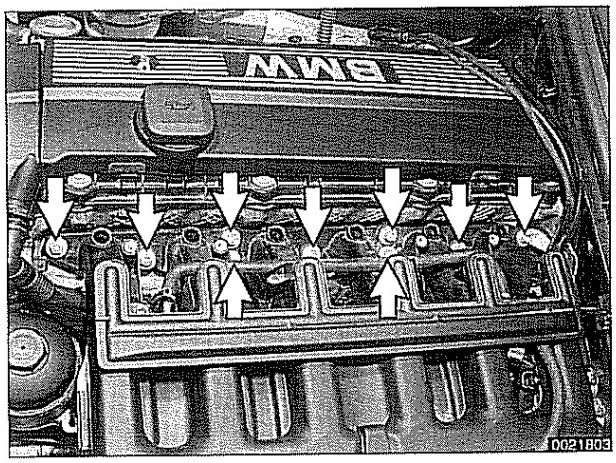
➢ Working underneath car, remove lower intake manifold support mounting bolts (**arrows**).



➢ M52 TU, M54 engine: Remove fuel rail mounting bolts (**arrows**):
- Carefully pry fuel rail off manifold.
- Separate fuel line support bracket at rear of intake manifold.

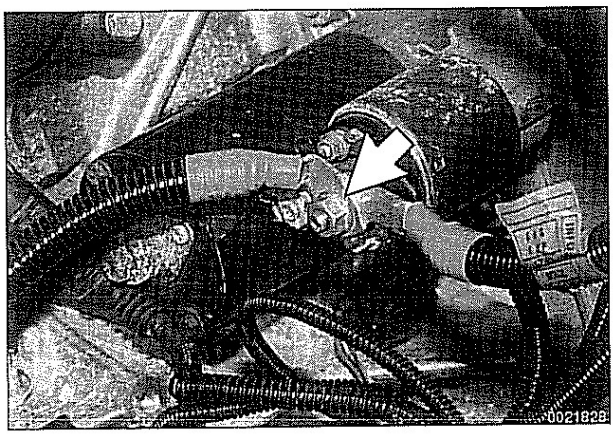
NOTE—
- *M52 TU engine shown. M54 engine is similar.*
- *M52 engine: Fuel rail is removed with intake manifold.*

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➢ Remove intake manifold mounting hardware (**arrows**).

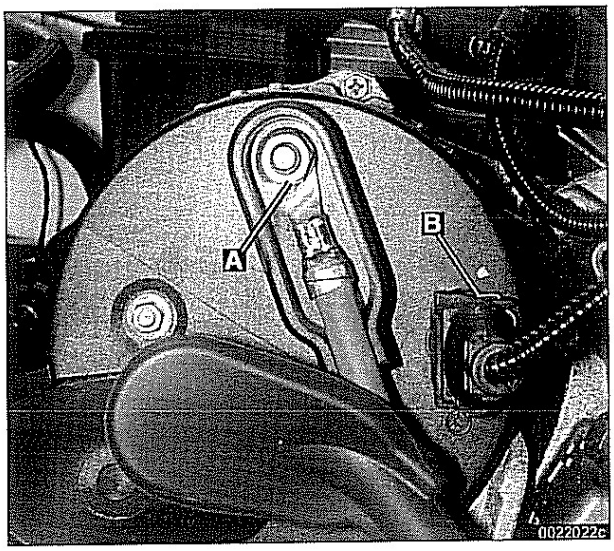
NOTE—
M52 TU engine shown. M52 and M54 engines are similar.



➢ Lift up manifold just enough to remove positive cables from starter motor terminal 50 (**arrow**).

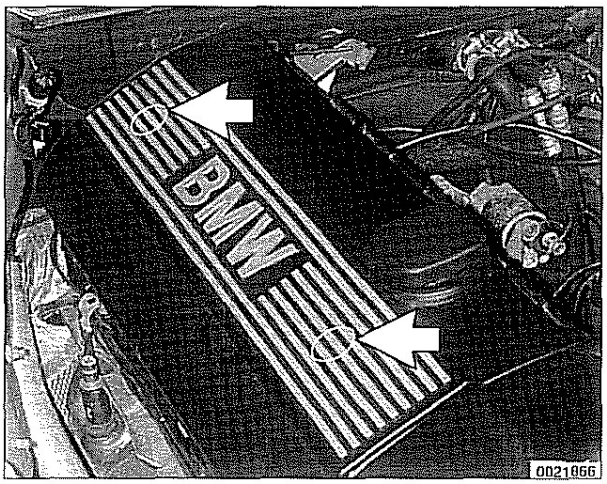
– Remove intake manifold from cylinder head while carefully checking for electrical connections, tie wraps, and hoses.

CAUTION—
Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.



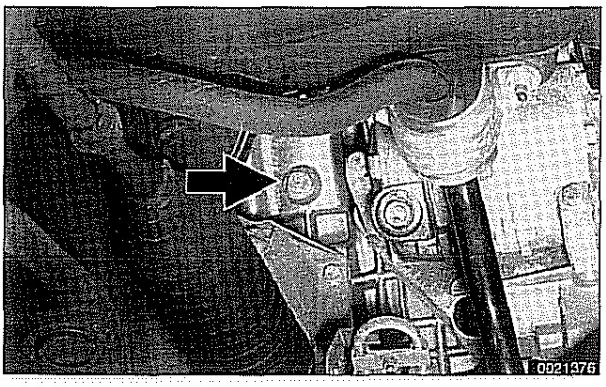
➢ Remove fastener (**A**) and harness connector (**B**) from alternator.

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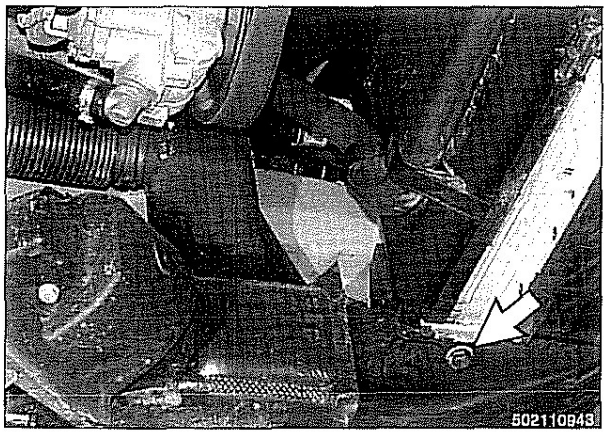
➢ Remove cylinder head top cover:
- Remove plastic trim caps (**arrows**).
- Remove cover retaining fasteners and lift off cover.

– Remove alternator cooling tube.



➢ Drain engine coolant and remove coolant hoses:
- Remove expansion tank cap on coolant reservoir.
- Place a 3 gallon pail beneath engine to capture coolant.
- Remove coolant drain plug located on exhaust side of cylinder 2 of engine block (**arrow**).

NOTE—
Drain plug for M52 TU and M54 engine shown. Plug for M52 located between cylinders 4 and 5.

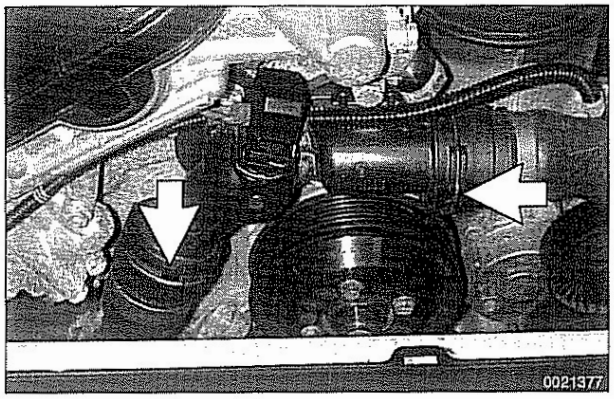


➢ Drain radiator by removing plastic drain plug (**arrow**) from bottom of radiator.

WARNING—
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.

NOTE—
Catch and dispose of drained coolant according to local, state, and federal laws.

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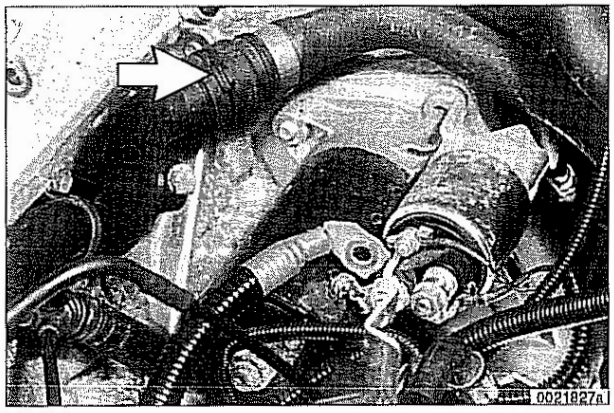


➢ Remove hoses from thermostat housing by releasing locks (**arrows**). If applicable, detach electrical harness connector for thermostat housing.

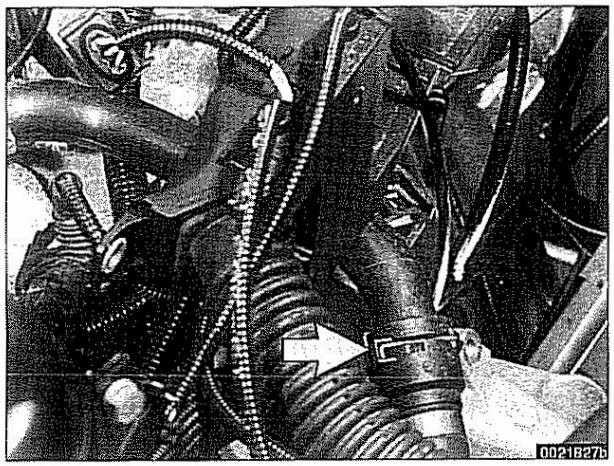
NOTE—
Two different types of hose fasteners are used on the E39 car; lock clamp type as shown above or standard band clamps.

– On vehicles equipped with mechanical cooling fan: Remove belt-driven cooling fan and radiator as described in **170 Radiator and Cooling System**.

CAUTION—
32 mm radiator fan mounting nut has left hand threads.



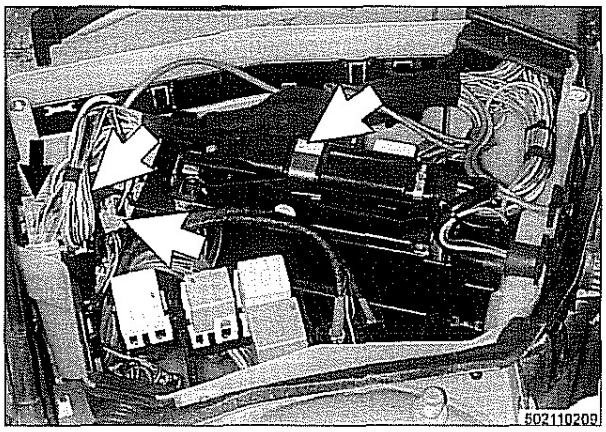
➢ Disconnect coolant hose (**arrow**) at rear left side of engine above starter.



➢ Disconnect coolant hose (**arrow**) at front left side of engine mount.

– Unbolt power steering fluid reservoir and pull aside without detaching hoses. Secure to fender with cord or stiff wire.

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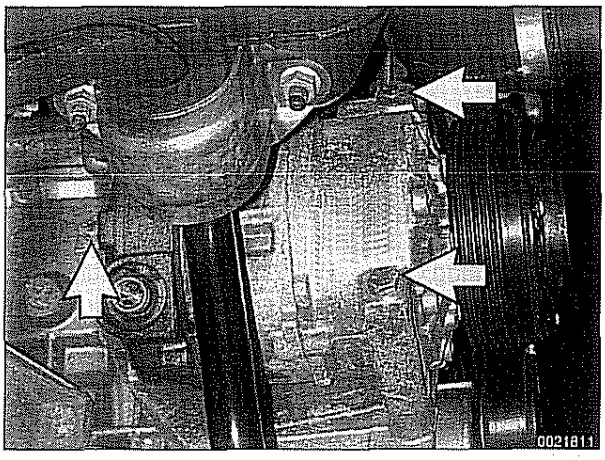
- Working at E-box at right rear of engine compartment:
  - Disconnect engine electrical harness connectors (**arrows**).
  - Lift off harness looms and lay over engine.

– Remove polyribbed drive belts. Mark direction of rotation if belts will be reused. See **020 Maintenance**.

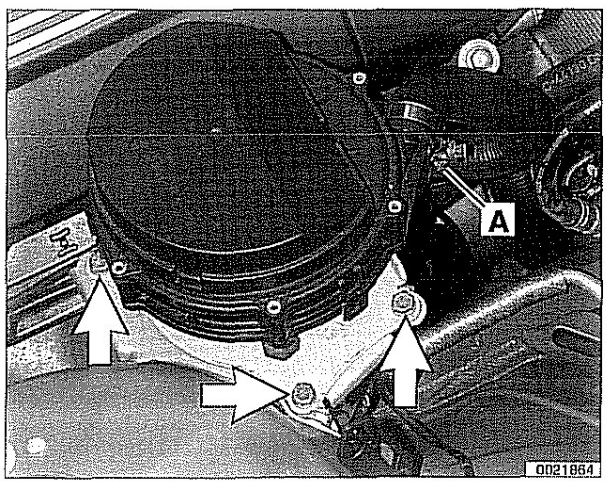
– Remove exhaust system and transmission from car. See **180 Exhaust System**, **230 Manual Transmission** or **240 Automatic Transmission**.

NOTE—
Detach automatic transmission cooler lines from radiator, remove brackets holding lines to side of engine, and store lines in a clean environment.

– Remove power steering pump:
  - If necessary, remove steering pump pulley.
  - Remove front and rear pump mounting bolts.
  - Suspend pump from body using stiff wire.

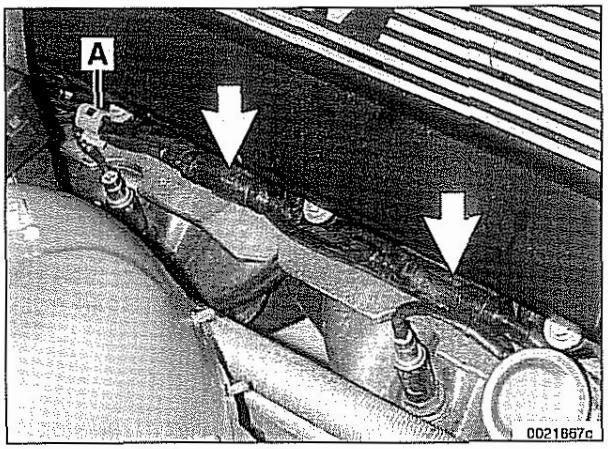


- Remove A/C compressor mounting bolts (**arrows**) and A/C compressor from its mounting bracket without disconnecting, distorting, or deforming any refrigerant lines. Suspend from body using stiff wire.



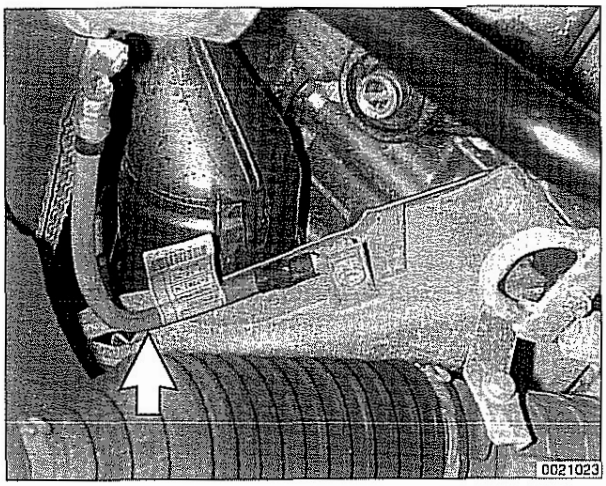
- If applicable, remove secondary air pump:
  - Remove hose at one-way valve (**A**).
  - Remove bolts at support bracket on strut tower (**arrows**).
  - Disconnect electrical harness from bottom of secondary air pump.
  - Remove bracket from strut tower.

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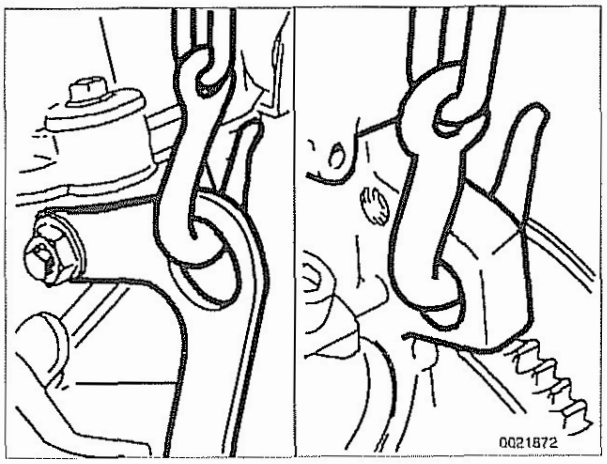


- M52 TU, M54 engine: Separate oxygen sensor electrical harness connectors (**arrows**) and mounting clip (**A**) on right side of engine.

> ***CAUTION—***
> *Be sure to mark oxygen sensor connectors so that they can be assembled correctly. Do not interchange connectors.*



- Remove chassis ground strap (**arrow**) at right engine mounting pedestal.



- Install an engine lifting device (BMW 11 0 000 or equivalent) to the front and rear engine supports and raise engine until its weight is supported. Detach left and right engine mounts.

– Carefully raise engine out of car, checking for any wiring, fuel lines, or mechanical parts that might become snagged as engine is removed.

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– Installation is reverse of removal, noting the following:
  - Replace all gaskets, O-rings and seals.
  - Use new fuel injector seals.
  - Check that engine drive belts properly engage pulley grooves.
  - Inspect O-ring seal between mass air flow sensor and air filter housing. To facilitate reassembly, coat seal with acid-free grease.
  - Change engine oil and filter and check all other fluid levels. See **020 Maintenance**.
  - Refill and bleed cooling system. See **170 Radiator and Cooling System**.

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

Tightening torques

Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Engine mount to subframe (M10)	45 Nm (33 ft-lb)
Exhaust manifold to cylinder head	
M6	10 Nm (89 in-lb)
M7 or M8	20 Nm (15 ft-lb)
Intake manifold to cylinder head	
M7	15 Nm (11 ft-lb)
M8	22 Nm (16 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

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ENGINE, REMOVAL AND INSTALLATION (V–8 MODELS)

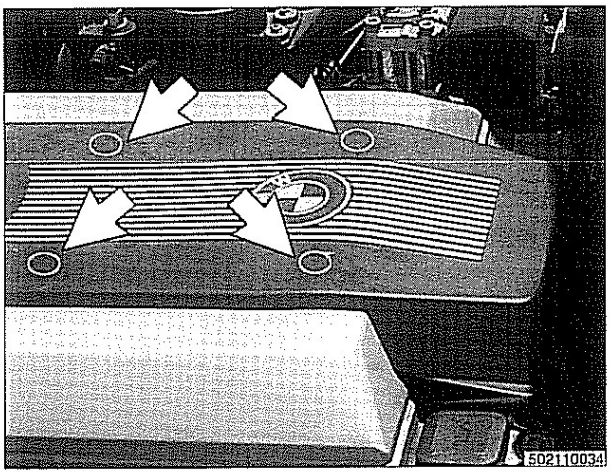
NOTE—
- *Engine removal procedures are similar for all V-8 models. When differences exist, they are noted at the beginning of each step. Engine are referred to by engine code. If necessary, See **100 Engine–General** for engine code and application information.*
- *Be sure to cover all painted surfaces before beginning the removal procedure. As an aid to installation, label all components, wires and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.*

> ***WARNING—***
> *Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.*

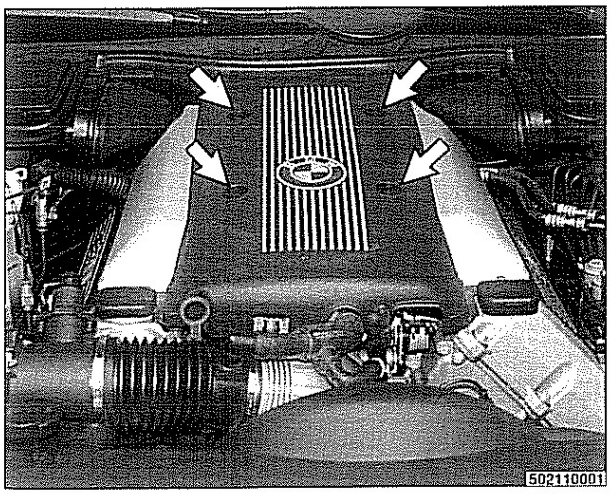
– Disconnect negative (–) cable from battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

– Remove engine hood or place hood in service position. See **410 Fenders, Engine Hood**.

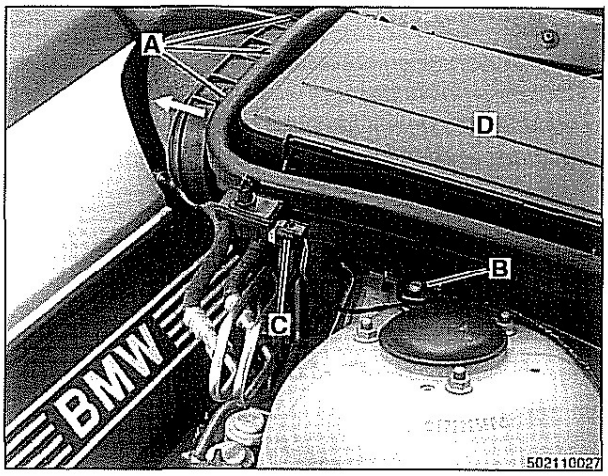


Remove intake manifold cover, version 1:
- Remove plastic trim caps (**arrows**).
- Remove cover mounting fasteners and lift off cover.

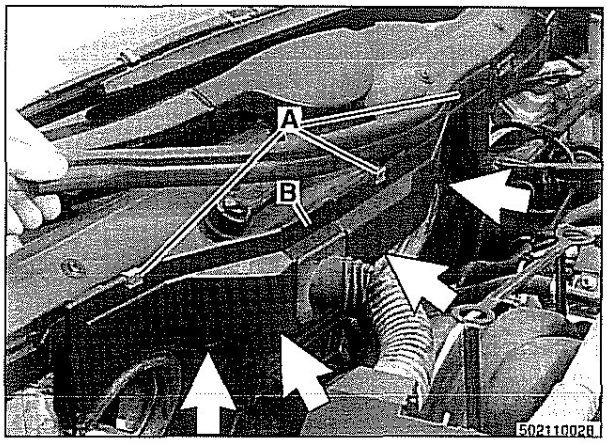


Remove intake manifold cover, version 2:
- Press down on locking pins (**arrows**) to release locks.
- Lift cover straight up to remove.

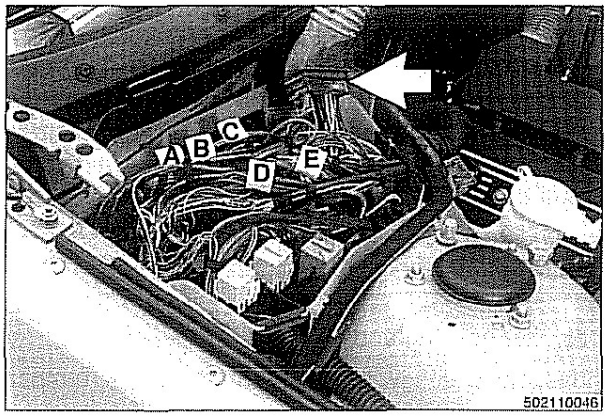
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- Remove left interior ventilation duct:
  - Release duct locking tabs (**A**). Early models: release locking strap.
  - Rotate duct inward (**arrow**) to detach.
  - Release spring lock (**B**) to unlock ventilation housing.
  - Disconnect electrical harness connector from hood switch (**C**).
  - Release locking clip and remove ventilation filter cover (**D**).
  - Slide air housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.



- Remove rear engine compartment bulkhead panel:
  - Remove rubber sealing strip.
  - Remove 3 mounting clips (**A**).
  - Remove harness supporting clip (**B**).
  - Unlock panel retainers (**arrows**).
  - Lift out panel.



- Separate engine wiring harness (**arrow**) from electrical box at right side of engine compartment:
  - Remove E-box cover.
  - Disconnect electrical harness connectors leading from engine wiring harness (**arrow**). Connectors are labelled (**A**, **B**, **C**, **D**, **E**) for locating purposes.
  - Lay engine harness on top of engine.

– Drain engine coolant from engine block and radiator. See **170 Radiator and Cooling System**.
  - Remove drain plugs from right and left side of engine block (between cylinders 2/3 and 6/7).
  - After coolant has drained, reinstall drain plugs using new sealing washers.
  - Drain radiator and reinstall drain plug.

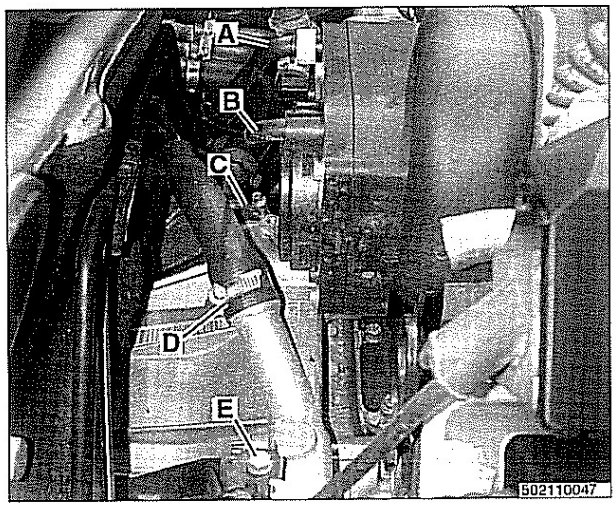
Tightening torques

Coolant drain plug to cylinder block (M14)	25 Nm (18 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

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Engine Removal and Installation

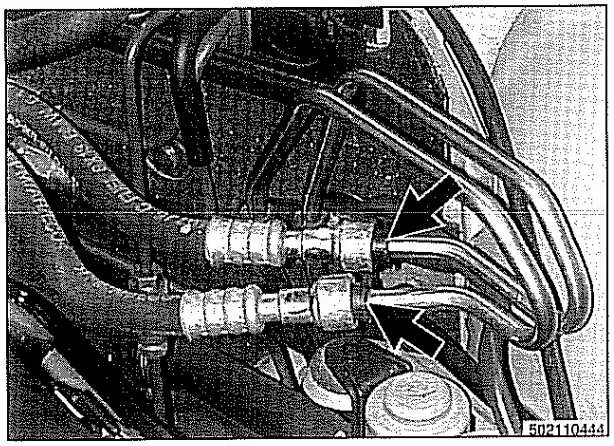
WARNING—
Use extreme caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.



- Working at rear of intake manifold:
  - Disconnect brake booster vacuum line (**A**).
  - Disconnect fuel tank vent line (**B**).
  - Disconnect hoses (**C** and **D**) at coolant manifold.
  - Remove transmission harness support (**E**).

– Remove oil filter housing assembly from fender:
  - Remove oil filter housing mounting fasteners.
  - Use stiff wire to secure oil filter housing to engine.

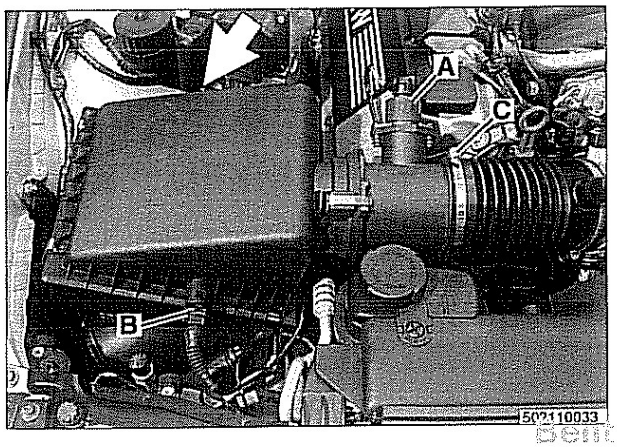
NOTE—
Do not disconnect oil lines from filter housing.



- Disconnect supply and return fuel lines (where applicable) at or near fuel rail. Plug open fuel lines.

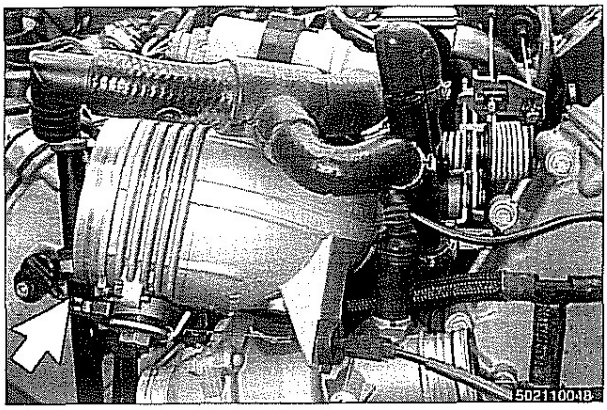
NOTE—
*BMW uses three styles of fuel line connections; a single use clamp, a locking fitting that uses special tool 16 1 050 to release, and a quick release sleeve (**arrows**) that disconnects the line when depressed.*

WARNING—
- *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

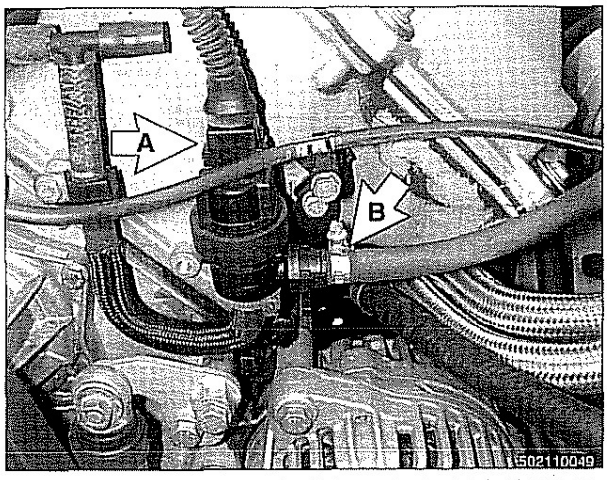


- Remove air filter housing and mass air flow sensor:
  - Disconnect mass air flow sensor (**A**) and intake air temperature sensor (**B**) electrical harness connectors.
  - Remove air filter housing mounting fastener (**arrow**).
  - Loosen intake hose clamp (**C**).
  - M62 engine: Remove hose at idle air stabilizer.
  - Remove air filter housing with mass air flow sensor.
  - Remove intake hose from throttle body.

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➢ M62 engine, remove ASC throttle body.
- Disconnect electrical harness from throttle position sensor.
- Disconnect ASC actuator cable (**arrow**).
- Remove mounting fasteners and remove throttle body.

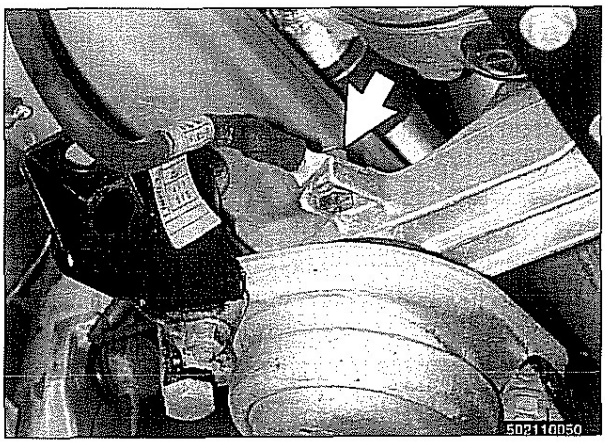


➢ On front of left side cylinder head, disconnect electrical harness connector (**A**), and remove and plug fuel tank vent valve vacuum line (**B**).

– Raise car and support in a safe manner.

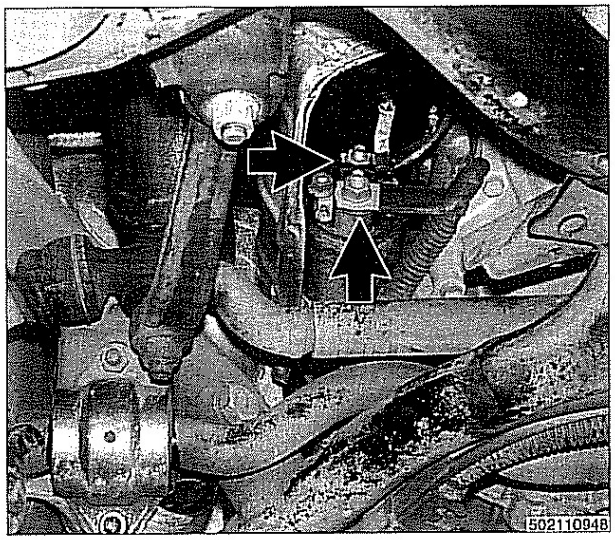
> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Working beneath car:
- Remove engine splash shield.
- Remove right and left heat shield from front suspension subframe.



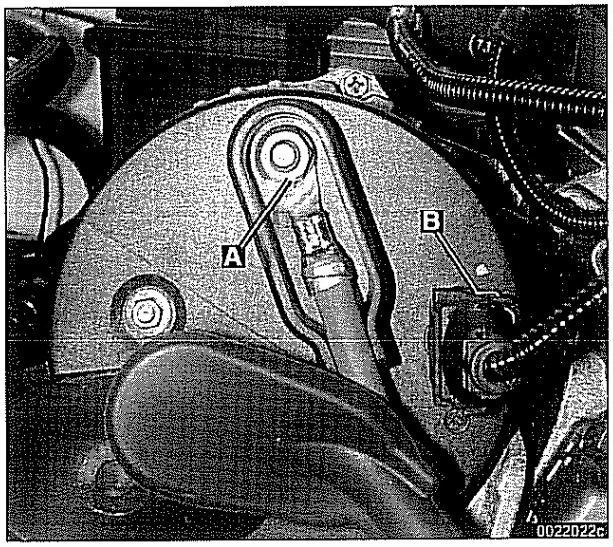
➢ Working underneath engine compartment, disconnect ground cable on right side engine mount (**arrow**).

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- Working at right side of transmission bellhousing, disconnect electrical harness connections (**arrows**) from starter. Remove starter retaining bolts and remove starter from transmission mount.
  - M62 TU engine: Disconnect electrical harness connector for right oxygen sensor from retaining clip and remove retaining clip from transmission.

– Working underneath engine compartment at left side:
  - Unclip positive battery cable from oil pan.
  - Remove alternator cooling duct.



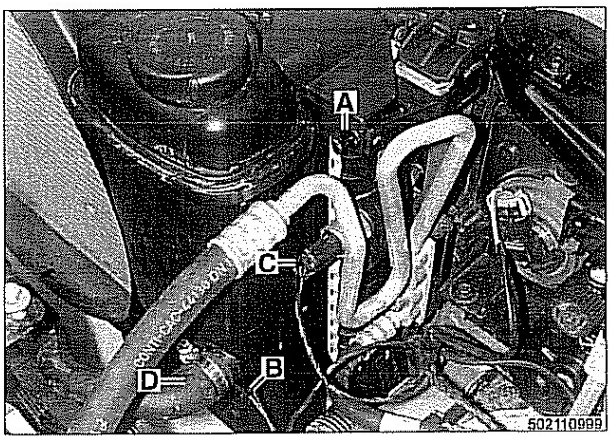
- M62 engine: Remove fastener **A** and plug connector **B** from alternator.

– M62 TU engine: Remove electrical harness connectors from front of water cooled alternator.

– Remove exhaust system and transmission. See **180 Exhaust System** and **230 Manual Transmission** or **240 Automatic Transmission**.

– Working at front of engine:
  - Remove upper and lower hoses from radiator.
  - Disconnect expansion tank hose from coolant pump.

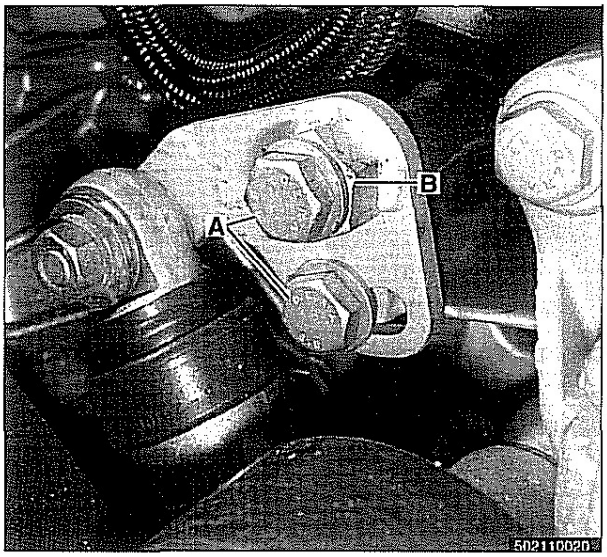
– Remove belt-driven cooling fan:
  - Counterhold fan with special tool 11 5 050.
  - Turn fan mounting nut (32 mm) clockwise (left hand threads) to loosen.
  - Rotate fan clockwise to remove.



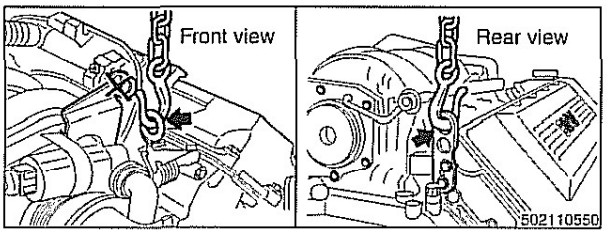
- Remove cooling fan shroud:
  - Disconnect electrical connectors from coolant level sensor (**B**) and coolant temperature sensor (**C**).
  - Remove expansion rivets (**A**) from each side of shroud.
  - Remove coolant hose (**D**).
  - Slide fan shroud with expansion tank up. Remove radiator overflow tube from spout of expansion tank. Remove radiator fan shroud with expansion tank.

– Remove radiator. See **170 Radiator and Cooling System**.

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- Remove polyribbed A/C compressor belt:
  - Mark direction of belt travel if belts are to be reused.
  - Loosen bolts (**A**).
  - Turn adjusting lug (**B**) clockwise to release belt tension.
- Working beneath car, remove power steering pump and air conditioner compressor. Suspend from body using stiff wire.
- Remove exhaust manifolds. See **180 Exhaust System.**



- Install engine lifting device (BMW 11 0 000 or equivalent) to front and rear engine supports and raise engine until it's weight is supported. Detach engine mounts.
  - Watch carefully for hoses and electrical wires that might snag.
- Installation is reverse of removal:
  - Replace all gaskets, O-rings and seals.
  - V-8 engine mounts have two sets of mounting holes. E39 cars use front most mounting holes.
  - On cars with automatic transmission, use new O-rings at ATF cooler lines.
  - Use new alignment sleeves when installing transmission.
  - Be sure engine drive belts properly engage pulley grooves. When installing belt, preload tensioner to stop (toward belt), then tighten tensioner clamping nut.
  - Install front exhaust pipes using new gaskets and copper paste and new mounting hardware. See **180 Exhaust System.**
  - Change engine oil and filter. Check all other fluid levels as described in **020 Maintenance.**
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System.**

> ***CAUTION—***
> *Do not interchange knock sensor harness connectors. Serious engine damage may result.*

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Tightening torques

ATF cooler lines to radiator (use new O-rings) M18 cap nut M22 cap nut	 20 Nm (15 ft-lb) 22 Nm (17 ft-lb
Coolant drain plug to cylinder block (M14)	25 Nm (18 ft-lb)
Engine mount to engine bracket or subframe (M10)	47 Nm (35 ft-lb)
Exhaust flange nuts (8 mm)	25 Nm (18 ft-lb)
Radiator cooling fan to coolant pump (left-hand threads)	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)
Wiring to alternator (M8 nut)	13 Nm (9.5 ft-lb)



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113 Cylinder Head Removal and Installation

General 113-2
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GENERAL

This group covers cylinder head removal and installation as well as cylinder head/valve diagnostic procedures.

In the procedures in this repair group, engines are referred to by engine code. If necessary, see **100 Engine-General** for engine code and application information.

The information given in this repair group assumes that the engine is installed in the engine bay. On the 6-cylinder engines, the VANOS control unit must be removed in order to remove the cylinder head from the engine block. On M52 TU and M54 engines, camshafts must be removed from the cylinder head before the head is removed.

The cylinder head removal and installation procedures for the M62 V-8 are also included, but the procedures for the M62 TU V-8 with VANOS are not provided.

For cylinder head and valvetrain reconditioning information, see **116 Cylinder Head and Valvetrain**.

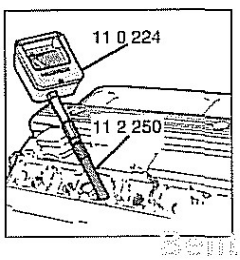
For specific repair procedures, refer to the appropriate repair group:

- **020 Maintenance**
- **116 Cylinder Head and Valvetrain**
- **117 Camshaft Timing Chain**
- **170 Radiator and Cooling System**
- **610 Component locations**

NOTE—
*If a head gasket problem is suspected, a compression test or leak-down test will usually detect the fault. See **Diagnostic Testing** later in this group.*

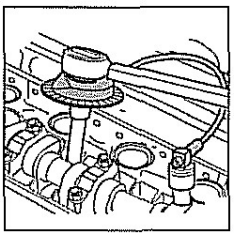
Special tools

Special BMW service tools are required to properly remove and install the cylinder head on engines covered by this manual. The special tools are used to time the valvetrain to the crankshaft, and to remove the VANOS control unit, the camshafts and the Torx (E12) head bolts. Read the entire procedure through before beginning the job.

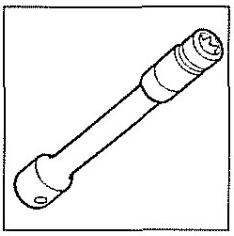


➢ Compression gauge
(Tool No. BMW 11 0 224/11 2 250)

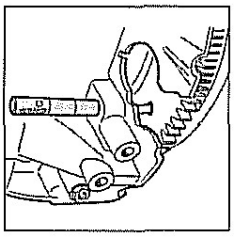
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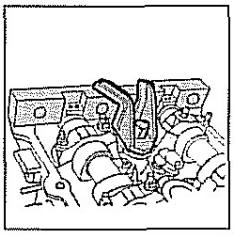
Rotary angle torque dial gauge
(Tool No. BMW 11 2 250/00 9 120)



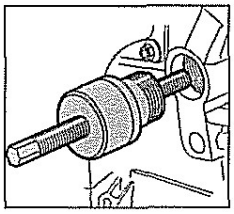
E12 Torx socket for cylinder head bolts
(Tool No. BMW 11 2 250)



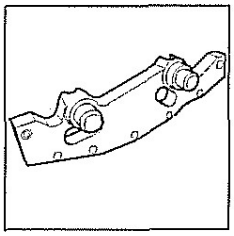
Crankshaft locking tool
(Tool No. BMW 11 2 300)



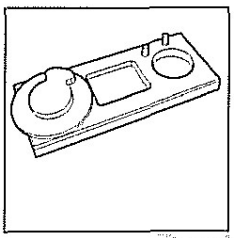
Camshaft locking tool set, 6–cylinder
(Tool No. BMW 11 3 240)



Timing chain adjustable tension setup tool, 6–cylinder
(Tool No. BMW 11 4 220)



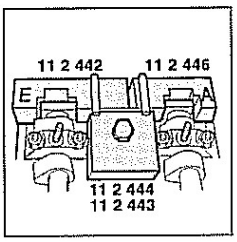
Double VANOS adjustment plate
(Tool No. BMW 11 6 150)



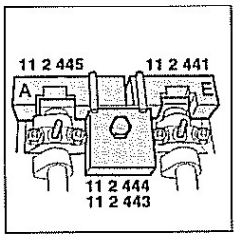
Secondary sprocket setup tool for double VANOS
(Tool No. BMW 11 6 180)

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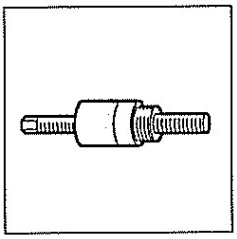
Cylinder Head Removal and Installation



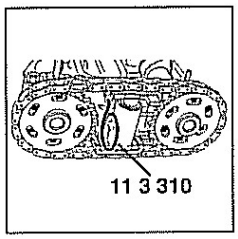
- Camshaft locking tools (cyl. 5–8), V–8
  (Tool No. BMW 11 2 442/11 2 446/11 2 443/11 2 444)



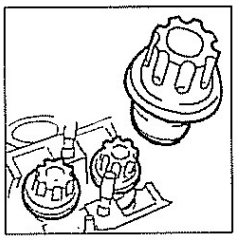
- Camshaft locking tools (cyl. 1–4), V-8
  (Tool No. BMW 11 2 445/11 2 441/11 2 443/11 2 444)



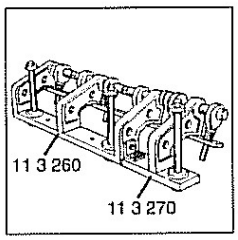
- Timing chain adjustable tension setup tool, V-8
  (Tool No. BMW 11 3 390)



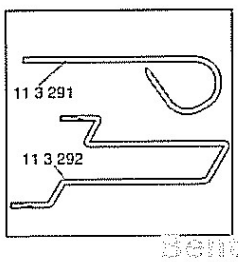
- Secondary timing chain tensioner locking pin, V-8
  (Tool No. BMW 11 3 310)



- Hydraulic lifter securing plugs
  (Tool No. BMW 11 3 250)

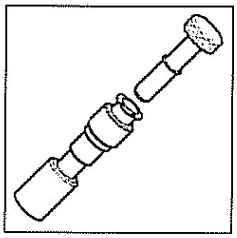


- Camshaft bearing cap tensioner (6–cylinder)
  for camshaft removal and installation
  (Tool No. BMW 11 3 260/11 3 270)

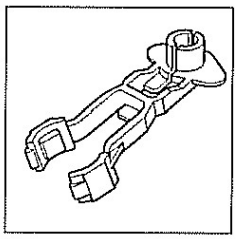


- Secondary timing chain tensioner lock set
  (Tool No. BMW 11 3 291/11 3 292)

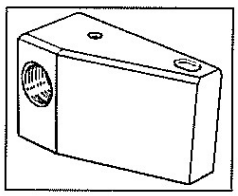
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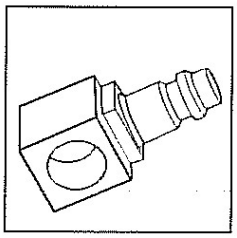
- Fuel line plugs
  (Tool No. BMW 13 5 281/13 5 282)



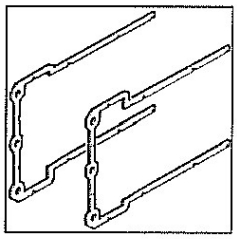
- Fuel line removal tool for quick-disconnect fittings
  (Tool No. BMW 16 1 050)



- Tensioning bracket (V-8)
  (Tool No. BMW 11 7 380)



- Compressed air fitting for testing VANOS operation
  (Tool No. BMW 11 3 450)



- Upper timing cover installation tool set, V-8
  (Tool No. BMW 11 1 410)

DIAGNOSTIC TESTING

Cylinder compression, checking

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

NOTE—
Performing a compression test may cause a fault to set in the ECM and may illuminate the Malfunction Indicator Light (MIL). The light can only be turned out using either BMW special service scan tools or an equivalent aftermarket scan tool. Disconnecting the battery will not erase the fault memory or turn out the light. See ***OBD On-Board Diagnostics****.*

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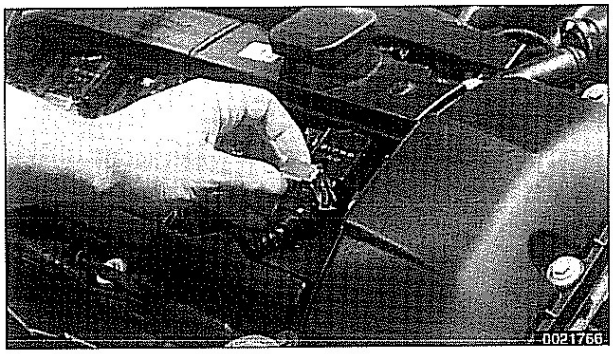
Cylinder Head Removal and Installation

– Disable ignition system by removing DME main relay. See **610 Component Locations** for relay location.

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

> ***CAUTION—***
> *Failure to remove the DME main relay or attempting to disable the fuel and ignition systems by other methods may result in damage to the engine control module (ECM).*

– Remove plastic cylinder head cover(s).



➢ Pull up on spring clips to disconnect ignition coil harness connectors at each cylinder.

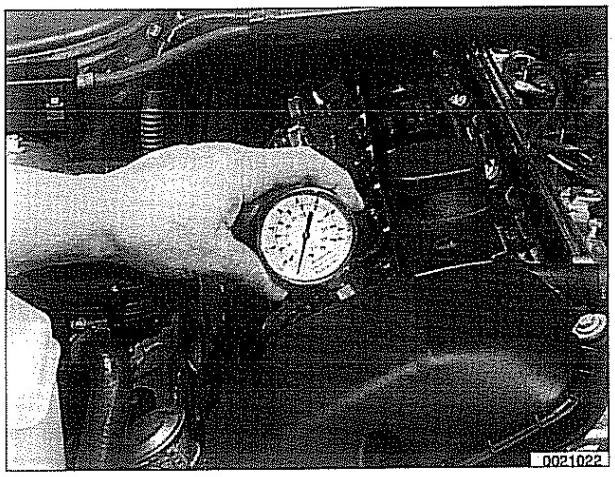
– Remove coil grounding straps.

> ***CAUTION—***
> *Note location of all grounds. Failure to reinstall grounds can result in permanent damage to engine control module or ignition system components.*

– Remove coils.

– Remove spark plugs from all cylinders.

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



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

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

NOTE—
- *The compression gauge reading should increase with each compression stroke and reach near its maximum reading in about 4-6 strokes.*
- *All cylinders should reach maximum compression in the same number of strokes. If a cylinder needs significantly more strokes to reach maximum compression, there is a problem.*

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– Release pressure at compression gauge valve, then remove gauge from spark plug hole. Repeat test for each cylinder and compare results with values given in **Table a.**

Table a. Compression testing specifications

Minimum compression	
6–cylinder	10–11 bar (142-156 psi)
V-8	12–14 bar (174–203 psi)
Maximum difference between cylinders (all engines)	0.5 bar (7 psi)

– Compression readings may be interpreted as follows:
  - Low compression indicates a poorly sealed combustion chamber.
  - Relatively even pressures that are below specification normally indicate worn piston rings and/or cylinder walls.
  - Erratic values tend to indicate valve leakage.
  - Dramatic differences between cylinders are often a sign of a failed head gasket, burned valve, or broken piston ring.

– If readings are within specifications, reinstall spark plugs and ignition coils.

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

Tightening torque

Spark plug to cylinder head	25 Nm (18 ft-lb)
Ignition coils to cylinder head	10 Nm (7.5 ft-lb)

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

Wet compression test

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

– Repeat compression test, this time squirt a teaspoon of oil into each cylinder. The oil will temporarily help seal between piston rings and cylinder wall, practically eliminating leakage past rings for a short time.

– If this test yields a higher reading than "dry" compression test, there is probably leakage between piston rings and cylinder walls, due either to wear or to broken piston rings.

– Little or no change in compression reading indicates other leakage, probably from valves.

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Cylinder leak-down test

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

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

CYLINDER HEAD REMOVAL AND INSTALLATION (M52 ENGINE)

> ***WARNING —***
> *Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.*

Cylinder head removal and installation is a time consuming repair procedure requiring multiple special service tools. Read the entire procedure before beginning the repair.

This procedure includes the following steps:

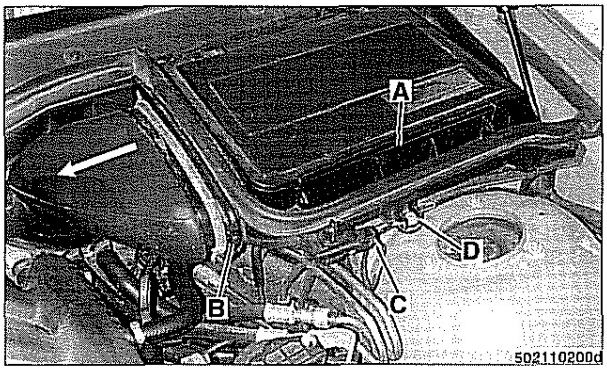
- **Cylinder head, removing, M52 engine**
- **Cylinder head, installing, M52 engine**

Cylinder head, removing, M52 engine

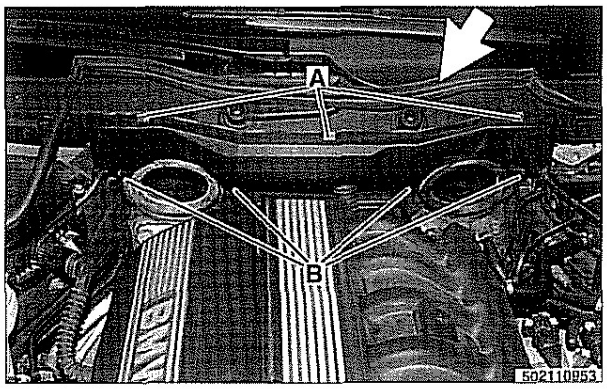
– Disconnect negative (–) cable from battery in luggage compartment.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*

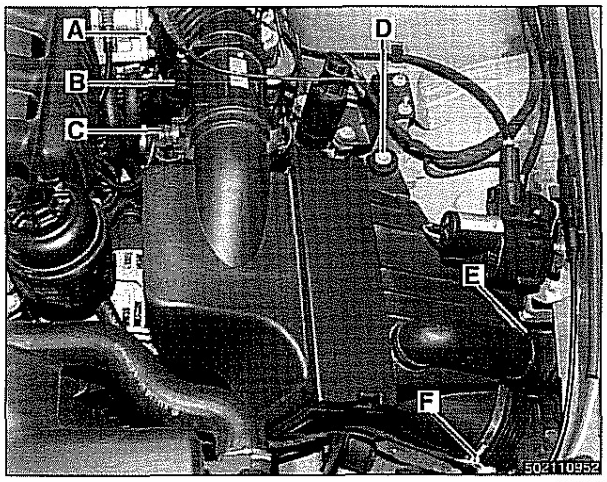
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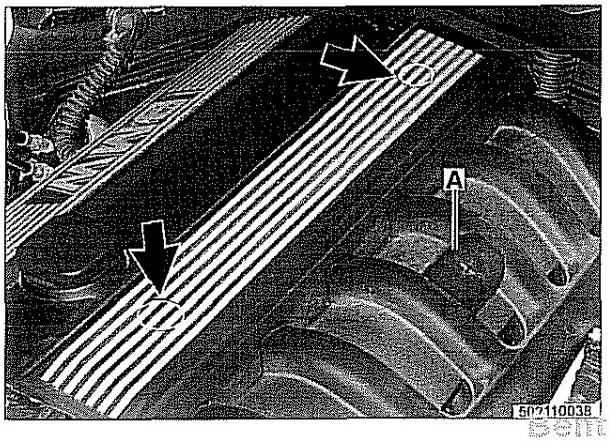
- Remove left and right interior ventilation ducts (left shown):
  - Release ventilation filter cover latch (**A**) and remove cover.
  - Release plastic locking tab (**B**) or release locking tabs on top of duct (later models).
  - Rotate duct counterclockwise to unlock from bulkhead and remove (**arrow**).
  - Disconnect electrical connector from hood switch (**C**).
  - Release spring lock (**D**).
  - Slide filter housing away from inner fender to remove.
  - Removal of right side ventilation duct is similar.



- Remove rear bulkhead panel:
  - Remove rubber sealing gasket (**arrow**).
  - Remove 3 mounting clips (**A**).
  - Remove 4 retaining screws (**B**).
  - Lift out panel.



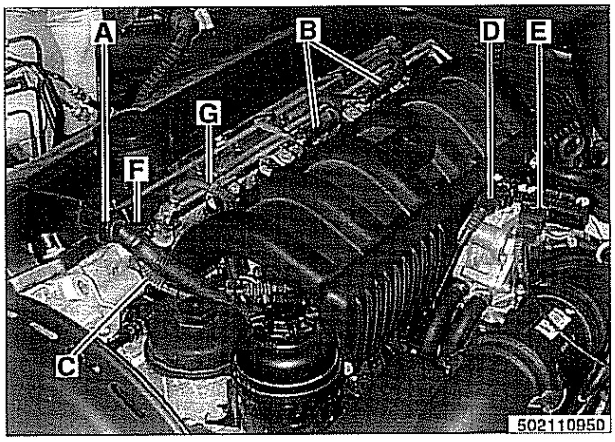
- Remove complete air filter housing:
  - Loosen intake duct hose clamp (**A**) at throttle assembly.
  - Loosen clamp and remove idle control hose from intake duct (**B**) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (**C**) from mass air flow sensor.
  - Remove air filter housing mounting screw (**D**).
  - Disconnect vent tube (**E**).
  - Loosen air intake duct clamp (**F**).
  - Carefully lift air filter housing out of engine bay.

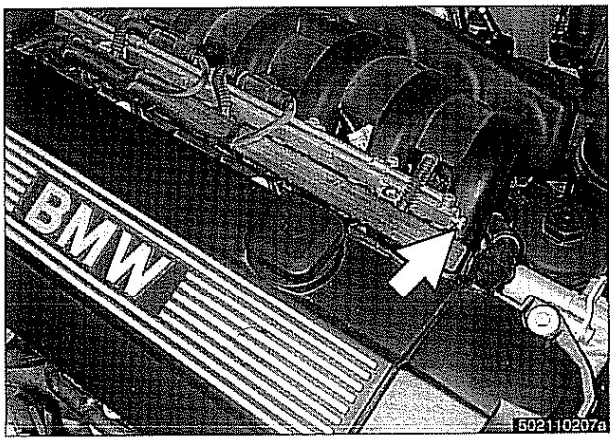


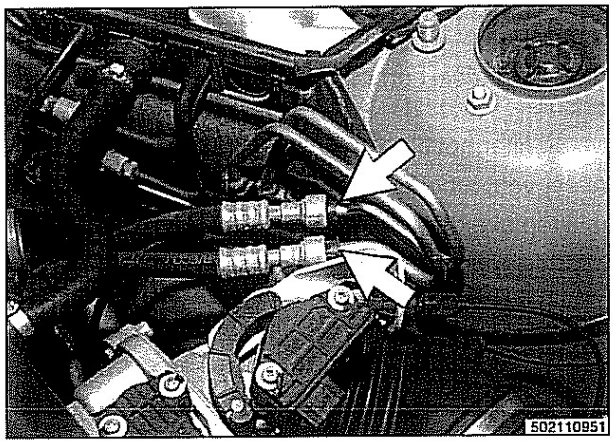
- Remove positive battery cable and intake manifold cover:
  - Remove protective cover from positive (+) jumper post (**A**).
  - Loosen and remove battery lead mounting nut.
  - Remove battery lead and push down through intake manifold.
  - Remove trim caps (**arrows**) from fuel injector cover.
  - Remove cover hold down fasteners and lift off cover.

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Cylinder Head Removal and Installation







- Working above engine, disconnect the following:
  - Vent line from cylinder head cover (**A**).
  - Oxygen sensor connectors (**B**).
  - Electrical harness connector from VANOS solenoid valve (**C**).
  - Electrical harness connectors at throttle valve position switch (**D**), ASC valve position switch (**E**), fuel injector harness (**F**) and vent valve (**G**).

> ***CAUTION—***
> *Be sure to mark oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.*

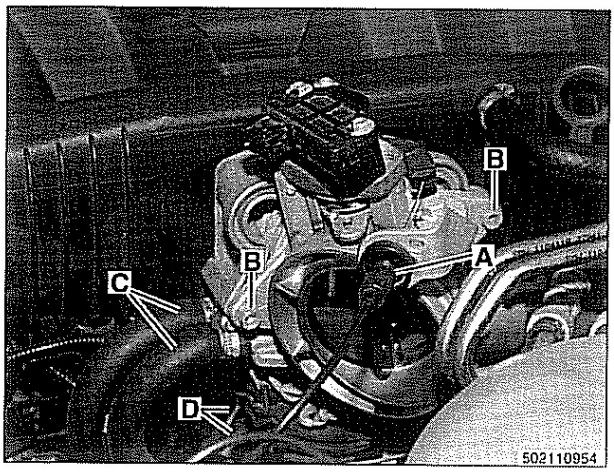
- Where applicable, remove schraeder valve cap (**arrow**) from air connection on fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

> ***WARNING—***
> - *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug open fuel lines.*
> - *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

- Disconnect fuel lines by sliding locking collar in (**arrows**) and pulling lines apart.

NOTE—
BMW uses three styles of fuel line connections; a one-time use clamp; a locking fitting that uses BMW special tool 16 1 050 to release; and a quick release sleeve (above) that disconnects the line when depressed.

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➢ Remove intake throttle valve and ASC throttle assemblies:

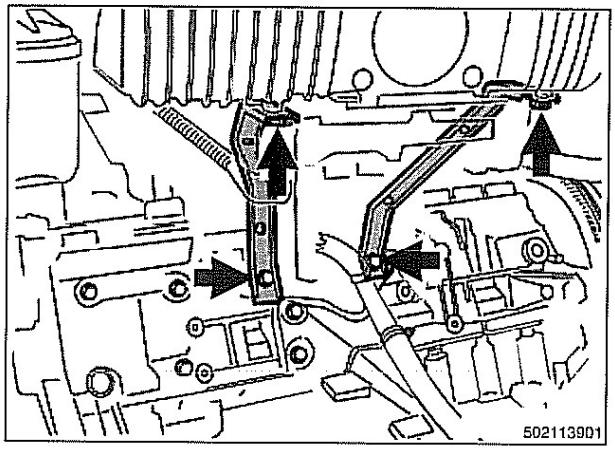
- Disconnect ASC throttle cable (**A**).
- Remove ASC throttle housing mounting fasteners (**B**).

NOTE—
*It is not necessary to disconnect coolant hoses (**C**) or bowden cables (**D**).*

- Remove intake throttle housing mounting hardware, pull throttle housing off intake manifold, and set aside.

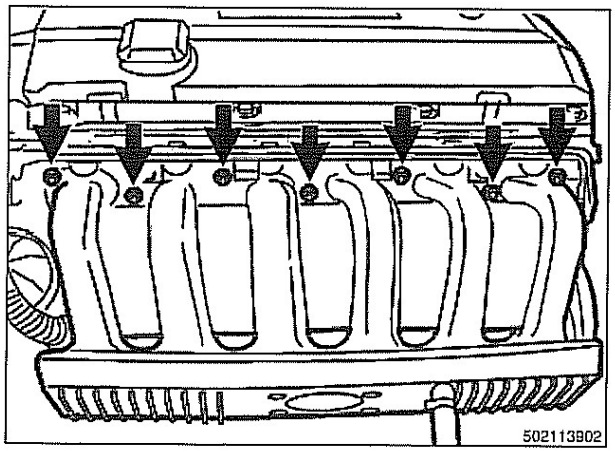
– Working under intake manifold, disconnect the following:

- Engine oil dipstick tube support.
- Oil separator return line from dipstick tube.
- Intake air temperature sensor electrical harness connector (underside of intake manifold near throttle body).
- Fuel tank vent line and electrical harness at canister vent valve.



➢ Remove lower intake manifold supports (**arrows**).

– Disconnect coolant line retaining bracket at cylinder block.



➢ Remove manifold mounting hardware (**arrows**).

– Remove intake manifold from cylinder head while carefully checking for electrical connections or hoses.

NOTE—
Fuel rail is removed with intake manifold.

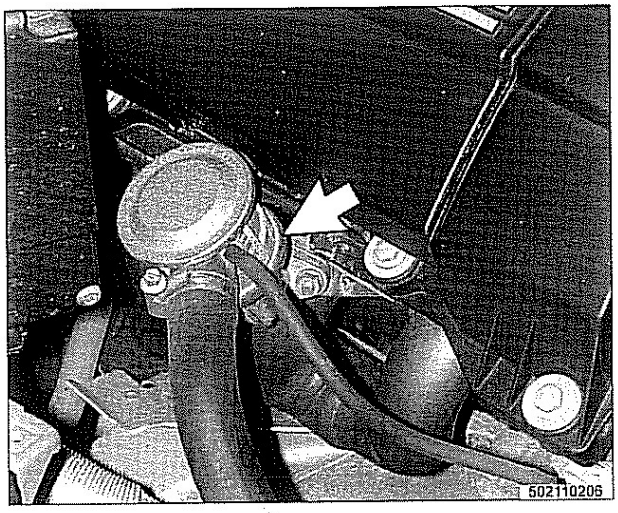
> ***CAUTION—***
> *Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.*

– Drain cooling system (engine block and radiator), then remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

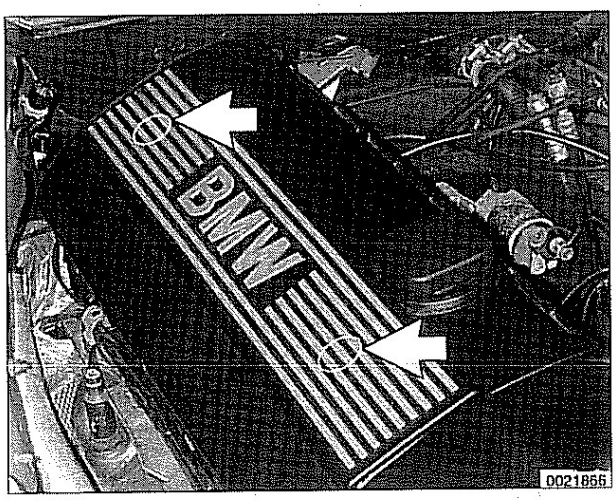
– Disconnect coolant hoses from thermostat housing.

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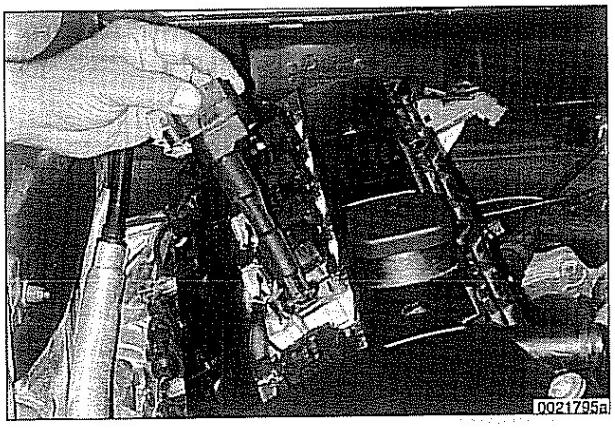
Cylinder Head Removal and Installation



- Remove secondary air injection check valve (**arrow**).



- Remove cylinder head top cover:
  - Remove plastic trim caps (**arrows**).
  - Remove engine oil filler cap.
  - Remove cover hold down fasteners and lift off cover.



- Remove ignition coils:
  - Disconnect ignition coil harness connectors.
  - Remove coil mounting fasteners.
  - Remove coils.
  - Remove ground straps.

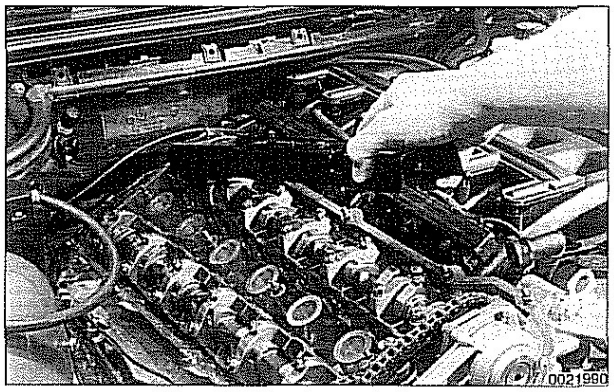
NOTE—
Make note of ground wire at mounting studs arrangement during removal.

– Remove spark plugs.

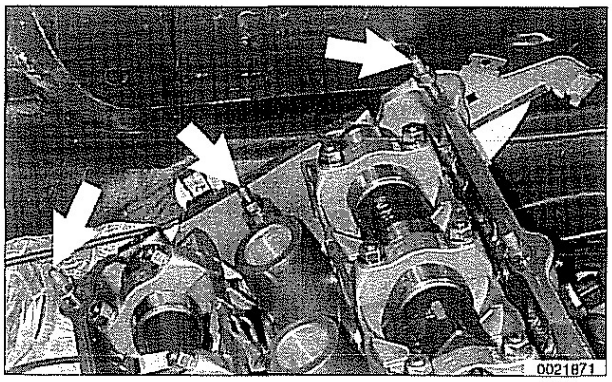
– Remove cylinder head cover mounting fasteners and remove cylinder head cover.

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

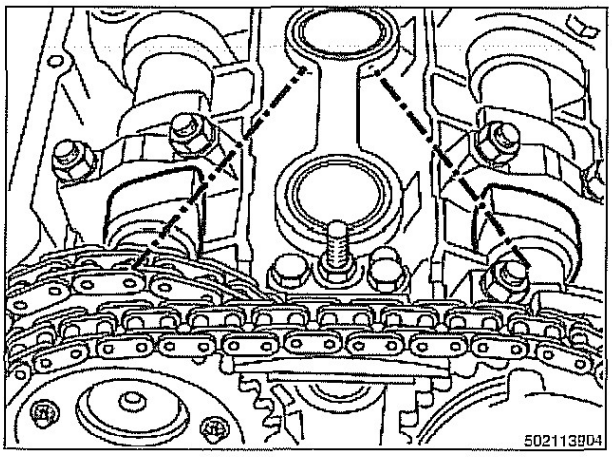
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➢ Remove oil baffle cover from above intake camshaft.

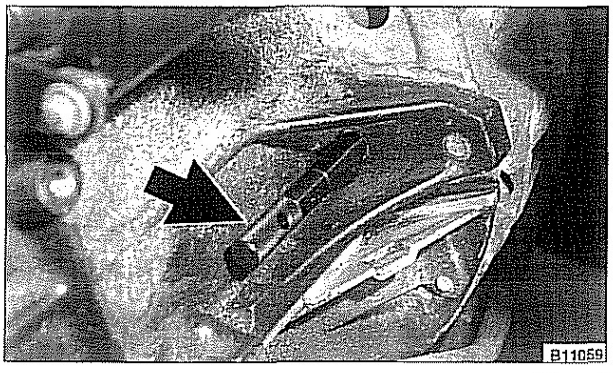


➢ Unscrew and remove three cylinder head cover studs (**arrows**) at rear of cylinder head.



➢ Set engine to approximate top dead center (TDC) by turning crankshaft bolt in direction of rotation (clockwise when viewed from front of engine) until camshaft lobes for cylinder 1 face each other (**dotted lines**) and arrows on camshaft sprockets face up.

– Set engine to TDC by aligning "**OIT**" mark of vibration damper with boss cast on lower timing chain cover.

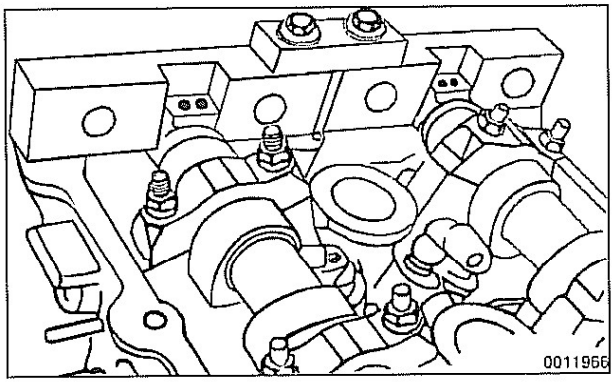


➢ Lock crankshaft at TDC:

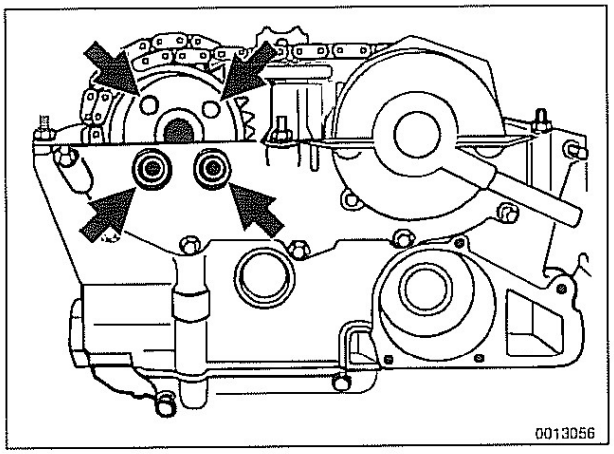
- Remove sealing plug from bore on lower left side of engine block below starter. Secure crankshaft in TDC position with BMW special tool 11 2 300.

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Cylinder Head Removal and Installation

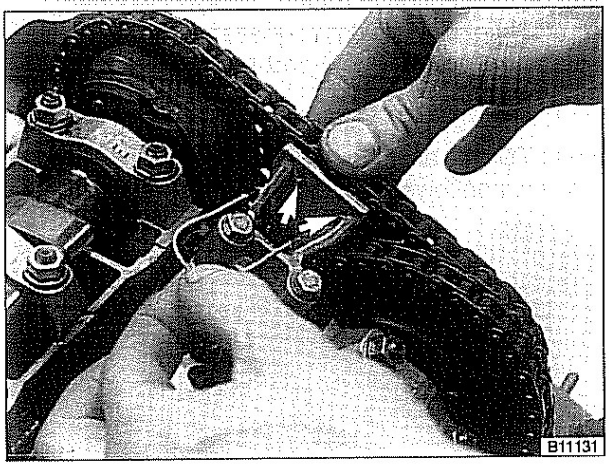


- Secure camshafts in TDC position using BMW special tool set 11 3 240.



- Remove access plugs from VANOS control unit in front of exhaust camshaft sprocket.
  - Remove 4 bolts (**arrows**) from exhaust camshaft sprocket (Torx E10).

> ***CAUTION—***
> *Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting fasteners.*



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

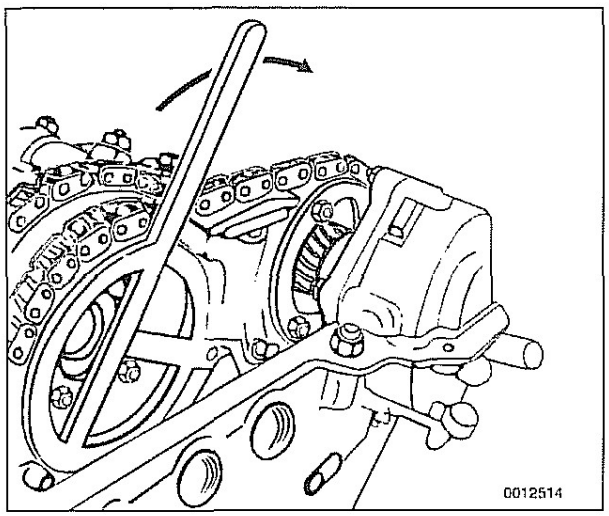
NOTE—
Some tensioners may have a single hole for special tool.

- Remove secondary chain tensioner.
- Disconnect harness connector and oil line fitting from bottom of VANOS control unit.

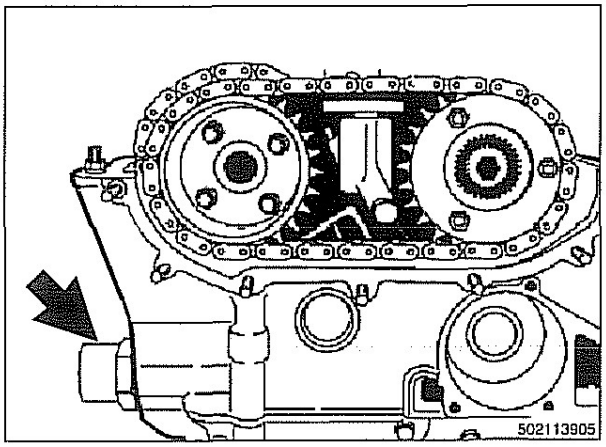
NOTE—
Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.

- Remove VANOS control unit mounting nuts and bolt at front of cylinder head.

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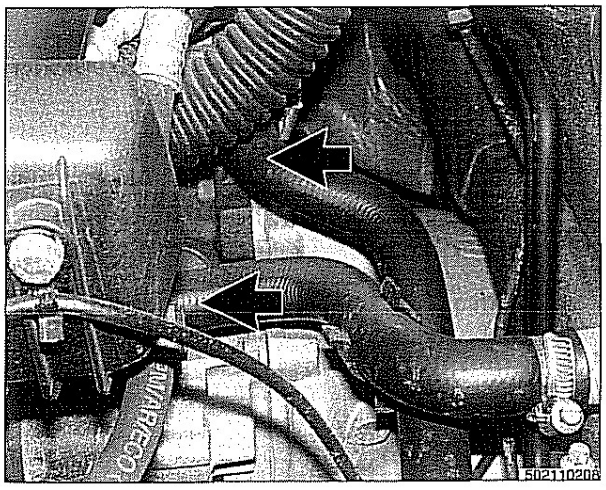
- Use a spanner tool to rotate exhaust sprocket until stop on intake sprocket is contacted.
- Slide VANOS control unit forward to remove.



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

> ***WARNING —***
> *Remove tensioner slowly — it is under spring pressure.*

- Working at the intake side of cylinder 1:
  - Detach electrical harness connector for camshaft position sensor and remove sensor.
  - Detach electrical harness connector for coolant temperature sensor.
- Remove exhaust manifolds. Discard nuts. See **180 Exhaust System.**



- Disconnect heating system hoses (**arrows**) from back of cylinder head.

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Cylinder Head Removal and Installation

– Remove secondary timing chain and sprockets:
  - Remove mounting nuts from front of intake camshaft sprocket. Remove and label shim.

> ***CAUTION—***
> *Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting fasteners.*

  - Remove mounting nuts from front of exhaust camshaft sprocket and remove and label thrust washer.

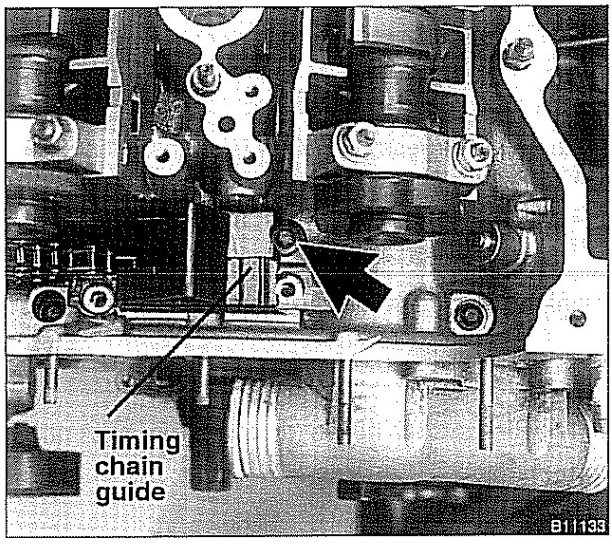
NOTE—
Where applicable, make note of thrust washer positions. The thicker (0.4 mm) washer is mounted outermost.

  - Remove secondary sprockets together with camshaft timing chain from front of camshafts.

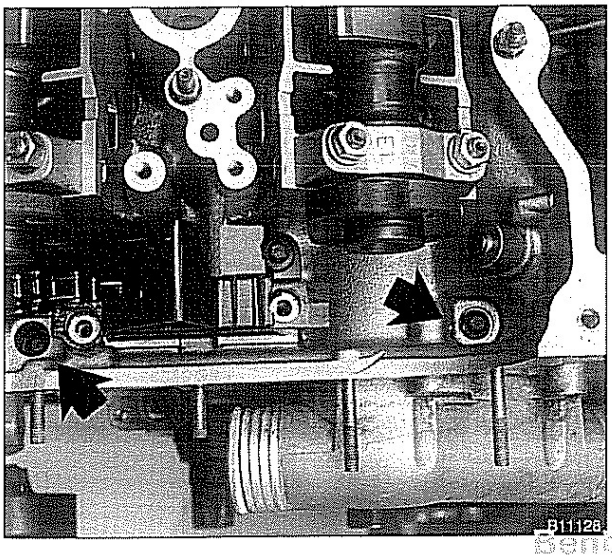
> ***CAUTION—***
> *The camshafts must be locked in the TDC position using the special service tool as described earlier. The arrows on the sprockets should not be used to accurately set the engine to TDC. The tool holds the camshafts parallel to each other and perpendicular to the cylinder head cover gasket surface.*

NOTE—
Do not remove the sprockets from the chain unless these parts are being replaced. Wire tie each sprocket to the chain to keep the sprockets timed to each other.

> ***CAUTION—***
> *The crankshaft must not be allowed to rotate once the camshaft timing chain is removed. The pistons can contact the valves.*



➢ Unscrew timing chain guide and remove.



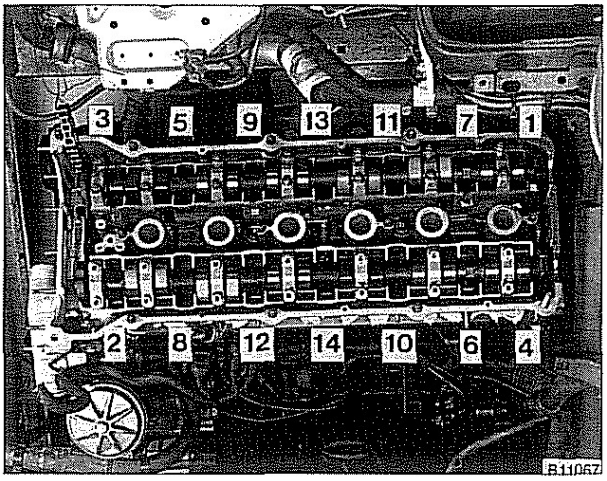
– Lift off primary sprocket with chain.
  - Secure chain with wire to prevent chain from dropping into lower timing cover.

➢ Unscrew timing case cover to cylinder head bolts (**arrows**).

NOTE—
Photo shows timing chain guide in place; it should first be removed as described previously.

– Remove crankshaft locking tool (BMW special tool 11 2 300). Using the crankshaft vibration damper bolt, turn engine opposite of normal direction of rotation (counterclockwise as viewed from the front) approximately 30°. This prevents accidental contact between valves and pistons during installation.

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Cylinder head bolt loosening sequence.

– Using BMW special tool 11 2 250 or an equivalent tool, loosen cylinder head bolts in sequence. Discard head bolts.

– Separate the cylinder head from the block and remove head. Evaluate head as described in **116 Cylinder Head and Valvetrain.**

Cylinder head, installing, M52 engine

If the camshafts were removed and installed while the cylinder head was off, a minimum waiting time is required after installing the camshafts. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, resulting in open valves.

Camshaft installation 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

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

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

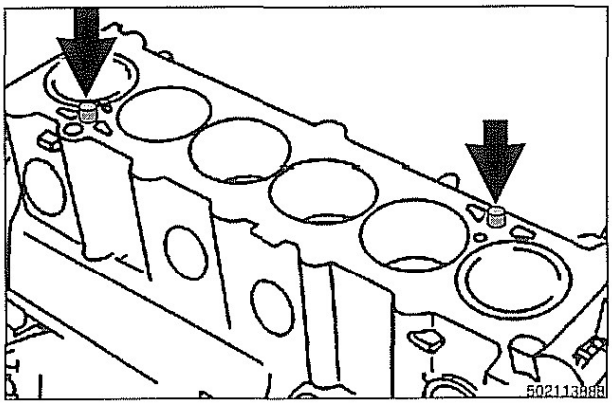
– Remove all debris and fluids from bolt holes and clean with a thread chaser.

– Check gasket surface of cylinder head and cylinder block for warpage using a straight edge.

NOTE—
If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available from an authorized BMW dealer.

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Cylinder Head Removal and Installation



- Check that two locating dowels are correctly positioned in block and are not damaged.
- Apply permanently elastic sealing compound Three Bond 1209 ® to joints where cylinder block joins timing case cover.
- Place new cylinder head gasket on cylinder block.

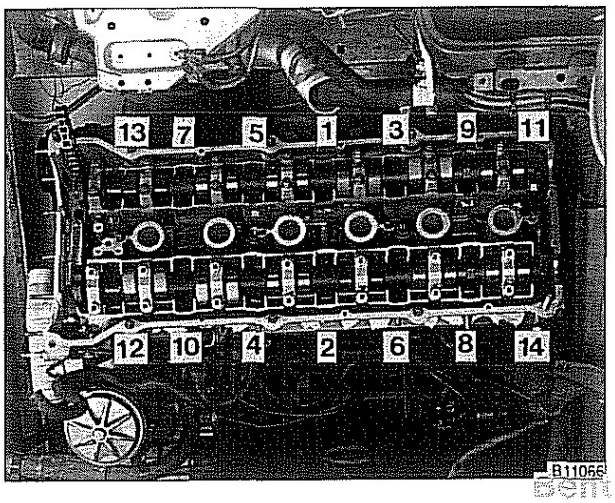
NOTE —
The word "OBEN" or "TOP", printed on the gasket, should face up. The cylinder head gasket will fit correctly in only one orientation.

- With camshafts locked in TDC position with BMW special tools as described during cylinder head removal, set cylinder head in position, guiding primary chain through cylinder head opening.

NOTE —
- *The camshafts must be locked in the TDC position at the rear of the cylinder head with BMW special tool 11 3 240 before installing the cylinder head.*
- *Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation, is still in that position before lowering the cylinder head into position.*

- Lightly lubricate new cylinder head bolts. Loosely install bolts and their washers, then thread them in until they are finger tight.

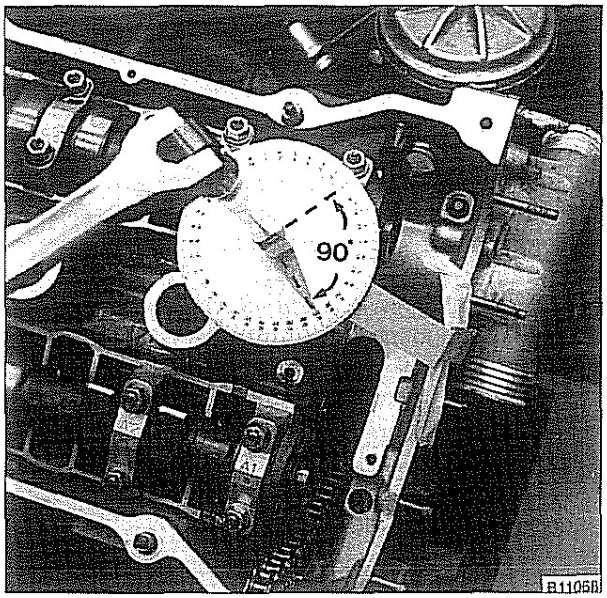
NOTE —
- *Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.*
- *Check that all washers for the cylinder head bolts are in place before installing the bolts. Some of the washers may be staked to the cylinder head.*



CAUTION —
Cylinder head bolts for a cast iron engine block are different length and require different tightening torque than bolts for an aluminum cylinder block engines (95 mm versus 110 mm bolts).

- Install cylinder head-to-lower timing chain cover bolts finger tight.
- Tighten cylinder head bolts in correct sequence to initial torque value.

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➢ Use BMW tool 11 2 110 or torque angle gauge to tighten cylinder head bolts in sequence to stage 2 and 3.

Tightening torques

Cylinder head to cast iron block	
Stage 1	30 Nm (22 ft-lb)
Stage 2	+90°
Stage 3	-90°
Cylinder head to aluminum block	
Stage 1	40 Nm (30 ft-lb)
Stage 2	+90°
Stage 3	-90°

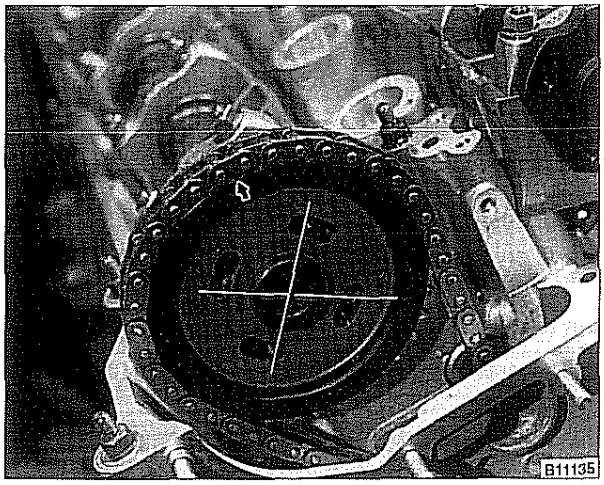
– Tighten cylinder head-to-lower timing chain cover bolts.

Tightening torques

Cylinder head to lower timing chain cover	10 Nm (89 in-lb)

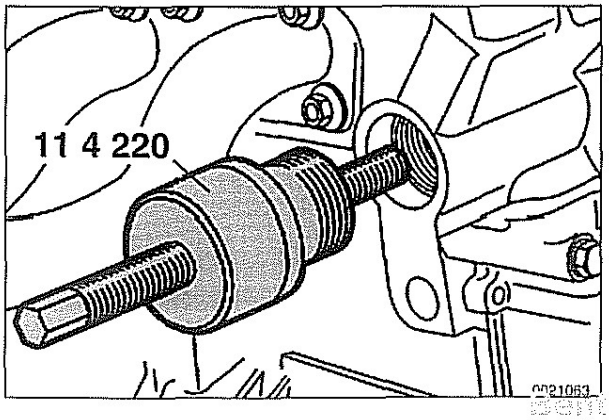
– Inspect secondary chain guide rail and tensioner rail for grooves caused by chain contact. Replace any part that is worn.

NOTE—
- *Inspect timing chain sprockets. Sprockets that have worn or missing teeth should be replaced.*
- *If any of the 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 as described under **119 Lubrication System**.*



CAUTION—
The procedure outlined below assumes that the camshafts and the crankshaft are locked in the TDC position with special tools.

➢ Mount primary timing chain sprocket to primary chain so that arrow on sprocket faces up. Mount sprocket to camshaft so that tapped holes in camshaft are on left side of elongated holes in sprocket.

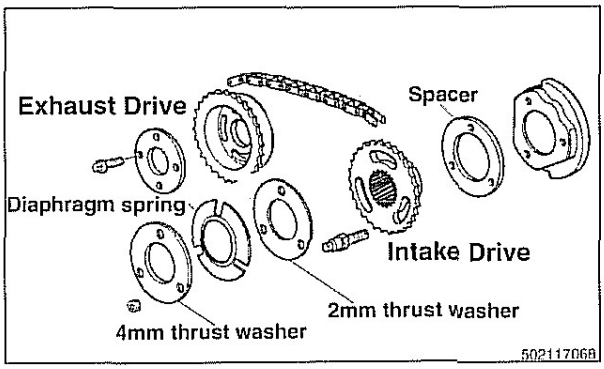


➢ Install BMW special tool 11 4 220 into primary timing chain tensioner sleeve. Thread center spindle in finger tight until slack is removed from chain.

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NOTE—
BMW special tool 11 4 220 is an adjustable primary chain tensioner and simulates the function of the hydraulic tensioner.

- Check that elongated holes in primary sprocket are now centered to bolt holes in camshaft and chain is free of slack. If not, reposition sprocket to chain and reinstall.
- Install secondary timing chain guide and secondary chain tensioner. Tighten mounting bolts (tensioner remains locked down for now using BMW special tool 11 3 292).
- Install cylinder identification trigger plate to front of intake camshaft with studs.
- Install spacer to front of intake camshaft.
- Install secondary chain sprockets and chain as an assembly so that arrows on sprockets are pointing up. Center mounting holes in sprockets to bolt holes in camshafts.



- Install thrust washers and diaphragm spring to intake cam sprocket.
- Install shim and torx bolts to exhaust camshaft. Tighten finger tight; do not torque down.
- Tighten intake sprocket nuts.

CAUTION—
Hold the camshaft stationary (at hex on camshaft) when loosening or tightening sprocket mounting bolts and studs.

Tightening torque

Intake sprocket nuts to studs	10 ±1 Nm (89 ±9 in-lb)

- Turn crankshaft approx. 30° in direction of rotation to bring engine to TDC. Lock crankshaft in TDC position with BMW special tool 11 2 300.

CAUTION—
The camshafts and crankshaft must be locked in the TDC position using BMW special tools 11 2 300 and 11 3 240. If the camshafts and crankshaft are not at TDC, the valves can contact the pistons.

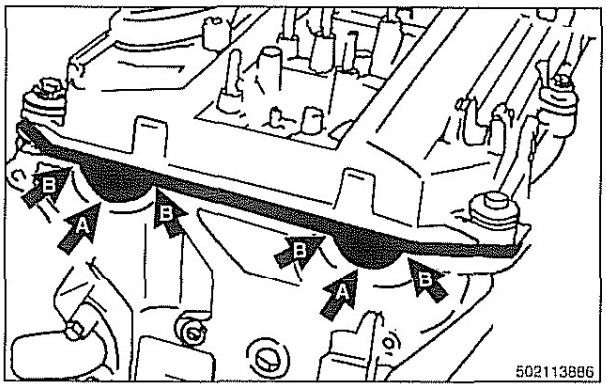
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NOTE—
Be sure the secondary timing chain tensioner is locked down and the exhaust camshaft mounting bolts are loose before proceeding.

– Install VANOS control unit. See VANOS control unit, installing (M52 engine) in **117 Camshaft Timing Chain**.

> ***CAUTION—***
> *Incorrect installation of the VANOS control may result in damage to the engine valvetrain.*

– Install exhaust manifolds using new gaskets and nuts. Coat manifold studs with copper paste prior to installing nuts.



Install intake camshaft cover and cylinder head cover.

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

– Installation of remaining parts is reverse of removal, noting the following:

- Reinstall electrical harness connectors for oil pressure switch and coolant temperature sensor before installing intake manifold.
- Refill cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.
- If necessary, adjust accelerator cable.
- Reconnect battery last.

Tightening Torques

VANOS oil line	32 Nm (24 ft-lb)
VANOS solenoid to control unit	30 Nm (22 ft-lb)
Coolant drain plug to cylinder block	25 Nm (18 ft-lb)
Cylinder head cover to cylinder head (M6 bolts)	10 Nm (89 in-lb)
Intake manifold to cylinder head	15 Nm (11 ft-lb)
Radiator cooling fan to coolant pump	40 Nm (30 ft-lb)
Radiator drain screw to radiator	2.5 Nm (22 in-lb)

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CYLINDER HEAD REMOVAL AND INSTALLATION (M52 TU AND M54 ENGINES)

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

Cylinder head removal and installation is a time consuming repair procedure requiring multiple special service tools. Read the entire procedure before beginning the repair.

This topic includes the following procedures:

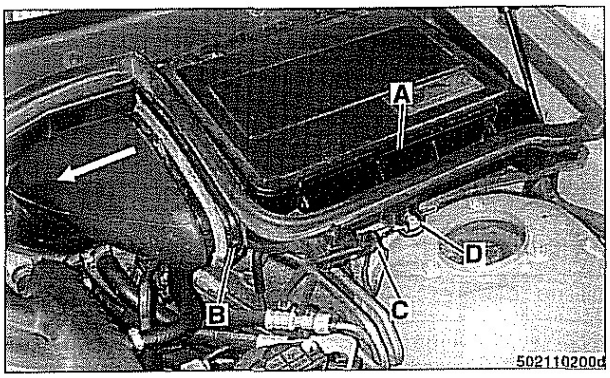
- **Cylinder head, removing, M52 TU and M54 engines**
- **Cylinder head, installing, M52 TU and M54 engines**

Cylinder head, removing, M52 TU and M54 engines

Allow engine to cool before beginning this procedure.

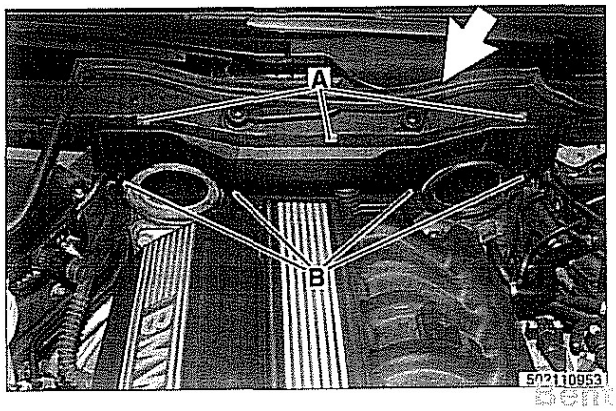
– Disconnect negative (–) cable from battery.

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



Remove left and right interior ventilation ducts (left side shown):

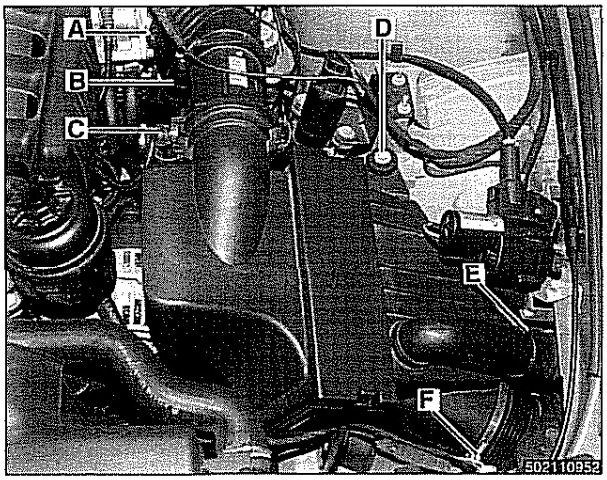
- Release ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**) or release locking tabs on top of duct (later models).
- Turn duct counterclockwise to unlock from bulkhead and remove (**arrow**).
- Disconnect electrical harness from hood switch (**C**).
- Release spring lock fastener (**D**).
- Slide filter housing away from inner fender to remove.
- Removal of right side ventilation duct is similar.



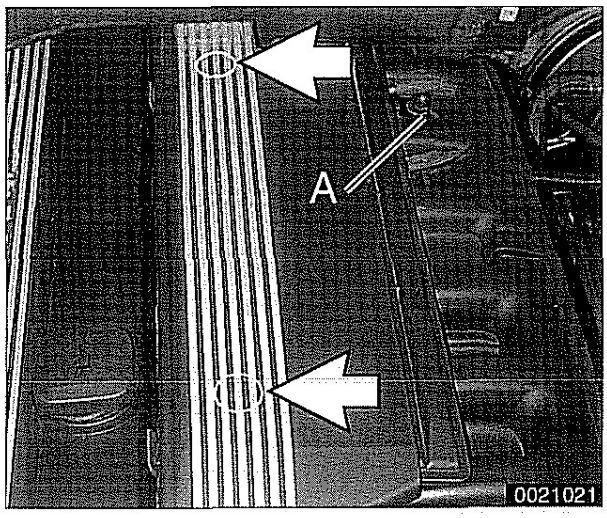
Remove rear bulkhead panel:

- Lift off rubber sealing gasket (**arrow**).
- Remove 3 mounting clips (**A**).
- Remove 4 retaining screws (**B**).
- Lift off panel.

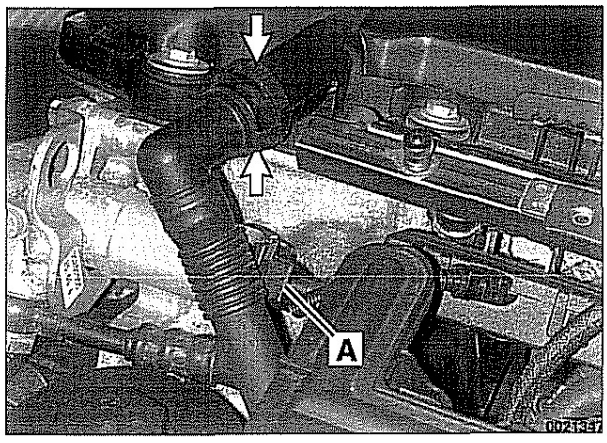
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- Remove complete air filter housing assembly with mass air flow sensor:
  - Loosen intake duct hose clamp (**A**) at throttle assembly.
  - Loosen clamp and remove idle control line from intake duct (**B**) and disconnect idle speed control valve electrical harness connector.
  - Disconnect electrical harness connector (**C**) from mass air flow sensor.
  - Remove air filter housing mounting screw (**D**).
  - Disconnect vent tube (**E**).
  - Loosen air intake duct clamp (**F**).
  - Carefully lift air filter housing, mass air flow sensor, and intake duct hose out of engine bay.



- Disconnect positive battery cable and remove intake manifold cover:
  - Remove protective cover from positive (+) jumper post.
  - Loosen and remove battery lead mounting nut (**A**).
  - Remove lead and push down through intake manifold.
  - Remove trim covers (**arrows**) from fuel injector cover.
  - Remove cover hold down fasteners and lift off cover.



- Working above engine, disconnect the following:
  - Vent line from cylinder head cover. To remove, pinch clips (**arrows**).
  - Electrical harness connector from VANOS solenoid valve (**A**).

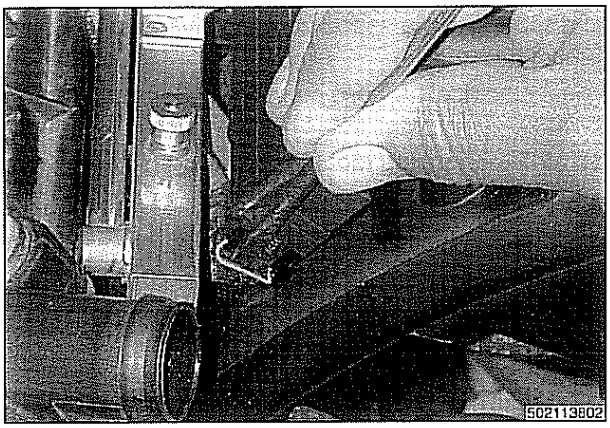
– Remove oxygen sensors and exhaust manifolds. See **180 Exhaust System**.

CAUTION—
- *Remove oxygen sensors before removing exhaust manifold to prevent damage.*
- *Label oxygen sensor harness connectors so that they can be reassembled correctly. Do not interchange connectors.*

NOTE—
Front exhaust manifold must be removed before rear manifold.

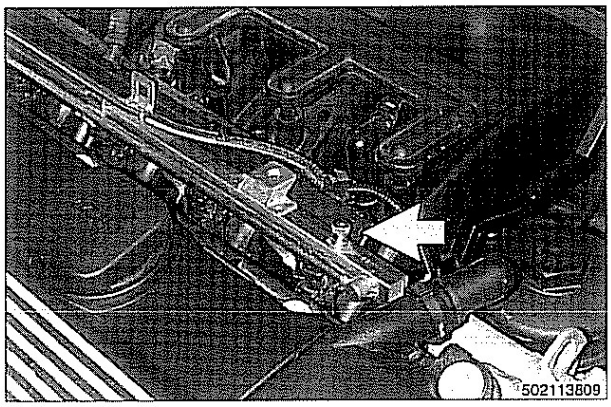
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– Working at side of intake manifold near left strut tower, disconnect intake manifold resonance valve electrical harness connector.



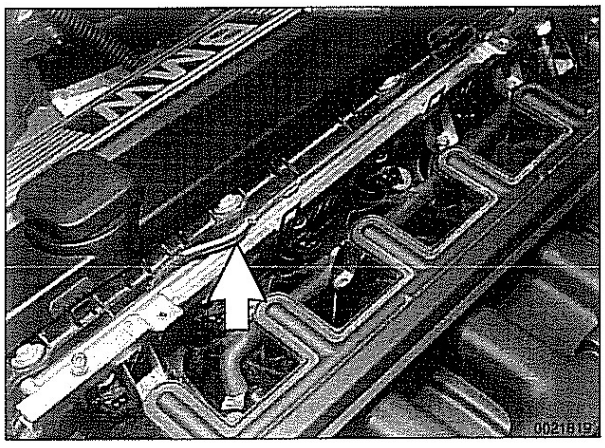
Disconnect fuel injector electrical harness connectors from injectors.

- Use small screwdriver to pry out wire lock clip on fuel injector 1 connector.
- Repeat for remaining injectors.
- Release harness conduit fasteners from injector rail.
- Disconnect intake air temperature sensor electrical harness connection (between intake runners for cylinders 3 and 4).
- Lift off connector assembly and lay aside.



Where applicable, remove schraeder valve cap (**arrow**) from fuel rail. Using a tire chuck, blow fuel back through feed line using a brief burst of compressed air (maximum of 3 bar or 43.5 psi).

WARNING—
- *Fuel is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*



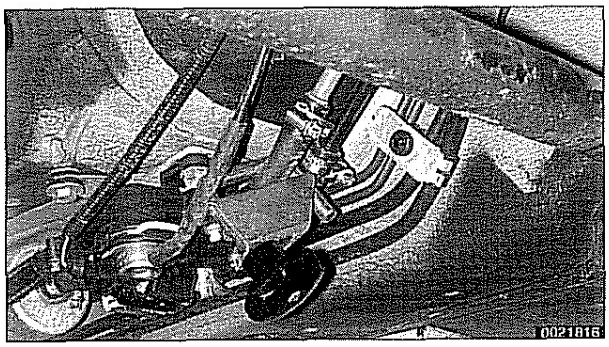
Disconnect manifold vacuum line (**arrow**).

– Raise car and support in a safe manner.

CAUTION—
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.

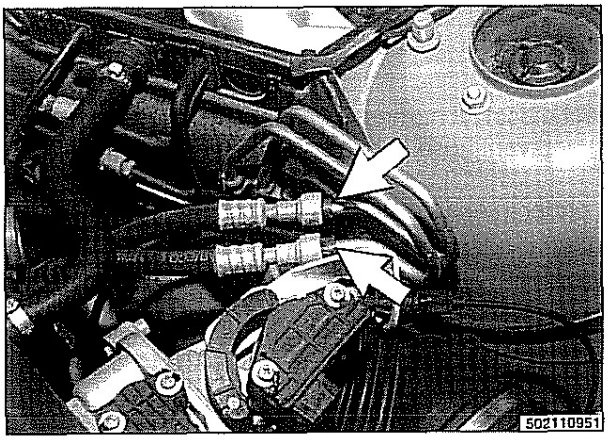
– Remove protective engine splash guard from below engine.

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- Working beneath car (on left side under driver seat), remove fuel filter cover and clamp off fuel hose(s).

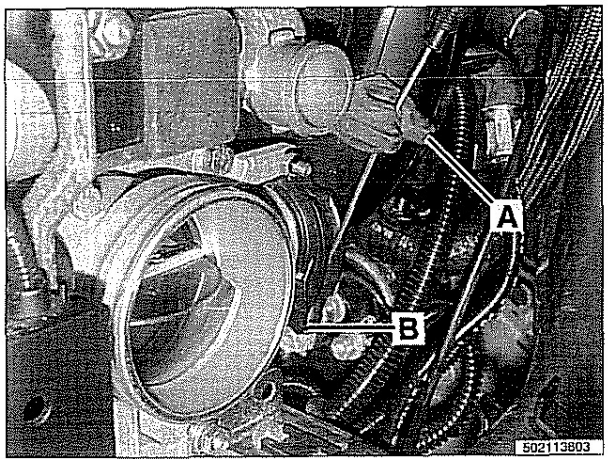
NOTE—
M54 engines use a single fuel line to the non-return fuel rail.



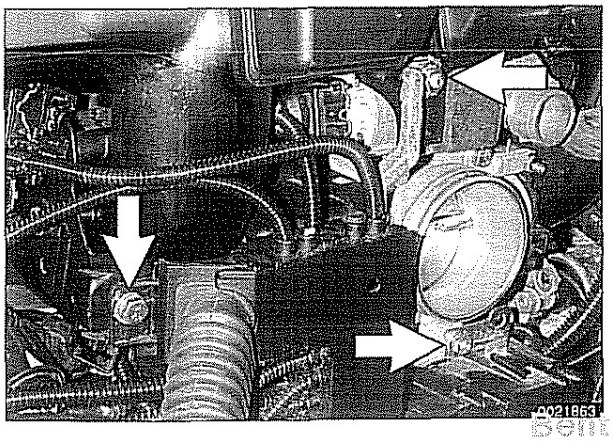
- Disconnect fuel lines by pressing in on spring lock (**arrows**).

> ***CAUTION—***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.*

NOTE—
BMW uses various styles of line connections; a one-time band clamp; a self-locking connector (that use BMW special tool 16 1 050 to release); and a quick release connector (above).



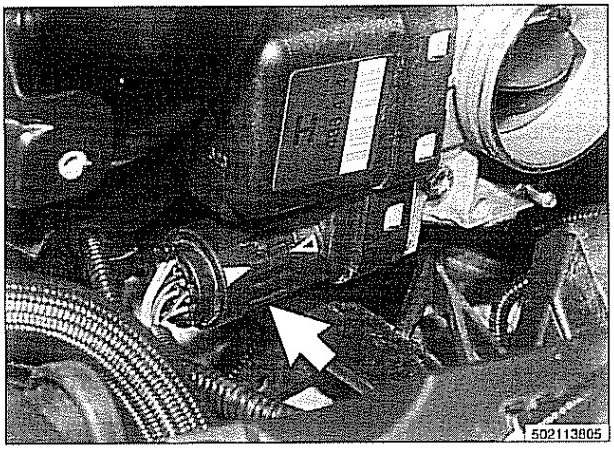
- M52 TU engine: Pull throttle cable out of rubber retainer (**A**) and unhook ball end of cable (**B**) from throttle actuator.



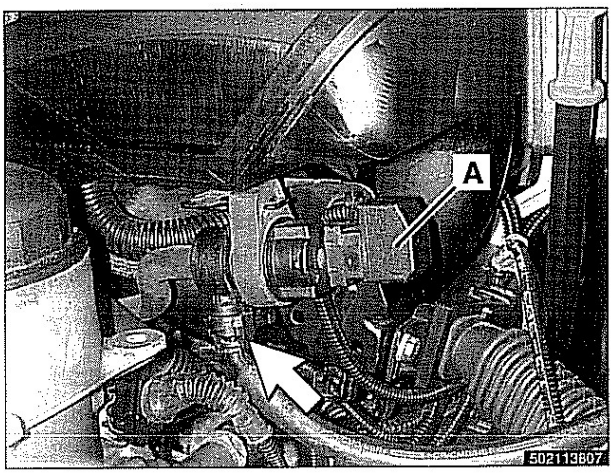
- Remove fasteners retaining wiring harness at throttle body and support bracket (**arrows**).

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Cylinder Head Removal and Installation

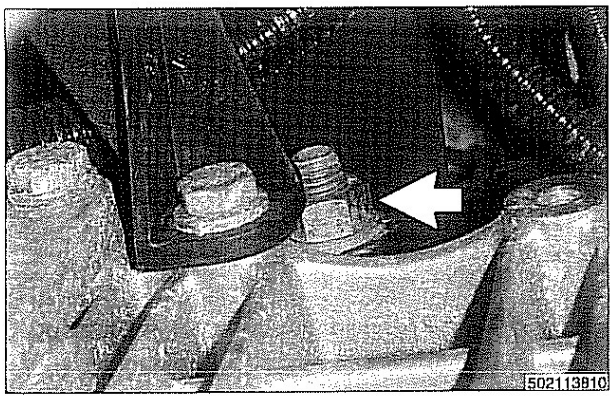


➢ Working at throttle housing, unscrew and disconnect electrical harness plug (**arrow**).



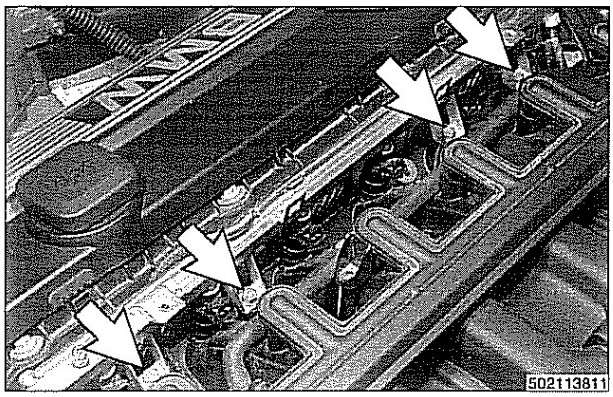
➢ Disconnect electrical harness connector at fuel tank venting valve (**A**) and vent hose at quick disconnect fitting (**arrow**).

– Working under intake manifold, disconnect the following:
  - Engine oil dipstick tube support.
  - Oil separator return line from dipstick tube.
  - Knock sensor harness connector from support.

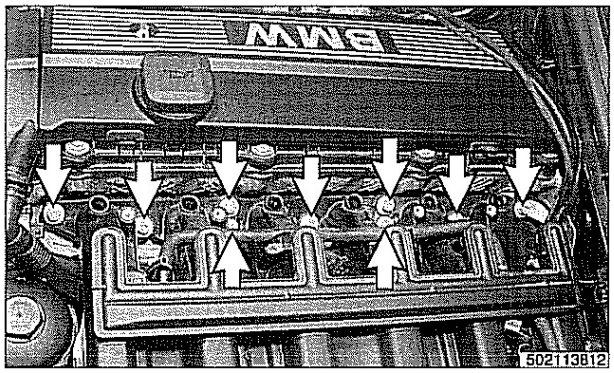


➢ Working underneath car, remove intake manifold support mounting nut (**arrow**), located adjacent to left engine mount.

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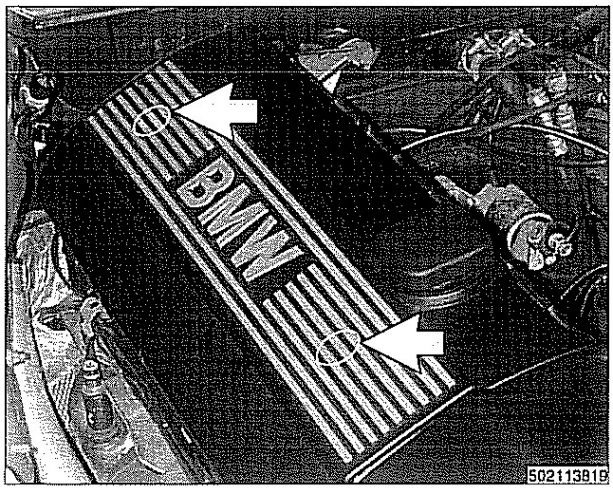
- Remove fuel rail mounting bolts (**arrows**):
  - Carefully pry fuel rail off manifold.
  - Separate fuel line support bracket at rear of intake manifold.
  - Guide fuel line(s) out of rear of engine compartment while lifting fuel rail out.



- Remove intake manifold mounting hardware (**arrows**).

– Remove intake manifold from cylinder head while carefully checking for electrical connections or hoses.

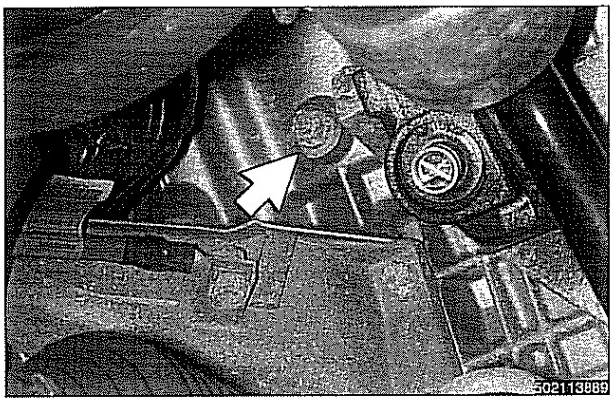
> ***CAUTION—***
> *Stuff clean rags into open intake ports to prevent any parts from falling into the engine intake.*



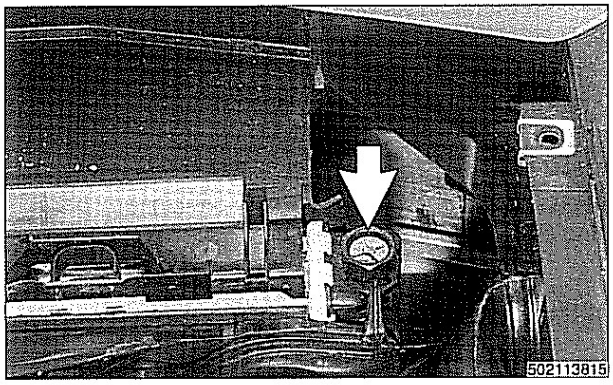
- Remove cylinder head top cover:
  - Remove plastic trim caps (**arrows**).
  - Remove cover hold down fasteners and lift off cover.

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Cylinder Head Removal and Installation



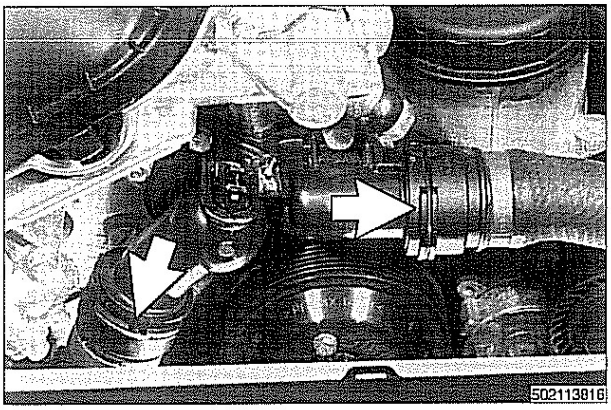
- Drain engine coolant and remove coolant hoses:
  - Remove expansion tank cap on radiator.
  - Place a 3 gallon pail beneath engine to capture coolant.
  - Remove coolant drain plug (**arrow**) located on exhaust side of cylinder 2 of engine block.



- Drain radiator into a 3 gallon pail by removing plastic drain plug (**arrow**) completely.

> ***WARNING—***
> *Use caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.*

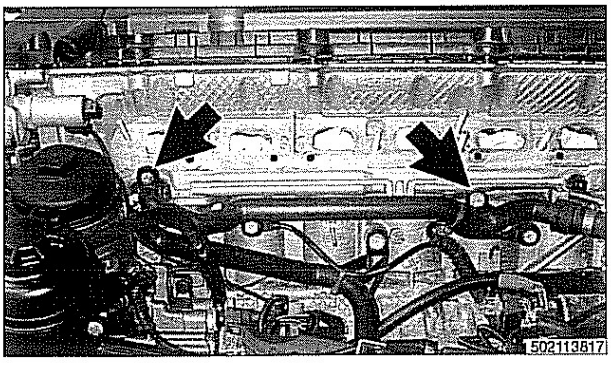
NOTE—
Catch and dispose of drained coolant according to local, state, and federal laws.



- Remove thermostat housing:
  - Disconnect electrical harness connector at thermostat housing.
  - Remove hoses from thermostat housing by releasing locks (**arrows**).
  - Unbolt (4 bolts) and remove thermostat housing.

– On vehicles equipped with mechanical cooling fan: Remove belt-driven cooling fan and radiator shroud as described in **170 Radiator and Cooling System**.

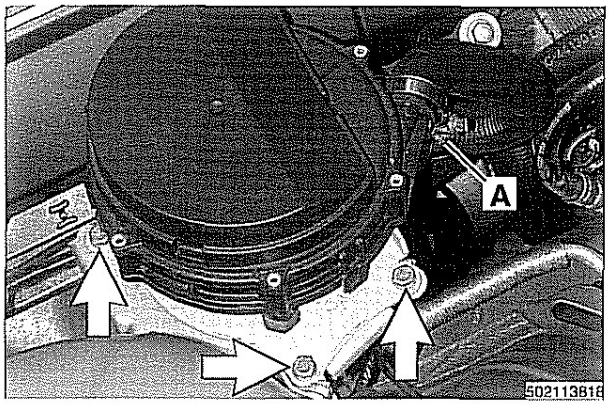
> ***CAUTION—***
> *32 mm radiator fan mounting nut has left hand threads.*



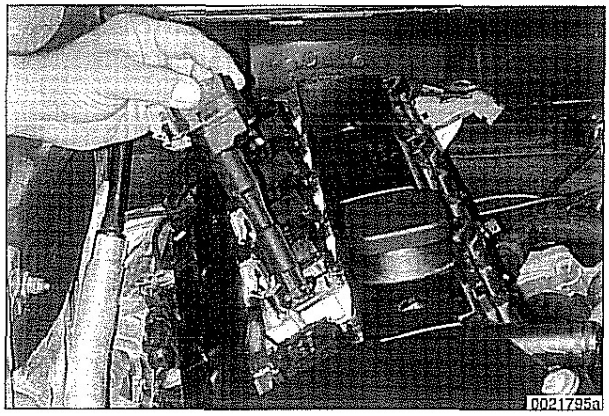
- Remove fasteners (**arrows**) from heater bypass tube. Pull tube out of cylinder head and set to side, leaving heater hose connected.

– Unbolt power steering fluid reservoir and pull aside without disconnecting hoses. Secure to fender with cord or stiff wire.

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- If applicable, remove secondary air injection pump:
  - Disconnect hose at one-way valve (**A**).
  - Remove bolts at support bracket on strut tower (**arrows**).
  - Disconnect electrical harness from bottom of secondary air injection pump.
  - Remove mounting bracket from strut tower.



- Remove ignition coils:
  - Disconnect ignition coil harness connectors.
  - Remove coil mounting fasteners.
  - Remove coils.
  - Remove ground straps.

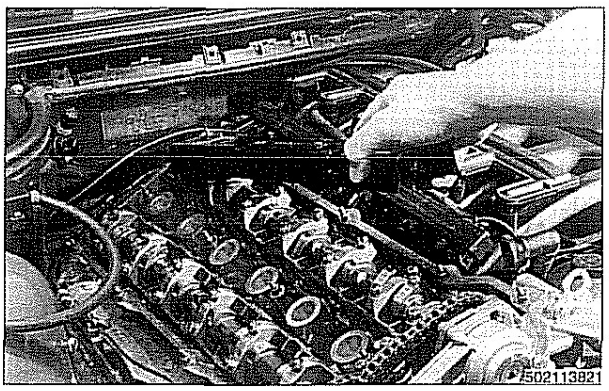
> ***CAUTION—***
> *Note location of all ground wires. Failure to reinstall grounds can result in permanent damage to engine control module or ignition system components.*

  - Set coil harness to side of engine compartment.

– Remove cylinder head cover mounting fasteners and remove cylinder head cover.

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

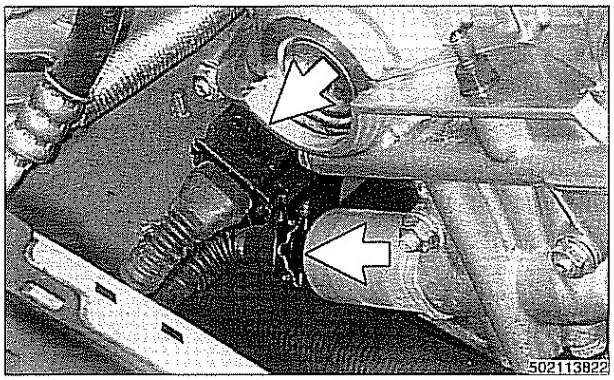
– Remove spark plugs.



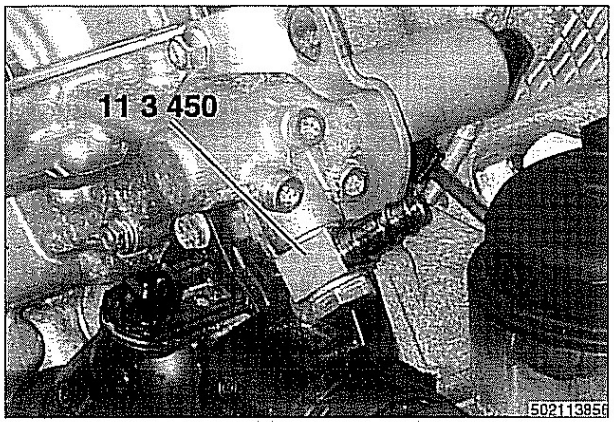
- Remove oil baffle cover from above intake camshaft.

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Cylinder Head Removal and Installation

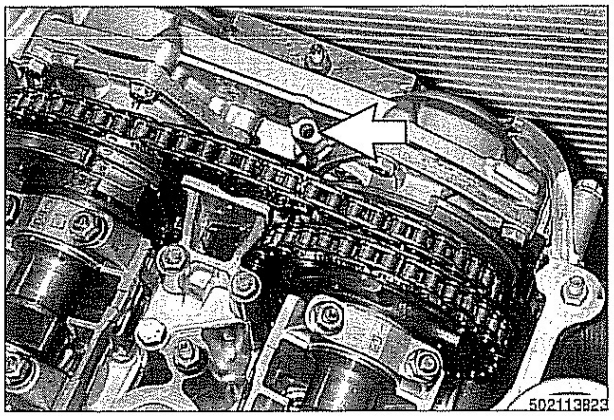


- Disconnect electrical harness connections at exhaust camshaft position sensor and exhaust camshaft VANOS control valve (**arrows**).

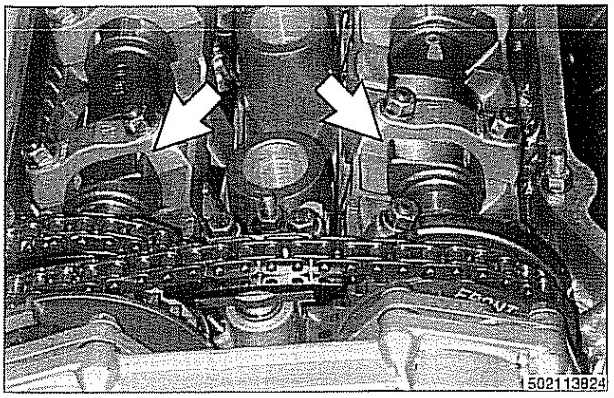


- Remove banjo bolt from VANOS unit oil pressure line. Use banjo bolt to attach BMW special tool 11 3 450 (compressed air fitting) to VANOS control unit.

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



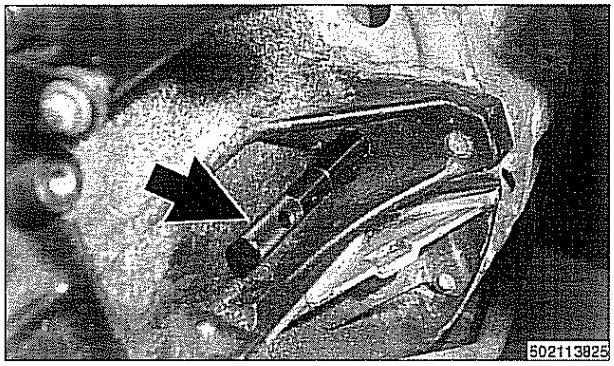
- Cover oil hole (**arrow**) in VANOS unit with shop towel to capture oil which will spray when compressed air is applied.
- Connect compressed air line to air fitting. Apply air pressure set to 2–8 bar (30–115 psi).



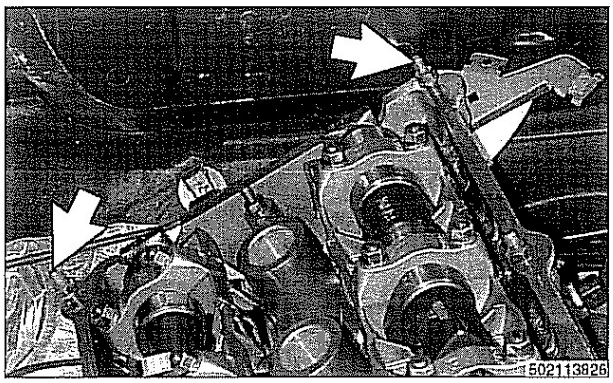
- With compressed air line connected, rotate engine at vibration damper in direction of rotation (clockwise) at least twice, until cylinder 1 intake and exhaust camshaft lobes face each other (**arrows**) in the top dead center (TDC) position for cylinder 1.

> ***CAUTION—***
> *Do not rotate engine counterclockwise to reach the top dead center position. If engine rotated beyond top dead center, complete another two complete rotations.*

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- 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**).

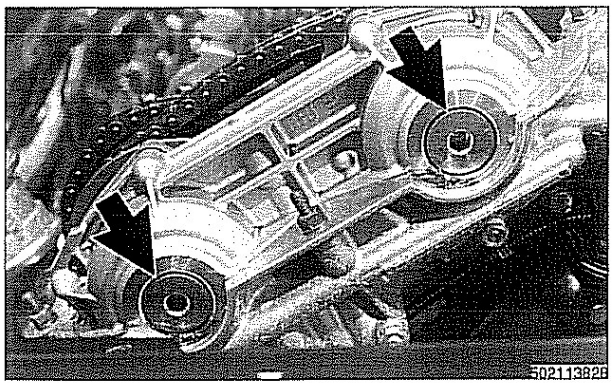


- Unscrew and remove two cylinder head cover studs (**arrows**) at rear of cylinder head.



- Secure camshafts in TDC position using BMW special tool set 11 3 240.

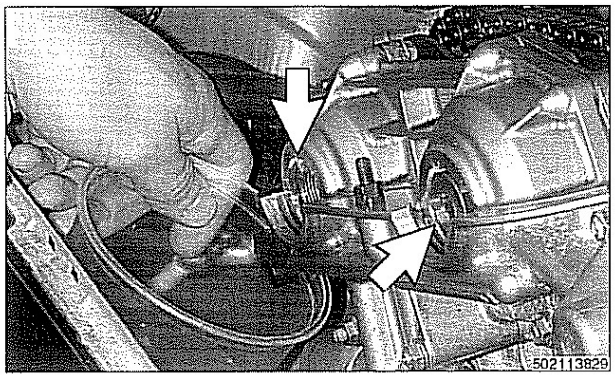
– Disconnect compressed air line, leaving compressed air fitting attached to VANOS unit.



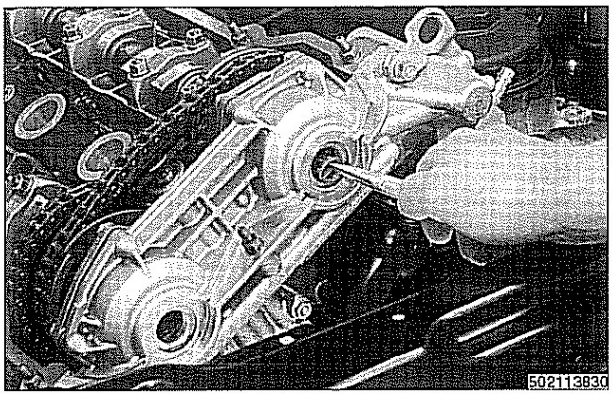
- Unscrew sealing plugs (**arrows**) from VANOS unit.

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Cylinder Head Removal and Installation

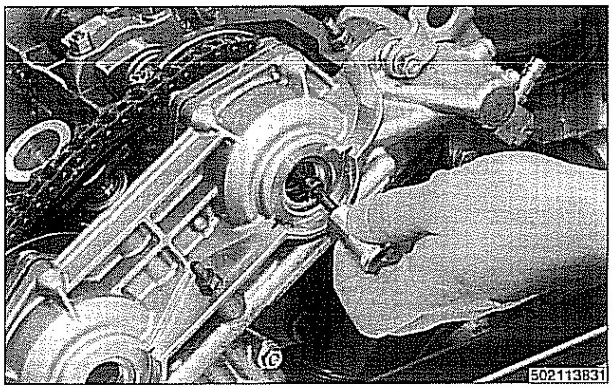


- Oil will drain from plugs (**arrows**) when removed. Have a container and rags ready. Do not allow oil to run onto drive belts.



- Pull sealing caps straight out of VANOS unit using short needle nose pliers.

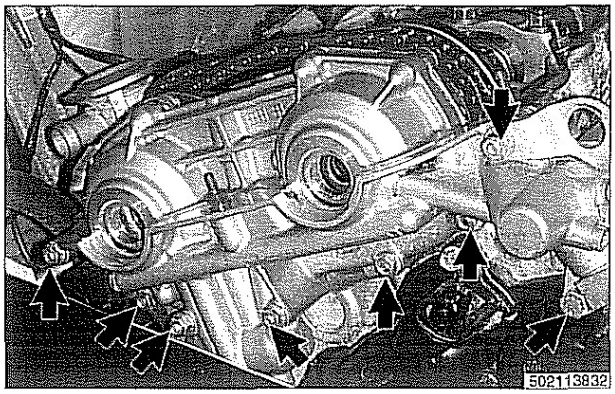
NOTE —
Additional oil may drain from VANOS unit.



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

> ***CAUTION—***
> *Set screws have left-hand threads. Loosen in clockwise direction.*

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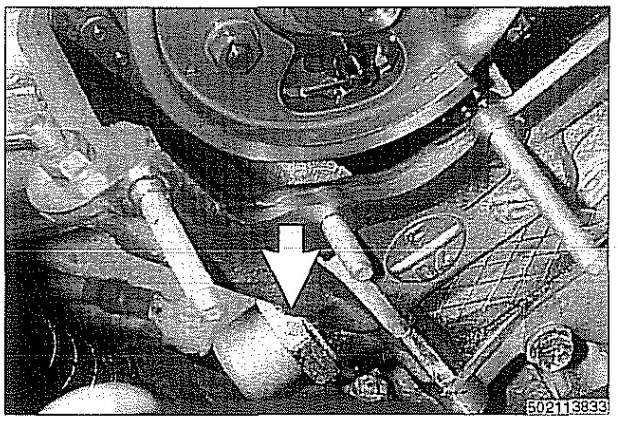


- Remove VANOS unit:
  - Remove engine lifting eye.
  - Remove VANOS mounting nuts (**arrows**) and pull VANOS unit and metal gasket off.

CAUTION—
Do not crank the engine with VANOS unit removed. Piston/valve interference may result.

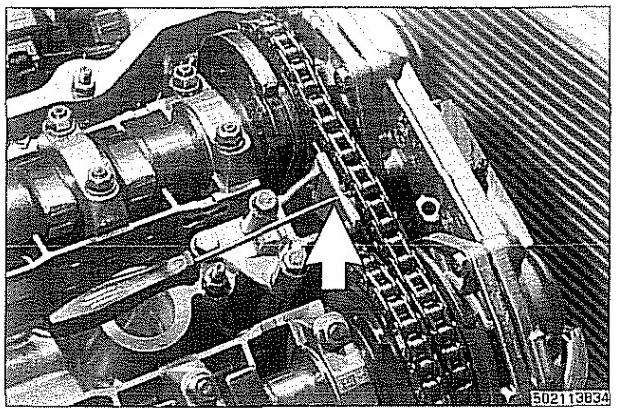
NOTE—
The VANOS unit will contain a small quantity of oil. Place shop towel to catch oil as unit is removed or tilted.

CAUTION—
If the VANOS adjustment unit is replaced, or if operations are completed that may change the timing of the camshafts, the camshaft timing must be checked. See 117 Camshaft Timing Chain.



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

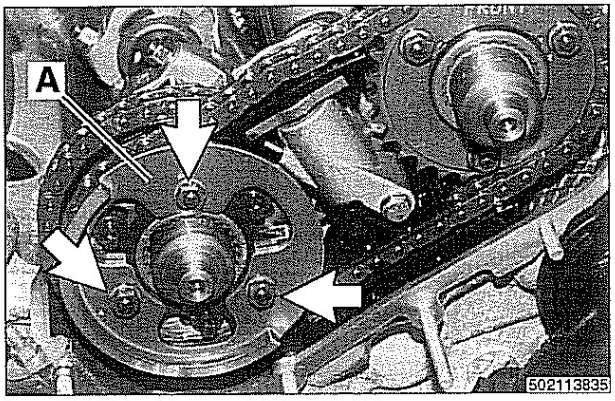
CAUTION—
Primary camshaft chain tensioner is under spring pressure.



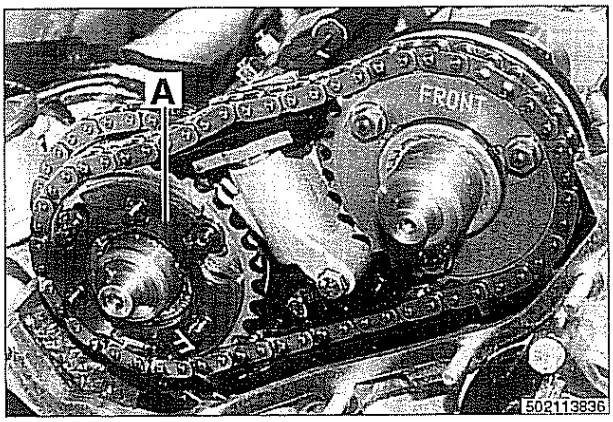
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 291, or a thin drift or pin.

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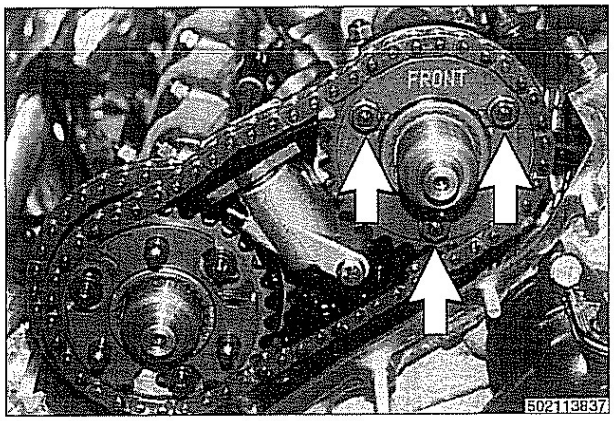
Cylinder Head Removal and Installation



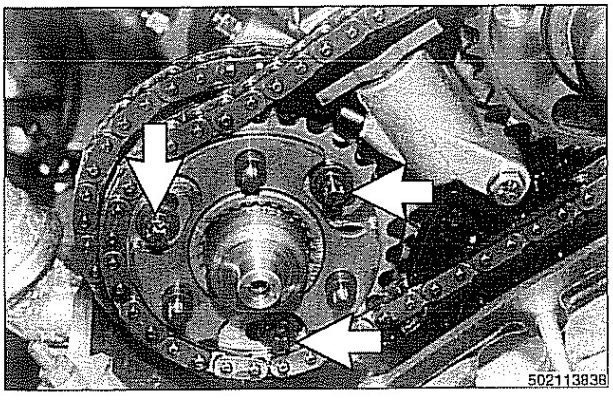
- Remove exhaust camshaft impulse wheel mounting nuts (**arrows**). Remove impulse wheel (**A**).



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

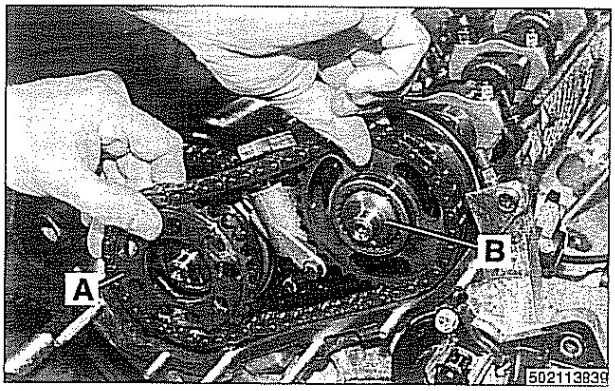


- Remove intake camshaft sprocket mounting nuts (**arrows**) and remove spring plate (labelled **FRONT**).



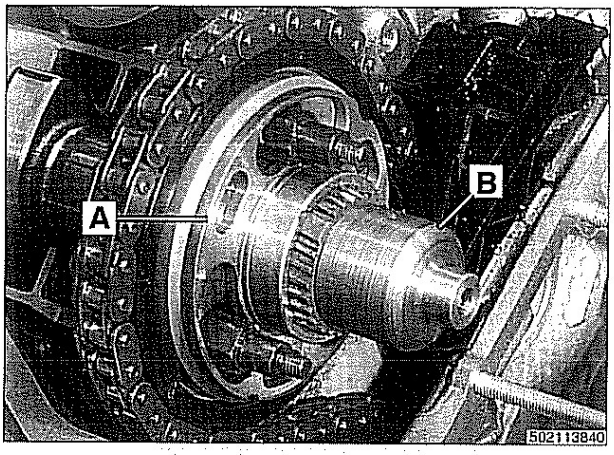
- Remove torx screws from exhaust camshaft sprocket (**arrows**).

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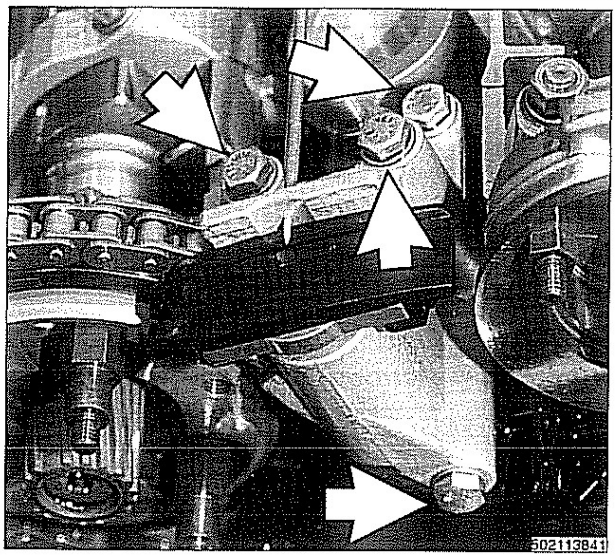


- Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (**A**), and splined shaft (**B**).

> ***CAUTION—***
> *Splined shafts share the same part number for both intake and exhaust camshafts. Used splined shafts must be reinstalled in their original positions.*



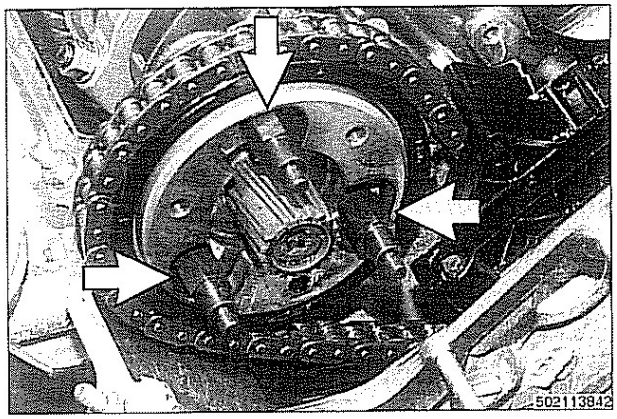
- Remove exhaust camshaft splined sleeve (**A**) and shaft (**B**).



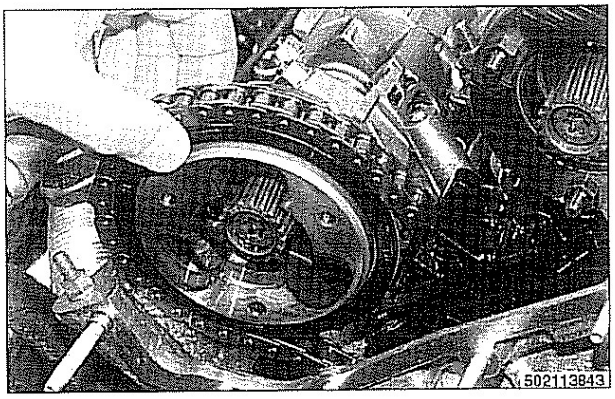
- Remove secondary chain tensioner mounting bolts (**arrows**) and remove tensioner with retaining pin in place.

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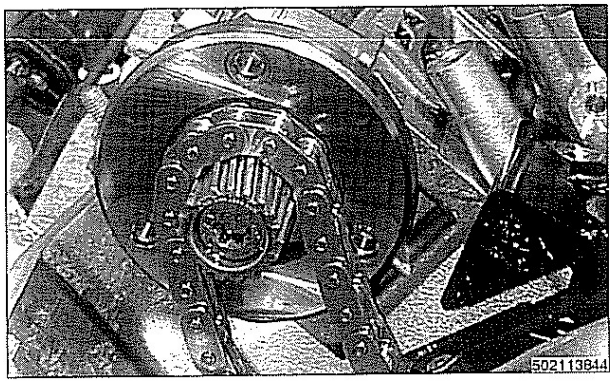
Cylinder Head Removal and Installation



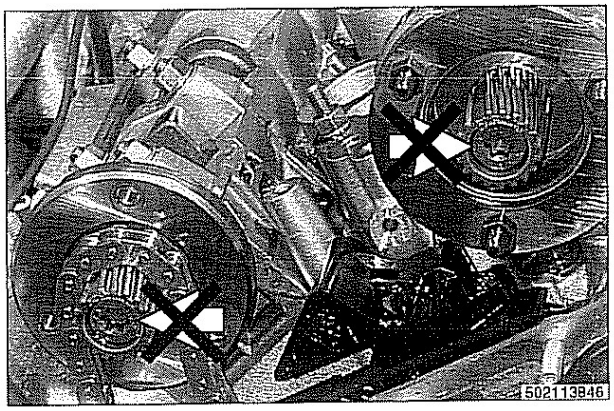
- Remove sprocket mounting studs (**arrows**) from exhaust camshaft.



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

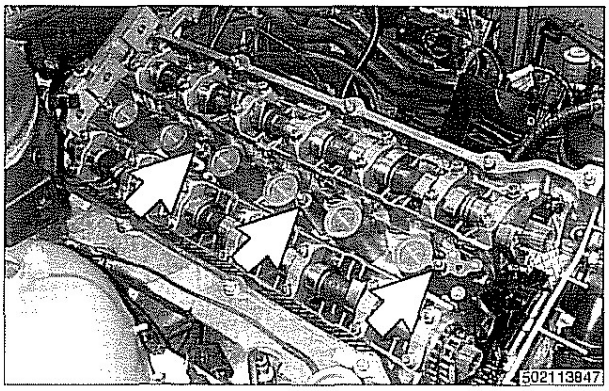


- Place timing chain on end of exhaust camshaft.



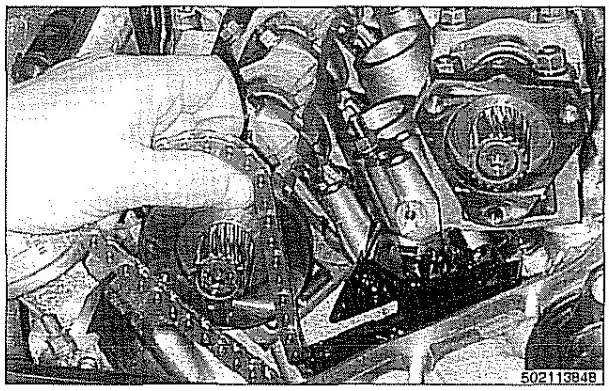
- Spline retaining screws (**arrows**) should not be removed from camshaft.

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

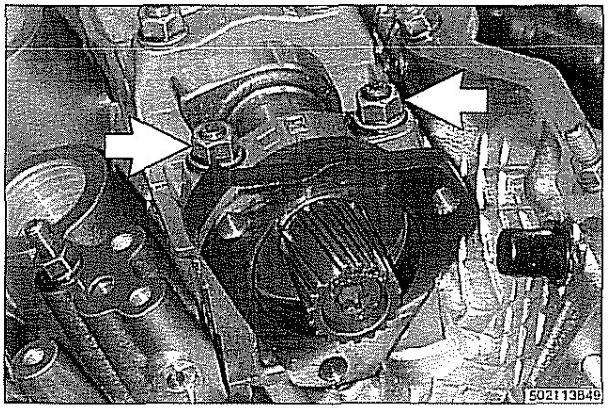
– Remove crankshaft locking tool from transmission bell housing.



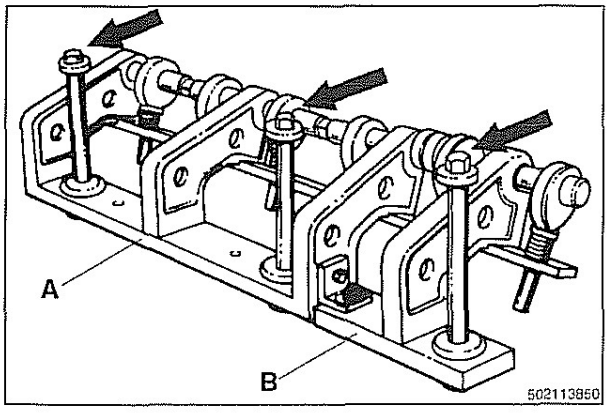
- Lift primary chain and hold under tension, then rotate engine at vibration damper in opposite direction of normal rotation (counterclockwise) approximately 30°.

> ***CAUTION—***
> *By turning crankshaft 30°, pistons are moved away from top dead center, to prevent possible valve interference to pistons during camshaft servicing.*

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



- Remove camshaft bearing cap 1 on intake camshaft.

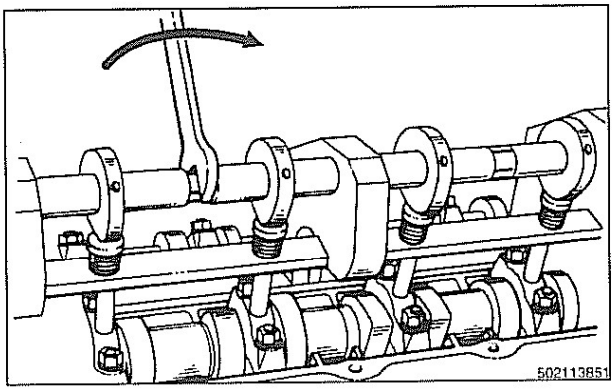


- Fit BMW special tools 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head and screw long bolts (**arrows**) into spark plug threads. Tensioning pins on tool will align with the bearing caps on the intake camshaft.

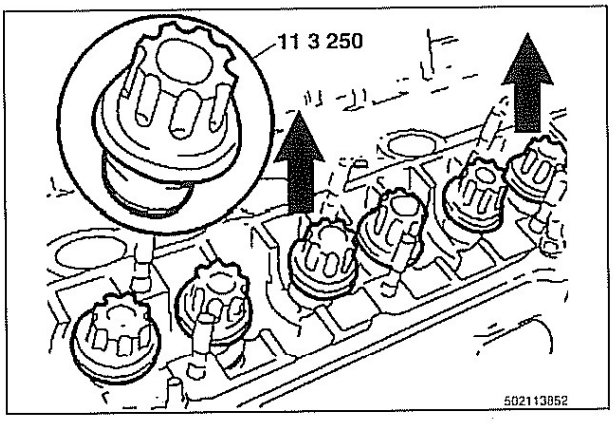
> ***CAUTION—***
> *Do not over torque bolts into spark plug holes.*

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Cylinder Head Removal and Installation



- Turn eccentric shaft of special tool to pretension intake camshaft bearing caps. Remove nuts on all intake camshaft bearing caps.
- 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.



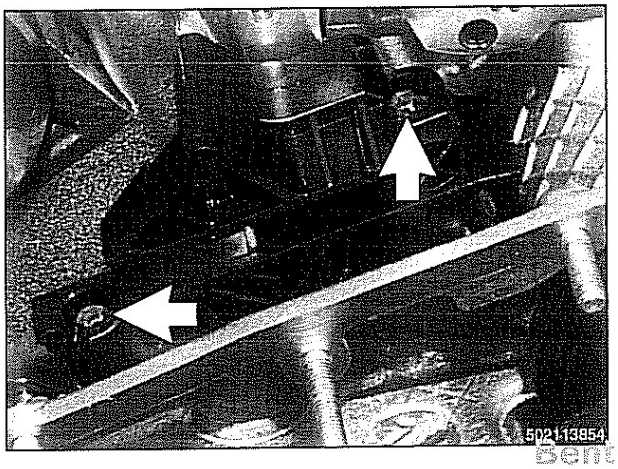
- Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool. With lifters secure or removed, lift out camshaft bearing carriers from cylinder head.

CAUTION—

- *Use care to not let hydraulic lifters fall out as camshaft carrier is removed.*
- *Hydraulic lifters should be stored in an upright position.*
- *Used hydraulic lifters must be reinstalled into their original lifter bores.*

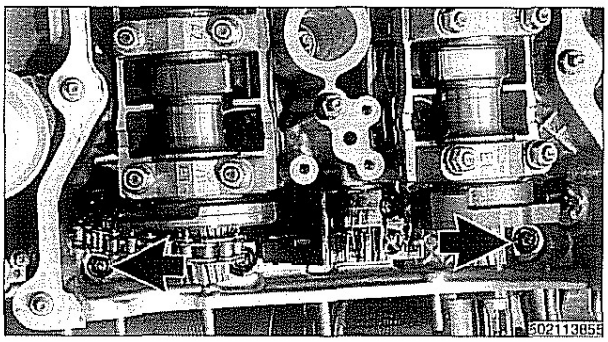


- Remove intake camshaft position sensor (**arrow**) from side of cylinder head.

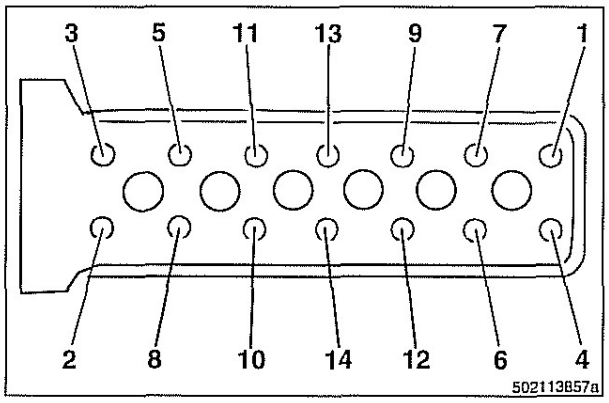


- Remove secondary chain lower guide bolts (**arrow**). Remove chain guide.

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➢ Remove bolts (**arrows**) holding timing chain cover to cylinder head. (Photo shows camshafts and camshaft bearing caps in place).



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

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

– Lift off cylinder head. Refer to **116 Cylinder Head and Valvetrain** for cylinder head reconditioning information.

Cylinder head, installing, M52 TU and M54 engines

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

CAUTION—
Remove foreign matter and liquid from bolt holes. Trapped oil or coolant in bolt holes can cause damage to block.

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

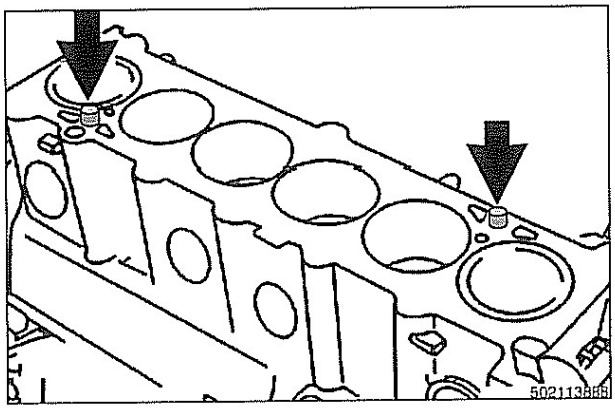
Evaluate cylinder head as shown in **116 Cylinder Head and Valvetrain**.

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

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Cylinder Head Removal and Installation

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



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

- Apply elastic sealing compound Three Bond 1209 ® to corner joints on cylinder block to timing chain cover.

- Place new cylinder head gasket on cylinder block.

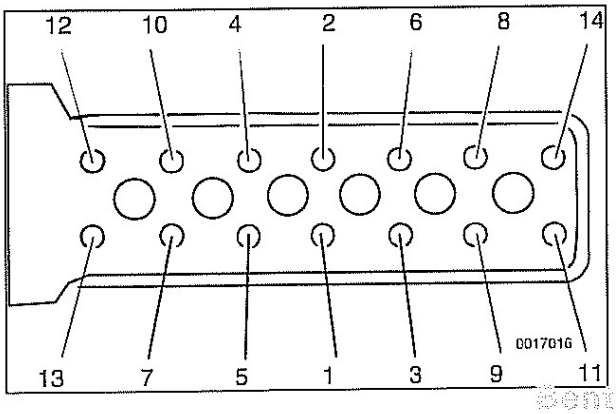
NOTE —
The word "OBEN" or "TOP", printed on the gasket, should face up. The cylinder head gasket will fit correctly in only one orientation.

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

CAUTION—
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the cylinder head into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

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

NOTE —
- *Cylinder head bolts should not be reused. They are stretch-type bolts and must be replaced whenever loosened.*
- *Aluminum cylinder blocks use different length cylinder head bolts and torque values than cast iron blocks.*
- *Check that all washers for the head bolts are in place before installing the bolts. Some of the washers may be staked to the cylinder head.*



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

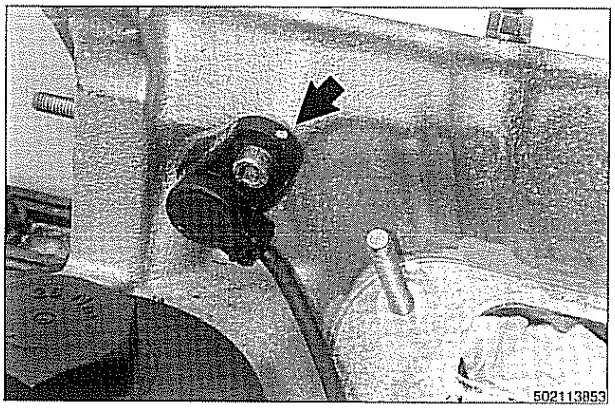
CAUTION—
The bolts should be tightened in three stages as listed below. The final stages require the use of a BMW special tool 11 2 110 or a suitable protractor to tighten the bolts to a specified torque angle.

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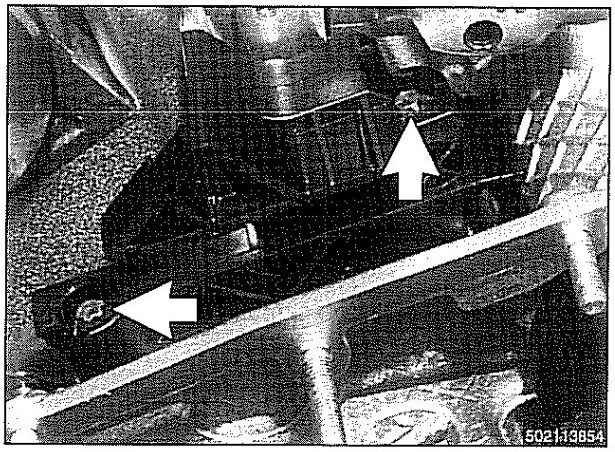
– Secure cylinder head bolts by torquing an additional 90° each for Stage 2 and 3.

Tightening torques

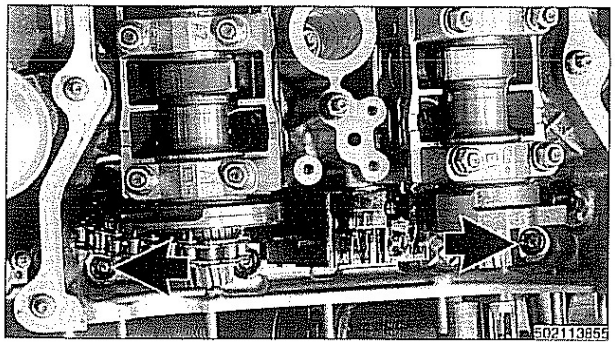
Cylinder head to engine block (aluminum block)	
Stage 1	40 Nm (30 ft-lb)
Stage 2	+90°
Stage 3	-90°



➢ Install intake camshaft position sensor (**arrow**).



➢ Install lower secondary chain guide. Tighten torx bolts to specifications. The bolt on the intake camshaft side is long and extends into the engine block.



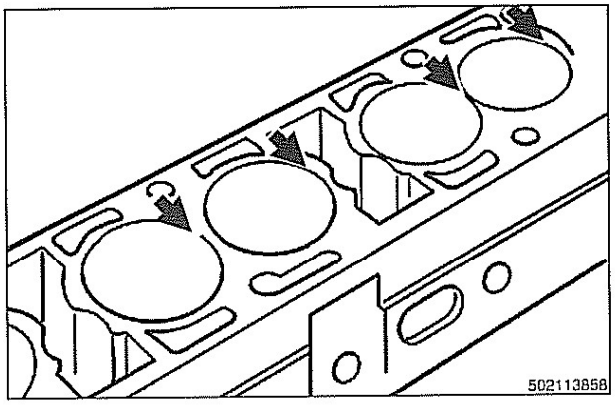
➢ Install and tighten cylinder head-to-lower timing chain cover bolts (**arrows**). (Photo shows camshafts in place).

Tightening torque

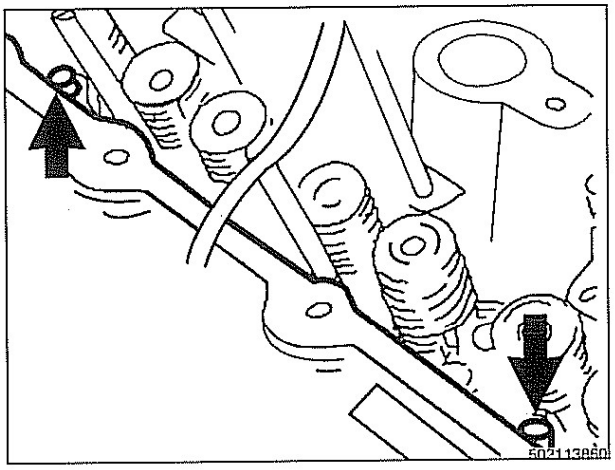
Secondary chain guide to cylinder head	10 Nm (89 in-lb)
Cylinder head to lower timing chain cover	
M6	10 Nm (89 in-lb)
M7	15 Nm (11 ft-lb)

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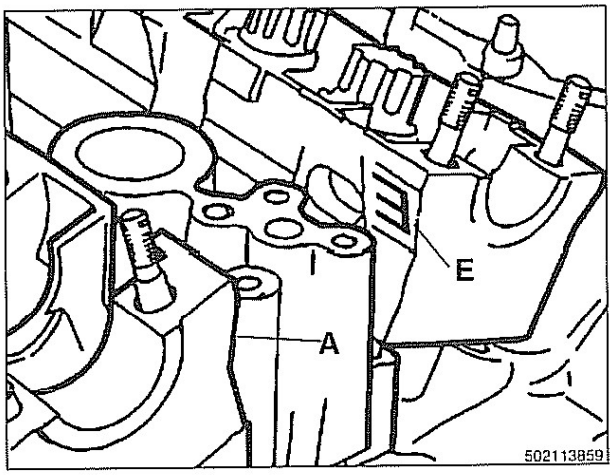
Cylinder Head Removal and Installation



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



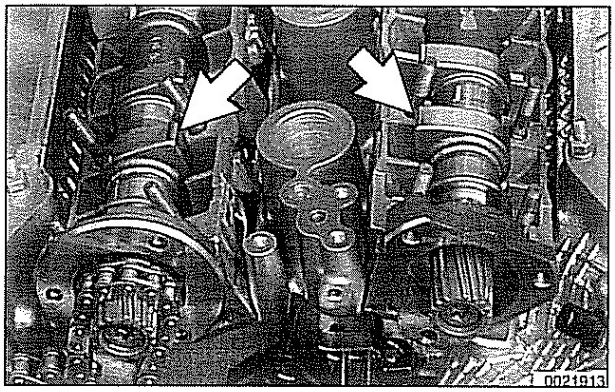
➢ Center camshaft carrier with hydraulic lifters on pins (**arrows**) at bearing positions 2 and 7.



➢ Note marks on carriers: (**E**) for intake side and (**A**) for exhaust side.

– Lift timing chain and put exhaust cam onto exhaust camshaft carrier. Place intake camshaft on camshaft carrier.

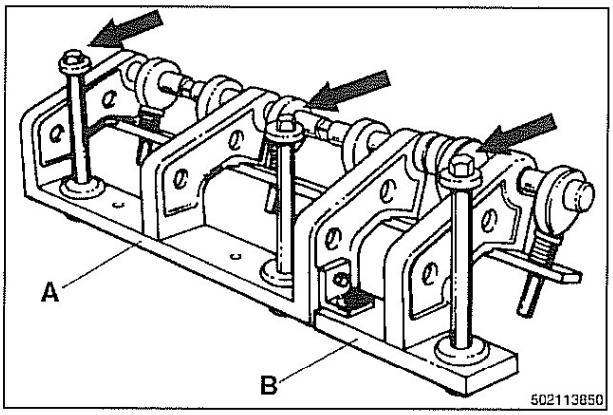
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➢ Rotate camshafts until intake and exhaust lobes for cylinder 1 face each other (**arrows**).

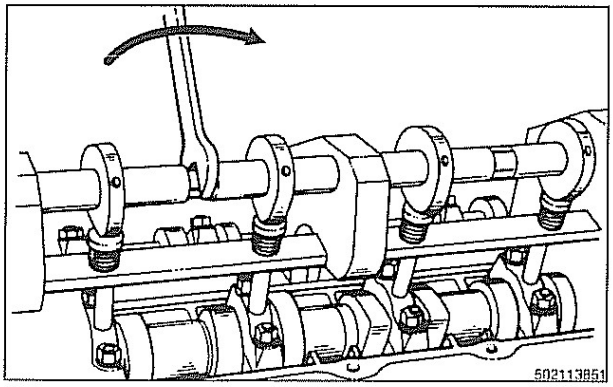
> ***CAUTION—***
> *Be sure that crankshaft is still positioned at least 30° away from TDC.*

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



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

> ***CAUTION—***
> *Do not overtighten bolts in spark plug holes.*



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

Tightening torque

Camshaft bearing cap to cylinder head (M7)	14 Nm (10 ft-lb)

– Release tension on eccentric shaft and remove BMW special tools 11 3 260/270.

– 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 piston back to top dead center. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.*

Crankshaft / valve timing waiting times

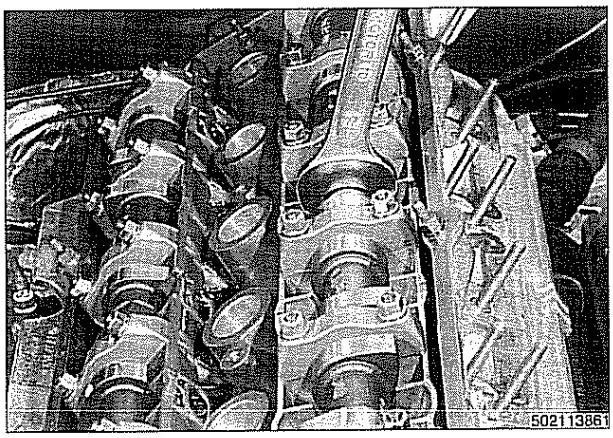
68° F (20° C) and higher	4 minutes
50 – 68° F (10 – 20° C)	11 minutes
32 – 50° F (0 – 10° C)	30 minutes

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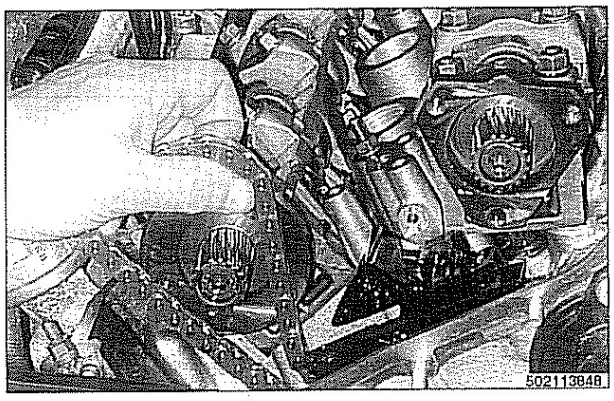
Cylinder Head Removal and Installation



- Secure camshafts in TDC position using BMW special tool set 11 3 240.

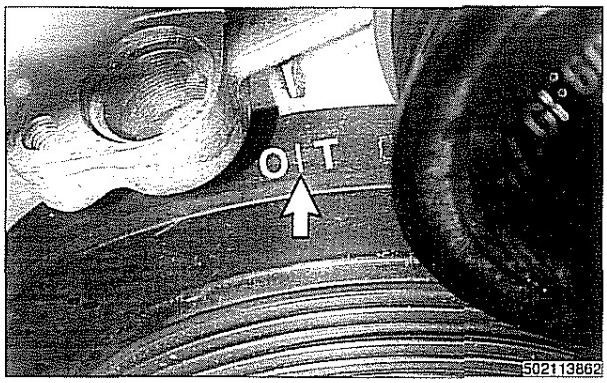


- In necessary, turn camshaft slightly so that special tools are squarely seated on cylinder head.

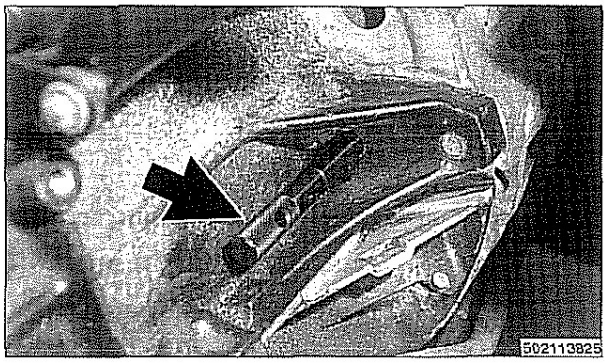


- Lift timing chain and hold under tension.

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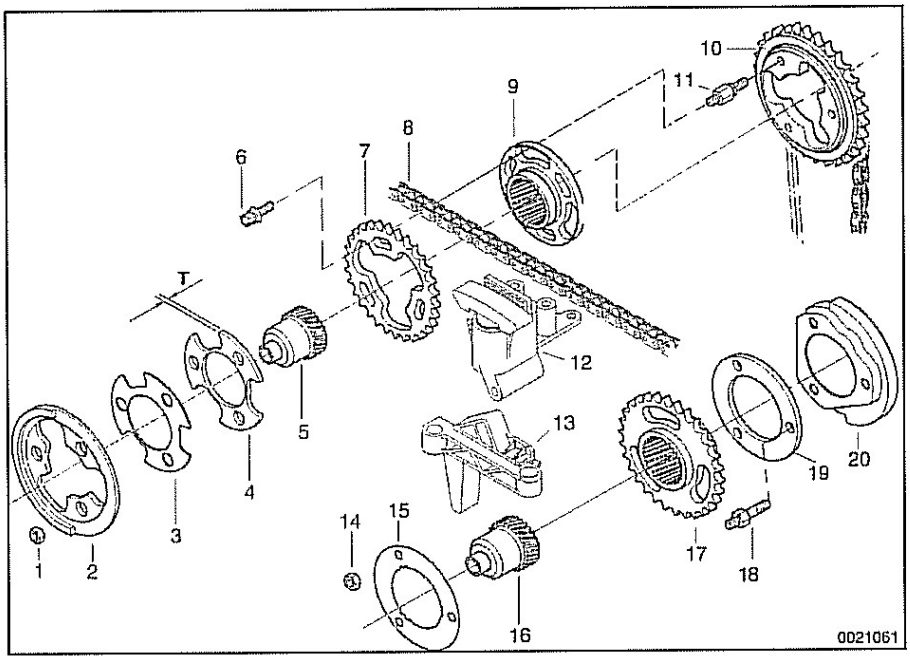


- While maintaining tension on timing chain, rotate crankshaft at vibration damper from 30° before TDC in direction of rotation (clockwise) until number 1 cylinder is at TDC position with line between the **OIT (arrow)** on front pulley lined up with boss on lower timing chain cover.



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

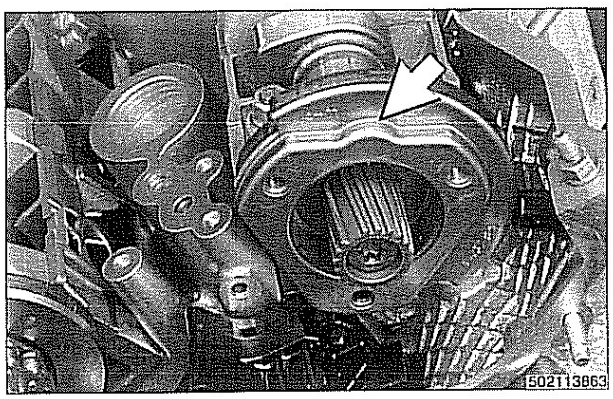
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Double VANOS Timing Chain Components

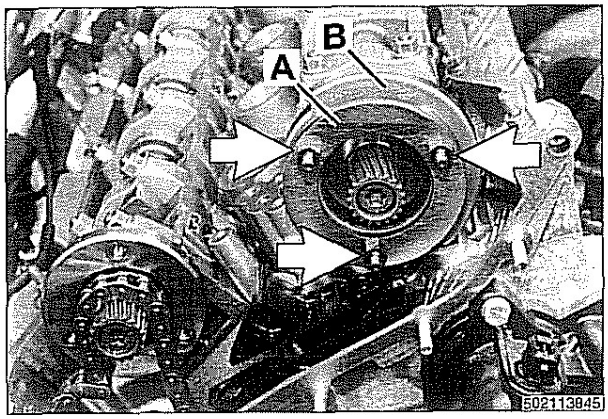
1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate, exhaust
4. Thrust spacer (T = 3.5 mm)
5. Splined shaft
6. Torx screw
7. Exhaust camshaft secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded locating stud
12. Secondary chain 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

Double VANOS timing chain components, installing, M52 TU and M54 engines



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

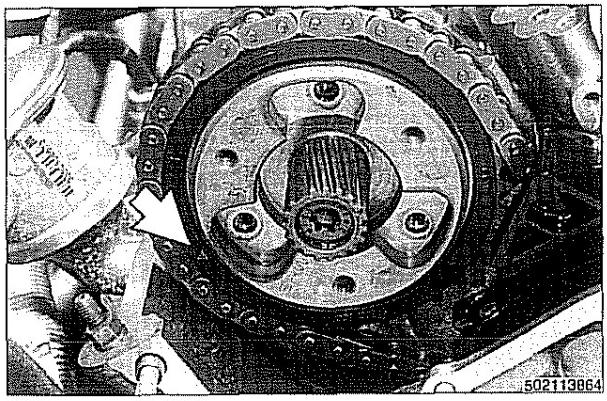
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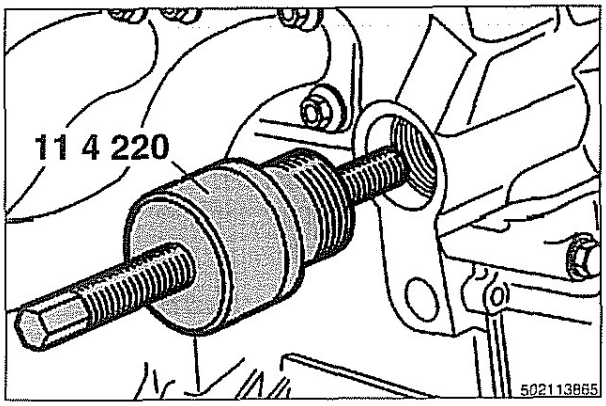
- Fit thrust spacer (**A**) to intake camshaft (**B**) and tighten down with threaded locating studs. Place longer threaded end of studs into camshaft (**arrows**).

Tightening torque

Impulse wheel studs to intake camshaft)	20 Nm (15 ft-lb)



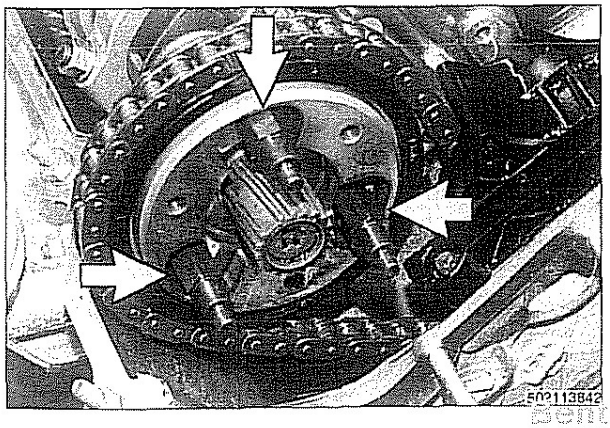
- Fit primary sprocket to primary timing chain and install on exhaust camshaft so that pointer on sprocket (**arrow**) lines up with cylinder head sealing surface.



- 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 primary chain tensioner and simulates the function of the tensioner.

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



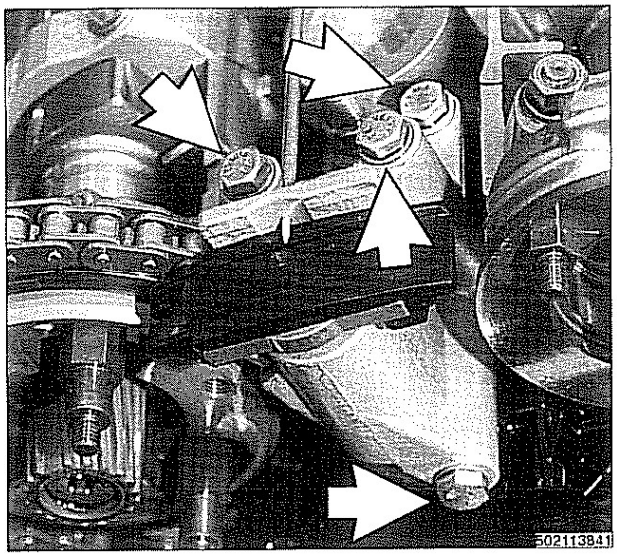
- Insert and tighten down threaded locating studs (**arrows**) in end of exhaust camshaft. Note installed position of studs.

Tightening torques

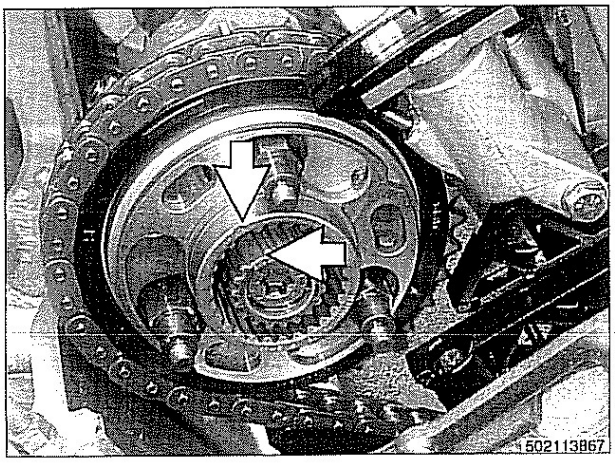
Exhaust camshaft locating stud	20 Nm (15 ft-lb)

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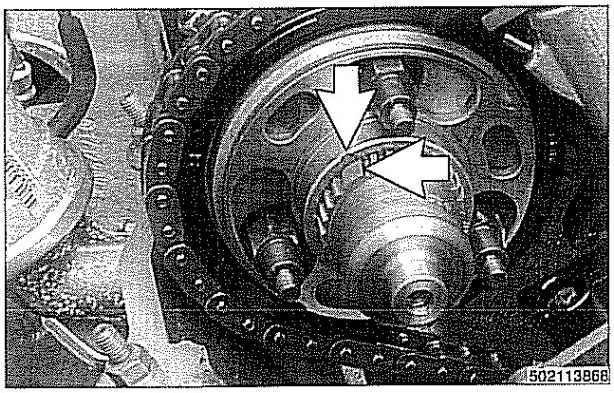
Cylinder Head Removal and Installation



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

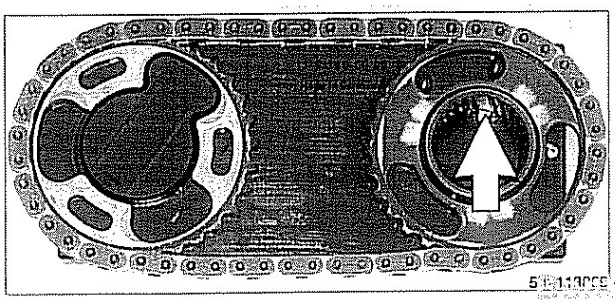


- Install exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



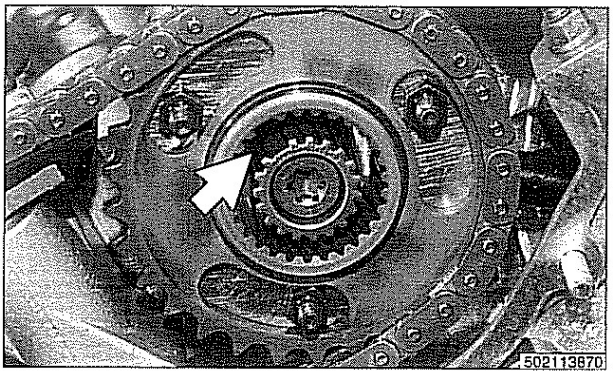
- Slide splined shaft onto exhaust camshaft. Be sure that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).

– Push splined shaft in further to rotate splined sleeve until the three threaded holes in primary chain sprocket are centered in the small slots of the splined sleeve.



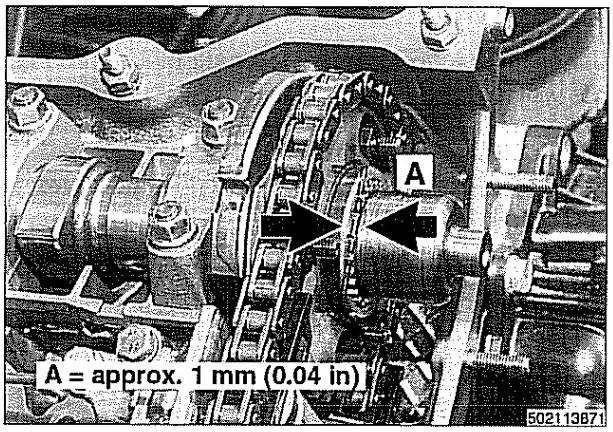
- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.

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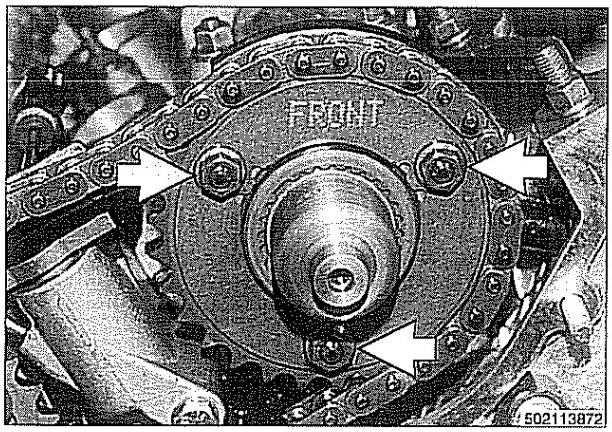


- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (**arrow**).

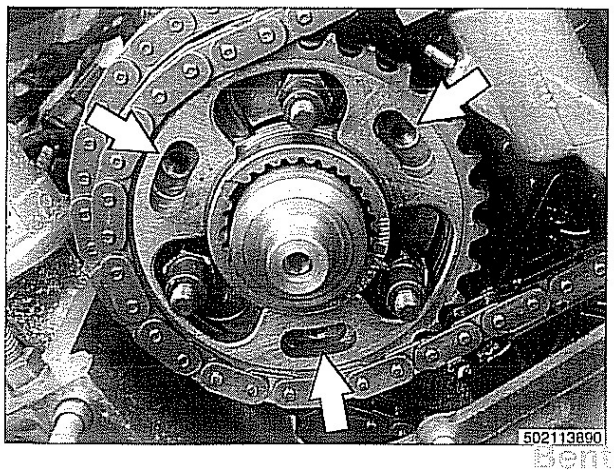
> ***CAUTION—***
> *Do not alter position of sprockets with respect to chain when removing from special tool 11 6 180.*



- 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.

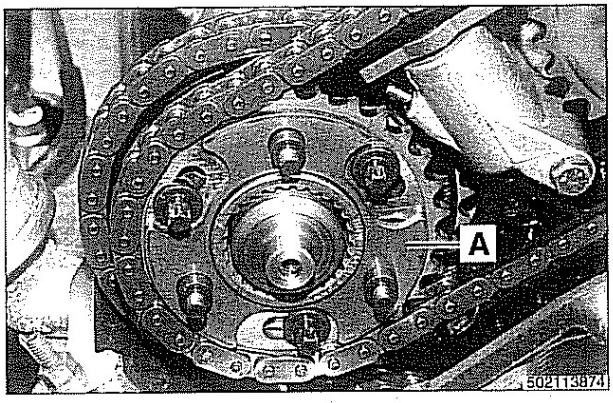


- Install intake camshaft spring plate so that **FRONT** mark is visible. Install mounting nuts (**arrows**) finger tight.

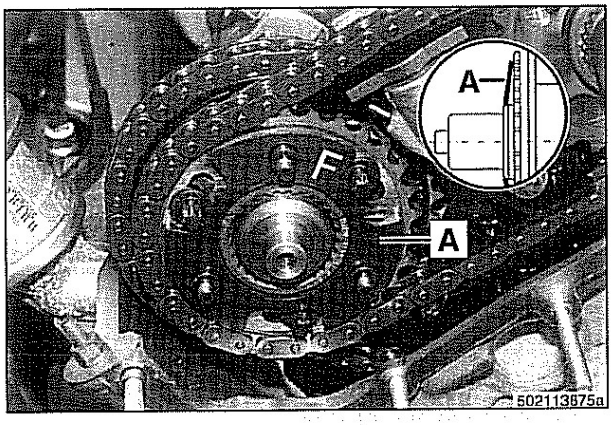


- Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft assembly.
  - Initially tighten to approx. 5 Nm (44 in-lb) and then back off by half a turn.

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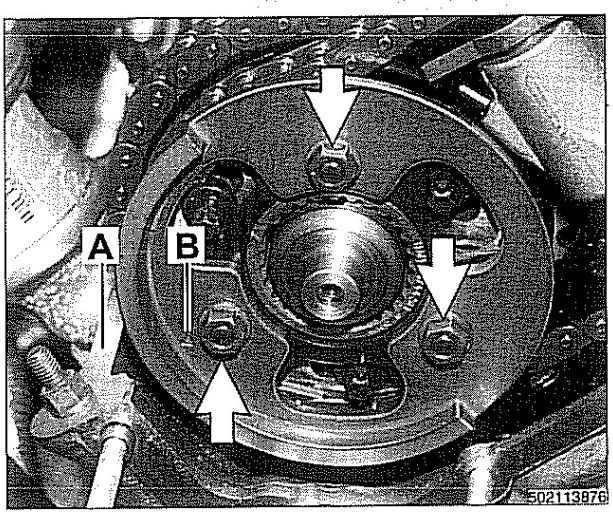


- Fit thrust spacer (**A**) on exhaust camshaft.



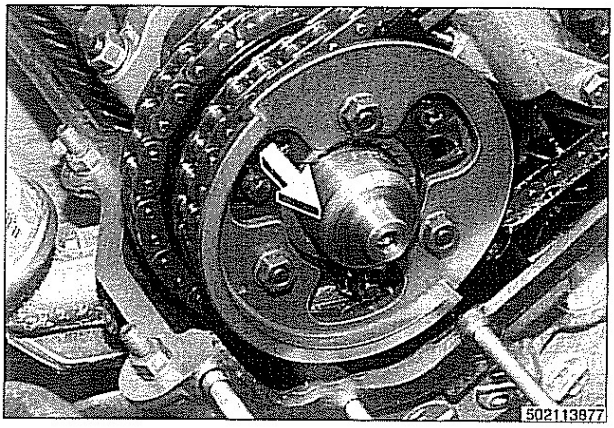
- Install spring plate (**A**) to exhaust camshaft. Make sure that (**F**) mark is visible.

NOTE —
*If **F** mark is no longer visible, install spring plate as shown in inset.*



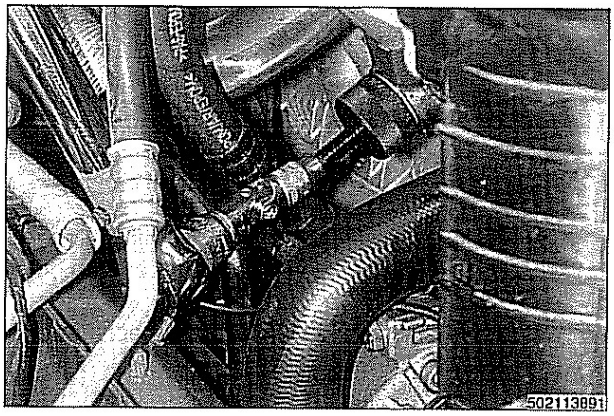
- Install exhaust camshaft impulse wheel, aligning pointer (**B**) with top edge of cylinder head (**A**). Install mounting nuts (**arrows**) finger tight.

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➢ Pull out exhaust camshaft splined shaft to stop.

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

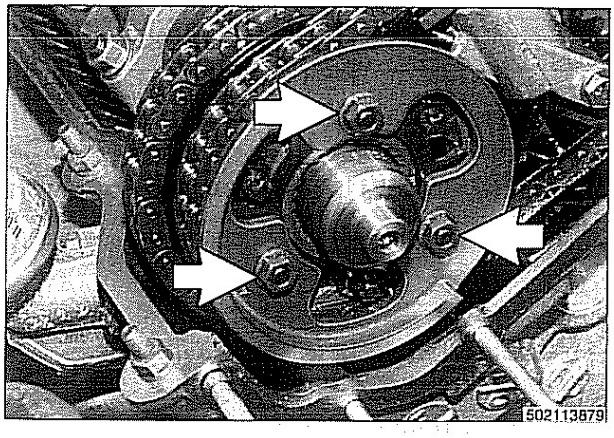


➢ Preload primary chain:

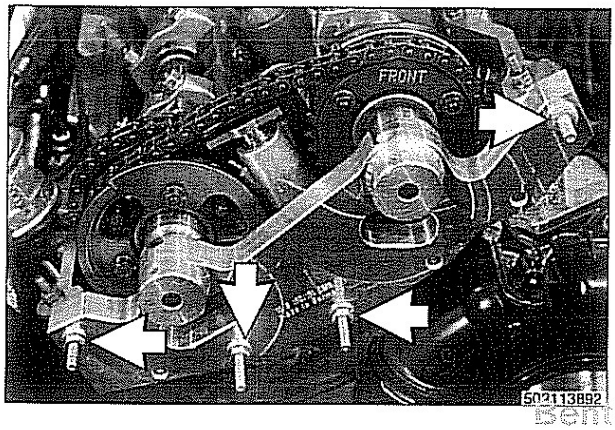
- Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

Tightening torque

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



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

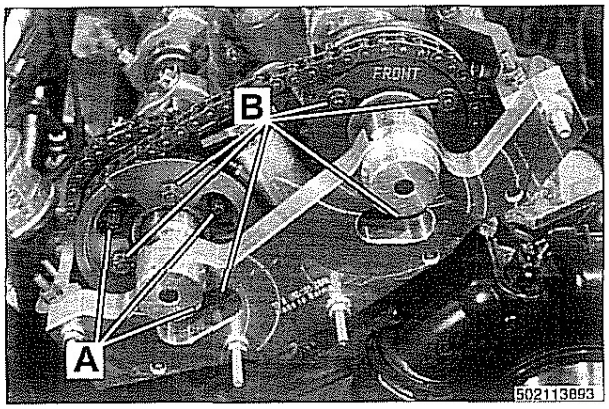


➢ Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case. Install nuts (**arrows**) finger tight, then tighten down uniformly until special tool is in full contact with cylinder head.

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

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Cylinder Head Removal and Installation



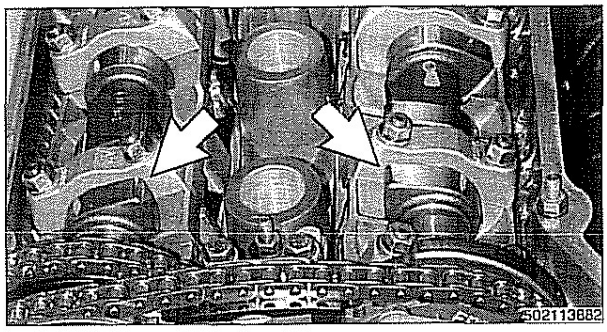
- Secure camshaft sprockets and impulse wheels:
  - Tighten mounting screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Tighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down mounting screws (**A**) and nuts (**B**)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

Tightening torques

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

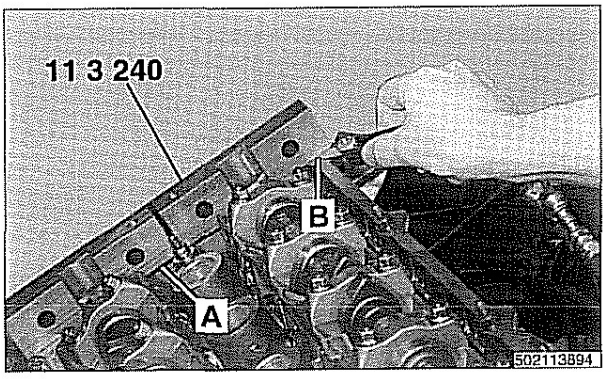
– *Remove crankshaft locking tool from transmission bell housing so that crankshaft is no longer secured in TDC position.*

– 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.*

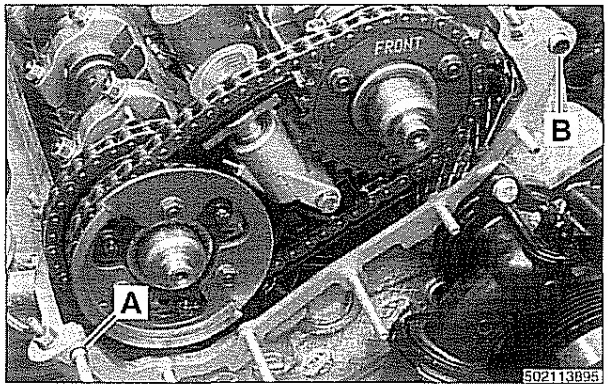


- Place BMW special tool set 11 3 240 over camshafts and measure clearances.

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

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

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

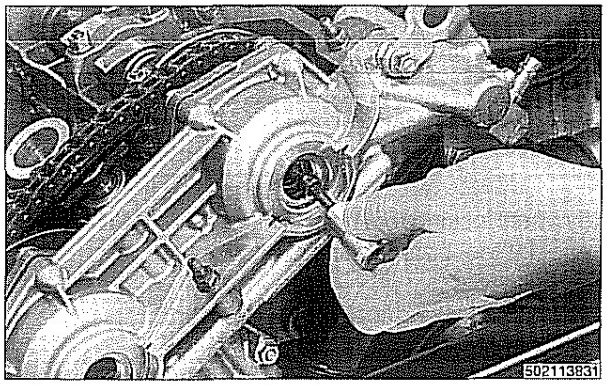
> ***CAUTION—***
> - *Check locating dowel (**A**) and dowel sleeve (**B**) at top of cylinder head for damage or incorrect installation.*
> - *Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil. If any foreign material is present on the sealing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

– Install new steel gasket to front of cylinder head and install VANOS unit.

NOTE—
*If VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described in **117 Camshaft Timing Chain**.*

– Reinstall engine lifting eye.

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

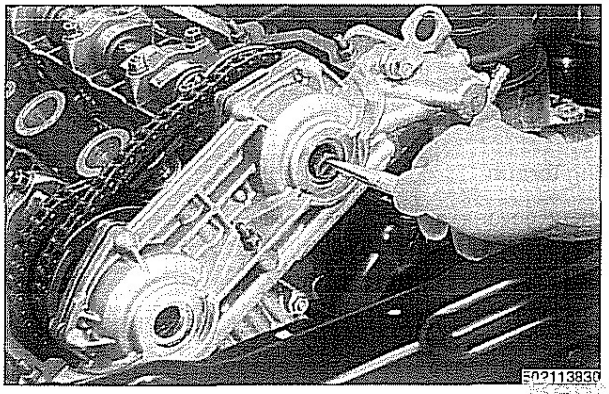


– Reconnect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.

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

> ***CAUTION—***
> *Set screws have left hand thread. Tighten counterclockwise.*

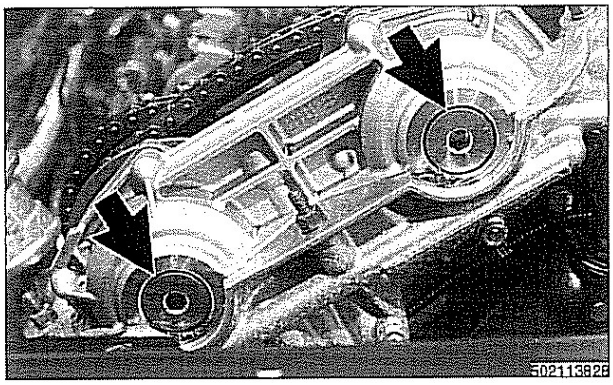
Tightening torque	
Hydraulic piston to splined shaft	10 Nm (89 in-lb)



- Replace sealing caps inside VANOS unit with short needle nose pliers.

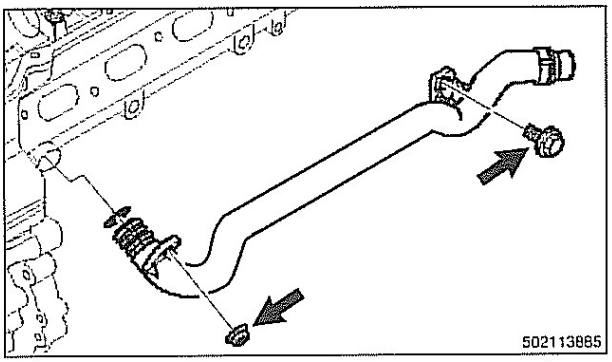
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Cylinder Head Removal and Installation



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

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



- Install coolant pipe fasteners at base of cylinder head and tighten fasteners (**arrows**).

NOTE —
Use new sealing O-ring on coolant pipe.

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

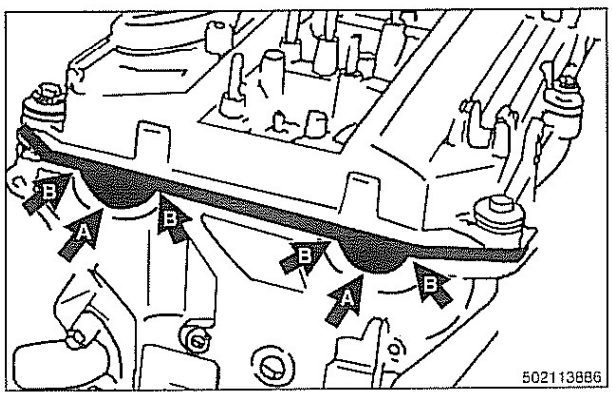
Tightening torque	
Oil line to VANOS unit (banjo bolt)	32 Nm (24 ft-lb)

– Remove adjustable timing chain tensioner tool and reinstall chain tensioner.

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

– Remove flywheel locking tool from transmission bell housing. Replace special tool bore sealing plug.

– Remove camshaft locking tools from cylinder head.



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

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

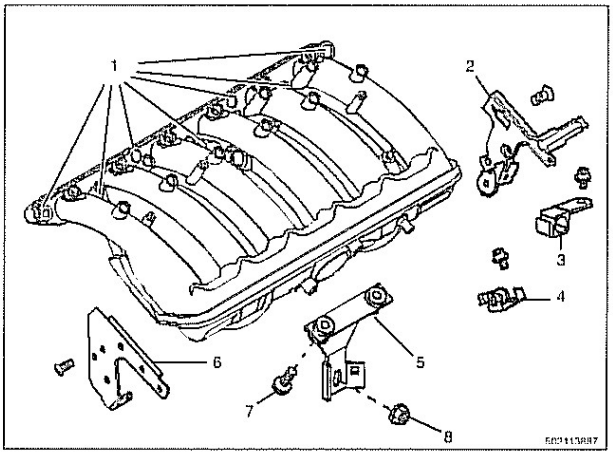
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– Install exhaust manifolds using new gaskets and nuts. Coat manifold studs with copper paste prior to installing nuts.

Tightening torque

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

– Install electrical harness connectors for oil pressure sender and coolant temperature sensor before installing intake manifold.



➢ Install intake manifold:

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

– Intake manifold installation is reverse of removal, noting the following:

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

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

Tightening torque

Intake manifold to cylinder head (M7)	15 Nm (11 ft-lb)
Mounting bracket to cylinder block (M10)	47 Nm (33 ft-lb)
Mounting bracket to intake manifold (M6)	10 Nm (89 in-lb)

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– Installation of the remaining parts is reverse or removal, noting the following:
  - Refill cooling system as described in **170 Radiator and Cooling System**.
  - Change engine oil and filter as described in **020 Maintenance**.
  - If necessary, adjust accelerator cable.
  - Reconnect battery.

> ***CAUTION—***
> *To prevent damaging the engine electronic systems, install all ground wire previously removed, including the ground wires for the ignition coils.*

Tightening torque

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

CYLINDER HEAD REMOVAL AND INSTALLATION (M62 ENGINE)

This procedure covers cylinder head removal and installation for the M62 V-8 engine. Procedures for the M62 TU VANOS engine are not covered in this manual.

Intake manifold, left cylinder head, and right cylinder head removal and installation are written as separate procedures. The intake manifold must be removed before the cylinder heads can be removed.

> ***WARNING—***
> *Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.*

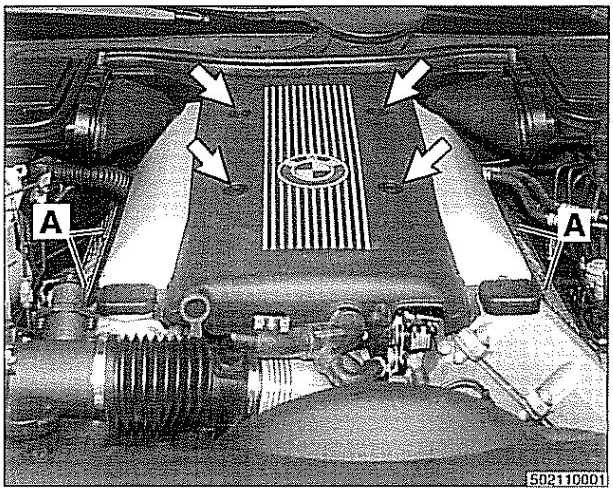
Cylinder head removal and installation requires multiple special service tools. Read the entire procedure before beginning the repair.

Intake manifold, removal and installation, M62 engine

– Disconnect negative (-) battery cable.

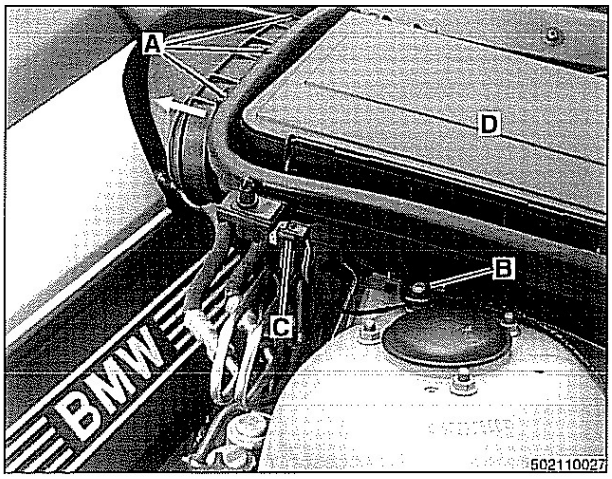
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*

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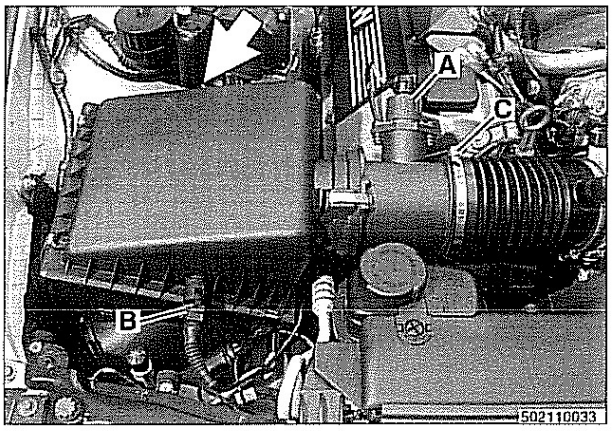


- Remove top engine cover by releasing quick release fasteners (**arrows**) by pressing down.

NOTE —
Earlier models may have an engine cover with pry off caps and fasteners in place of quick release fasteners.



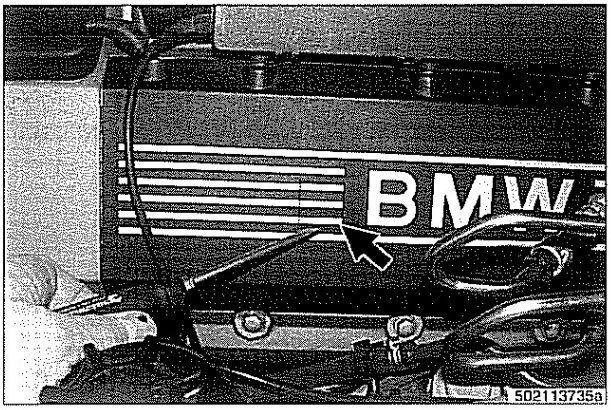
- Remove left and right interior ventilation ducts (left side shown):
  - Release locking tabs (**A**) or locking strap (early models, not shown).
  - Release spring lock (**B**).
  - Rotate duct inward (**arrow**) to remove.
  - Disconnect electrical harness from hood light switch (**C**).
  - Release locking clip and remove ventilation housing cover (**D**).
  - Lift out housing from inner fender.
  - Removal of right side ventilation housing is similar.



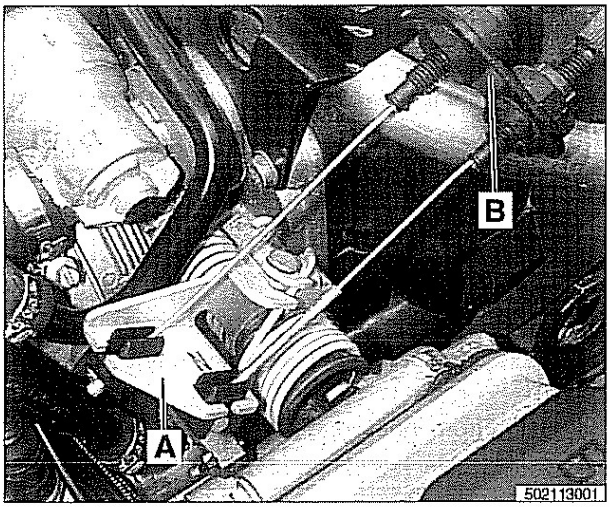
- Air filter housing assembly, removing:
  - Disconnect electrical harness connectors from mass air flow sensor (**A**) and temperature sensor (**B**).
  - Loosen hose clamp (**C**).
  - Remove filter housing mounting fastener (**arrow**) and remove filter housing with mass air flow sensor.

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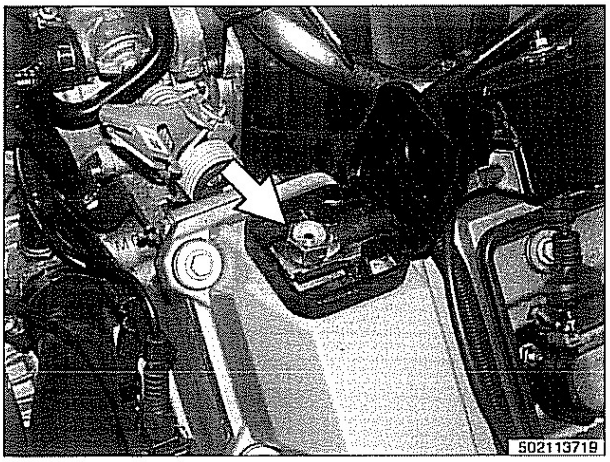
Cylinder Head Removal and Installation



- Pry out ignition coil cover trim caps, remove fasteners and covers from left and right sides.

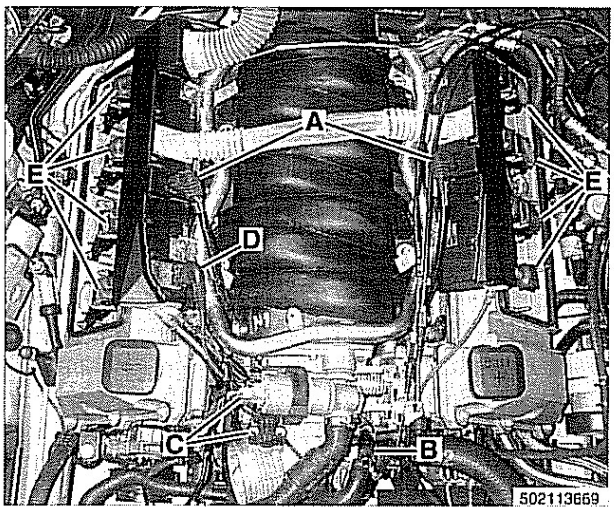


- Disconnect throttle cables from throttle shaft (**A**) and remove cables from support bracket (**B**).

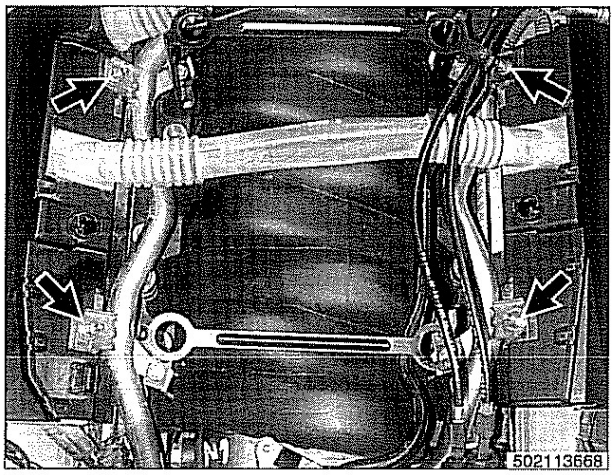


- Disconnect cable from jump start post (**arrow**) on left cylinder head cover.

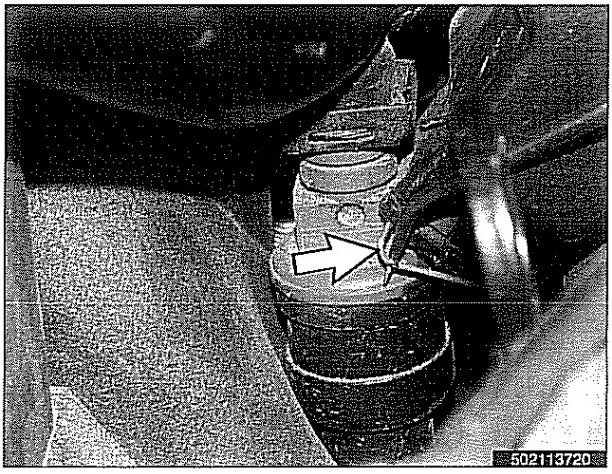
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- Disconnect the following electrical harness connectors:
  - Knock sensors (**A**).
  - Thermostat (**B**).
  - Throttle position sensor and idle valve (**C**).
  - Camshaft position sensor (**D**).
  - Ignition coils (**E**).



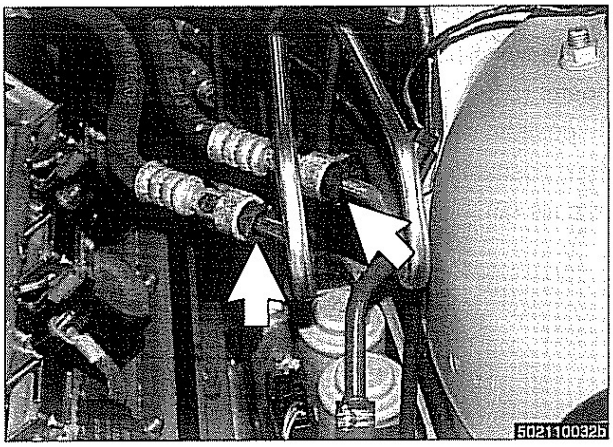
- Remove mounting nuts (arrows) from wiring harness ducts.



- Release fuel injector connectors by releasing spring clip (**arrow**) on each injector.
  - Lift up and remove electrical ducts and set to one side.

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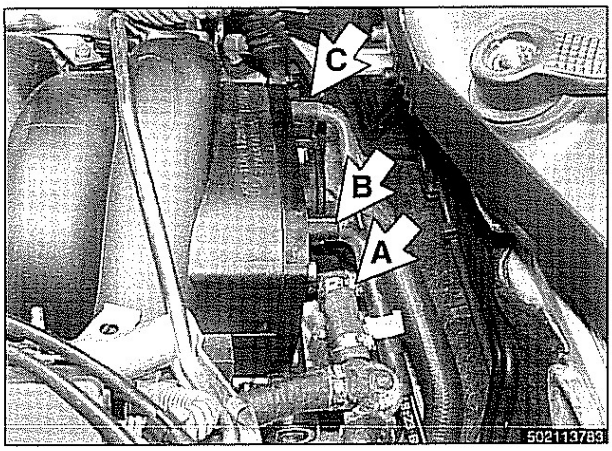
Cylinder Head Removal and Installation



- Label and disconnect fuel lines from fuel rail by pressing locking sleeves (**arrows**) in to release lines.

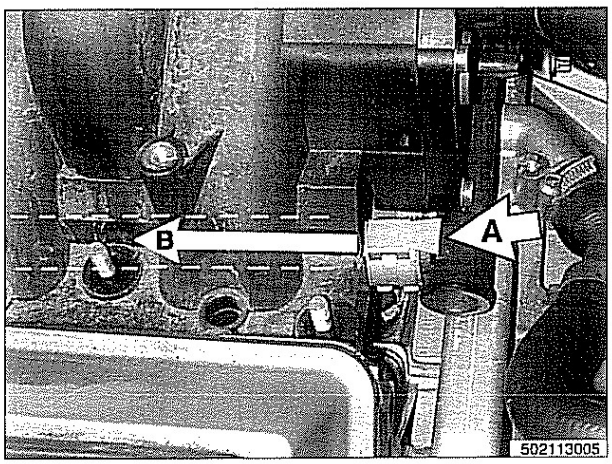
NOTE—
*BMW uses three styles of fuel line connections; a single use clamp; a locking fitting that uses special tool 16 1 050 to release; and a quick release sleeve (**arrow**) that disconnects the line when depressed.*

> ***CAUTION—***
> - *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb leaking fuel. Plug all open fuel lines.*
> - *Always unscrew fuel tank cap to release pressure in tank before removing fuel lines.*



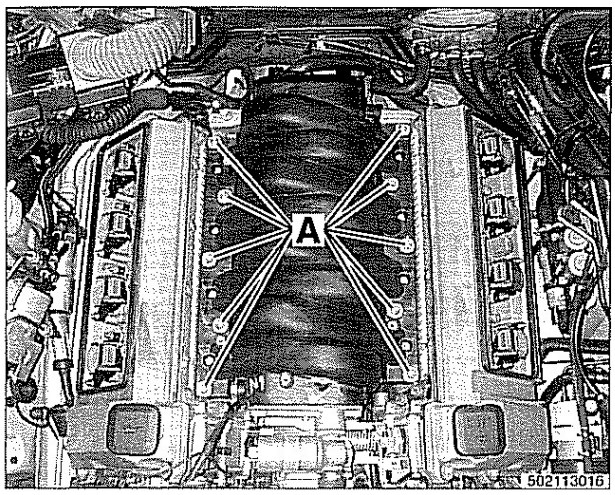
– Cap fuel lines and fuel rail inlets.

- Disconnect vacuum lines (**A, B** and **C**) from rear of intake manifold.



- Working at rear of intake manifold, disconnect crankcase ventilation valve from pipe by prying up on lock (**A**) and sliding tube forward (**B**).

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➢ Remove intake manifold fasteners (**A**).

– Carefully lift intake manifold off engine while checking that all hoses and harnesses have been disconnected.

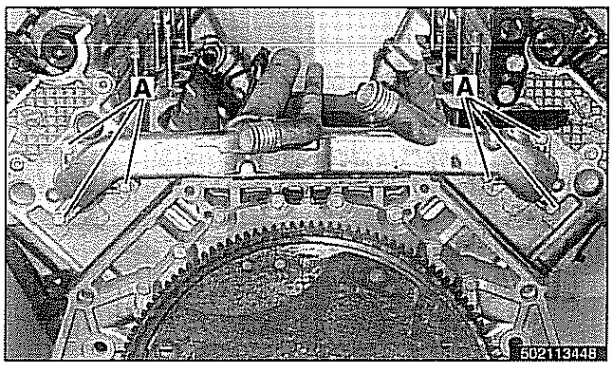
Left cylinder head, removing, M62 engine

– Remove intake manifold as described earlier.

– Remove left side exhaust manifold. See **180 Exhaust System.**

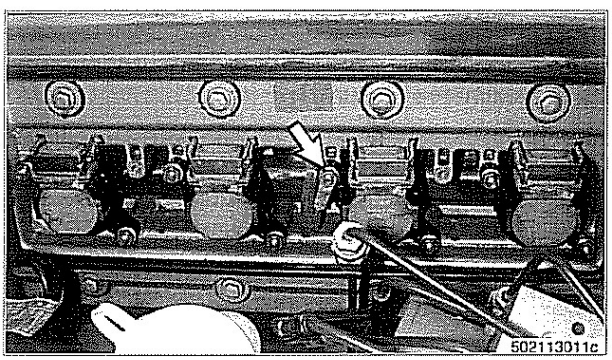
– Drain engine coolant, then remove viscous clutch cooling fan. See **170 Radiator and Cooling System.**

> ***WARNING —***
> *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.*



➢ Remove coolant manifold mounting fasteners and carefully remove manifold.

NOTE —
Engine shown removed from engine bay.

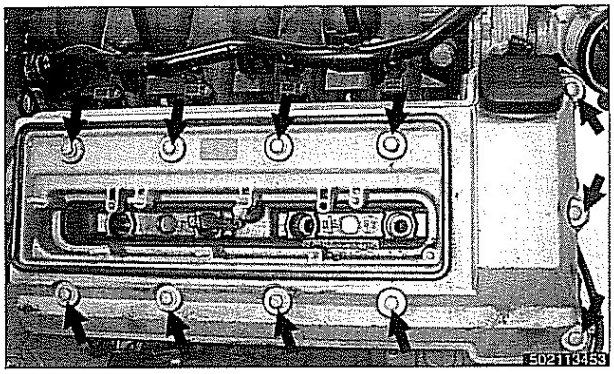


➢ Remove ignition coil fasteners and coils (noting location of ground strap).

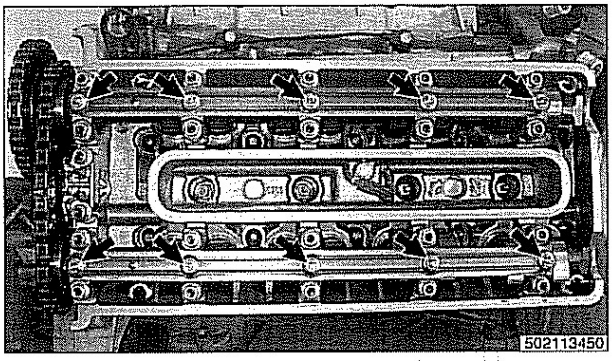
– Remove spark plugs.

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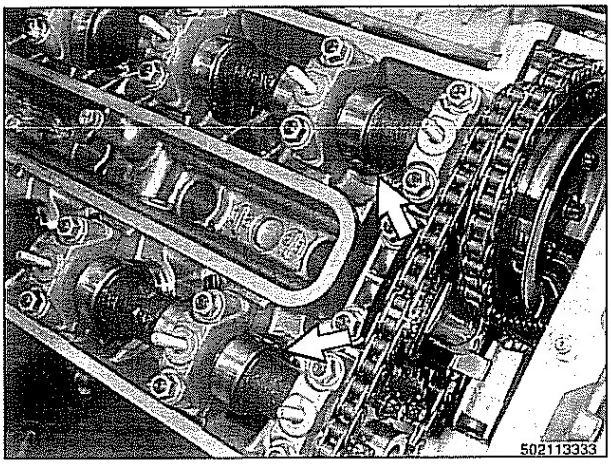
Cylinder Head Removal and Installation



- Remove cylinder head cover fasteners (**arrows**) and remove covers from left and right cylinder heads.

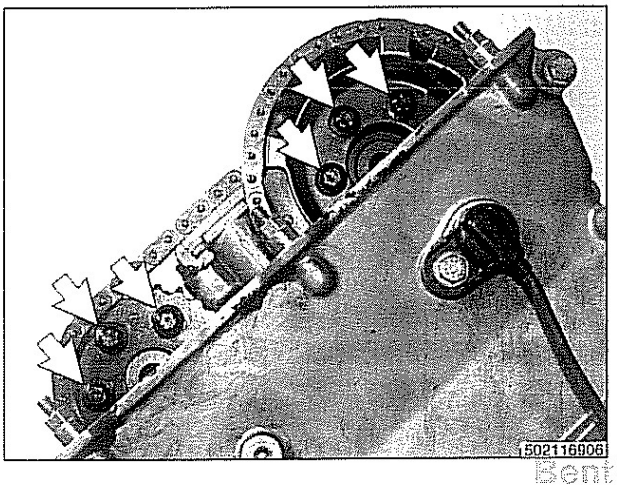


- Remove oil distribution tubes from camshaft bearing caps from left and right cylinder heads.



- Using crankshaft center bolt, turn crankshaft clockwise until number one cylinder (passenger side front cylinder) is in TDC overlap position (**arrow**).

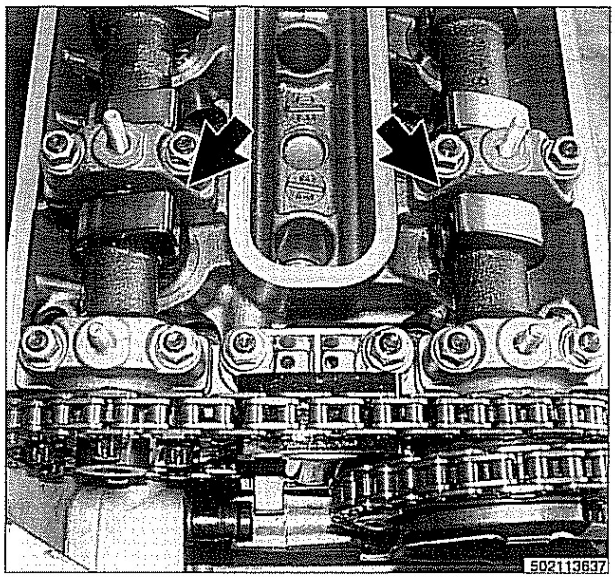
NOTE—
Number one cylinder is at valve overlap when both the intake and exhaust valves are starting to open (camshaft lobes facing down).



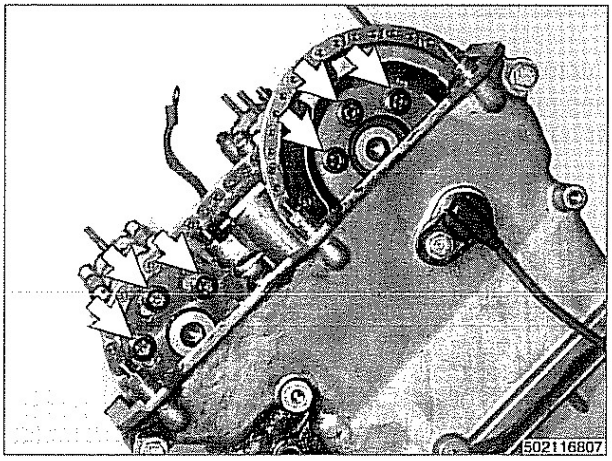
- Working at right cylinder head, loosen three accessible camshaft sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately $^{1}/_{2}$ turn.

CAUTION—
To prevent valve to piston contact when loosening camshaft sprocket fasteners, counterhold camshaft with 27 mm open-end wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.

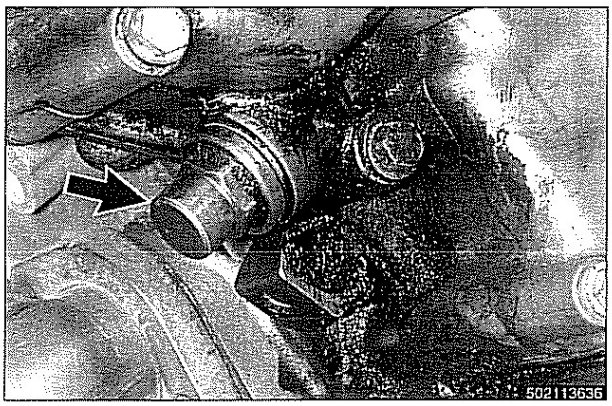
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- Rotate crankshaft vibration damper to TDC position. Right head camshaft lobes for number one cylinder should be in position shown (**arrows**).



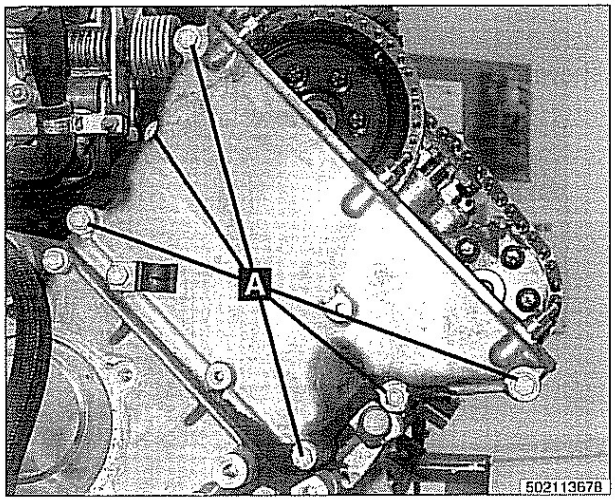
- Working at right cylinder head (passengers side) loosen remaining sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately $^1/_2$ turn.



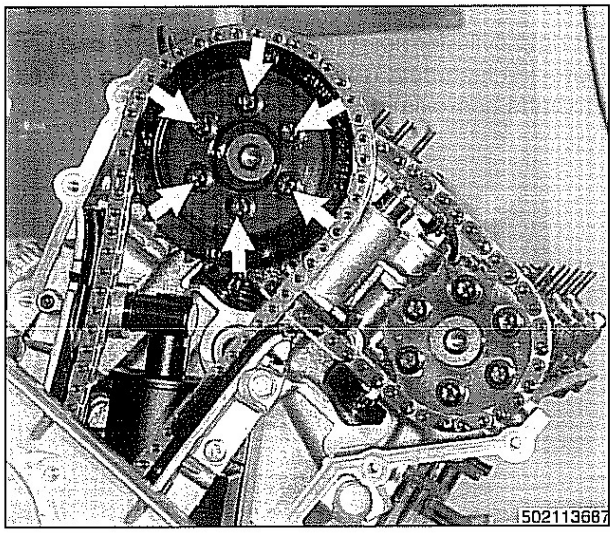
- Loosen and remove primary timing chain tensioner (**arrow**) from upper timing chain cover on right head.

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Cylinder Head Removal and Installation

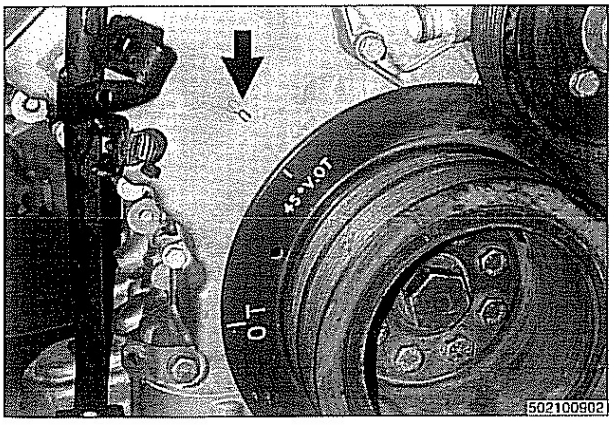


- Remove upper timing chain cover fasteners (**A**) and cover from left cylinder head.



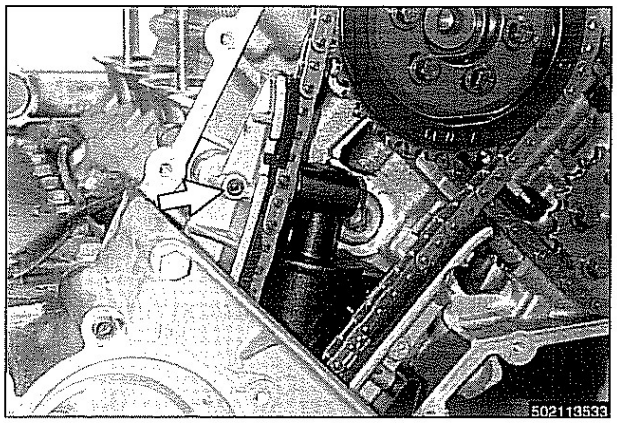
- Remove fasteners from intake camshaft sprocket (**arrows**) on left cylinder head.

– Remove primary timing chain sprocket and suspend timing chain using mechanics wire to prevent chain from dropping into lower housing.



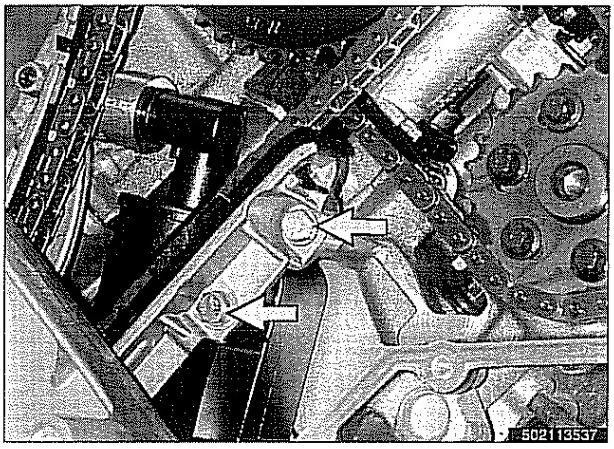
- Turn crankshaft counterclockwise until 45° mark on crankshaft is aligned with boss on front timing chain cover (**arrow**).

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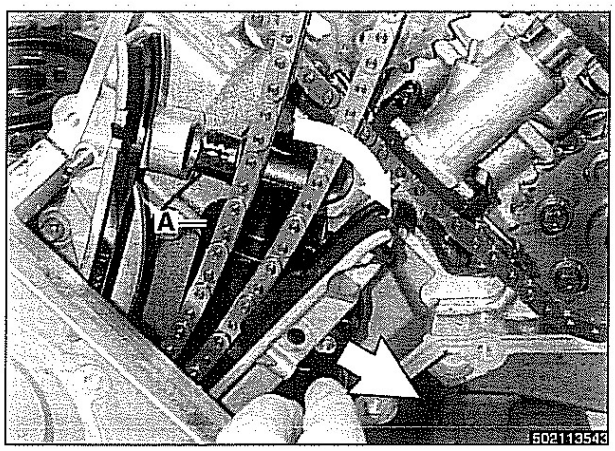


- Loosen chain rail set screw (**arrow**) 3 full turns (**do not remove**).

NOTE—
Allen screw secures crankcase vent tube in cylinder head.

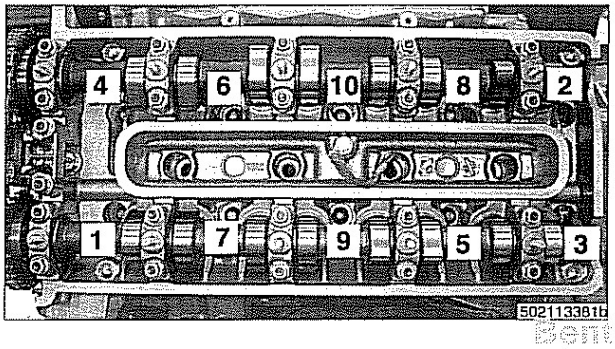


- Loosen and remove chain guide rail fasteners (**arrow**).



- Slide oil separator (**A**) out of crankcase vent connecting bracket (**arrows**).

CAUTION—
When removing the cylinder head carefully press oil separator outwards.



- Loosen cylinder head bolts in sequence 1–10 as shown (**arrows**) and discard used head bolts.
- Lift cylinder head off engine block while pressing out on oil separator.

CAUTION—
Be careful not to damage oil separator while removing cylinder head.

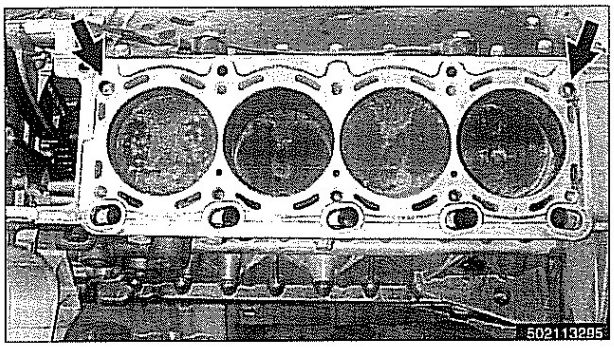
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– Evaluate cylinder head as described in **116 Cylinder head and valvetrain**.

Left cylinder head, installing, M62 engine

– Clean cylinder head and block sealing surfaces of gasket debris, making sure no debris drops into coolant or oil passages.

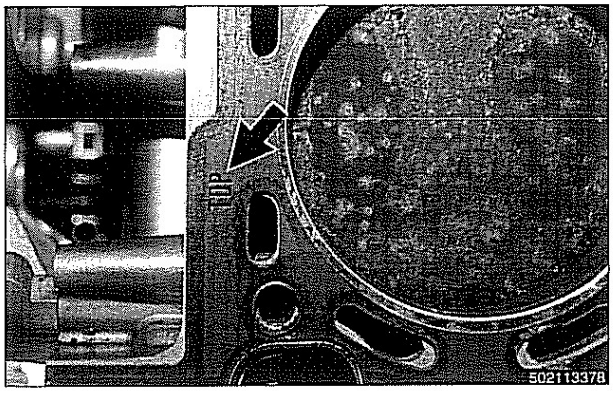
– Clean cylinder head bolt holes and check condition of threads.



➢ Check cylinder head locator sleeves (**arrows**) for damage.

> ***CAUTION—***
> *If the cylinder head has been machined, a special 0.3 mm thicker gasket should be installed. The thicker gasket is available through an authorized BMW dealer and should be marked accordingly.*

– Place new cylinder head gasket over locating sleeve on block.

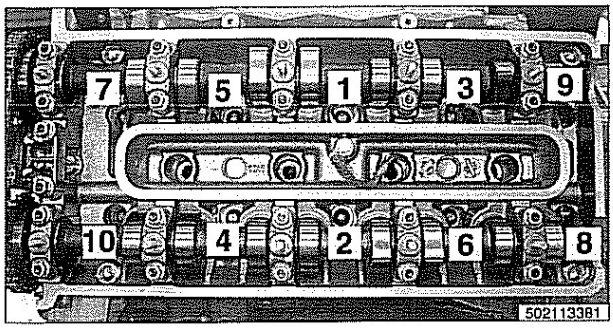


➢ The word "OBEN" or "TOP" (**arrow**) printed on the gasket, must face up.

– Set left side cylinder head in position on cylinder block while pressing oil separator outward.

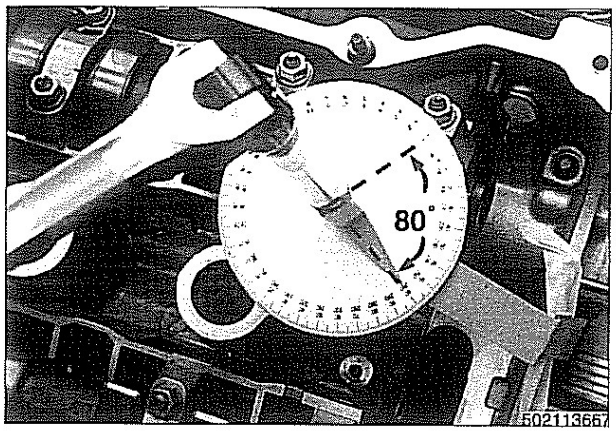
> ***CAUTION—***
> *Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation from TDC, is still in that position before installing the cylinder head. All pistons must be out of TDC position to prevent valve/piston contact.*

– Install new cylinder head bolts and washers finger tight. Be sure not to remove coating from new cylinder head bolts.



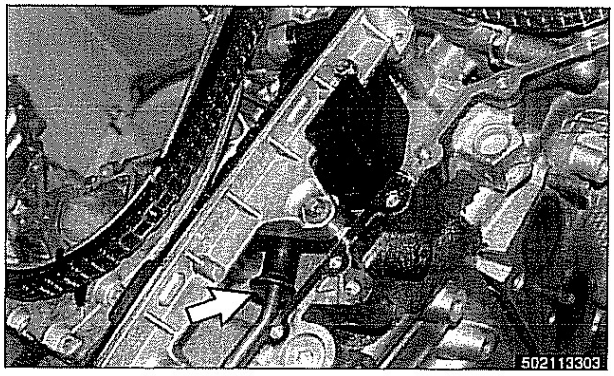
➢ Tighten cylinder head bolts in correct sequence (1-10) to stage 1 torque values.

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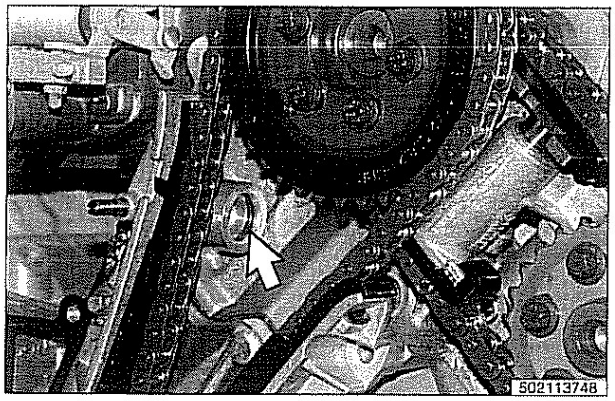
- Using a torque angle gauge, tighten cylinder head bolts to specified torque angle in stages 2 and 3.

Tightening torques	
Stage I	30 Nm (22 ft-lb)
Stage II	+80°
Stage III	+80°



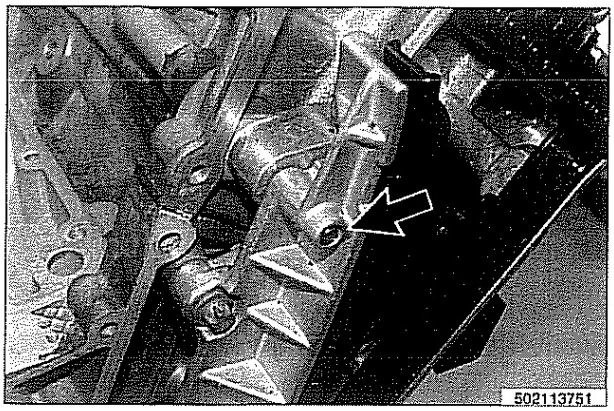
- If possible, confirm oil return pipe at bottom of separator is correctly seated (**arrow**).

NOTE—
Photo shows lower timing case cover removed.



- Remove old O-ring and install new O-ring (**arrow**) in angle section.

– Press oil separator into angle section and install guide rail retaining screws.

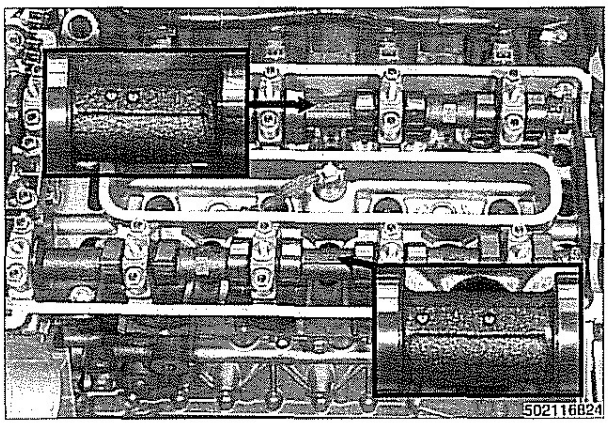


- Tighten allen screw (**arrow**) just until it makes contact with crankcase vent tube angle section without play.

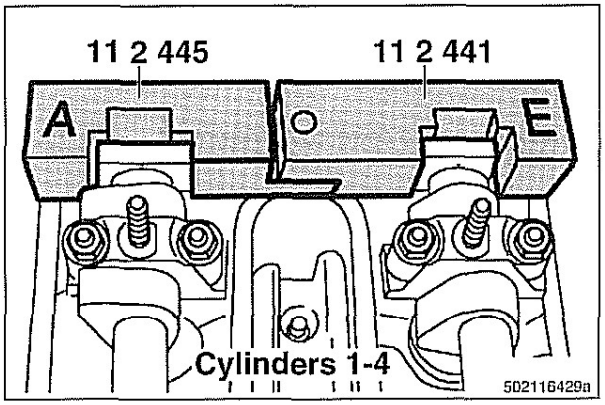
NOTE—
Allen screw secures crankcase vent tube in place. Do not torque down.

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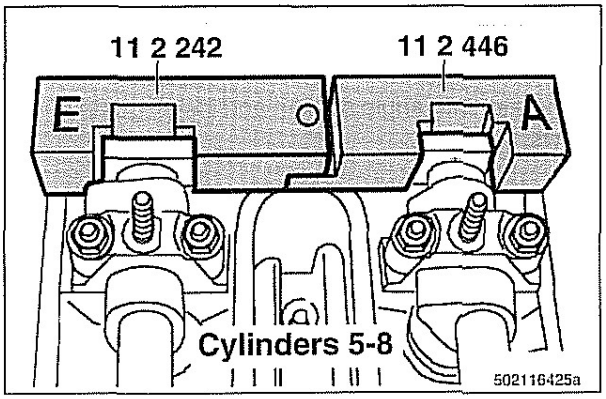
Cylinder Head Removal and Installation



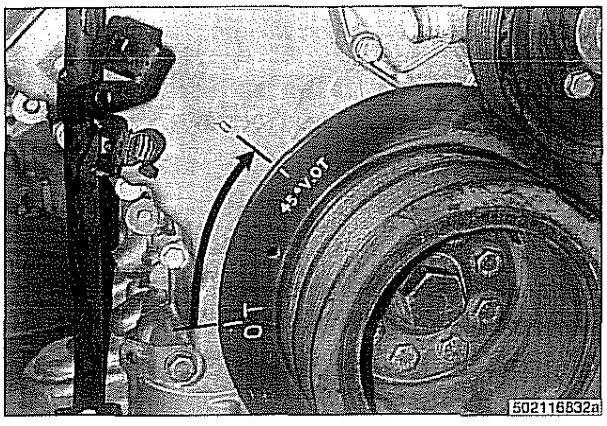
- Using BMW special tool 11 3 430, or a 27 mm open-ended wrench, rotate camshafts to cylinder 1 TDC position (until markings point upwards).



- Install camshaft locking tool set (BMW special tool set 11 2 440) on right cylinder head (cylinders 1–4). Fit on cylinder head without gaps.

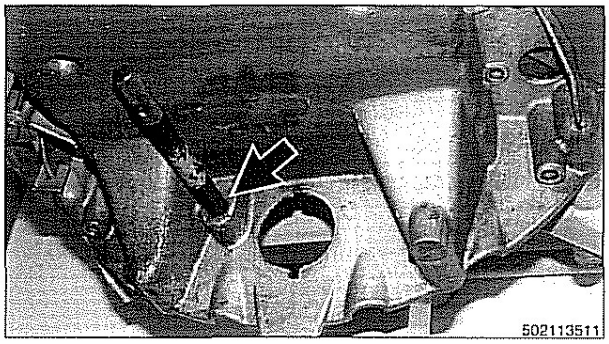


- Install camshaft locking tool set (BMW special tool set 11 2 440) on left cylinder head (cylinder head 5–8). Fit on cylinder head without gaps.



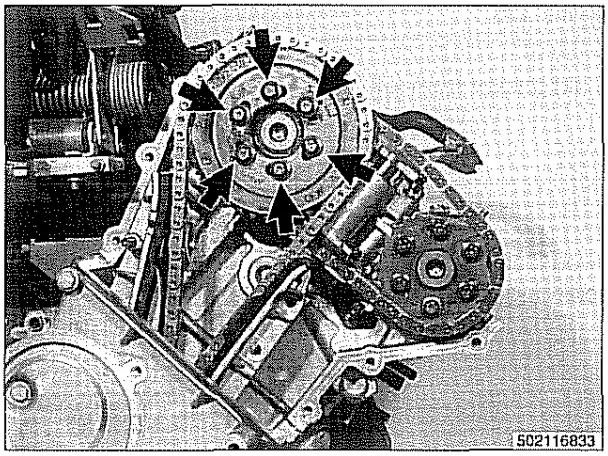
- Using crankshaft center bolt, rotate engine clockwise from the 45° mark to TDC position (**OIT** aligns with casting mark on cylinder block).

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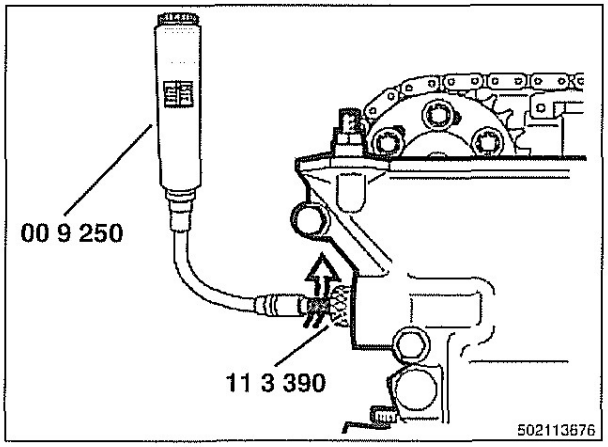
➢ Lock crankshaft in TDC position with BMW special tool 11 3 200 (**arrow**).

NOTE—
Boss for special tool 11 3 200 located at rear of engine oil pan.



➢ Working at left cylinder head (driver's side) fit primary sprocket and chain to camshaft flange, centering threaded bores.

- Insert bolts (**arrows**) and hand tighten.



➢ Install BMW special tool 11 3 390 into right timing case cover.

- Using BMW special tool 00 9 250, tighten adjusting screw on 11 3 390 to 0.7 Nm (6.3 in-lb).

NOTE—
BMW special tool 00 9 250 is a flexible shaft torque wrench.

– Tighten sprocket retaining bolts in the following order:

- All bolts on left cylinder head exhaust camshaft
- 3 accessible bolts on right cylinder head exhaust camshaft
- All bolts on left cylinder head intake camshaft
- 3 accessible bolts on right cylinder head intake camshaft

Tightening torques

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

– Remove camshaft and crankshaft locking tools from engine.

– Using crankshaft center bolt, turn engine clockwise to access remaining sprocket retaining bolts of right cylinder head camshafts. Tighten remaining bolts.

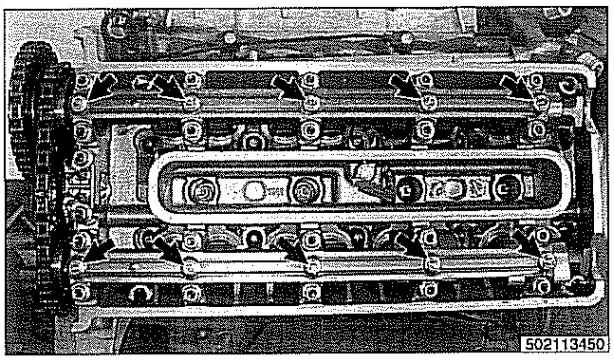
Tightening torques

Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

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– Remove adjustable timing chain tensioner tool from timing case cover and install primary timing chain tensioner with new sealing washer.

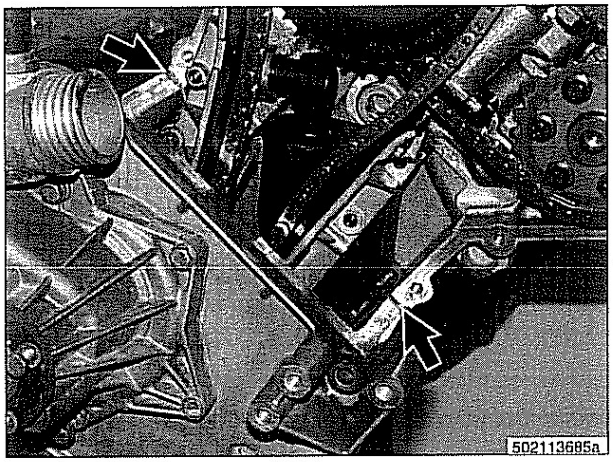
Tightening torque	
Chain tensioner cylinder to timing cover	65 Nm (48 ft-lb)



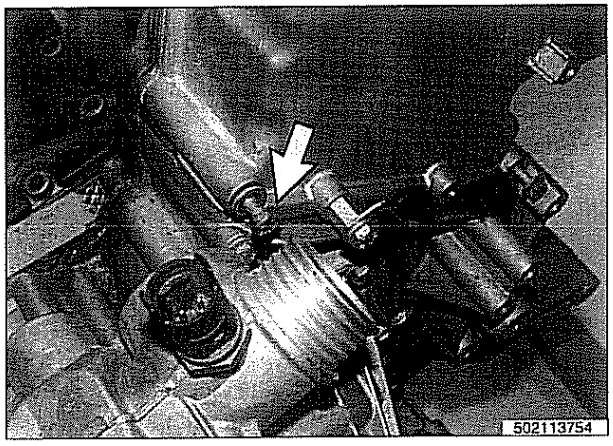
➢ Install oil supply lines and mounting nuts (**arrows**) to both heads.

Tightening torque	
Oil supply line nuts	10 Nm (7.5 ft-lb)

– Remove old gasket from left timing cover, and clean gasket surface.



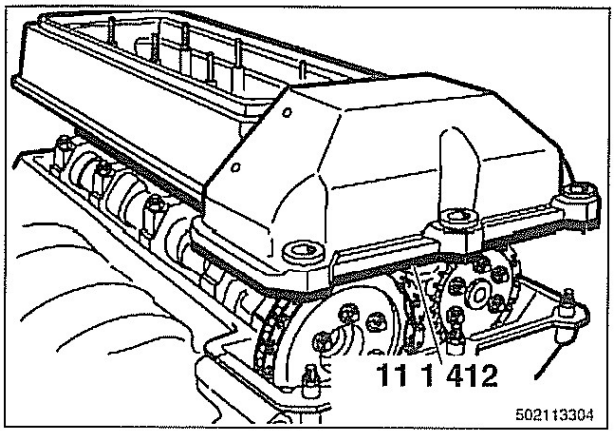
➢ Apply Three Bond 1209 ® sealant to joint between cylinder head and timing cover (**arrows**).



➢ Using a new gasket, install left timing cover with lower inner fastener inserted in cover (**arrow**). Position cover in place and tighten cover fasteners finger tight.

NOTE—
It is not possible to install lower inner fastener after cover is in place.

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➢ Remove left cylinder head cover gasket and install spacing tool (BMW 11 1 412) in place of gasket.

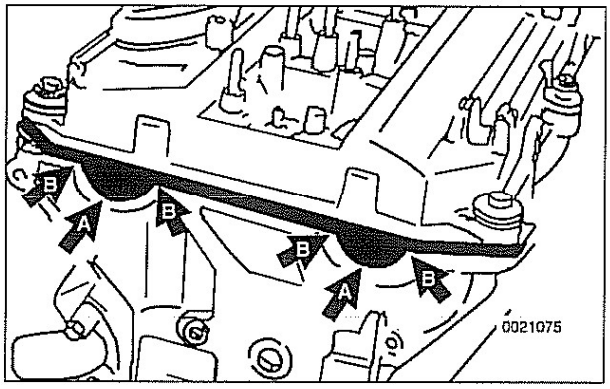
– Install left cylinder head cover fasteners and tighten uniformly in $^1/_2$ turn steps.

Tightening torque	
Cylinder head cover nuts	10 Nm (7.5 ft-lb)

– Tighten left upper timing cover retaining bolts in two passes.

Tightening torque	
Timing chain cover to head	10 Nm (7.5 ft-lb)

– Remove left cylinder head cover and BMW special tool 11 4 412.



➢ Reinstall cylinder head covers to left and right cylinder heads using new gaskets.

- Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
- Use a small amount of Three Bond 1209 ® or equivalent sealer at corners (**B**) of half-moon cutouts.

– Install left cylinder head cover fasteners and tighten uniformly in $^1/_2$ turn steps.

– Install exhaust manifolds using new gaskets and fasteners. See **180 Exhaust System.**

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– Remainder of installation is reverse of removal, noting the following:
  - Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from center out.
  - Be sure to reinstall ignition coil ground straps at cylinders no. 3 and no. 7. See **120 Ignition System.**
  - Reinstall cooling fan and shroud. See **170 Radiator and Cooling System.**
  - Refill and bleed cooling system as described in **170 Radiator and Cooling System.**
  - Change engine oil and filter as described in **020 Maintenance.**

CAUTION—
To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.

Tightening torques

Camshaft sprocket to camshaft	15 Nm (11 ft-lb)
Coolant manifold to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover nuts	10 Nm (7.5 ft-lb)
Exhaust manifold to head	22 Nm (17 ft-lb)
Engine mounts to subframe	42 Nm (30 ft-lb)
Spark plugs to cylinder head	22 Nm (17 ft-lb)

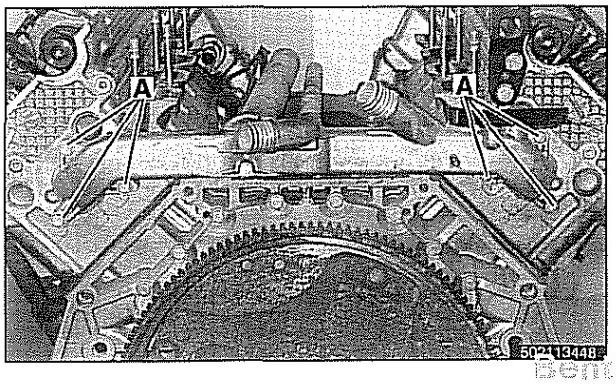
Right cylinder head, removing, M62 engine

– Remove left side exhaust manifold. See **180 Exhaust System.**

– Remove intake manifold. See **Intake manifold, removal and installation, M62 engine.**

– Drain engine coolant. See **170 Radiator and Cooling System.**

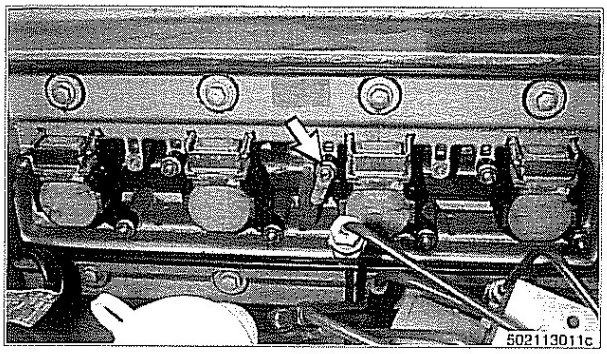
WARNING—
Use extreme caution when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Seek medical attention immediately if coolant is ingested.



Remove engine coolant manifold mounting fasteners and carefully remove manifold.

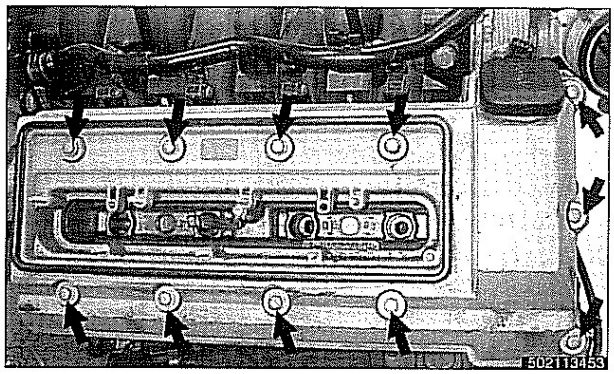
NOTE—
Engine is shown removed for clarity.

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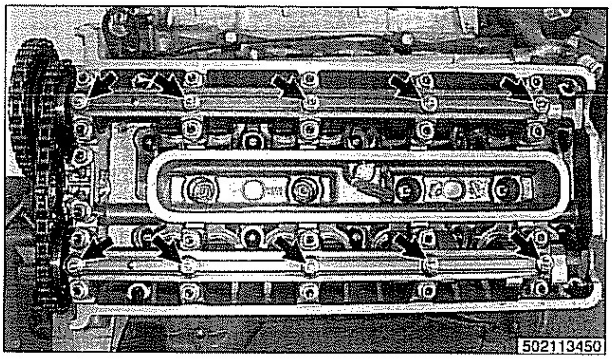


– Remove viscous clutch cooling fan. See **170 Radiator and Cooling System.**

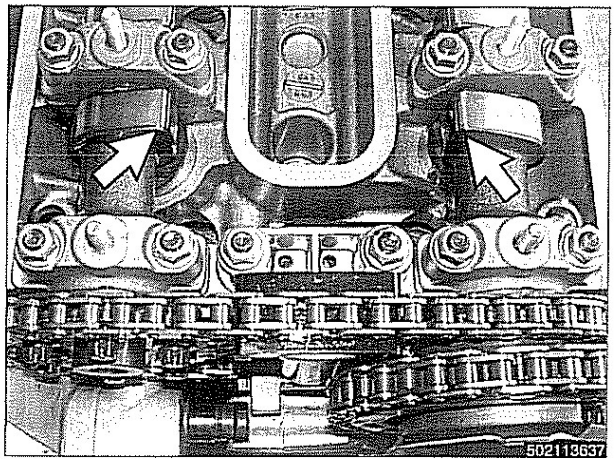
- Remove ignition coil fasteners and coils (noting location of ground strap).
  - Remove spark plugs.



- Remove cylinder head cover fasteners (**arrows**) and remove covers from right and left cylinder heads.



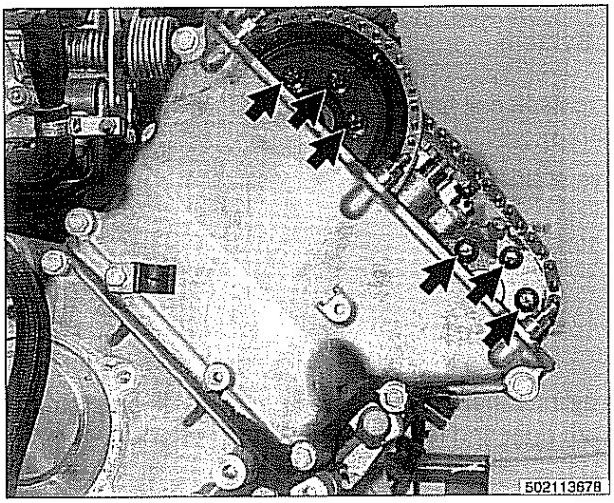
- Remove oil distribution tube fasteners and remove tubes from both cylinder heads.



- Using crankshaft center bolt, turn crankshaft clockwise until number one cylinder (front cylinder right side) is in TDC (**arrows**).

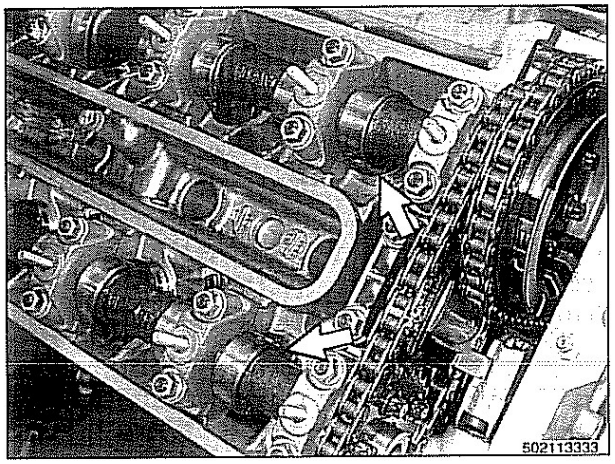
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Cylinder Head Removal and Installation

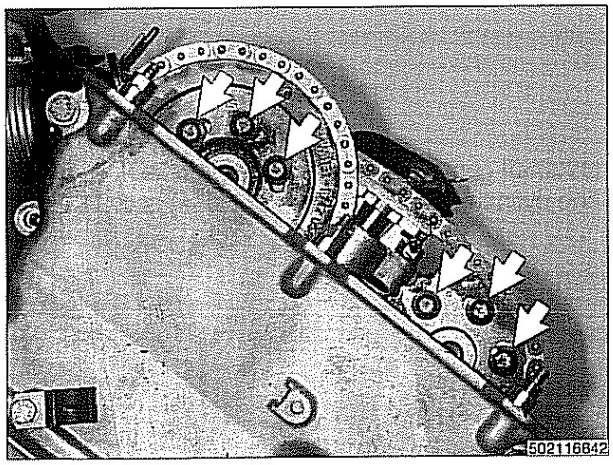


- Work at left side cylinder head loosen three accessible camshaft sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately $^{1}/_{2}$ turn.

> ***CAUTION—***
> *To prevent valve to piston contact, counterhold camshaft with 27 mm open-end wrench whenever loosening or tightening camshaft sprocket fasteners. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.*

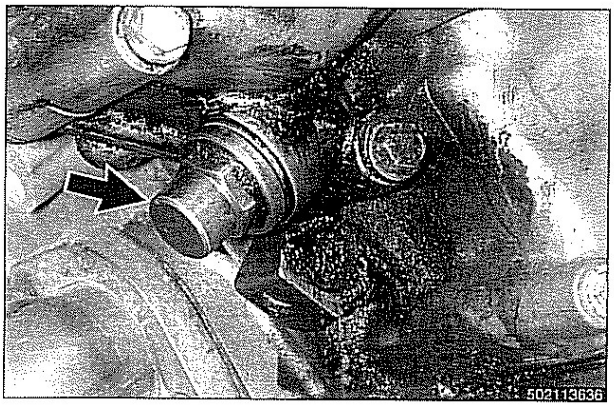


- Rotate crankshaft one complete rotation to TDC overlap. Right (passenger's side of engine) side camshaft lobes for number one cylinder should be in overlap position as shown (**arrows**).

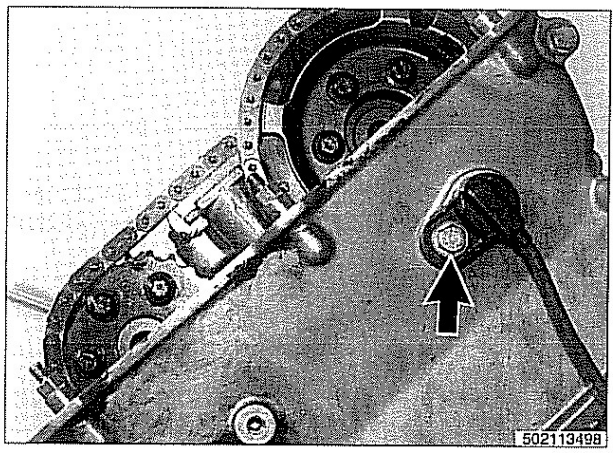


- Working at left cylinder head, loosen remaining sprocket fasteners (**arrows**) on both intake and exhaust camshafts approximately $^{1}/_{2}$ turn.

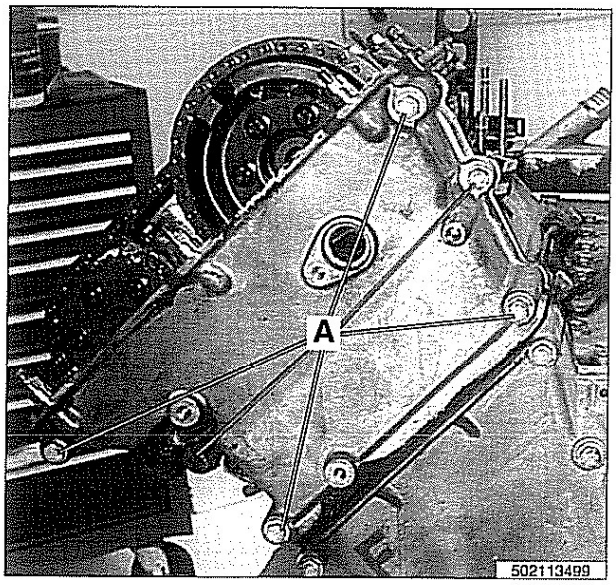
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- Loosen and remove primary timing chain tensioner (**arrow**) from right cylinder head.



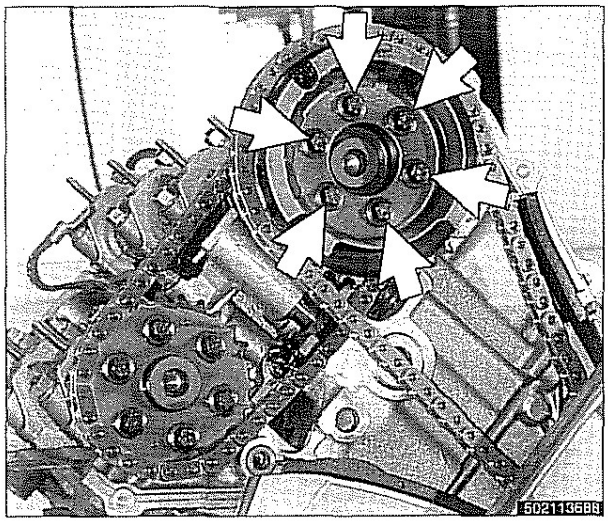
- Remove camshaft position sensor (**arrow**) from upper timing chain cover on right cylinder head.
- Remove dip stick tube support fastener.



- Remove upper timing chain cover fasteners (**A**) and remove cover from right cylinder head.

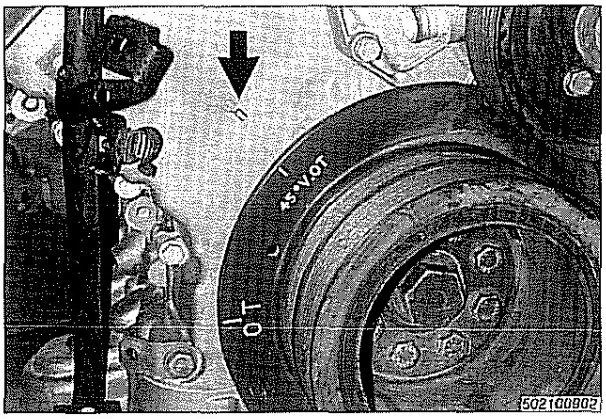
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Cylinder Head Removal and Installation

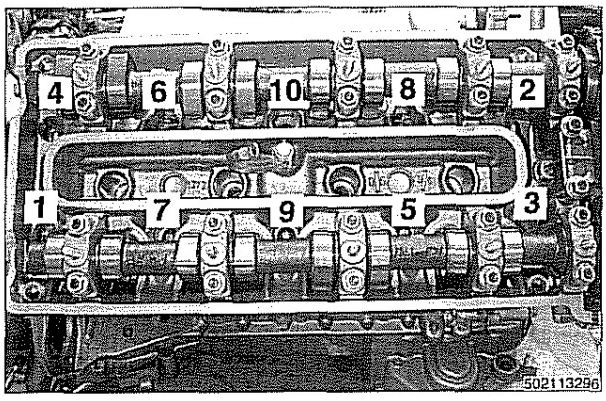


- Remove fasteners from intake camshaft sprocket (**arrows**) on right cylinder head.

– Remove primary timing chain sprocket and suspend timing chain using mechanics wire to prevent chain from dropping into lower housing.



- Turn crankshaft counterclockwise until 45° mark on crankshaft is aligned with boss on front timing chain cover (**arrow**).



- Loosen cylinder head bolts in sequence 1–10 as shown (**arrows**) and discard used head bolts.

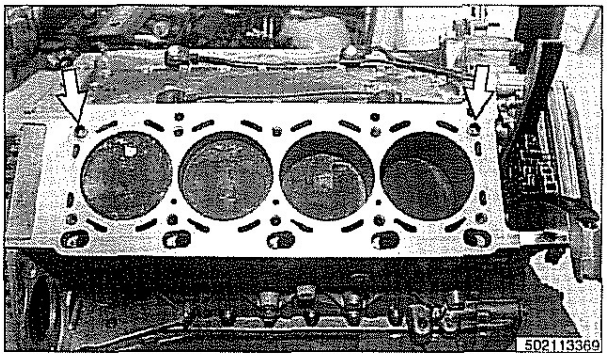
– Evaluate cylinder head. See **116 Cylinder head and valvetrain**.

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Right cylinder head, installing, M62 engine

– Clean cylinder head and block sealing surfaces of gasket debris, making sure no debris drops into coolant or oil passages.

> ***CAUTION—***
> *To prevent valve to piston contact when tightening camshaft sprocket fasteners, counterhold camshaft with 27 mm open-end wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.*

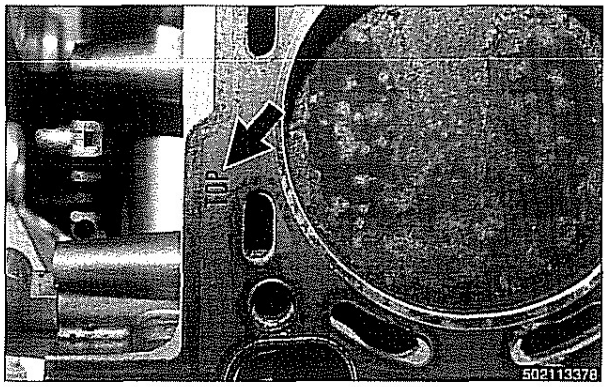


– Check cylinder head bolt holes and condition of threads. Remove debris and liquids from holes.

➢ Check cylinder head locator sleeves (**arrows**) for damage.

> ***CAUTION—***
> *If the cylinder head has been machined, a special 0.3 mm (0.011 in.) thicker gasket should be installed. The thicker gasket is available through an authorized BMW dealer and should be marked accordingly.*

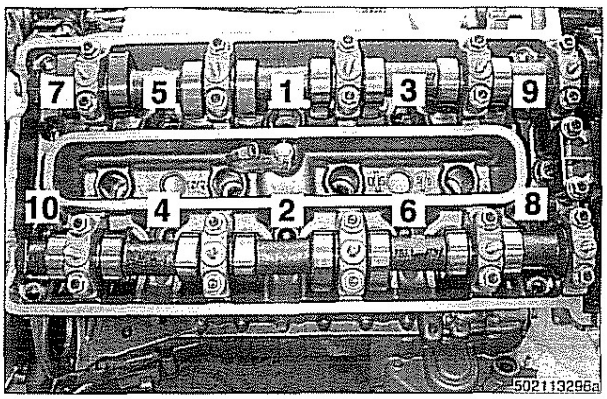
– Place new cylinder head gasket over locating sleeve on block.



➢ The word "OBEN" or "TOP" (**arrow**) printed on the gasket, must face up.

> ***CAUTION—***
> *Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation from TDC, is still in that position before installing the cylinder head. All pistons must be out of TDC position to prevent valve/piston contact.*

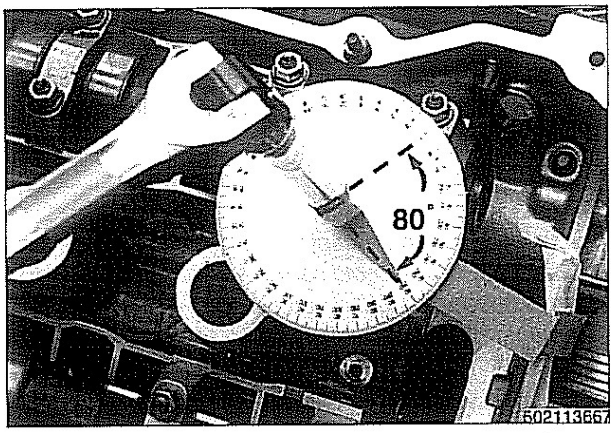
– Install new cylinder head bolts and washers finger tight. Be sure not to remove coating from bolts.



➢ Tighten cylinder head bolts in correct sequence (1-10) to stage 1 torque values.

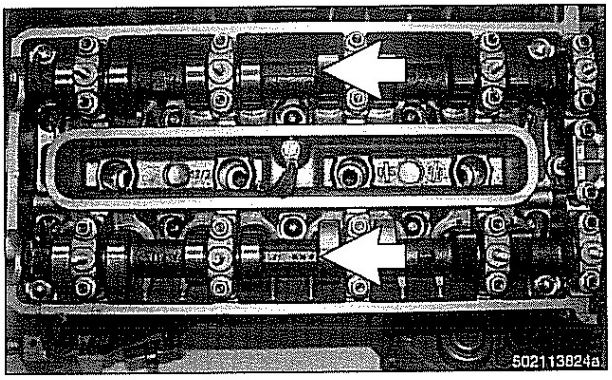
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Cylinder Head Removal and Installation



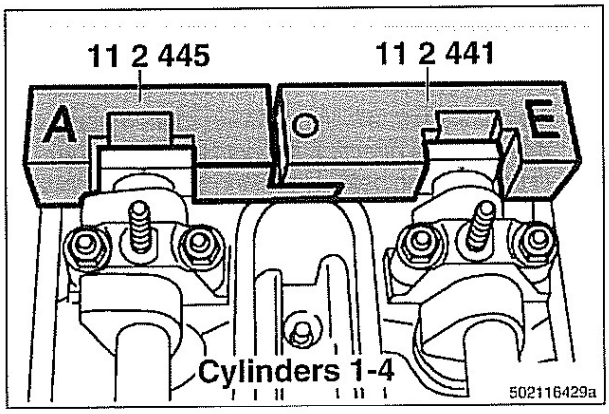
- Using a torque angle gauge, tighten cylinder head bolts to specified torque angle in stages 2 and 3.

Tightening torques	
Stage I	30 Nm (22 ft-lb)
Stage II	+80°
Stage III	+80°

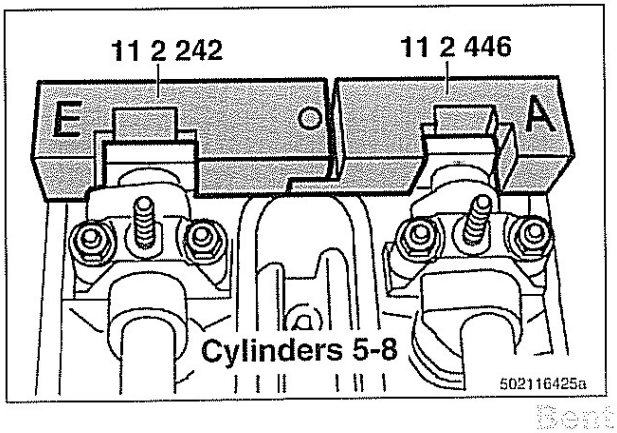


- Using BMW special tool 11 3 430, or a 27 mm open-ended wrench, rotate camshafts until marker bores (drilled holes) point upwards (**arrows**).

> ***CAUTION—***
> *Do not damage cylinder head with wrench. If necessary, grind outer side of wrench jaws to prevent damaging cylinder head.*

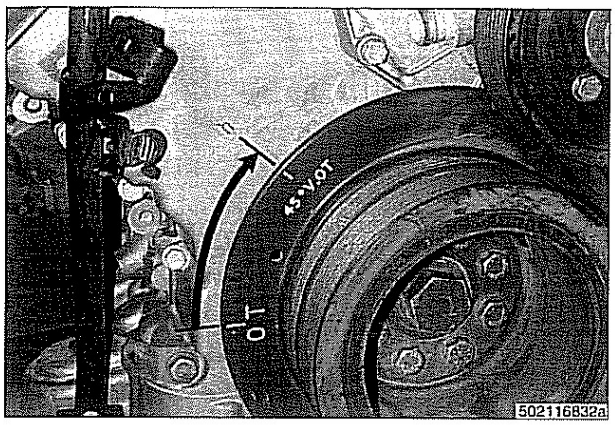


- Install camshaft locking tool set (BMW special tool set 11 2 440) on right cylinder head. Fit tools on cylinder heads without gaps.

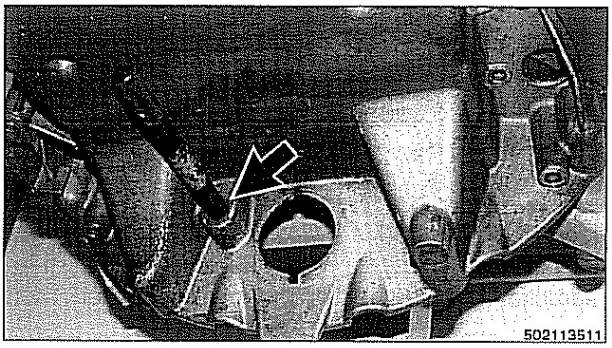


- Install camshaft locking tool set (BMW special tool set 11 2 440) on left cylinder head. Fit tools on cylinder head without gaps.

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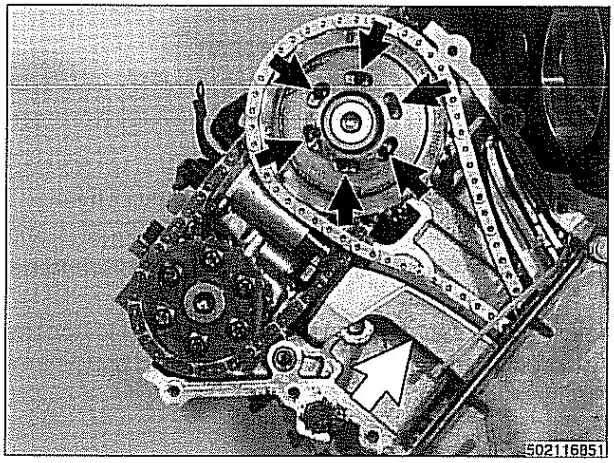
- Using crankshaft center bolt, rotate engine clockwise from the 45° before TDC up to TDC position (**OIT** aligns with casting mark on cylinder block).



- Lock crankshaft in TDC position with BMW special tool 11 3 200 (**arrow**).

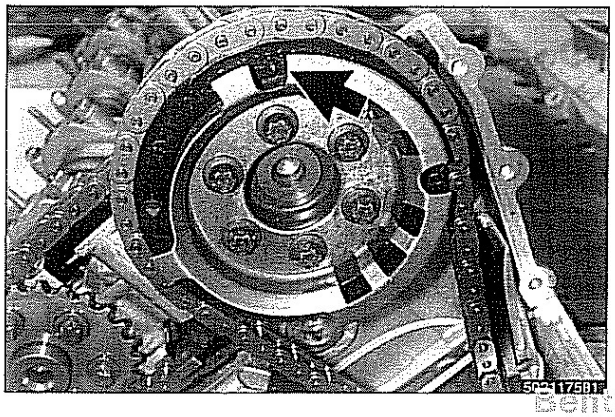
NOTE —
Special tool boss located at the rear of upper engine oil pan.

– Working at right cylinder head (cylinder 5–8) fit primary sprocket and chain to camshaft flange.



- Press timing chain tensioner rail against timing chain (**white arrow**) to check that fastener holes are centered in sprocket slots (**black arrows**).

NOTE —
If necessary, remove sprocket and realign position.

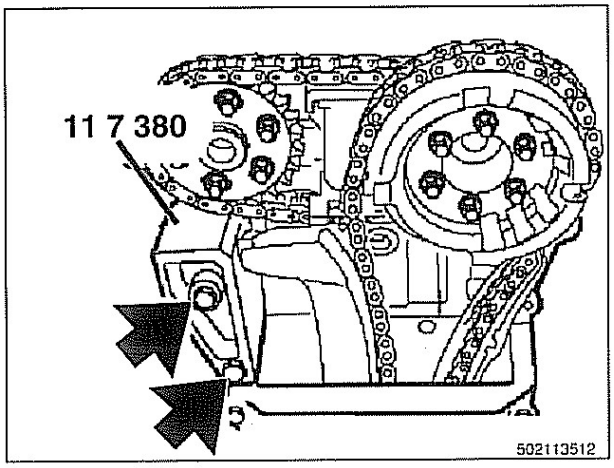


- Fit sensor gear with mark pointing up (**arrow**).

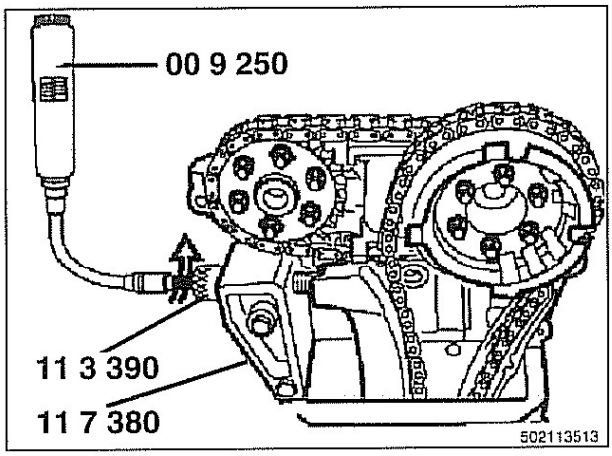
– Insert bolts and hand tighten.

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Cylinder Head Removal and Installation



Install BMW special tool 11 7 380.



Install special tool 11 3 390 into special tool 11 7 380 and tighten tensioner (11 3 390) to 0.7 Nm (6.3 in-lb) using special tool 00 9 250.

NOTE—
BMW special tool 00 9 250 is a flexible shaft torque wrench.

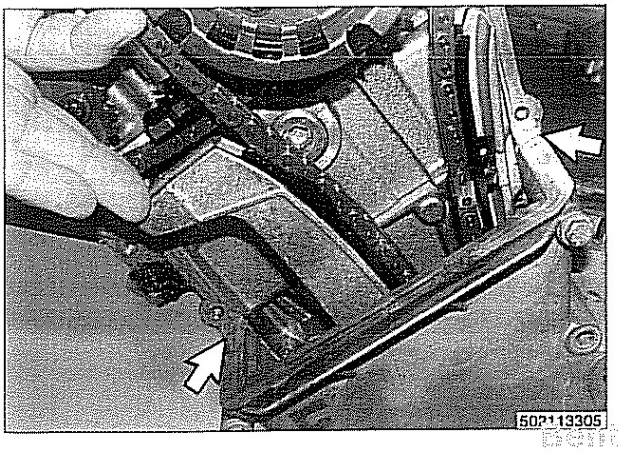
– Tighten sprocket retaining bolts in the following order:
  - 3 accessible bolts on left exhaust camshaft
  - All bolts on right exhaust camshaft
  - 3 accessible bolts on left intake camshaft
  - All bolts on right intake camshaft

Tightening torque	
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

– Remove camshaft and crankshaft locking tools from engine.

– Using crankshaft center bolt, turn engine clockwise to access remaining sprocket retaining bolts of left cylinder head camshafts. Tighten remaining bolts.

Tightening torque	
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

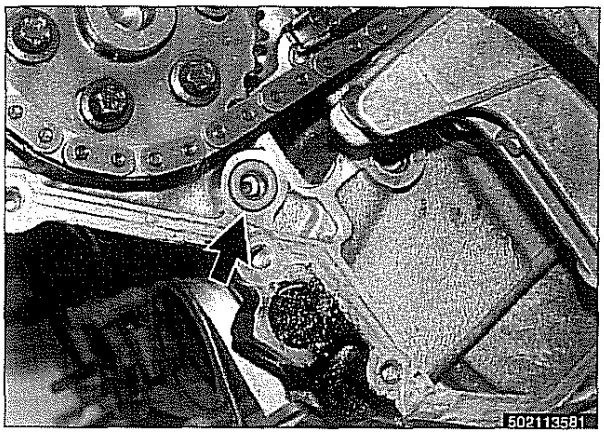


– Remove BMW special tool 11 3 390 and 11 7 380 from right cylinder head.

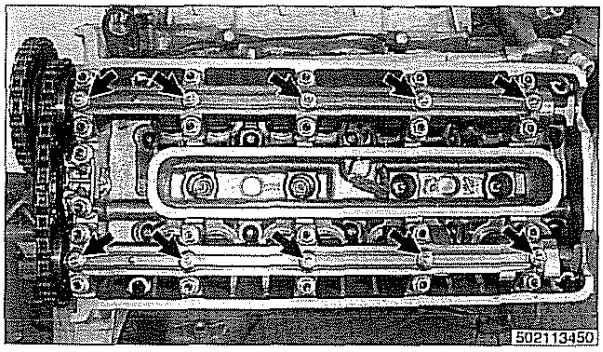
– Remove used gasket from right timing chain cover, clean gasket surface.

Install new gasket and apply three Bond 1209 ® sealant to joint between cylinder head and timing cover (**arrows**).

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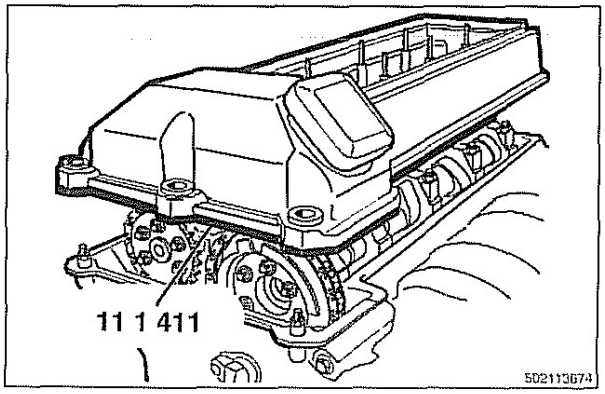


➢ Replace sealing O-ring (**arrow**) in right cylinder head before installing upper timing chain cover.



➢ Install oil supply lines and mounting nuts on both heads (**arrows**).

– Using a new gasket, install upper timing chain cover on right head and tighten cover fasteners finger tight.



➢ Remove right cylinder head cover gasket and install spacing tool (BMW 11 1 411) in place of gasket.

– Install right cylinder head cover fasteners and tighten uniformly in $^1/_2$ turn steps.

Tightening torque	
Cylinder head cover fasteners	10 Nm (7.5 ft-lb)

– Tighten right upper timing cover retaining fasteners in two passes.

Tightening torque	
Upper timing chain cover	10 Nm (7.5 ft-lb)

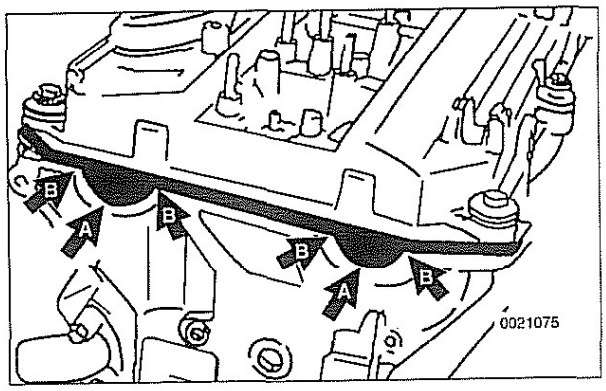
– Reinstall primary timing chain tensioner with new sealing washer.

Tightening torque	
Chain tensioner to timing cover	65 Nm (48 ft-lb)

– Remove right cylinder head cover and remove special spacing tool 11 4 411.

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Cylinder Head Removal and Installation



- Reinstall cylinder head covers to right and left cylinder heads using new gaskets.
  - Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
  - Use a small amount of Three Bond 1209 ® or equivalent sealer at corners (**B**) of half-moon cutouts.
- Install cylinder head cover fasteners and tighten uniformly in $^1/_2$ turn steps.

Tightening torque	
Cylinder head cover fasteners	10 Nm (7.5 ft-lb)

- Install exhaust manifolds using new gaskets and fasteners. See **180 Exhaust System**.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.

> ***CAUTION—***
> *To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.*

Tightening torques	
Camshaft sprocket to camshaft	15 Nm (11 ft-lb)
Coolant manifold to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover nuts	10 Nm (7.5 ft-lb)
Exhaust manifold to head	22 Nm (17 ft-lb)
Engine mount to subframe	42 Nm (30 ft-lb)
Spark plugs to cylinder head	22 Nm (17 ft-lb)



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116 Cylinder Head and Valvetrain

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GENERAL

This group covers cylinder head and valvetrain service and repair. Some of the repair procedures described here require that the cylinder head first be removed as described in **113 Cylinder Head Removal and Installation**.

NOTE—
- *For timing chain and VANOS repair information, see **117 Camshaft Timing Chain**.*
- *If it is determined that the cylinder head will require significant reconditioning work, a remanufactured cylinder head may be a good alternative. Remanufactured cylinder heads are available from an authorized BMW dealer.*

The information given in this repair group is organized according to engine code. For engine application information, see **100 Engine-General**.

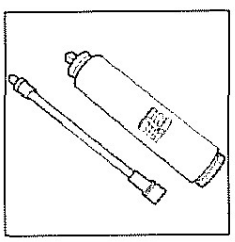
For specific repair procedures, refer to the appropriate repair group:

- **020 Maintenance**
- **100 Engine-General**
- **113 Cylinder Head Removal and Installation**
- **117 Camshaft Timing Chain**
- **170 Radiator and Cooling System**

Special Tools

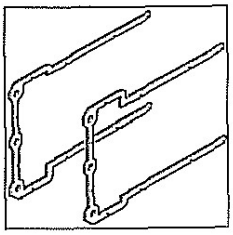
Special BMW tools are required for most cylinder head service described in this repair group. Many of these tools are expensive and only available through an authorized BMW dealer. If the special tools are not available, have the cylinder head removed and disassembled by an authorized BMW dealer. Be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

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

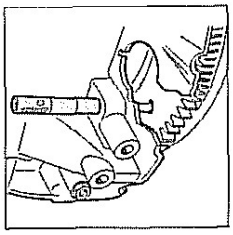


Torque wrench with flex shaft
(Tool No. BMW 00 9 250)

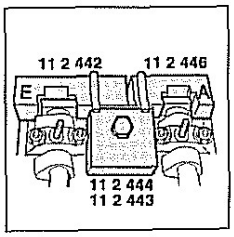
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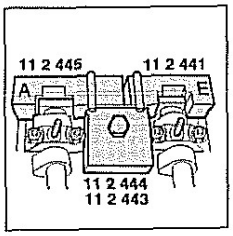
Upper timing cover seal seat tool set
(Tool No. BMW 11 1 410)



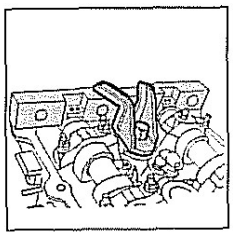
Crankshaft locking tool
(Tool No. BMW 11 2 300)



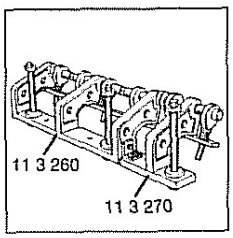
Camshaft locking tools set (V-8, cyl. 1–4)
(Tool No. BMW 11 2 440)



Camshaft locking tools set (V-8, cyl. 5–8)
(Tool No. BMW 11 2 440)

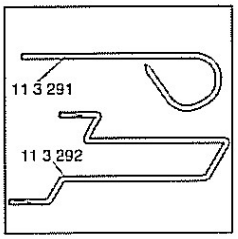


Camshaft locking tools set (6-cylinder)
(Tool No. BMW 11 3 240)

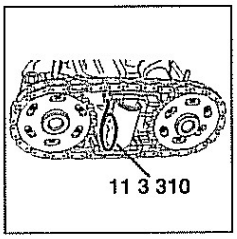


Camshaft bearing cap tensioning jig (6-cylinder)
(Tool No. BMW 11 3 260/270)

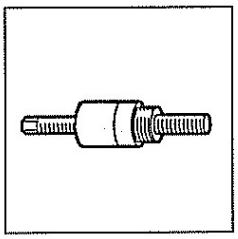
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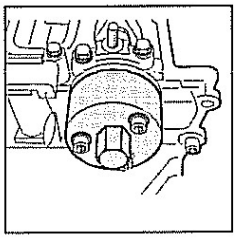
Secondary timing chain tensioner locking pin set (6-cylinder)
(Tool No. BMW 11 3 290)



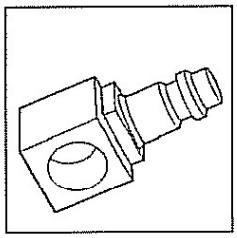
Secondary timing chain tensioner locking pin (V-8)
(Tool No. BMW 11 3 310)



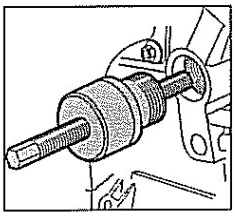
Adjustable primary timing chain tensioner tool (V-8)
(Tool No. BMW 11 3 390)



Camshaft installation tool (V-8)
(Tool No. BMW 11 3 430)

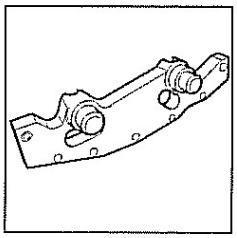


VANOS compressed air fitting
(Tool No. BMW 11 3 450)

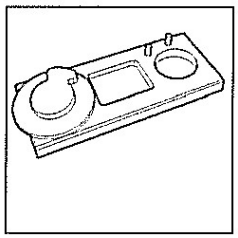


Adjustable primary timing chain tensioner tool (6-cylinder)
(Tool No. BMW 11 4 220)

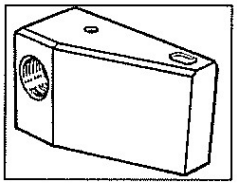
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Double VANOS set-up bracket
(Tool No. BMW 11 6 150)



Double VANOS secondary timing chain/camshaft sprocket setup tool (Tool No. BMW 11 6 180)



Timing chain tensioner bracket (V-8)
(Tool No. BMW 11 7 380)

CYLINDER HEAD

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

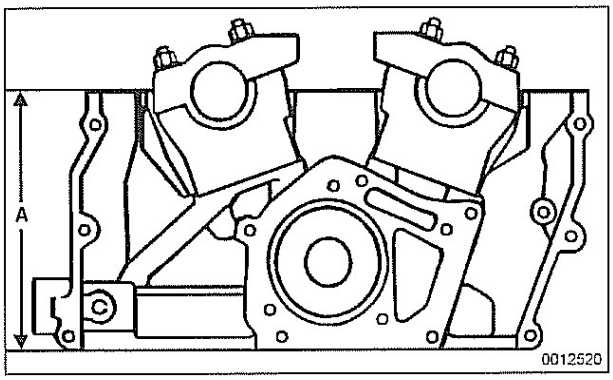
The disassembled cylinder head should be inspected for warpage and cracks. Check the valve guides and valve seats for wear before machining a warped head. Always decarbonize and clean the head before inspecting it.

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

NOTE—
When disassembling and inspecting the cylinder head, be sure to check the camshaft carrier bearing surfaces using a straight edge for warpage, and check the lifter bores for wear.

A high-quality straight edge can be used to check for warpage. A warpage of 0.05 mm (0.002 in.) is acceptable without machining. A warped cylinder head can be machined provided no more than 0.3 mm (0.012 in.) of material is removed. If further machining is required, the head should be replaced. Removing more than this amount will reduce the size of the combustion chamber and adversely affect engine performance. A 0.3 mm thicker head gasket for machined heads is available from an authorized BMW parts department.

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Before machining the head to correct for warpage, measure the total height (**A**) (thickness of the cylinder head). Minimum height specifications are given in **Table a. Cylinder head height**.

NOTE—
6 cylinder and V-8 engines share cylinder head height specifications.

Table a. Cylinder head height

New	Minimum height (A)
140.0 mm (5.512 in.)	139.7 mm (5.500 in.)

Valves, leak test

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

Camshaft wear

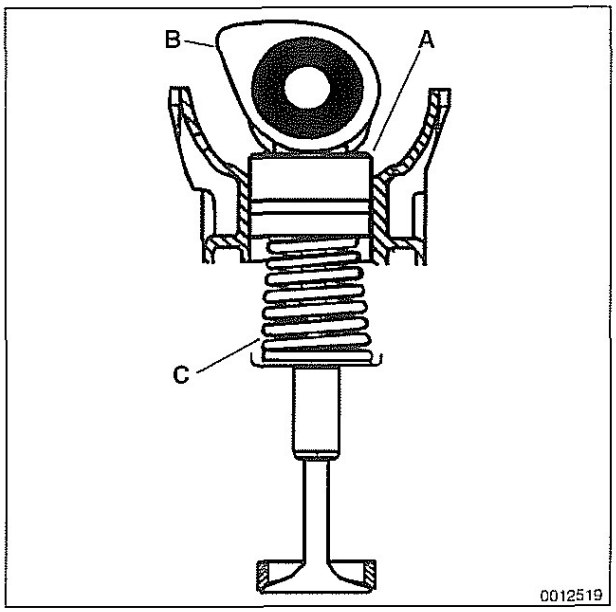
Camshaft wear is usually caused by insufficient lubrication. Visually inspect camshaft lobes and journals for wear. Camshaft wear specifications are given in **Table b. Camshaft wear specifications**.

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

Table b. Camshaft wear specifications

	6 cylinder engines	V-8 engines
Axial play	0.150-0.330 mm (0.0060-0.013 in.)	0.200-0.360 mm (0.008 - 0.014 in.)
Radial play	0.020-0.054 mm (0.0008-0.0021 in.)	0.040-0.074 mm (0.016 - 0.029 in.)

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Hydraulic lifters, checking and replacing

Self-adjusting hydraulic lifters (**A**) keep the valve clearances within a limited working range. Hydraulic lifters are sealed units and require no maintenance. Section view of camshaft (**B**) and valve with conical valve spring (**C**) shown.

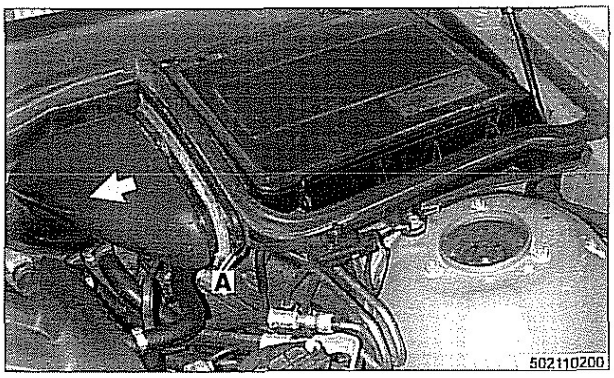
Under some circumstances, such as a cold start, the cam followers may emit noise. Hydraulic lifter noise is usually a high-pitched tapping or chattering noise. In most instances, this is considered normal as long as the noise goes away in a few minutes (maximum 20 minutes). If the noise does not go away,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

NOTE—
Before checking hydraulic lifters, make sure engine oil is fresh and at the proper level. Sticky lifters can be the result of sludge build up in the cylinder head and lifters.

– Run engine until it reaches normal operating temperature. Shut off engine.

– Working inside luggage compartment, disconnect negative battery cable.

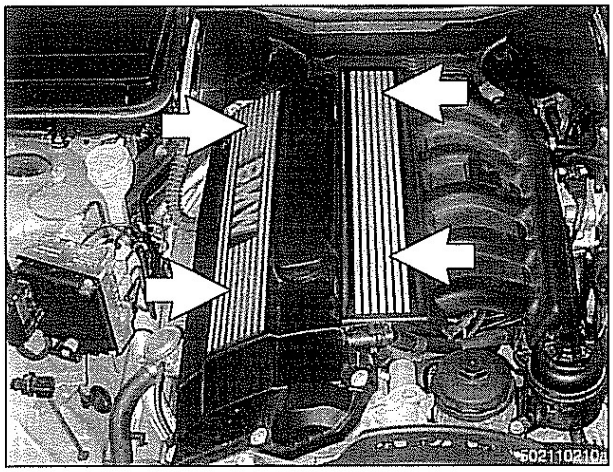
CAUTION—
- *Prior to disconnecting battery cable, read the battery disconnection cautions given in **001 General Cautions and Warnings.***
- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment prior to disconnecting the battery.*



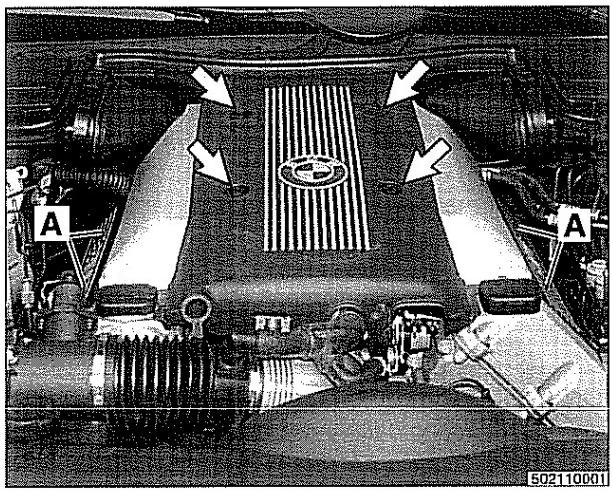
Remove left and right interior ventilation duct (left side shown):

- Release plastic locking tab (**A**) or release locking tabs on top of duct (later models).
- Rotate duct counterclockwise to unlock from bulkhead and remove (**arrow**).

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- 6-cylinder models: remove plastic top covers:
  - Pry out caps (**arrows**).
  - Remove fasteners and covers.



- V-8 models: remove plastic top covers:
  - Press down on locking pins (**arrows**) to release locks and remove top cover.
  - Pry out caps (**A**) from covers.
  - Remove fasteners and covers.

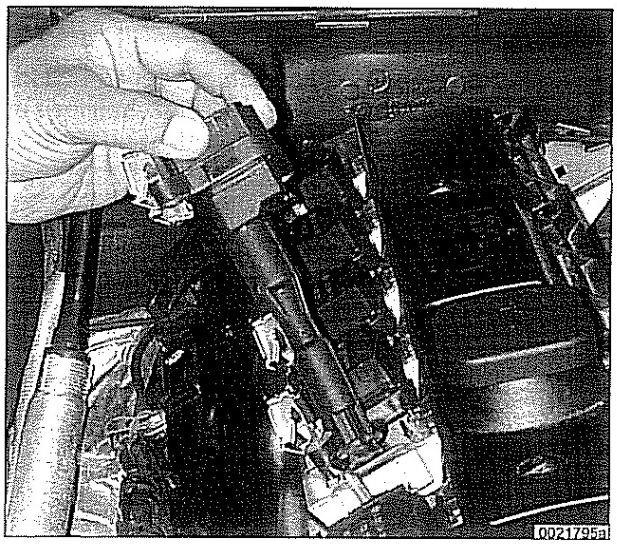


- Lift metal latch on coil harness connectors and disconnect harness connectors from coils. 6-cylinder shown, V-8 similar.

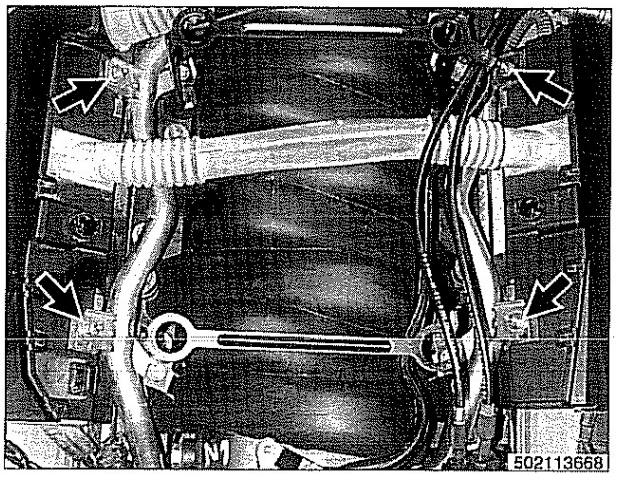
– Remove coil grounding straps.

NOTE —
Make note of ground wire at mounting studs arrangement during removal.

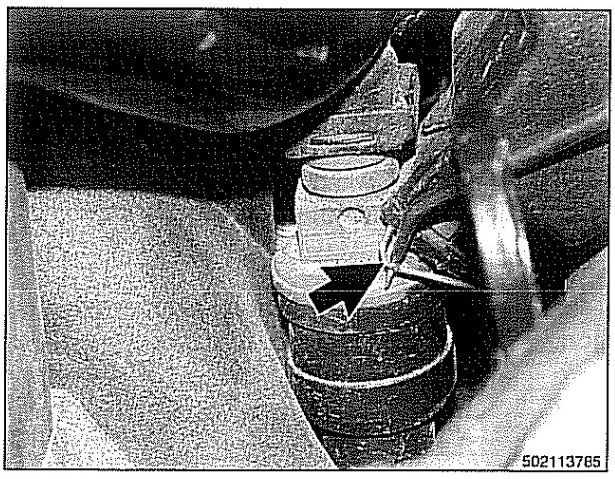
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➢ Remove ignition coils and spark plugs.



➢ V-8 models: remove mounting nuts (**arrows**) from wiring harness ducting.



➢ V-8 models: disconnect fuel injector electrical connectors from injectors:

- Pry one corner of wire lock clip (**arrow**) on first injector.
- Repeat for all injectors.
- Lift wire ducts off and set aside.

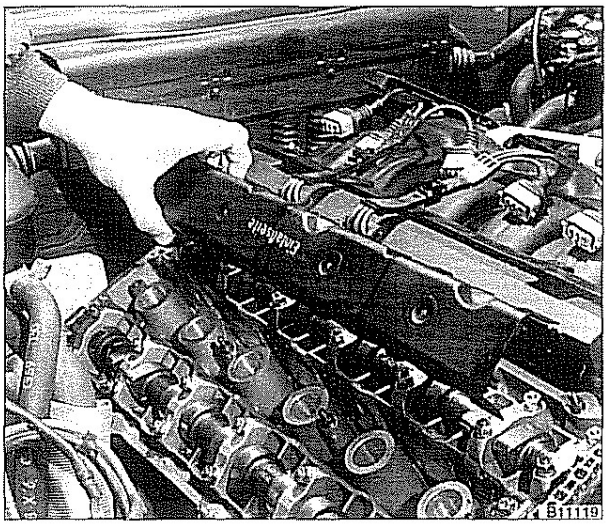
– V-8 models: disconnect battery jump start post terminal from left cylinder head cover.

– 6-cylinder models: remove oil filler cap and unclip vent connection from cylinder head cover.

– Remove cylinder head cover mounting fasteners and remove cylinder head cover(s).

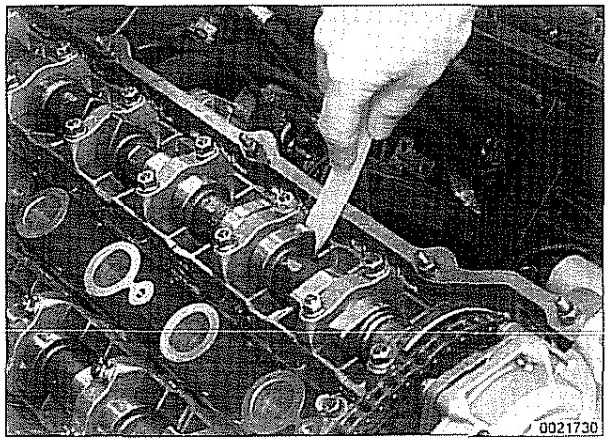
NOTE —
The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original locations. Make note of their arrangement during removal.

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➢ Remove oil baffle cover from above intake camshaft(s).

– Rotate engine at crankshaft vibration damper center bolt in normal direction of rotation (clockwise) until camshaft lobe of lifter to be tested points away from the lifter, allowing valve to be completely closed.



➢ Use a plastic or wooden stick to press down on top of lifter with approximately 3.5 Nm (2.25 ft-lb) of force.

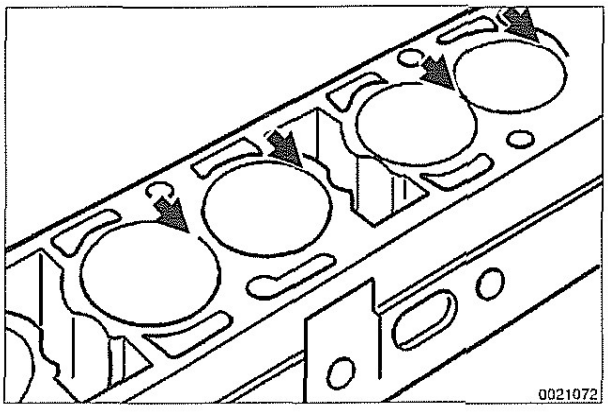
- If the lifter collapses slightly as though spring loaded, air may be trapped in the lifter.

NOTE—
Air trapped in hydraulic lifters may result from oil foaming (air being drawn in by the oil pump). This may be caused by a faulty oil pump control valve O-ring; leaking oil pump pickup gasket; or by oil starvation to pump.

– Press down on top of lifter for 10 to 15 seconds using approximately 6 to 9 Nm (4.5 to 6.75 ft-lb) of force.

- If any clearance is created between the lifter and the camshaft lobe, the check valve in the lifter is not closing. Replace lifter.

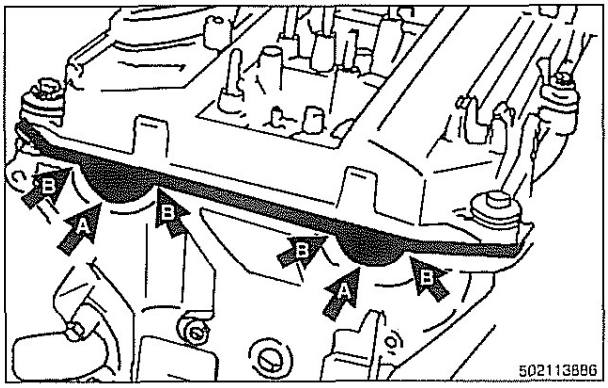
– To replace a hydraulic lifter, remove appropriate camshaft. Refer to camshaft removal procedures given in **Camshaft and lifter removal and installation.**



➢ Once camshaft is removed, withdraw faulty lifter(s) and replace with new lifter(s). Inspect lifter bores for wear and scoring at **arrows.**

– Reinstall camshafts. See **Camshaft and lifter removal and installation.**

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Install intake camshaft oil baffle cover and cylinder head cover:

- Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
- Use a small amount of Three Bond 1209 ® or equivalent sealant at corners (**B**) of half-moon cutouts and corners in front of cylinder head at joint to timing chain cover.
- Align cover at front and rear, then alternatively tighten fasteners from inside to outside.

Tightening torque

Spark plug to cylinder head	25 Nm (18 ft-lb)
Ignition coils to cylinder head	10 Nm (7.5 ft-lb)
Cylinder head cover to cylinder head (M6 screws)	10 Nm (89 in-lb)

Camshaft and Lifter Removal and Installation

The camshafts can be removed with the cylinder heads mounted on the engine (in the car).

On 6-cylinder engines there are two different procedures given, depending on whether the engine is equipped with single VANOS (M52 engine) or double VANOS (M52 TU or M54 engine).

For V-8 engines, camshaft removal and installation procedures are only included for the non-VANOS (M62) engine. Camshaft removal and installation for the VANOS equipped V-8 (M62 TU) is not covered in this manual.

Special BMW service tools should always be used to remove and install the camshafts. Removal of the camshafts without the special tools can result in cylinder head damage and camshaft breakage.

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Camshaft and lifter removal and installation (M52 engine)

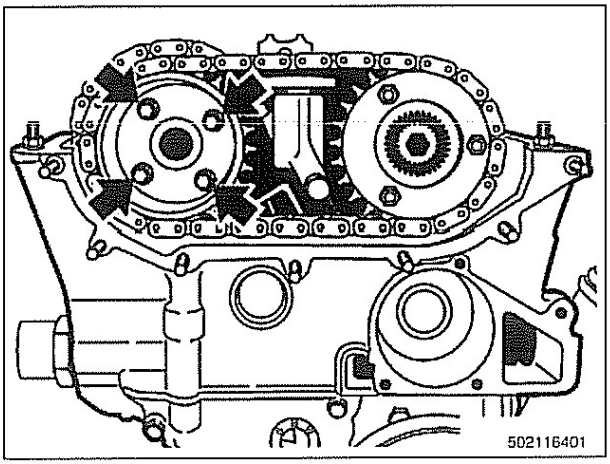
Camshafts and lifters, removing (M52 engine)

WARNING—
- *The process of evenly loosening the camshaft bearing cap nuts is NOT an acceptable method of removing the camshafts. Special tools should always be used to remove the camshafts. Be sure to read the procedure through before starting a job.*
- *Allow engine to cool before beginning this procedure.*

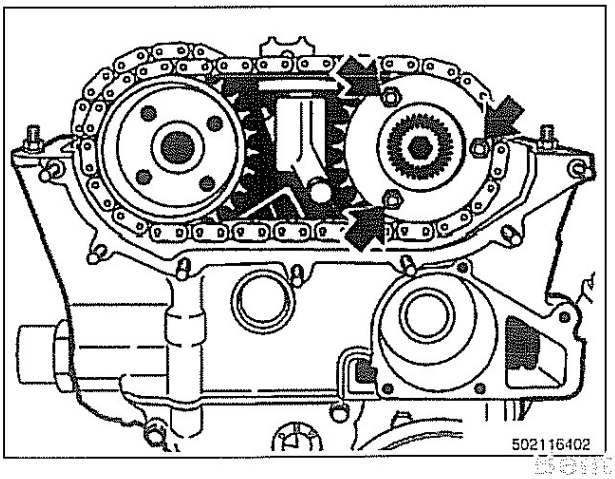
– Disconnect negative (–) cable from battery.

CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given in ***001 General Cautions and Warnings****.*

– Remove VANOS control unit from cylinder head. See **117 Camshaft Timing Chain**.

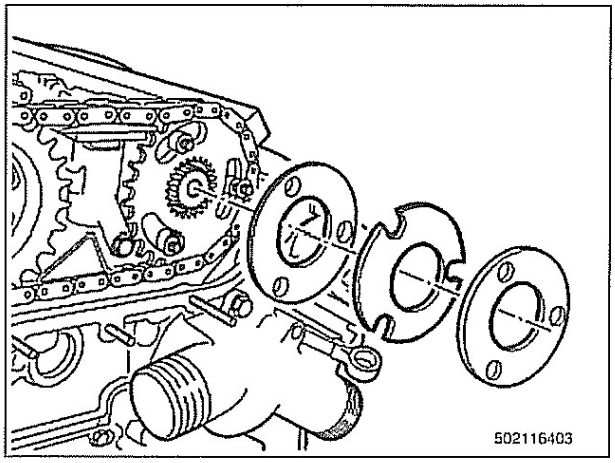


➢ Remove loosened bolts (**arrows**) from front of exhaust sprocket.

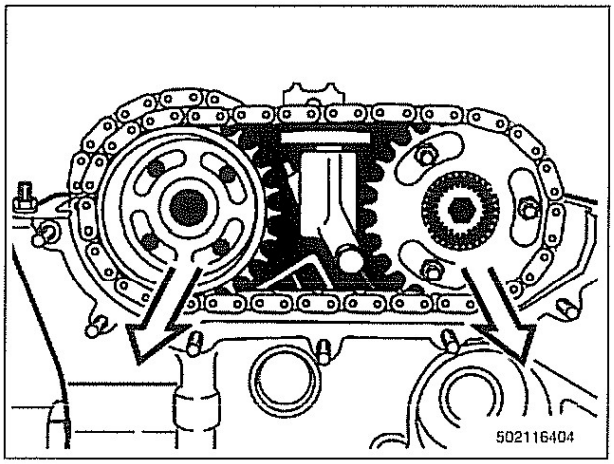


➢ Remove retaining nuts (**arrows**) from intake camshaft sprocket.

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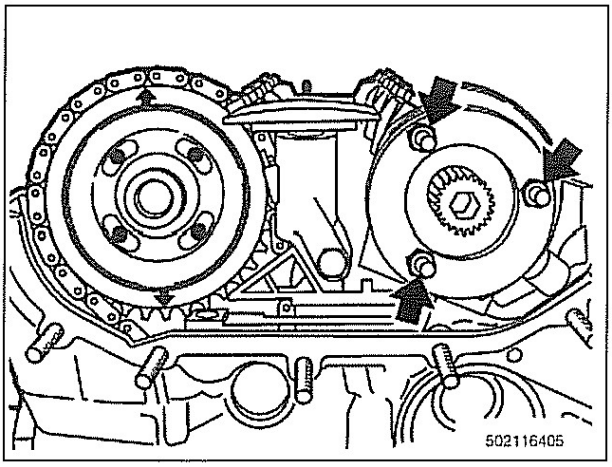


- Remove outer thrust washer, spring plate, and inner thrust washer.



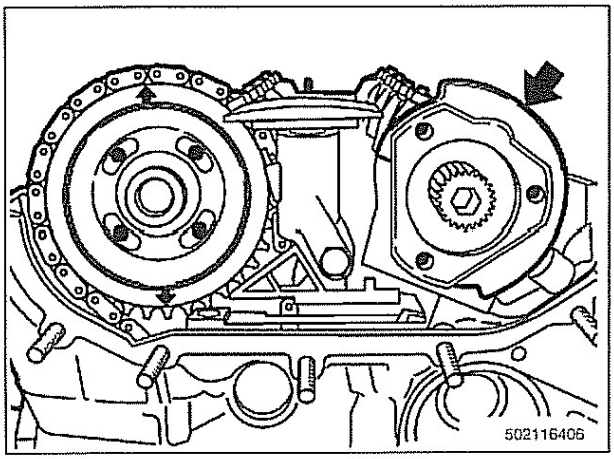
- Remove both camshaft sprockets with secondary timing chain.

NOTE —
Keep chain and sprockets together as an assembly for easier installation.

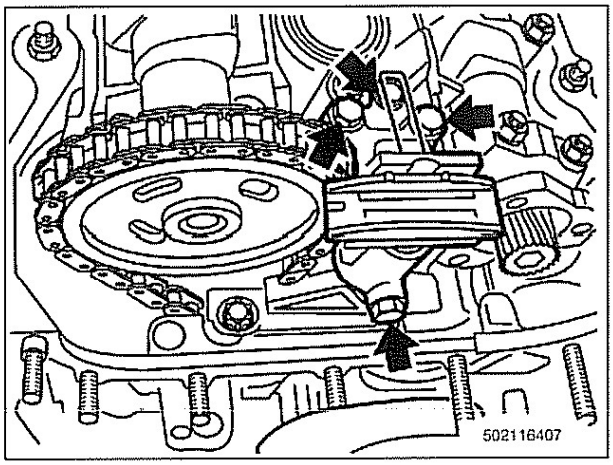


- Remove thrust washer studs (**arrows**) and remove thrust washer.

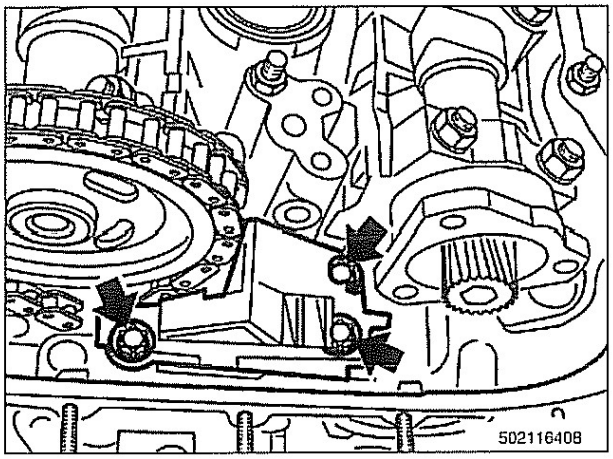
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- Remove sensor gear (**arrow**).

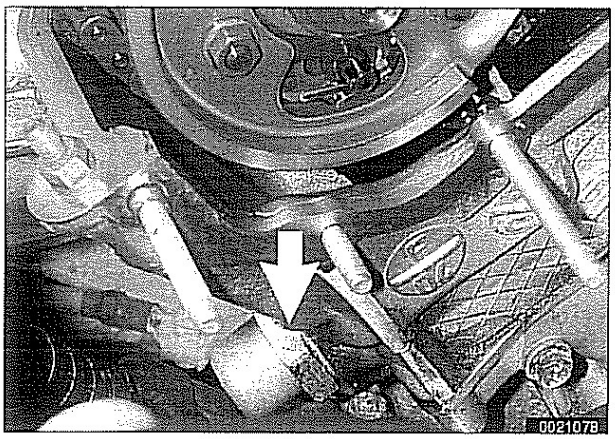


- Remove secondary timing chain tensioner retaining bolts (**arrows**) and remove tensioner.



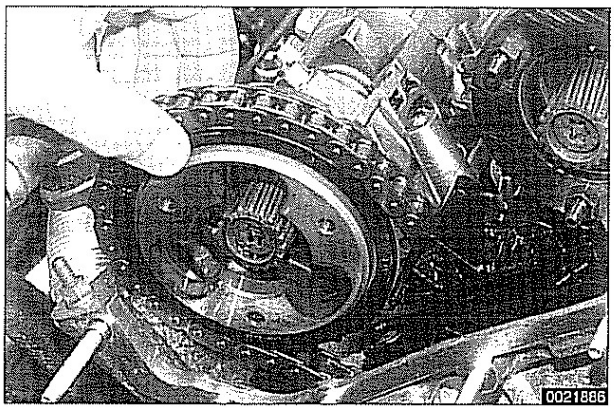
- Remove timing chain guide retaining bolts (**arrows**) and remove guide.

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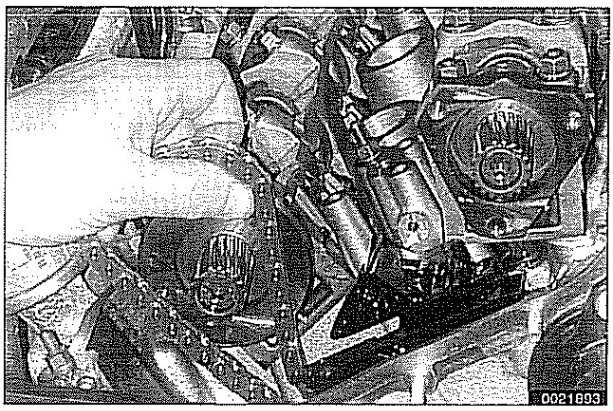
➢ Remove primary timing chain tensioner plug (**arrow**) and primary tensioner.

> ***CAUTION—***
> *Primary timing chain tensioner is under spring pressure.*



➢ Remove primary timing chain sprocket and timing chain from exhaust camshaft.

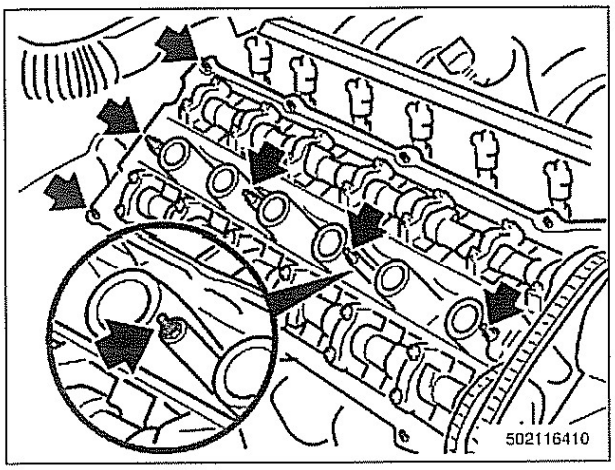
– Remove crankshaft locking tool (BMW 11 2 300) from flywheel (installed during VANOS removal).



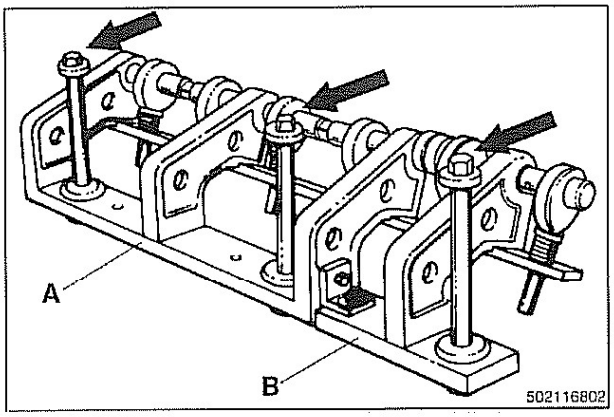
➢ Lift timing chain (holding under tension) and rotate engine counterclockwise 30° from TDC.

- Suspend timing chain with mechanic's wire.

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➢ Remove cylinder head cover retaining studs (**arrows**) from center and rear of cylinder head.

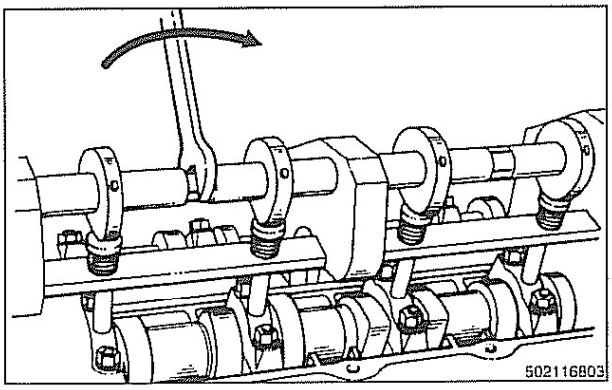


➢ Remove spark plugs and install BMW special tool 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head. Tighten tool retaining bolts in spark plug bores. Do not overtighten bolts.

Tightening torque	
BMW special tool 11 3 260 / 11 3 270 to cylinder head	23 Nm (17 ft-lb)

– Remove intake camshaft bearing cap for cylinder number 1.

CAUTION—
Intake camshaft bearing cap 1 is centered with adapter sleeves. To avoid camshaft damage, it must be removed before any other caps.



➢ Turn eccentric shaft on special tool until pressure is applied to camshaft bearing caps.

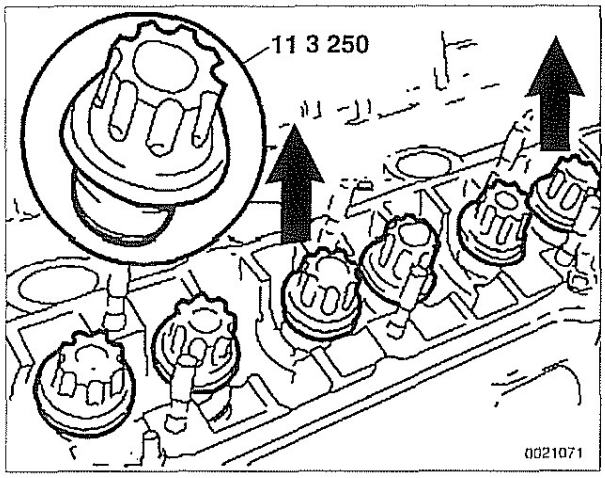
– Remove remaining bearing cap mounting nuts.

– Slowly release pressure on camshaft bearing caps by turning eccentric shaft. Remove bearing caps and camshaft. Repeat procedure on remaining camshaft.

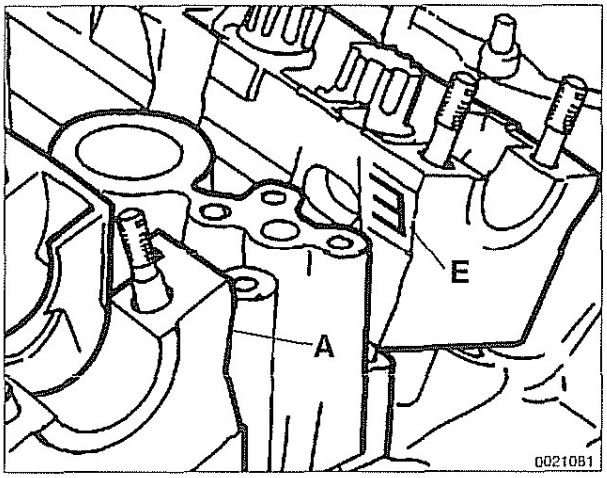
CAUTION—
Camshaft bearing caps must be reinstalled in their original locations.

NOTE—
- *The camshaft bearing caps are coded with a letter and a number. For example, "A1" is the first exhaust camshaft bearing cap at the front of the engine, and "E1" is the intake camshaft bearing cap at the front of the engine.*
- *The camshafts are stamped with a code letter - "E" for the intake side and "A" for the exhaust side.*
- *"E" is for Einlaβ, (German for intake) and "A" is for Auspuff, (German for exhaust).*

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- Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool.



- Remove camshaft bearing carrier from cylinder head.

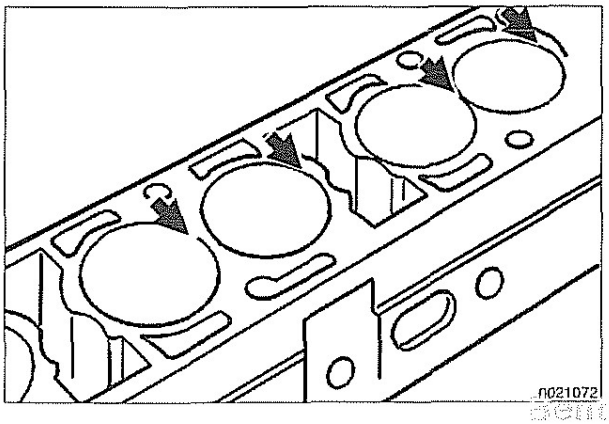
CAUTION—
Camshaft bearing carriers must be reinstalled in their original locations (E for intake and A for exhaust).

NOTE—
- *Do not let hydraulic lifters fall out as the camshaft carrier is removed.*
- *Hydraulic lifters should be stored in an upright position.*
- *Used hydraulic lifters must be replaced into original lifter bores.*

Camshafts and lifters, installing (M52 Engine)

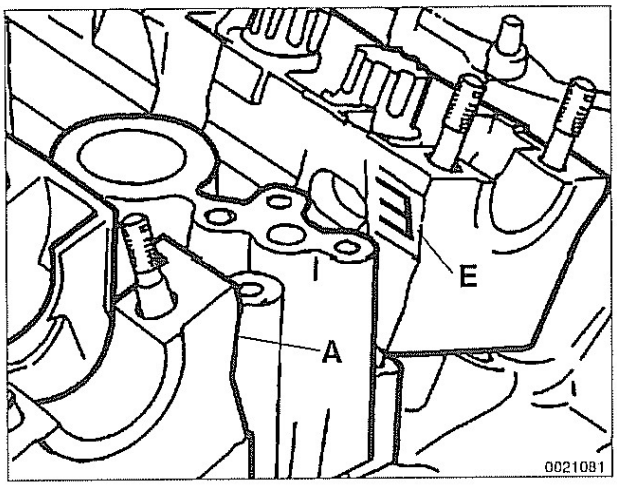
Lubricate camshafts, camshaft carriers, bearing caps, hydraulic lifters, friction washers, splined shafts and spline hubs with assembly lubricant before installation.

CAUTION—
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the camshafts into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

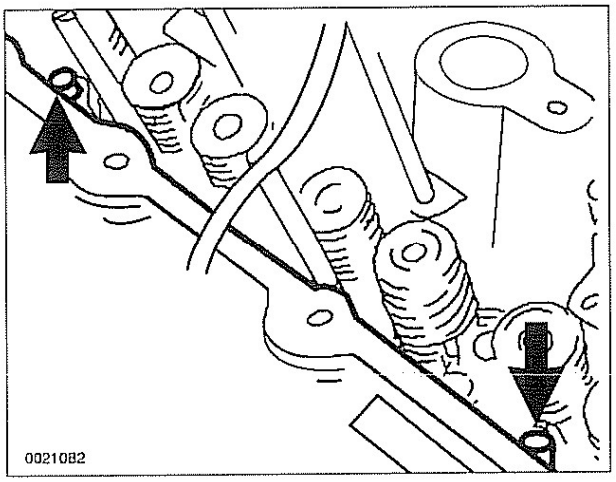


- Before installing camshaft carriers, examine bearing bores (**arrows**) on hydraulic lifter bores for signs of wear.

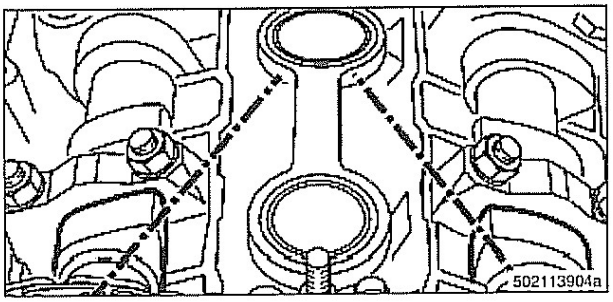
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- Install camshaft carriers with hydraulic lifters into cylinder head. Note marks on carriers: (**E**) for intake side and (**A**) for exhaust side.



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



- Install camshafts with number 1 cylinder camshaft lobes facing each other (**arrows**).

CAUTION—
A minimum waiting time is required for the hydraulic lifters to "bleed down" after installing the camshafts into the cylinder head, before bringing the pistons to TDC. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.

Camshaft installation waiting times

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

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– Remainder of installation is reverse of removal, noting the following:
  - See **117 Camshaft Timing Chain** for VANOS control unit installation.

Tightening torques

Camshaft bearing caps to cylinder head (M7)	15 Nm (11 ft-lb)
Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)
Spark plugs (M12)	23 Nm (17 ft-lb)

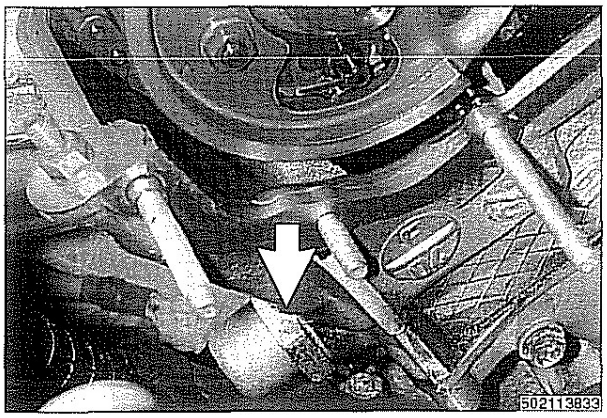
Camshaft and lifter, removal and installation (M52 TU and M54 engine)

Camshafts and lifters, removing (M52 TU and M54 engine)

WARNING—
Allow engine to cool before beginning this procedure.

– Disconnect negative (–) cable from battery.

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

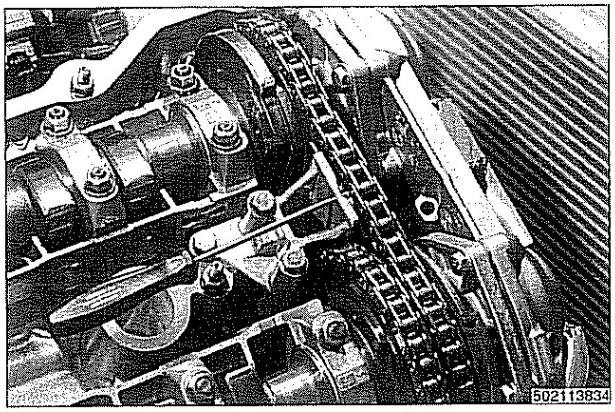


– Remove VANOS control unit. See **117 Camshaft Timing Chain.**

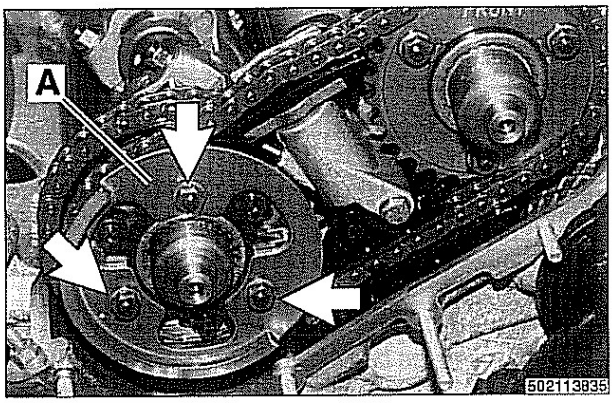
◀ Remove primary timing chain tensioner (**arrow**).

CAUTION—
Primary timing chain tensioner is under spring pressure.

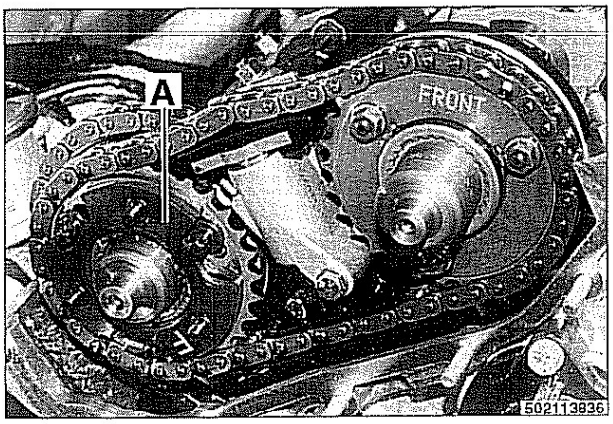
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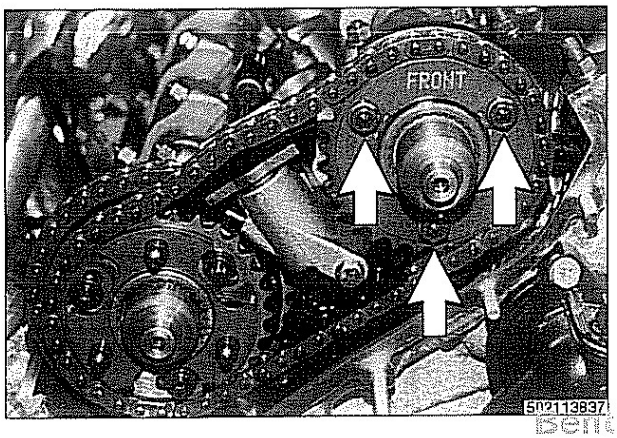
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292, or a thin drift or pin.



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

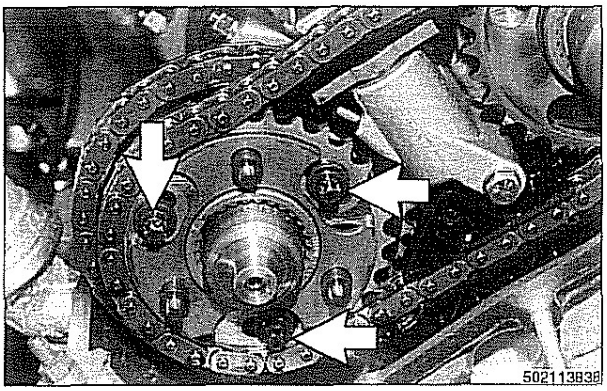


- Remove spring plate (**A**).

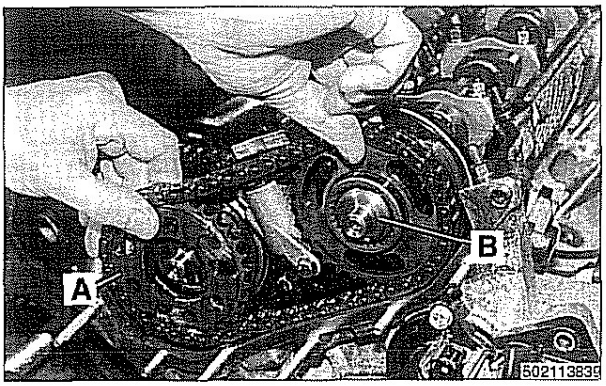


- Remove intake camshaft sprocket mounting nuts (**arrows**) and remove spring plate (labelled **FRONT**).

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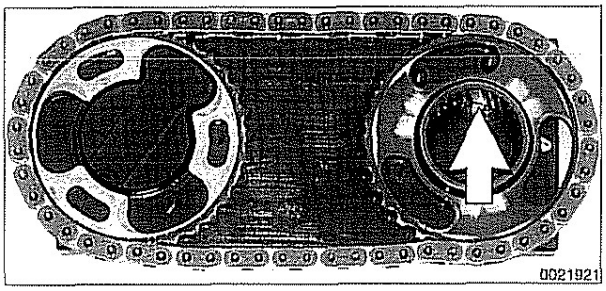


- Remove torx screws from exhaust camshaft sprocket (**arrows**).

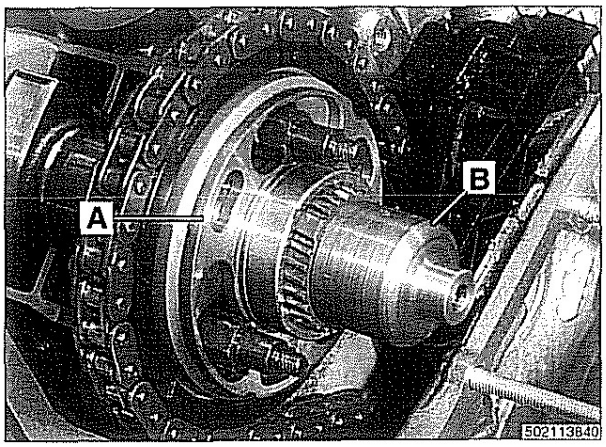


- Lift off exhaust and intake sprockets together with secondary chain, thrust spacer (**A**) from exhaust camshaft, and splined shaft (**B**) from intake camshaft.

> ***CAUTION—***
> *Splined shafts share the same part number for both intake and exhaust camshafts. Used splined shafts must be reinstalled in their original locations.*

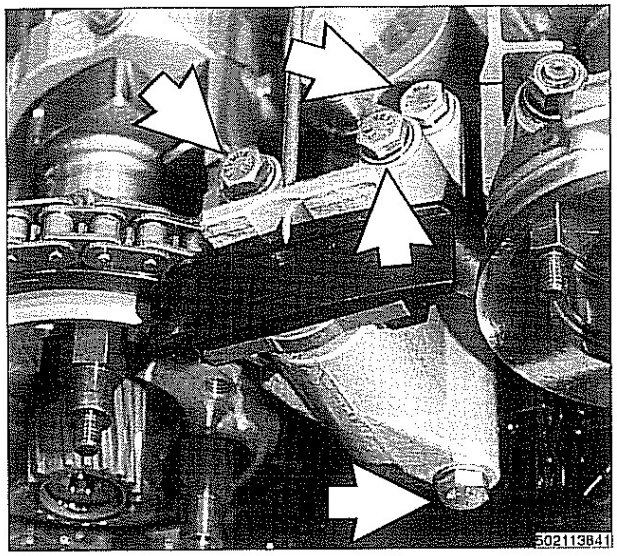


- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown.

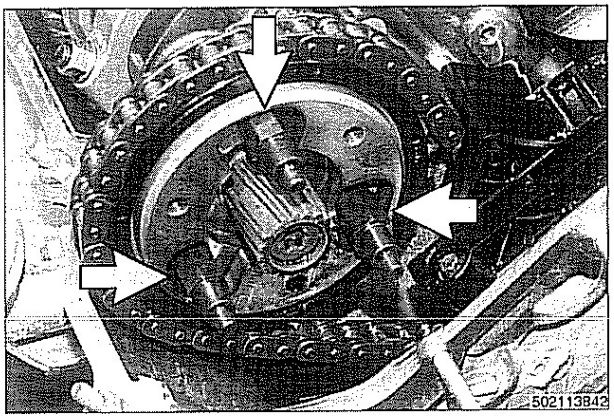


- Remove exhaust camshaft splined sleeve (**A**) and shaft (**B**).

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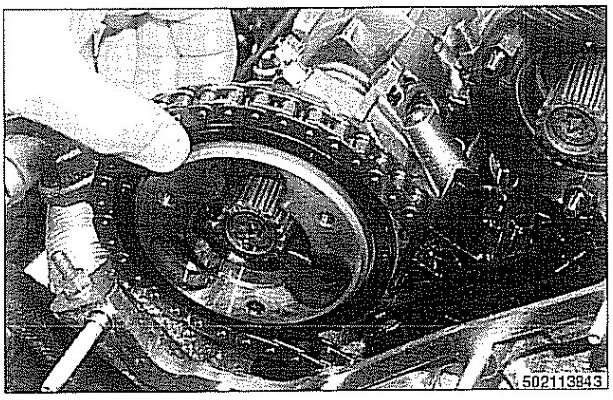


- Remove secondary chain tensioner mounting bolts (**arrows**) and remove tensioner with locking tool in place.



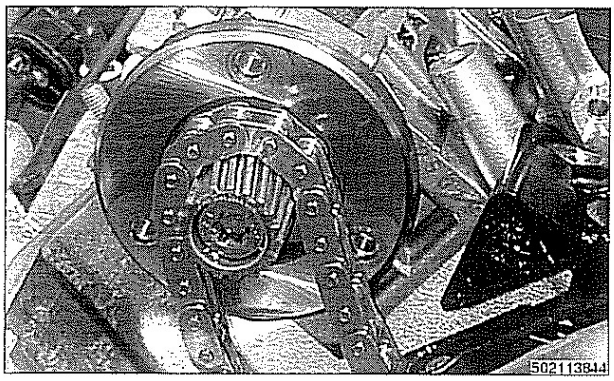
- Remove primary chain sprocket mounting studs (**arrows**) on exhaust camshaft.

NOTE—
Counterhold camshafts when loosening.

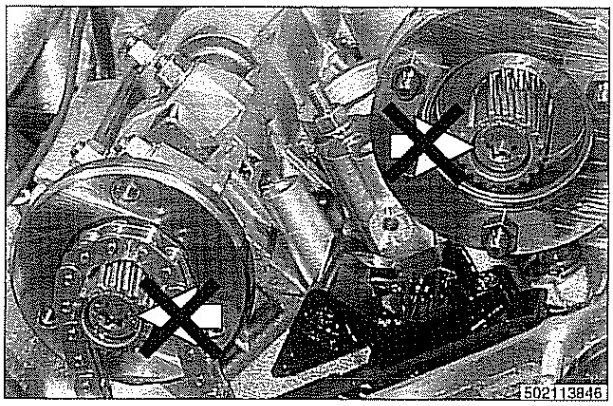


- Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.

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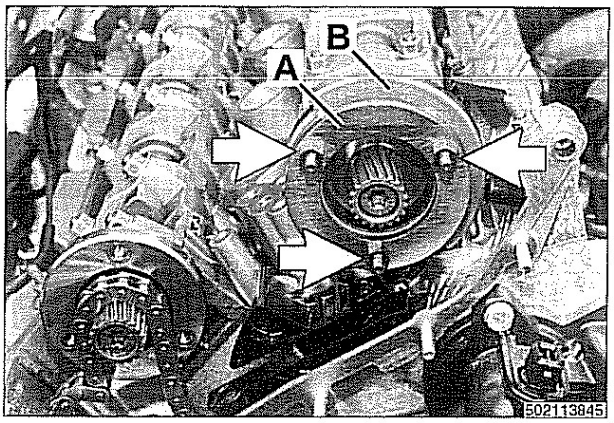


- Place timing chain on end of exhaust camshaft.

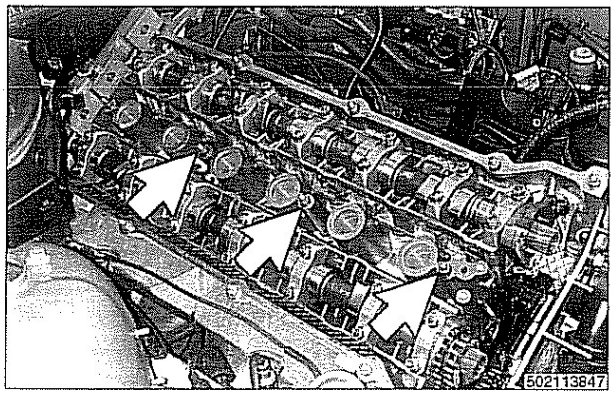


- Do not remove end spline retaining screws from camshafts (**arrows**).

> ***CAUTION—***
> *The end spline retaining screws precisely locate the end splines to the camshafts. Do not loosen these screws.*



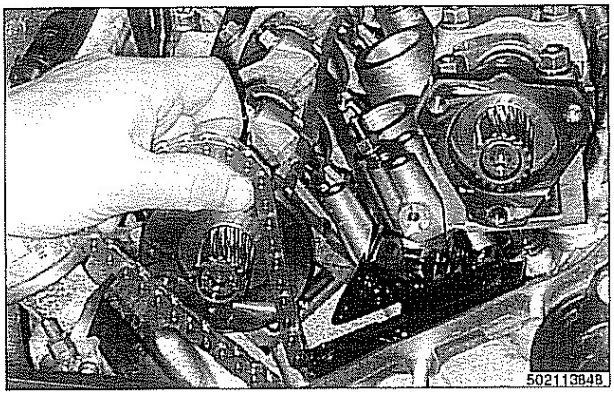
- Remove locating studs (**arrows**) from intake camshaft. Lift off intake camshaft thrust spacer (**A**) and impulse wheel (**B**).



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

– Remove crankshaft locking tool (BMW special tool 11 2 300) from crankcase.

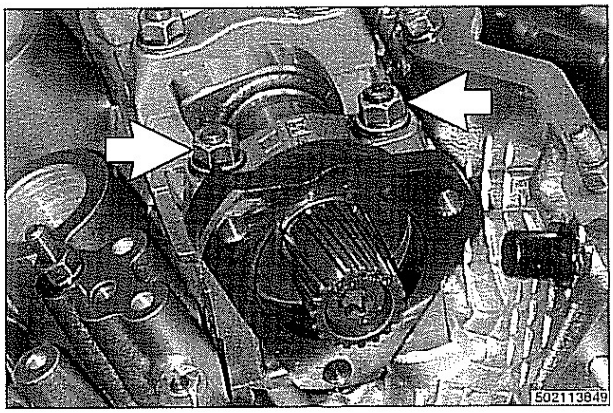
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➢ Lift primary chain and hold under tension, rotate engine against direction of rotation (counterclockwise) approximately 30°.

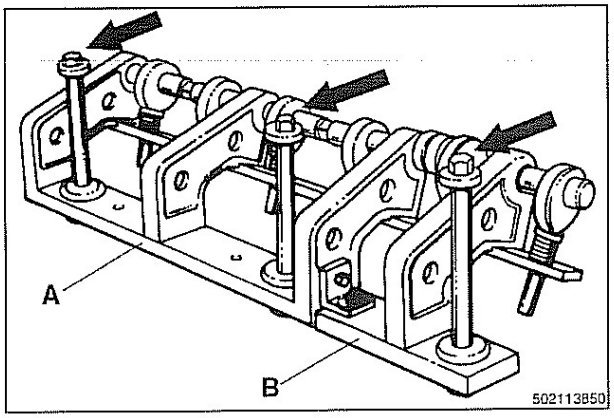
CAUTION—
To prevent damaging valves while working on camshafts, no pistons should be in the TDC position.

– Remove BMW special tool set 11 3 240 from rear of cylinder head.



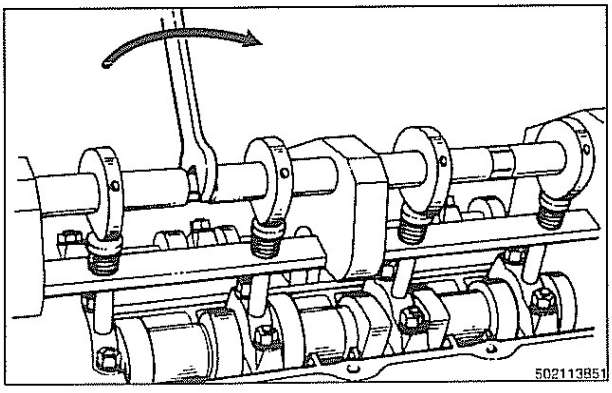
➢ Remove retaining nuts (**arrows**) and bearing cap 1 of intake camshaft.

CAUTION—
Intake camshaft bearing cap 1 is centered with adapter sleeves. To avoid camshaft damage, it must be removed before any other caps.



➢ Fit BMW special tools 11 3 260 (**A**) and 11 3 270 (**B**) to cylinder head and screw long bolts (**arrows**) into spark plug threads. Tensioners will align with the bearing caps on the intake camshaft.

CAUTION—
Do not over torque bolts into spark plug holes.

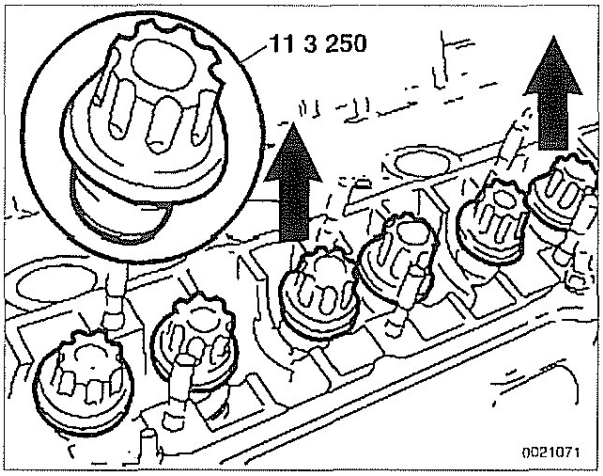


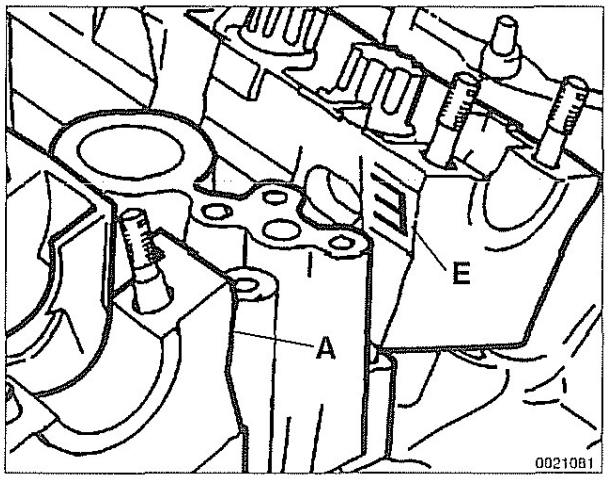
➢ Turn eccentric shaft of special tool to pretension intake camshaft bearing caps. Remove nuts on remaining bearing caps.

– Slowly release tension on eccentric shaft and remove BMW special tools. Remove bearing caps and set aside in order. Remove camshaft and store safely.

CAUTION—
Camshaft bearing caps must be installed in their original locations.

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NOTE—

- *The camshaft bearing caps are coded with a letter and a number. For example, "A1" is the first exhaust camshaft bearing cap at the front of the engine, and "E1" is the intake camshaft bearing cap at the front of the engine.*
- *The camshafts are stamped with a code letter - "E" for the intake side and "A" for the exhaust side.*
- *"E" is for Einlaβ, (German for intake) and "A" is for Auspuff, (German for exhaust).*

– Repeat procedure for exhaust camshaft.

➢ Secure hydraulic lifters in lifter bores using BMW special tool 11 3 250, or remove lifters using a magnetic pick-up tool.

CAUTION—
Used hydraulic lifters must be reinstalled in original lifter bores.

➢ Remove lower camshaft bearing carriers from cylinder head.

CAUTION—
Camshaft bearing carriers must be reinstalled in their original locations (E for intake and A for exhaust).

NOTE—

- *Do not allow hydraulic lifters to fall out of camshaft carriers.*
- *Hydraulic lifters should be stored in an upright position.*

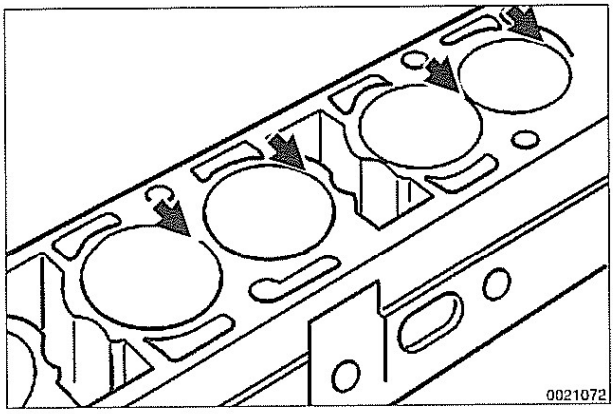
Camshafts and lifters, installing (M52TU and M54 engine)

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

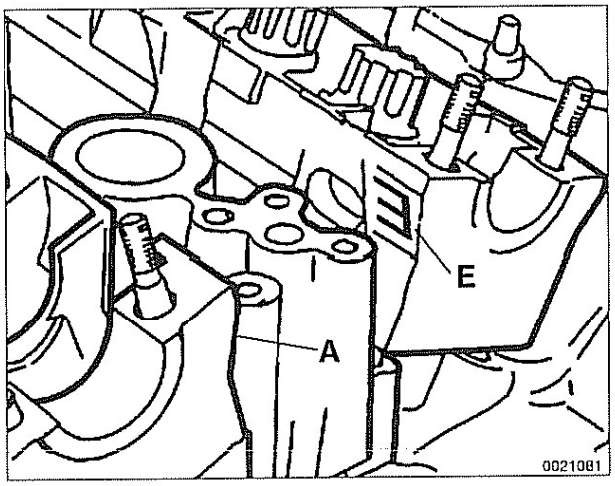
CAUTION—
Make sure the crankshaft, which had been rotated approximately 30° opposite the direction of engine rotation from TDC, is still in that position before lowering the camshafts into position. All pistons must be out of TDC position to prevent valve/piston interference when the camshafts are installed.

– Lift timing chain and place exhaust cam onto exhaust camshaft carriers. Place intake camshaft on camshaft carrier.

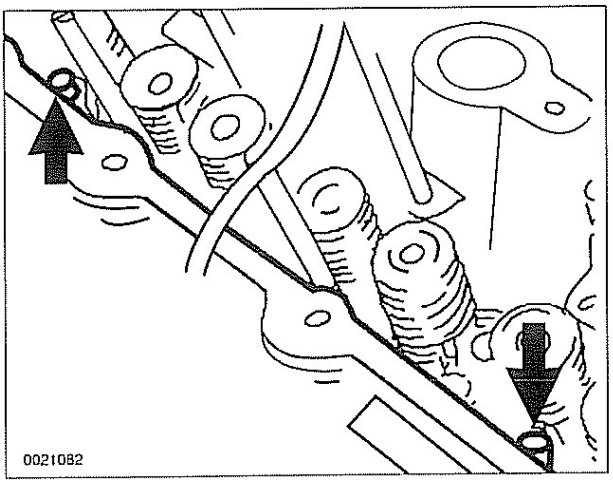
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- Before installing camshaft carriers, examine bearing bores (**arrows**) on hydraulic lifter bores for signs of wear.

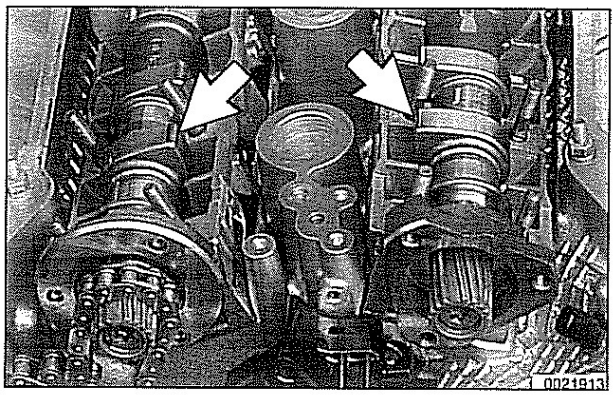


- Install camshaft carriers with hydraulic lifters into cylinder head. Note marks on carriers: (**E**) for intake side and (**A**) for exhaust side.



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

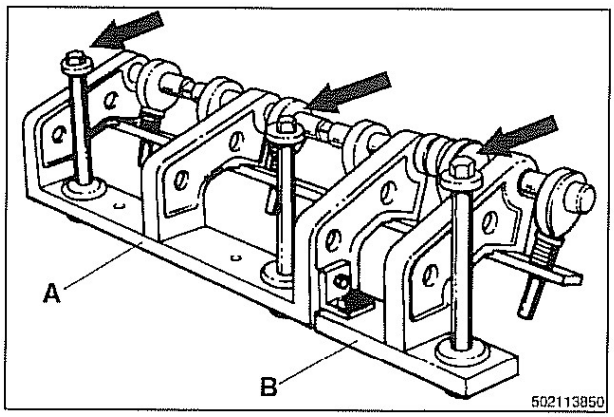
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➢ Rotate camshafts so that intake and exhaust lobes for cylinder 1 face each other (**arrows**).

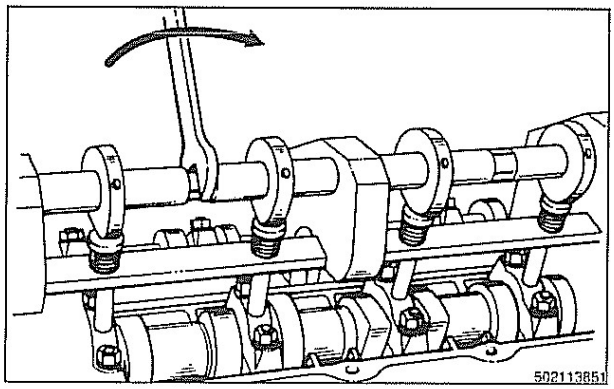
> ***CAUTION—***
> *A minimum waiting time is required for the hydraulic lifters to "bleed down" after installing the camshafts into the cylinder head, before bringing the piston to TDC. When the camshafts are removed, the hydraulic lifters can expand. This expansion can cause increased valve lift when the camshafts are bolted down, possibly resulting in piston interference.*

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



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

> ***CAUTION—***
> *Do not overtighten bolts into spark plug holes.*



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

Tightening torque	
Camshaft bearing cap to cylinder head (M7)	14 Nm (10 ft-lb)

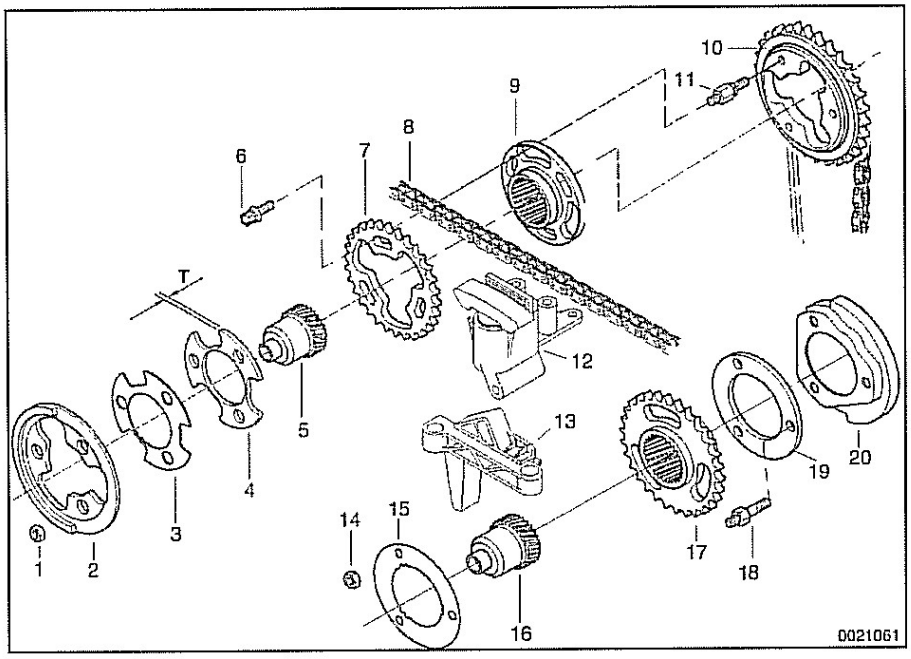
– Release tension on eccentric shaft and remove BMW special tools 11 3 260/270.

– Repeat procedure for exhaust camshaft.

NOTE—
Observe waiting time for lifter bleed down before continuing with camshaft installation.

Crankshaft / valve timing waiting times	
68° F (20° C) and higher	5 minutes
50 – 68° F (10 – 20° C)	15 minutes
32 – 50° F (0 – 10° C)	30 minutes

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Double VANOS timing chain components

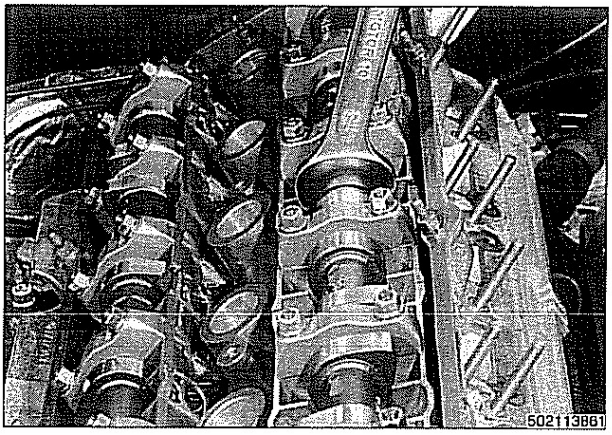
1. Impulse wheel mounting nut
2. Exhaust camshaft impulse wheel
3. Spring plate, exhaust
4. Thrust spacer (T = 3.5 mm)
5. Splined shaft
6. Torx screw
7. Exhaust camshaft secondary sprocket
8. Secondary timing chain
9. Splined sleeve
10. Primary sprocket
11. Threaded stud
12. Secondary chain tensioner
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

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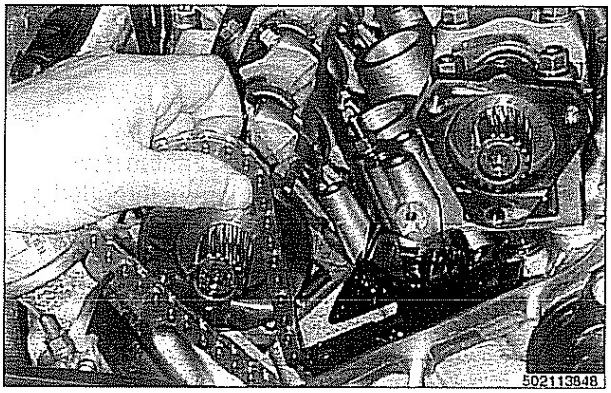
Double VANOS secondary timing chain components, installing (M52 TU, M54 engine)



- Secure camshafts in TDC position using BMW special tool set 11 3 240.

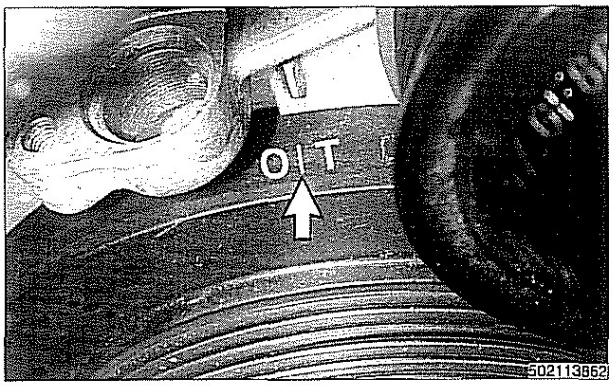


- If necessary, turn camshaft so that special tools are squarely seated on cylinder head.

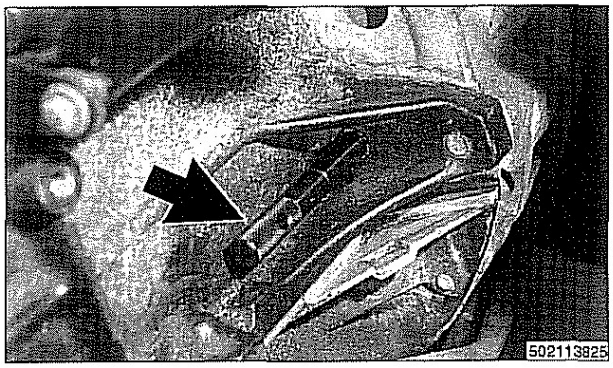


- Lift timing chain and hold under tension.

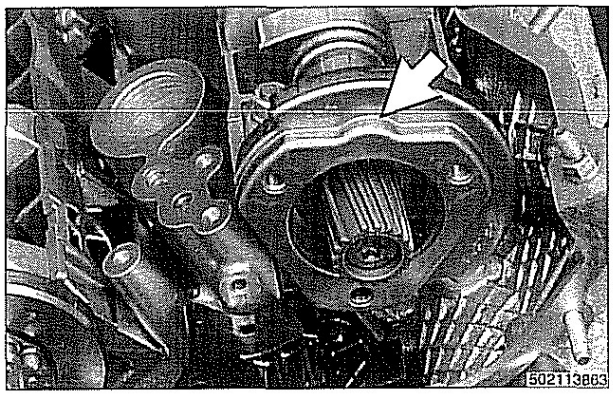
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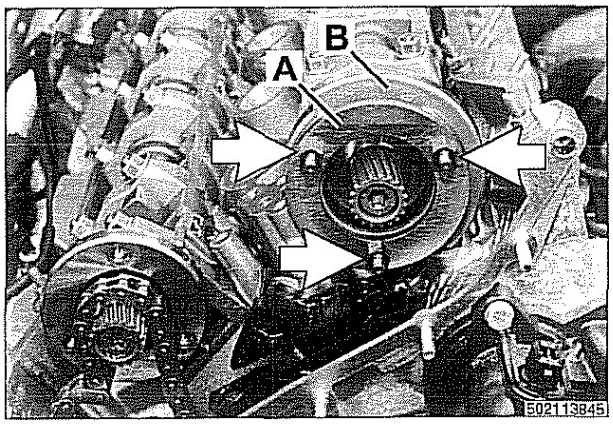
- While maintaining tension on timing chain, rotate crankshaft at vibration dampener from 30° before TDC in direction of rotation (clockwise) until number 1 cylinder is at TDC position with line between the **OIT** mark (**arrow**) on front pulley aligned with boss on lower timing chain cover.



- 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**).

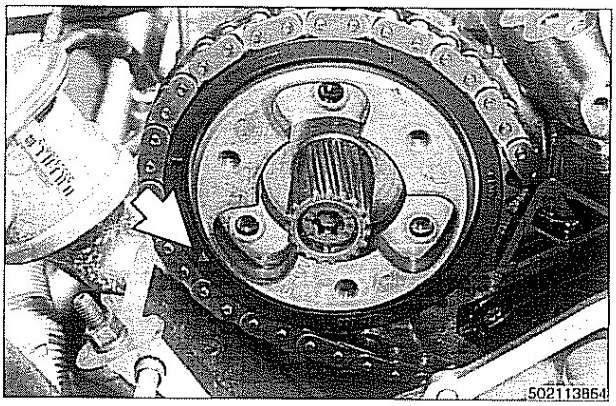


- Fit thrust spacer (**A**) to intake camshaft and tighten down with threaded locating studs (**arrows**). Place longer threaded portion of studs into camshaft.

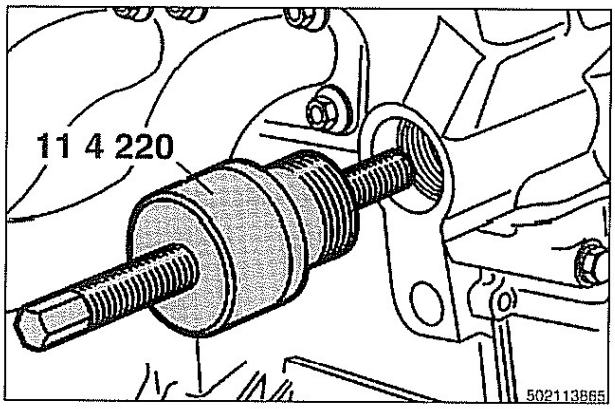
Tightening torque

Impulse wheel studs to intake camshaft (M7)	20 Nm (15 ft-lb)

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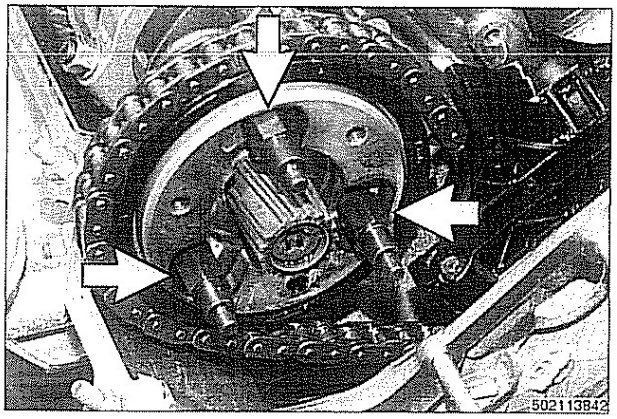
- Install primary timing chain on timing chain sprocket and place on exhaust camshaft so that pointer on sprocket (**arrow**) lines up with cylinder head sealing surface.



- Insert BMW special tool 11 4 220 into timing chain 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 primary chain tensioner and simulates the function of the tensioner.

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

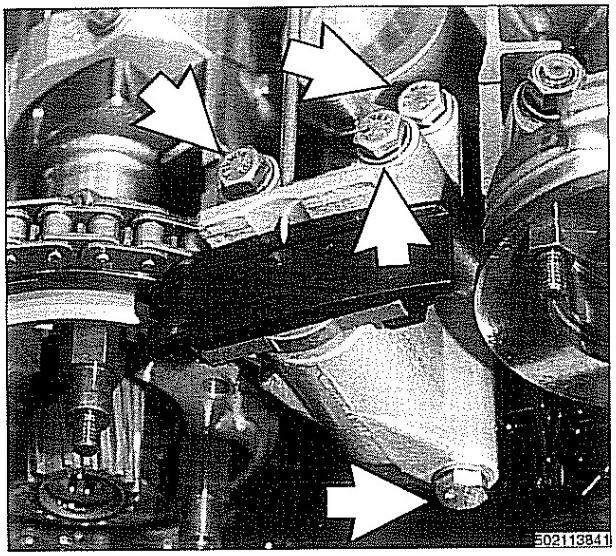


- Insert and tighten threaded locating studs (**arrows**) in exhaust camshaft.

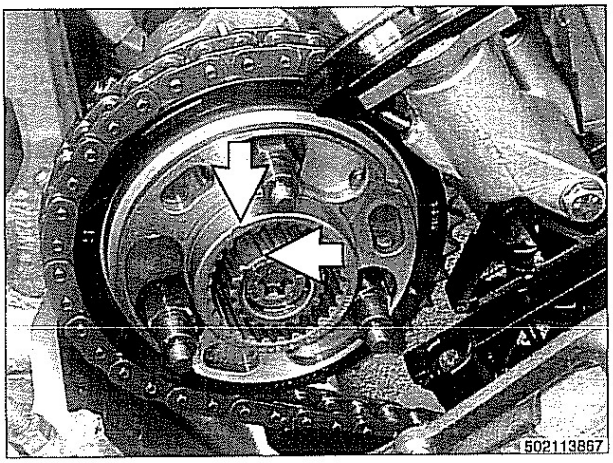
Tightening torques

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

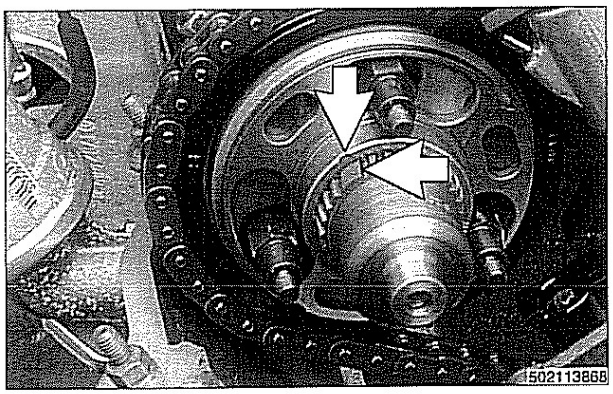
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- Install secondary chain tensioner (**arrows**). Keep tensioner compressed using BMW special tool 11 3 292 or suitable pin.



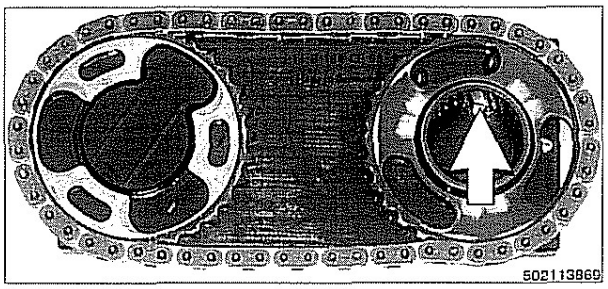
- Fit exhaust camshaft splined sleeve. Confirm that gap in sleeve splines aligns with corresponding gap in camshaft splines (**arrows**).



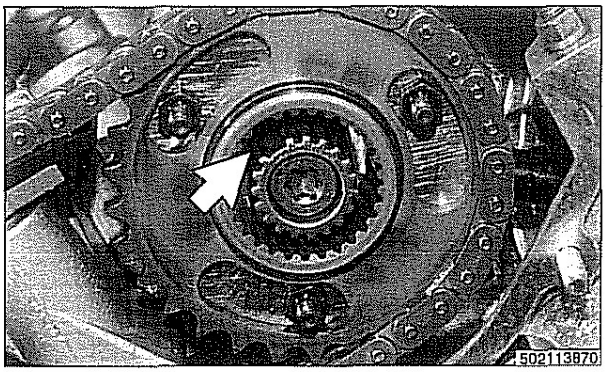
- Slide splined shaft onto exhaust camshaft so that locating tooth of shaft fits into spline gaps of camshaft and splined sleeve (**arrows**).

– Push splined shaft in further to rotate splined sleeve until the three threaded holes in primary chain sprocket are centered in the small slots of the splined sleeve.

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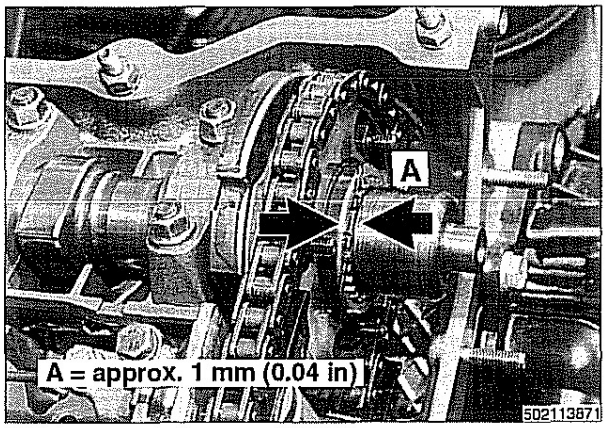


- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.

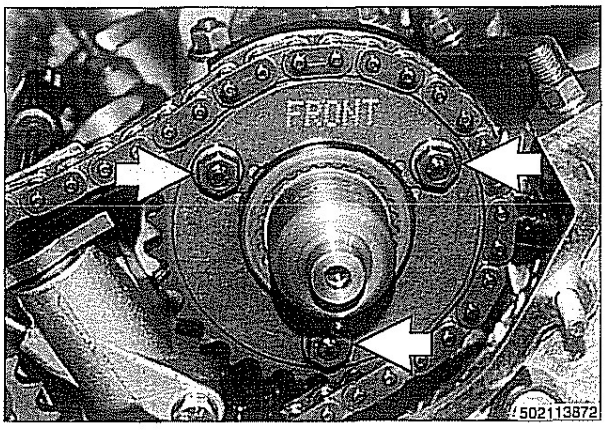


- Remove chain and sprockets from tool and slide sprockets on camshafts. Confirm that gap in intake sprocket splines lines up with corresponding gap in camshaft splines (**arrow**).

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

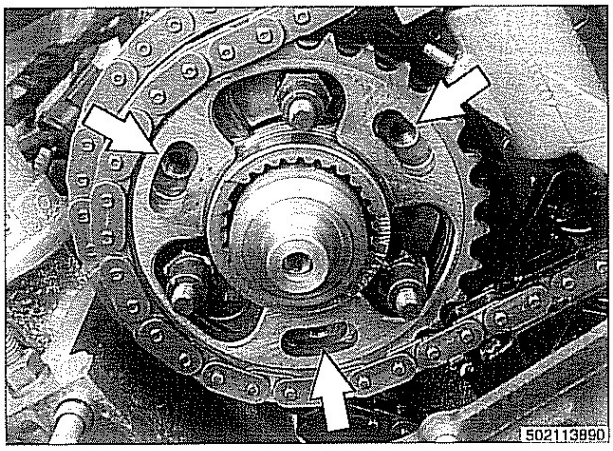


- While aligning locating tooth of shaft with spline gaps on camshaft and sprocket, slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines (**arrows**) are visible.

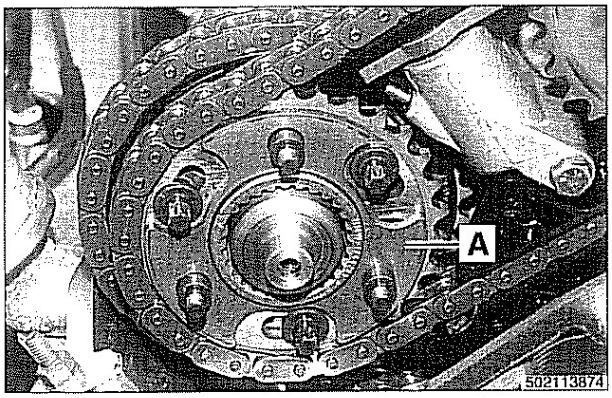


- Install intake camshaft spring plate so that **FRONT** mark is visible. Install mounting nuts (**arrows**) finger tight.

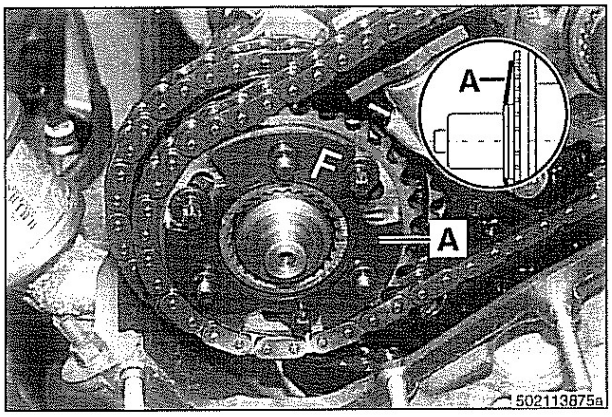
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- Insert sprocket mounting bolts (**arrows**) on exhaust side camshaft assembly.
  - Initially tighten to approx. 5 Nm (44 in-lb) and then back off by half a turn.



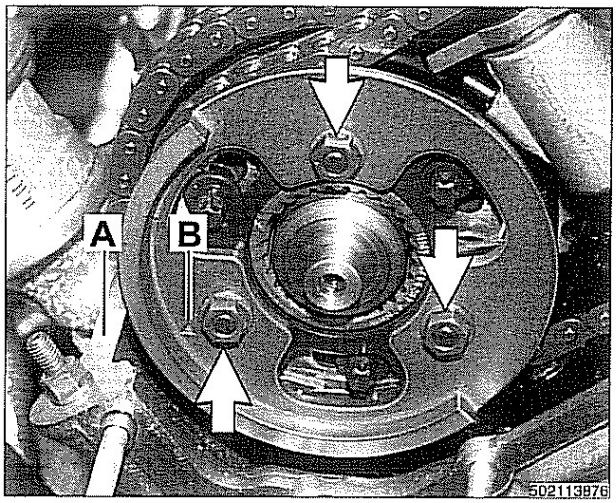
- Fit thrust spacer (**A**) on exhaust camshaft.



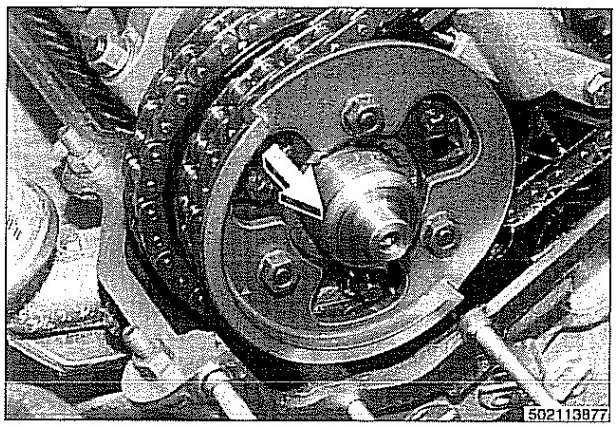
- Install spring plate (**A**) to exhaust camshaft. Make sure that (**F**) mark is visible.

  NOTE—
  *If **F** mark is no longer visible, install spring plate as shown in inset.*

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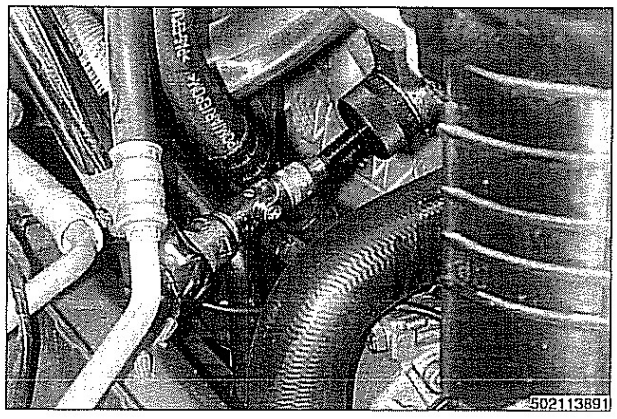


➢ Install exhaust camshaft impulse wheel, aligning pointer (**B**) with top edge of cylinder head (**A**). Install mounting nuts (**arrows**) finger tight.



➢ Pull out exhaust camshaft splined shaft to stop.

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



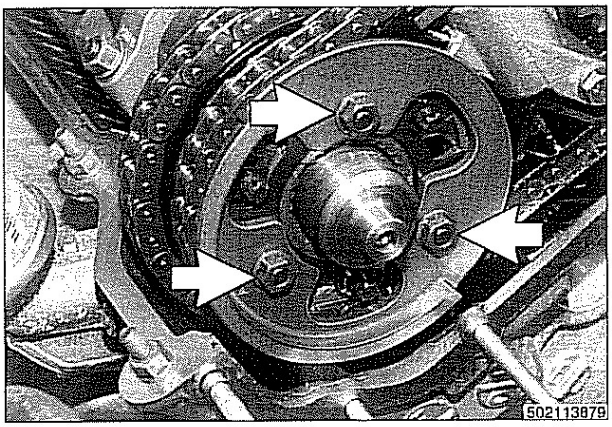
➢ Preload primary chain:

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

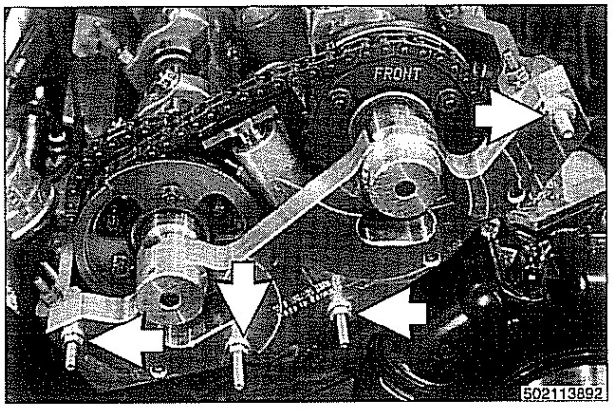
Tightening torque

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

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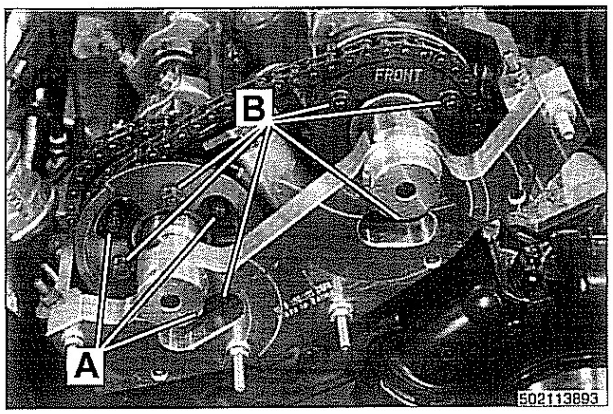


➢ Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



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

CAUTION—
Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.



➢ 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.

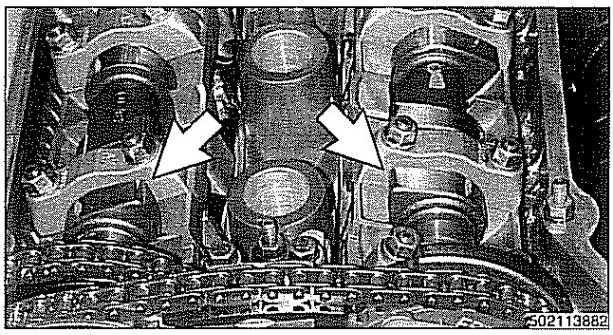
Tightening torques

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

– Remove crankshaft locking tool from crankcase.

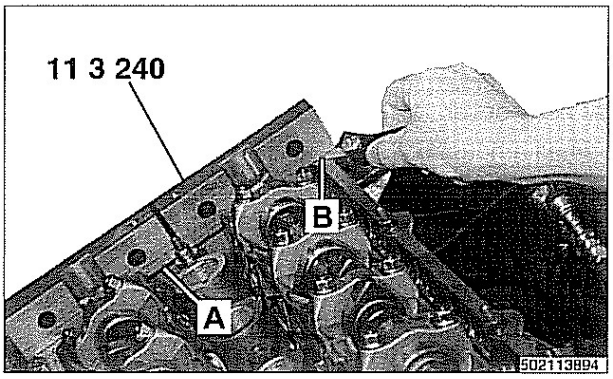
– Remove camshaft locking tools from cylinder head.

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

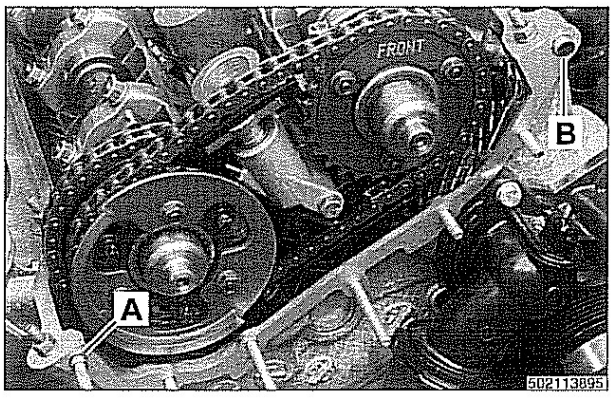
– Lock crankshaft in TDC position with BMW special tool 11 2 300.



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

NOTE—
- *If the exhaust side of the tool (**A**) is not flush with the head, camshaft timing is incorrect. Reset camshaft timing as described in **117 Camshaft Timing Chain**.*
- *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 set 11 3 240 (**B**) may be up to 1 mm (0.04 in.) above the surface of the cylinder head. This is normal. Reassemble engine. Otherwise, reset camshaft timing as described in **117 Camshaft Timing Chain**.*

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



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

> *CAUTION—*
> - *Make sure all gasket material is removed from face of cylinder head. Clean sealing face and keep free of oil.*
> - *Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.*

– Using a new steel gasket, install VANOS unit to front of cylinder head. See **117 Camshaft Timing Chain**.

NOTE—
*If VANOS control unit is being replaced, be sure to check and adjust camshaft timing as described in **117 Camshaft Timing Chain**.*

– Reinstall engine lifting eye.

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

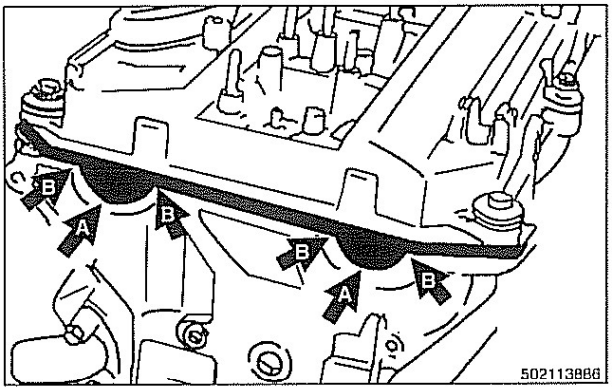
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– Remove adjustable primary timing chain tensioner tool and reinstall primary chain tensioner cylinder to cylinder head.

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

– Remove flywheel locking tool from crankcase. Replace special tool bore sealing plug.

– Remove camshaft locking tools from cylinder head.



➢ Install intake camshaft cover and cylinder head cover.

- Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
- Use a small amount of Three Bond ® 1209 or equivalent sealing compound at corners (**B**) of half-moon cutouts.
- Seat gasket and seal corners at VANOS unit with Three Bond ® 1209.

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

– Installation of the remaining parts is reverse or removal, noting the following:

- Change engine oil and filter as described in **020 Maintenance.**
- Reconnect battery.

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

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

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Camshaft removal and installation (M62 engine)

Camshafts, removing (M62 engine)

Special BMW service tools should always be used to remove and install the camshafts. Removal of the camshafts without the special tools can result in personal injury and /or cylinder head damage.

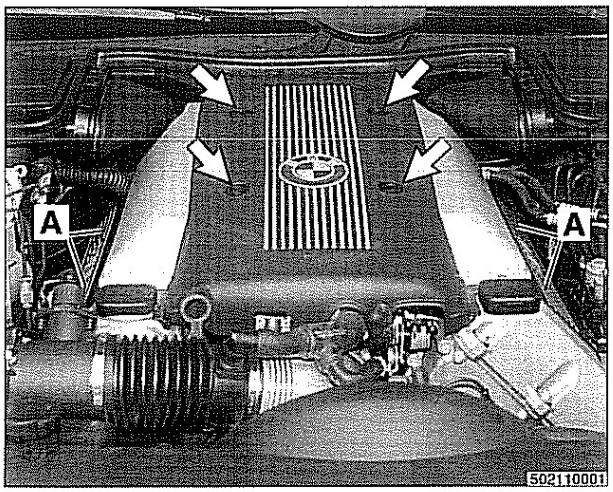
NOTE —
Cylinder bank 1–4 is referred to as the right cylinder bank and is located on the passenger side. Cylinder bank 5–8 is referred to as the left cylinder bank and is located on the driver's side.

> ***WARNING —***
> *Allow engine to cool before beginning this procedure.*

– Disconnect negative (–) cable from battery.

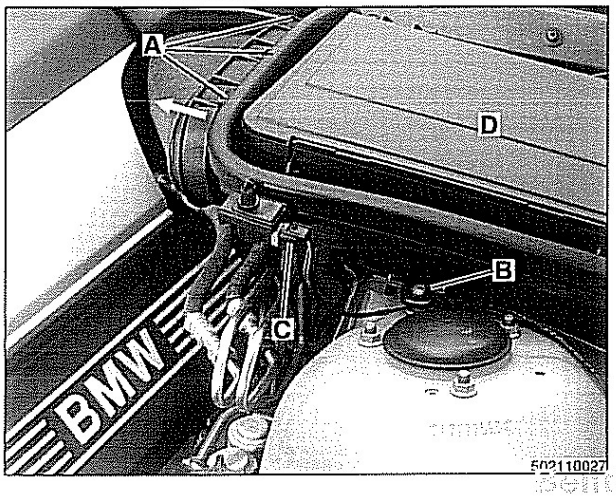
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*

– Drain coolant. See **170 Radiator and Cooling System**.



➢ Remove plastic engine covers:

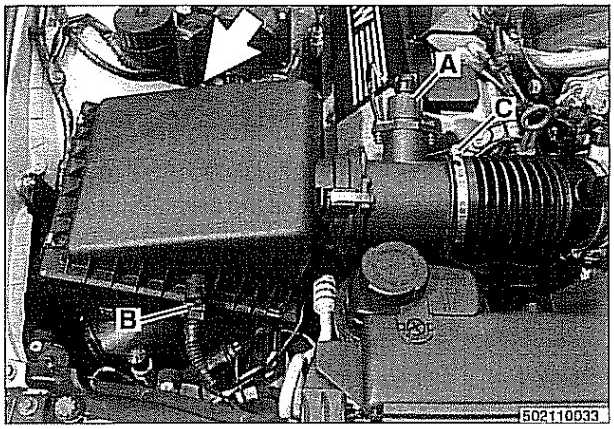
- Press down on locking pins (**arrows**) and remove top cover.
- Pry out trim caps (**A**) from covers.
- Remove fasteners from beneath trim caps and remove side covers.



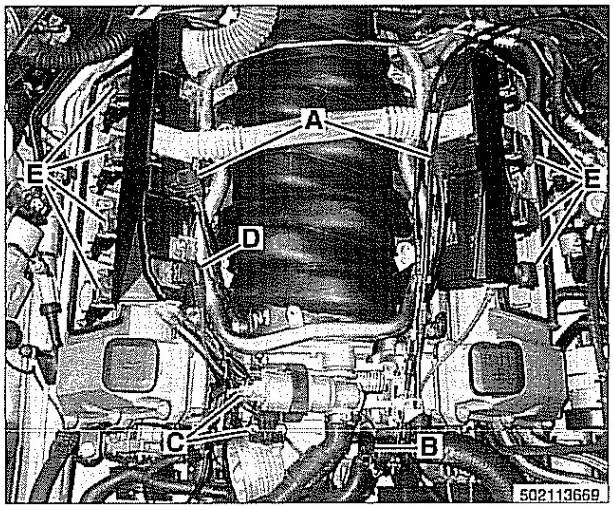
➢ Remove left and right interior ventilation filter housing (left side shown):

- Release locking tabs (**A**) or locking strap (early models, not shown).
- Rotate duct inward (**arrow**) to disconnect.
- Release spring lock (**B**) to unlock ventilation housing.
- Disconnect electrical harness from hood switch (**C**).
- Release locking clip and remove ventilation filter cover (**D**).
- Remove filter housing.
- Removal of right side ventilation duct is similar.

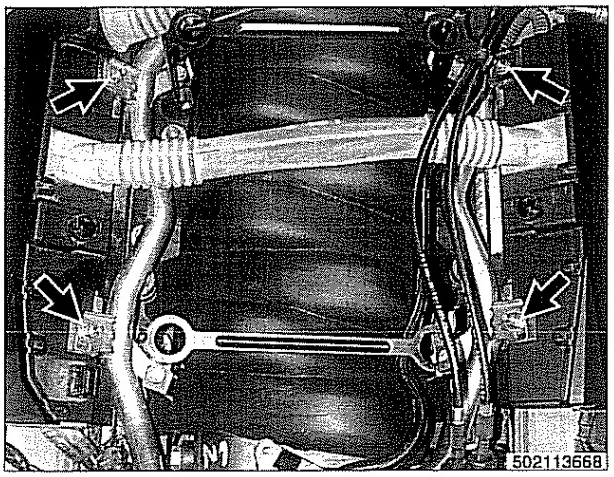
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- Remove air filter housing and ducts:
  - Loosen hose clamps as necessary and disconnect electrical harnesses.
  - Remove air filter housing mounting fastener (**arrow**).
  - Loosen hose clamp at throttle body.
  - Remove air filter housing with mass air flow sensor and duct.

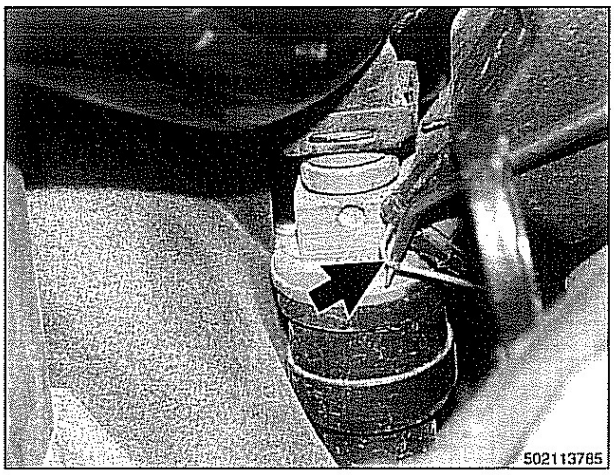


- Disconnect the following electrical harness connectors.
  - Knock sensors (**A**).
  - Thermostat housing (**B**).
  - Throttle position sensor/throttle position switch and idle valve (**C**).
  - Camshaft position sensor (**D**).
  - Ignition coils (**E**).

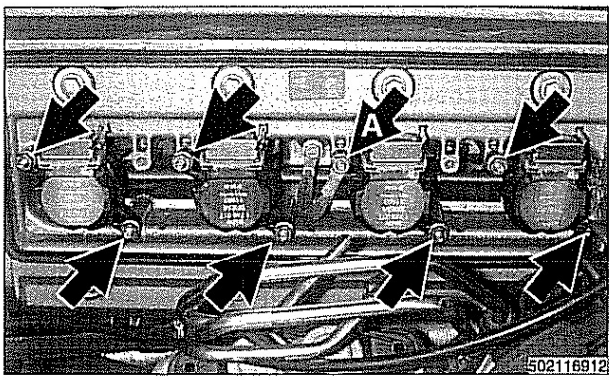


- Remove mounting nuts (**arrows**) from wiring harness ducting.

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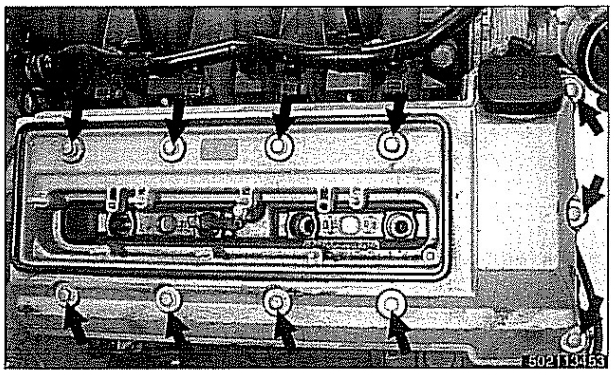
- Disconnect fuel injector electrical connectors from injectors.
  - Pry corner of wire lock clip (**arrow**) on first injector.
  - Repeat for all injectors.
  - Lift wiring ducts off and set aside.



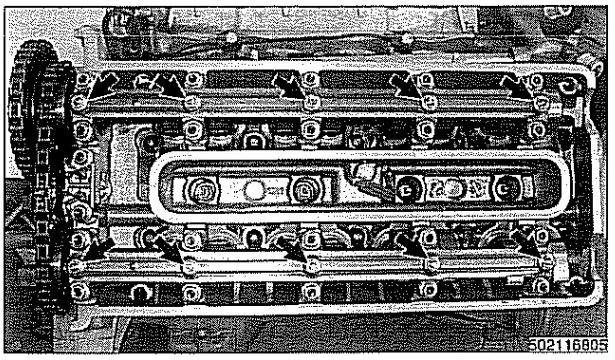
- Remove right and left side ignition coil mounting nuts (**arrows**) and coils.

  NOTE—
  *Make note of location for ground straps (**arrow A**).*

- Remove spark plugs.
- Disconnect positive (+) jumper junction from top of left cylinder head cover.

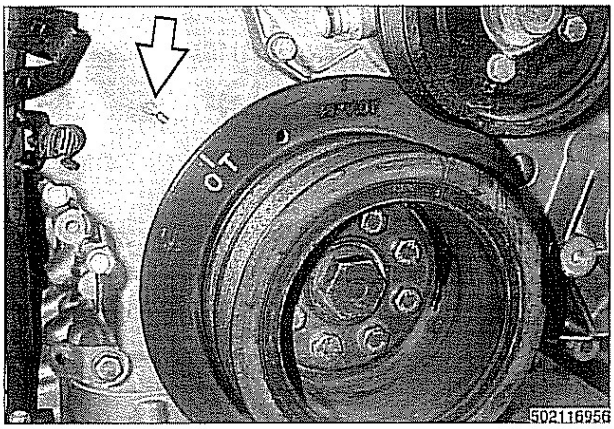


- Remove right and left cylinder head cover cap nuts (**arrows**) and remove covers.
- Remove belt driven cooling fan, see **170 Radiator and Cooling System**.

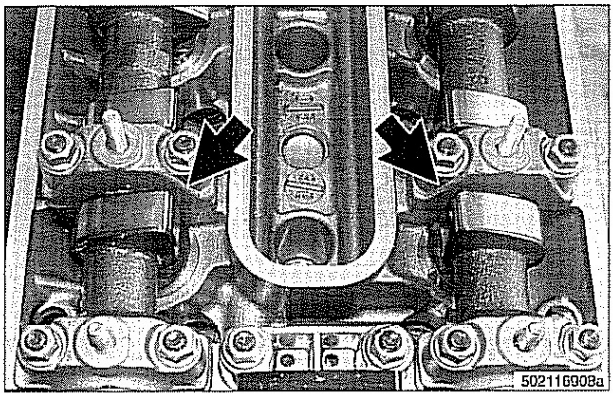


- Remove retaining nuts (**arrows**) and remove oil lines from left and right cylinder heads.

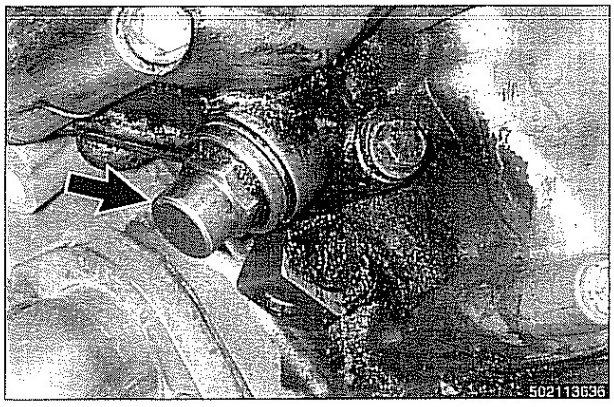
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➢ Using crankshaft center bolt, rotate engine clockwise one complete rotation until the first cylinder is at TDC.



➢ Confirm TDC position. Lobes of camshafts for cylinder head 1–4 (passengers side) should point up (**arrows**).



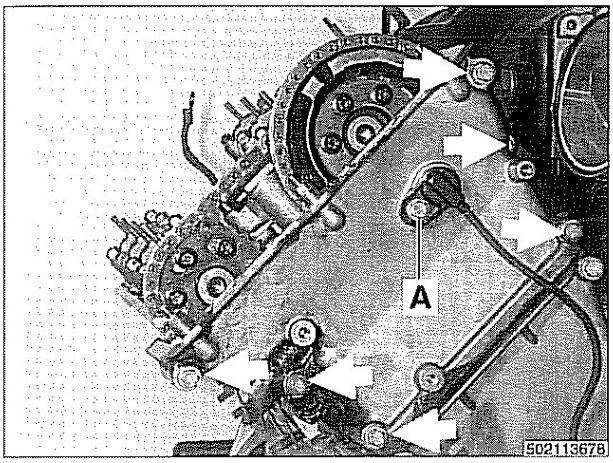
➢ Remove timing chain tensioner (**arrow**) from right side upper timing chain cover.

– Remove secondary air injection pipes in front of upper timing chain covers.

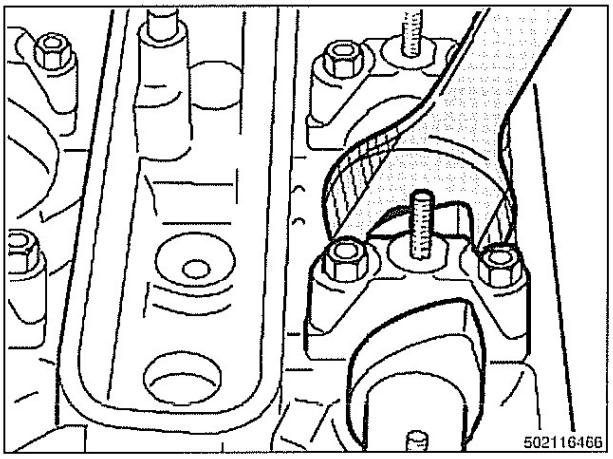
– Remove left and right coolant hoses from coolant pump housing.

– Detach dipstick tube from upper right timing cover.

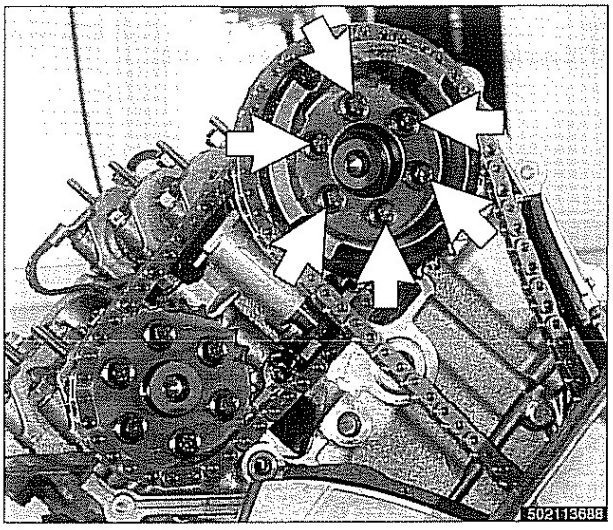
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- Remove camshaft position sensor (**A**) from timing chain cover. Remove bolts (**arrows**) from timing chain covers and remove covers from right and left cylinder heads.

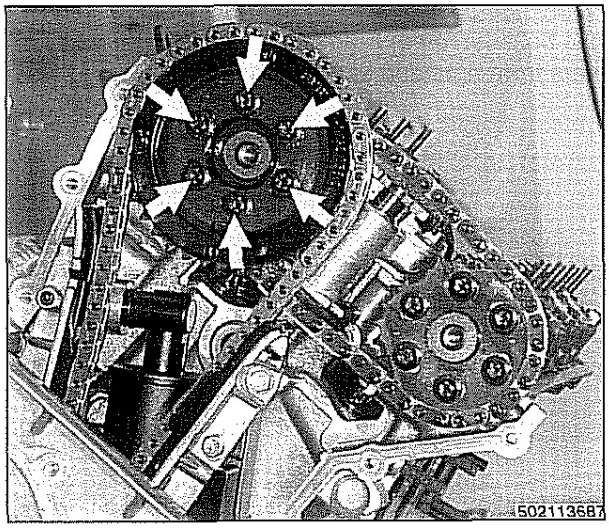


- Counterhold intake camshaft on right cylinder head.

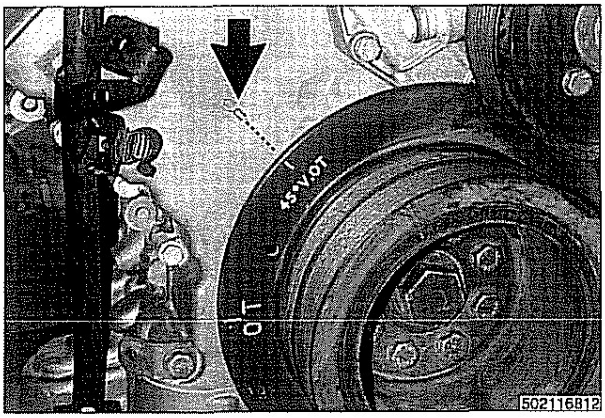


- Counterhold right intake camshaft and remove sprocket mounting bolts (**arrows**) from right cylinder head.
  - Remove camshaft impulse wheel and primary chain sprocket.
  - Slide primary timing chain off sprocket and suspend chain with stiff wire to prevent it from dropping into lower timing chain cover.

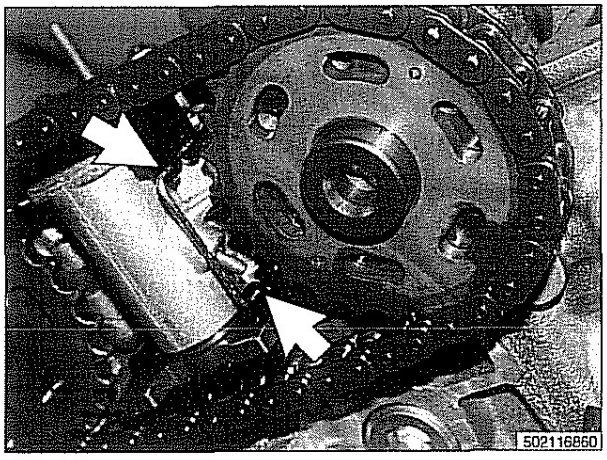
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- Counterhold left intake camshaft and remove sprocket mounting bolts (**arrows**) from left cylinder head.
  - Remove primary chain sprocket.
  - Slide primary timing chain off sprocket and supend timing chain with stiff wire to prevent it from dropping into lower timing chain cover.

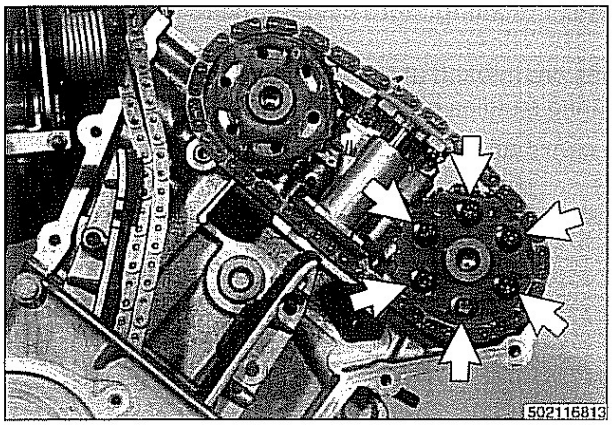


- Using crankshaft center bolt, rotate engine counterclockwise to 45° before TDC position. **45° V.OT** mark on pulley will align with boss cast on engine block (**arrow**).

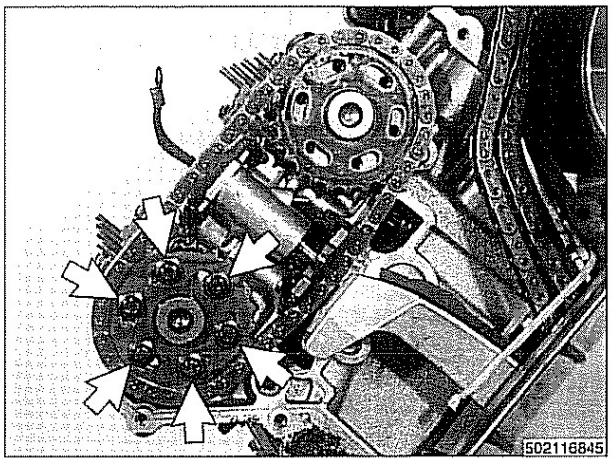


- Compress secondary chain tensioners and lock (**arrows**) using BMW special tool 11 3 310 or a stiff wire.

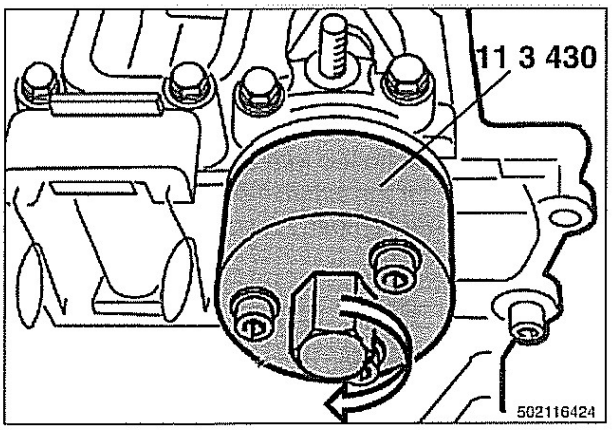
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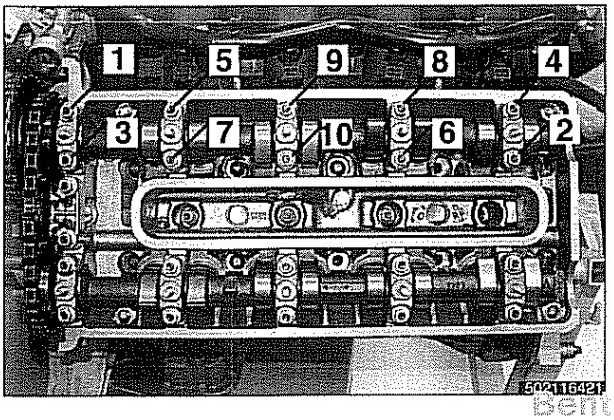
- While counter holding camshaft, remove exhaust camshaft sprocket bolts (**arrows**) from left cylinder head. Remove sprockets with chain.



- While counter holding camshaft, remove exhaust camshaft sprocket bolts (**arrows**) from right cylinder head. Remove sprockets with chain.



- Use BMW special tool 11 3 430 to rotate camshaft into disassembly position.



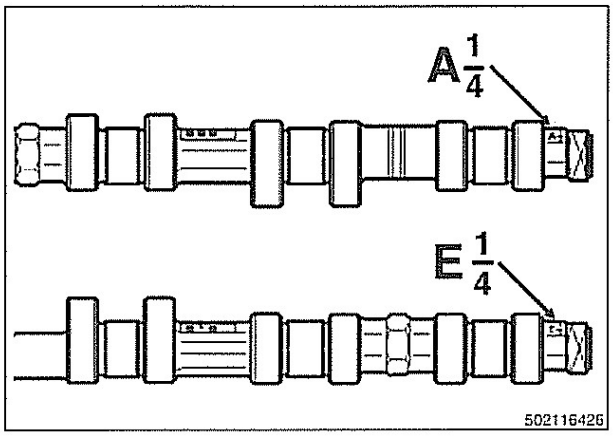
- Loosen camshaft bearing caps nuts in correct sequence (**1–10**) (left cylinder head shown).

  NOTE —
  Keep camshaft bearing caps in order. Used caps must not be interchanged.

– Remove exhaust camshaft by repeating process.
  - Remove camshafts from cylinder head.

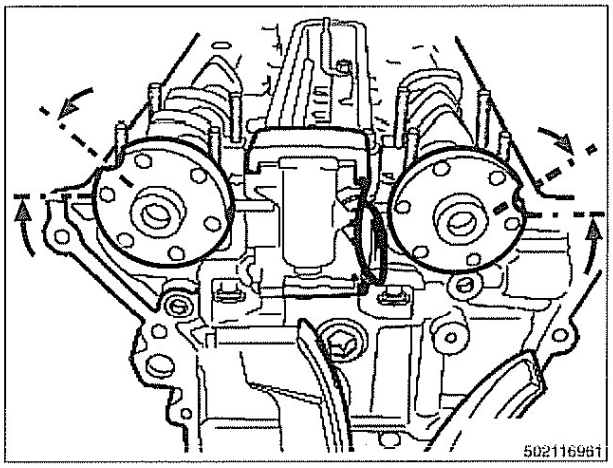
– Repeat camshaft removal process for right cylinder head.

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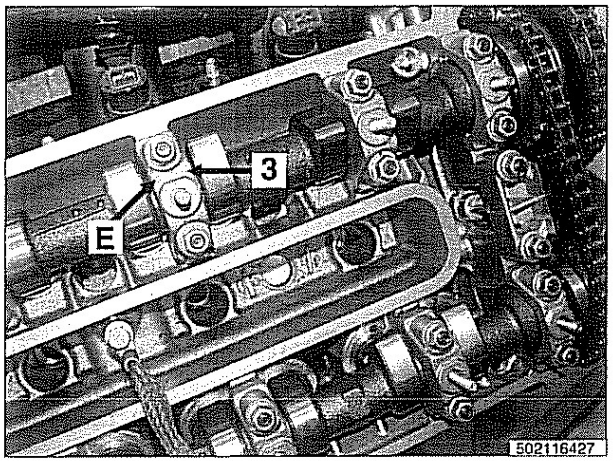


Camshafts, installing, right cylinder head (M62 engine)

- Camshafts are marked at rear. Install camshafts into camshaft bearing saddles of cylinder heads.
  - Intake camshaft for right cylinder head (1–4) is labelled E 1–4.
  - Exhaust camshaft for right cylinder head (1–4) is labelled A 1–4.



- Rotate camshafts so that recesses in intake and exhaust camshafts point upward 30 to 40° above sealing surface for valve cover (**arrows**).

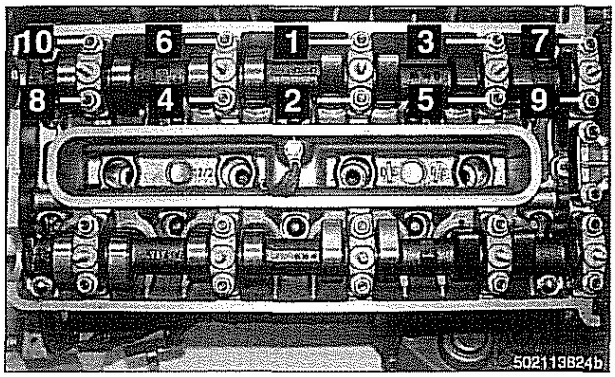


- Bearing caps are marked with a code for location.

NOTE —
The camshaft caps are stamped with a code letter - "E" for the intake side and "A" for the exhaust side. Number code is for position on head, with number 1 being the front bearing cap.

CAUTION—
Do not mix up camshaft bearing caps between cylinder banks.

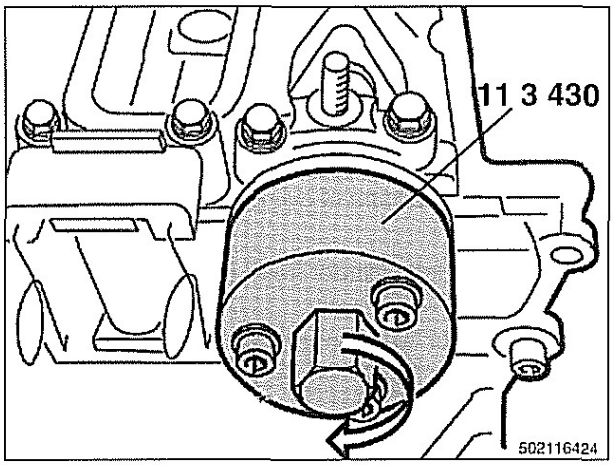
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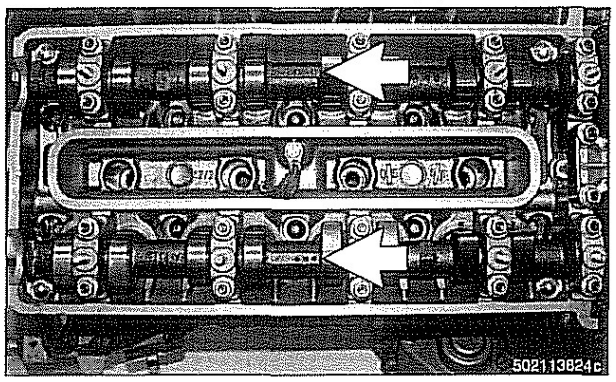
- Evenly tighten down bearing cap nuts in $^1/_2$ turn steps starting at number 1.

Tightening torque

Camshaft bearing cap	14 Nm (10 ft-lb)

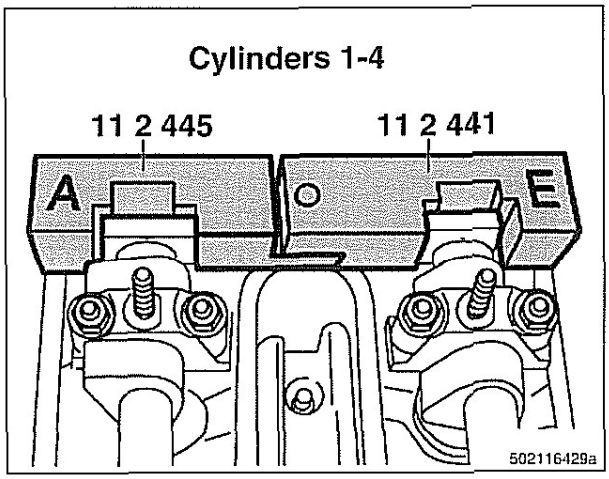


- Install BMW special tool 11 3 430 on camshaft.



- Rotate camshafts until marker bores (**arrows**) point upwards.

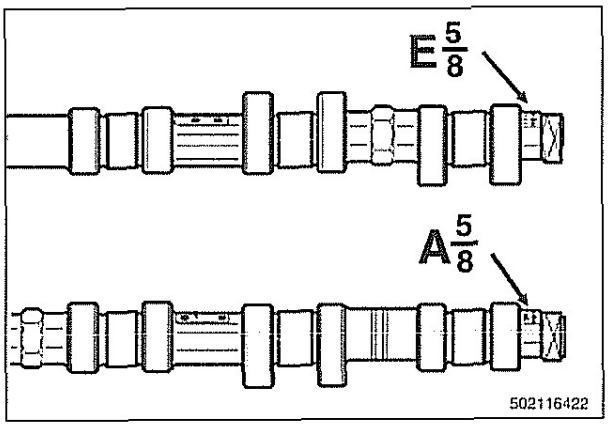
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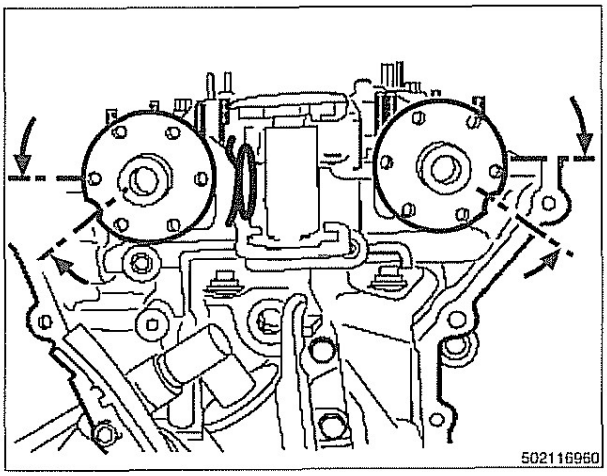
- Secure camshafts in TDC position using BMW special tools:
  - Align camshafts with open-end 27 mm wrench so BMW special tools fit on cylinder heads without gaps. Secure tool using number 4 cylinder spark plug hole.

> ***CAUTION—***
> *Do not damage the cylinder head. If necessary, machine open-end wrench to fit.*

Left side (cyl. 5–8) camshafts, installing (M62 engine)

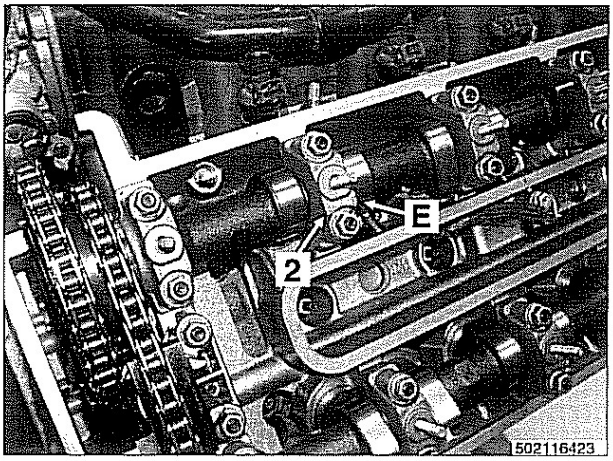


- Camshafts are marked for location at rear. Install camshafts into camshaft bearing saddles of cylinder heads, noting the following:
  - Intake camshaft for left cylinder head (5–8) is labelled E 5/8.
  - Exhaust camshaft for left cylinder head (5–8) is labelled A 5/8.



- Rotate camshafts so that recesses in intake and exhaust camshafts point downward 30 to 40° **(arrows)** from cylinder head cover sealing surface.

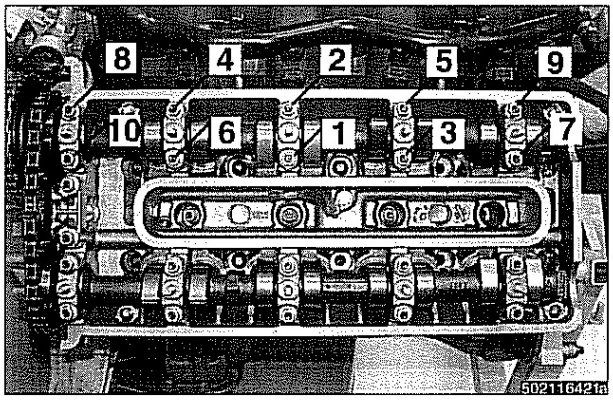
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- Bearing caps are marked with a code for location.

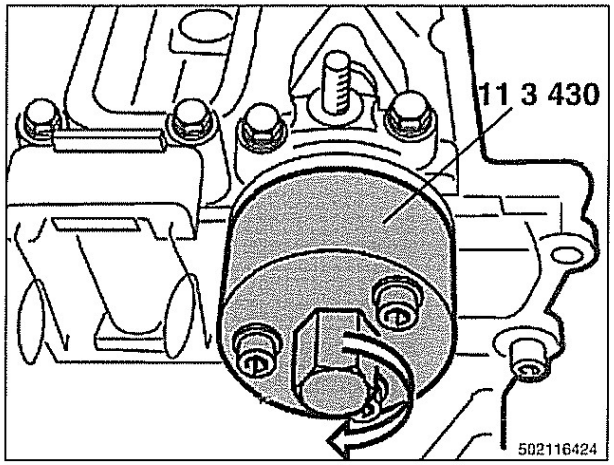
NOTE—
The camshaft caps are stamped with a code letter - "E" for the intake side and "A" for the exhaust side. Number code is for position on head, with number 1 being the front bearing cap.

CAUTION—
Do not mix up camshaft bearing caps.



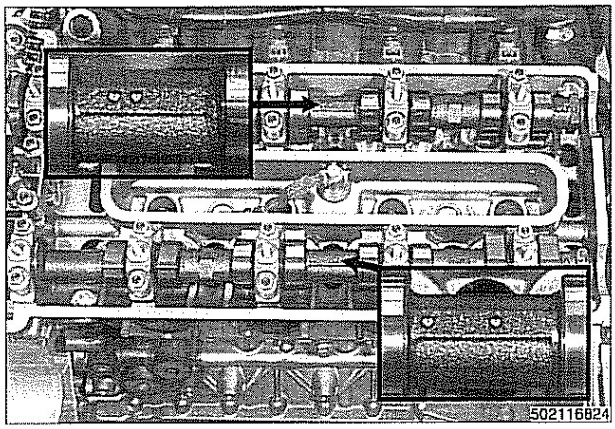
- Install and evenly tighten down bearing cap nuts in $^{1}/_{2}$ turn steps starting at number 1.

Tightening torque	
Camshaft bearing cap	14 Nm (10 ft-lb)

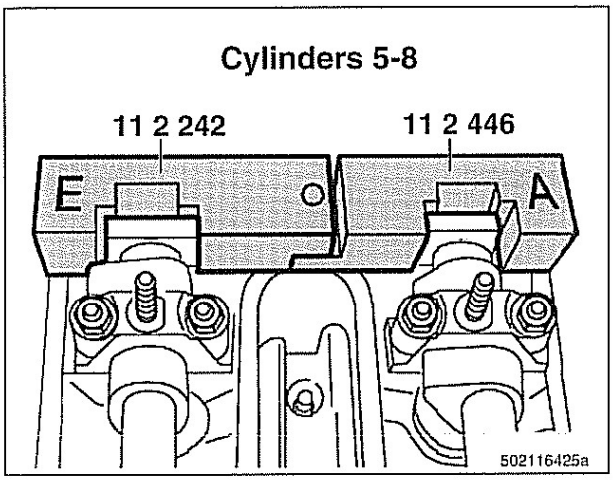


- Install BMW special tool 11 3 430 on camshaft.

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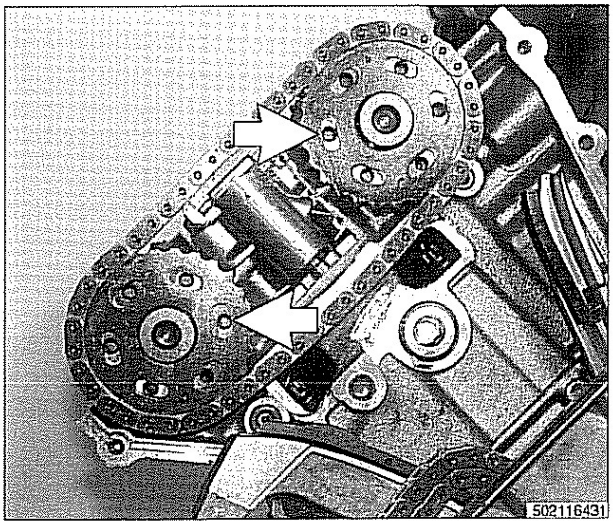
- Rotate camshafts until marker bores (**insets**) point upwards.



- Secure camshafts in TDC position using BMW special tools:
  - Align camshafts with open-end 27 mm wrench so BMW special tools fit on cylinder heads without gaps. Secure tool using number 8 cylinder spark plug hole.

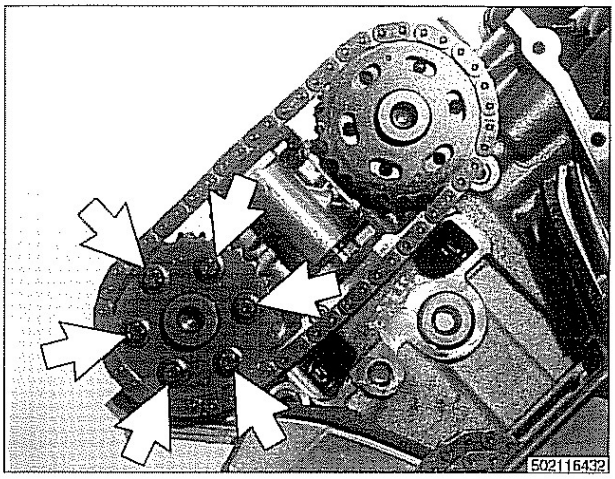
> ***CAUTION—***
> *Do not damage the cylinder head. If necessary, machine open-end wrench to fit.*

Timing chains and tensioners, installing (M62 engine)



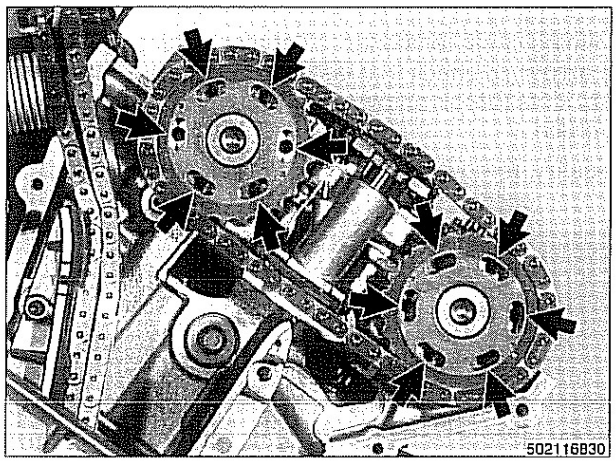
- Fit secondary sprockets and chain to camshafts on right cylinder head. Center slots in sprockets to threaded bores in end of camshafts (**arrows**).

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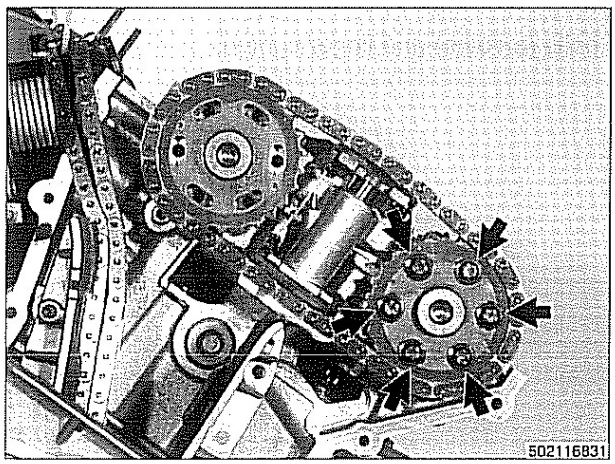


➢ Install exhaust camshaft bolts (**arrows**) finger tight.

– Remove secondary timing chain tensioner locking tool.



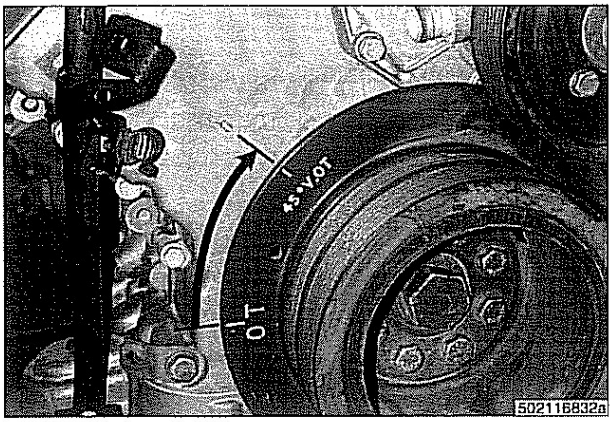
➢ Fit secondary sprockets and chain to camshafts on left cylinder head. Center slots in sprockets to threaded bores in end of camshafts (**arrows**).



➢ Insert exhaust camshaft bolts (**arrows**) finger tight in exhaust camshaft on left cylinder head.

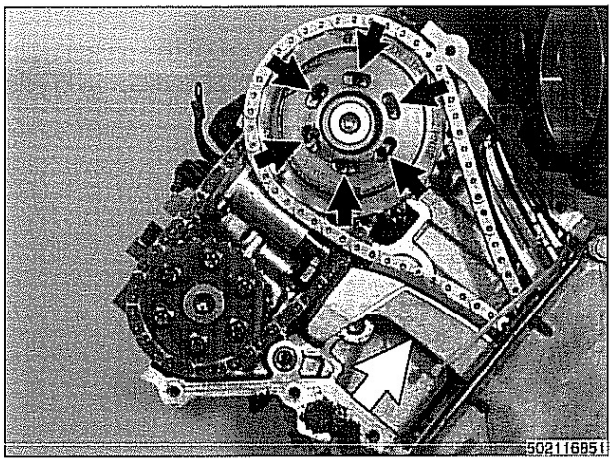
– Remove secondary timing chain tensioner locking tools from chain tensioners.

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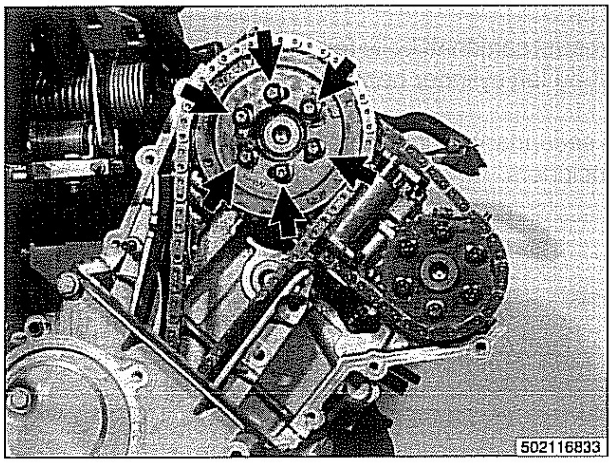
➢ Rotate engine clockwise (**arrow**) from 45° before TDC to TDC position.

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



➢ Fit sprocket with primary chain to intake camshaft on right cylinder head:

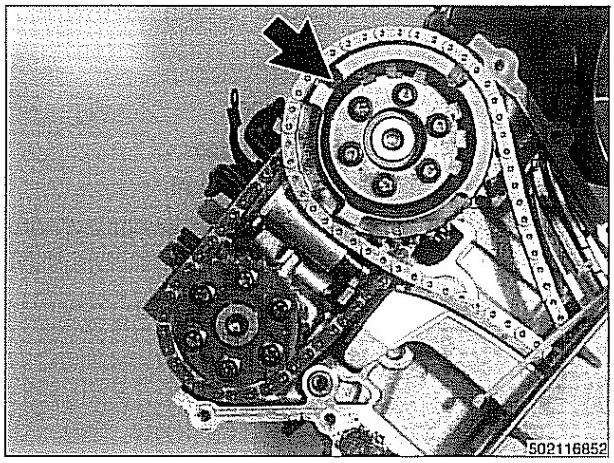
- Press timing chain tensioner rail against timing chain (**white arrow**) to check that fastener holes are centered in sprocket slots (**black arrows**) when slack is removed from timing chain.
- If necessary, remove sprocket and reposition.



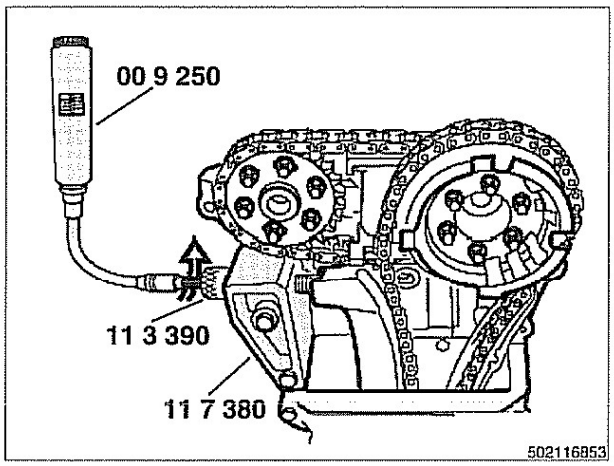
➢ Fit sprocket with chain to intake camshaft on cylinder head 5–8 with long bores aligned centrally.

- Install bolts (**arrows**) and finger tighten.

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- Fit sensor gear with mark (**arrow**) pointing upwards. Install bolts and finger tighten.

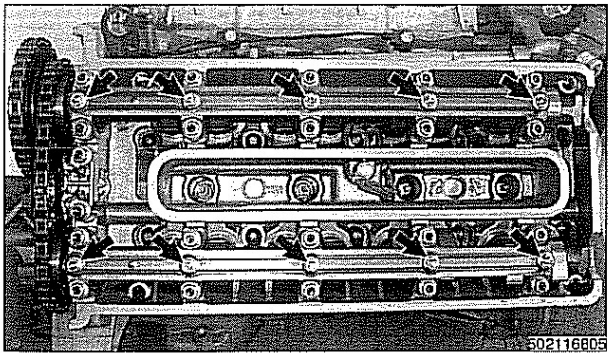


- Attach BMW special tool 11 7 380 to right cylinder head in place of upper timing case cover.
  - Install BMW special tool 11 3 390 into 11 7 380.
  - Using BMW special tool 00 9 250, tighten adjustable tensioner screw on 11 3 390 to 0.7 Nm (6.3 in-lb).
- Tighten camshaft sprocket bolts in the following order:
  1. Exhaust camshaft, left head.
  2. Exhaust camshaft, right head.
  3. Intake camshaft, left head.
  4. Intake camshaft, right head.

Tightening torques

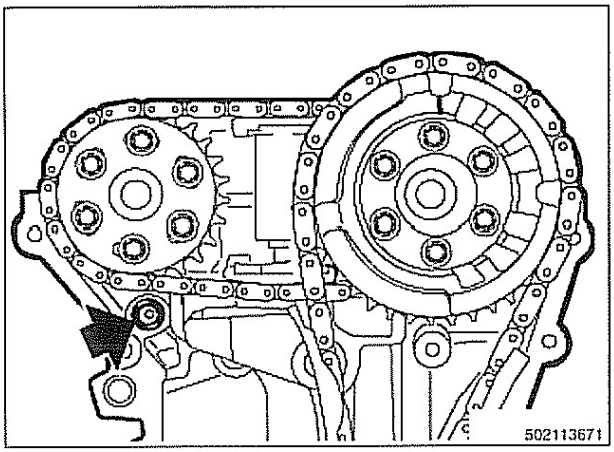
Sprocket to camshaft flange	15 Nm (11 ft-lb)

- Remove camshaft locking tools from both cylinder heads.
- Remove crankshaft locking tool.



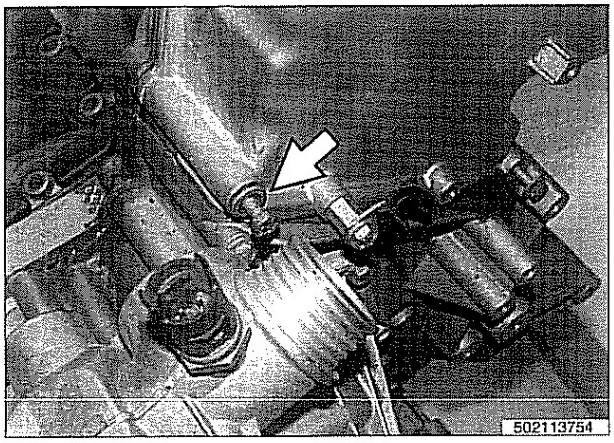
- Install oil lines to left and right cylinder heads.
- Remove adjustable timing chain tensioner tool and setup block from right cylinder head.

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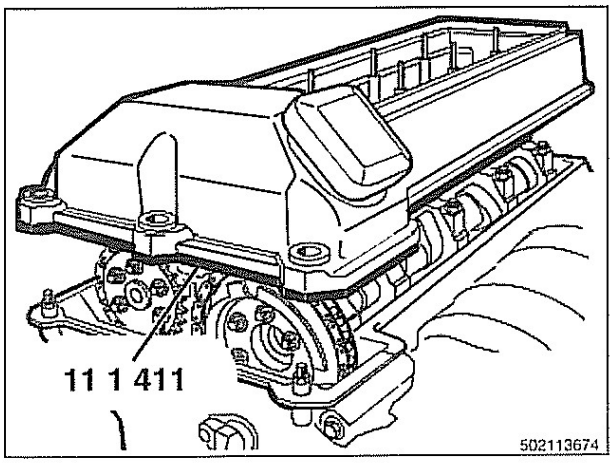


➢ Replace primary timing chain tensioner O-ring (**arrow**) in right cylinder head.

– Install right upper timing cover to engine:
- Remove old gasket from right timing cover.
- Clean gasket groove and install new gasket.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing cover. Install remaining timing cover bolts finger tight.



➢ Install left upper timing chain cover to engine:
- Remove old gasket from right timing chain cover.
- Clean gasket groove and install new gasket.
- Insert lower cover timing chain cover retaining bolt (**arrow**) to cover, then fit cover to cylinder head.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing chain cover. Install upper timing cover bolts finger tight.



➢ Remove cylinder head cover sealing gaskets from right cylinder head cover. Install BMW special tool 11 1 411 into gasket groove of cylinder head cover.
- Install right cylinder head cover with BMW special tool 11 1 411 to right cylinder head. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 1 and 2 (first two cylinders on right cylinder head).
- Tighten nuts uniformly in $^1/_2$ turn steps.

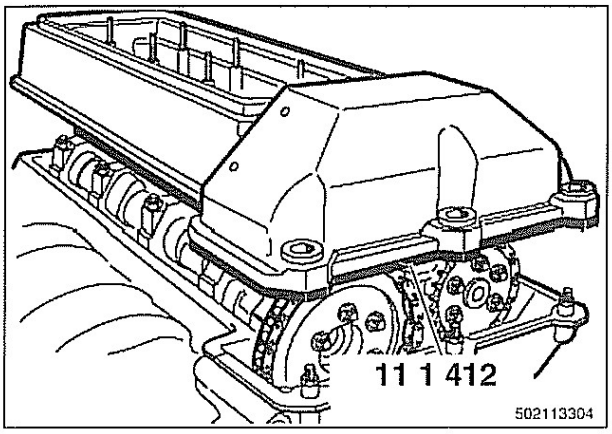
NOTE—
BMW special tool 11 1 411 presses upper timing chain cover to level of cylinder head.

Tightening torque	
Cylinder head cover nuts	10 Nm (7.5 ft-lb)

– Tighten right upper timing cover retaining bolts in two passes.

Tightening torque	
Timing chain cover to head	10 Nm (7.5 ft-lb)

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➢ Remove cylinder head cover sealing gaskets from left cylinder head cover. Install BMW special tool 11 1 412 into gasket groove of cylinder head cover.

- Install left cylinder head cover. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 5 and 6 (first two cylinders on left side cylinder bank).
- Tighten nuts uniformly in $^1/_2$ turn steps.

NOTE —
BMW special tool 11 1 412 presses upper timing chain cover to level of cylinder head.

Tightening torque	
Cylinder head cover nuts	10 Nm (7.5 ft-lb)

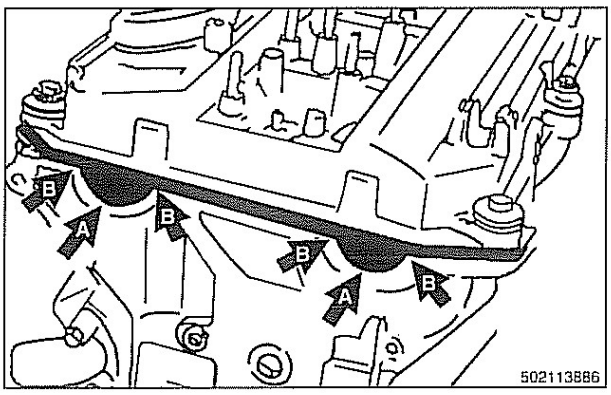
– Tighten left upper timing chain cover retaining bolts in two passes.

Tightening torque	
Timing chain cover to head	10 Nm (7.5 ft-lb)

– Remove cylinder head covers and remove BMW special tools 11 4 411/412 from cylinder head covers.

– Fit new gasket to cylinder head cover without strain.

– Apply Three Bond® 1209 sealant to joints between cylinder head and timing cover.



➢ Make sure half-moon cutouts (**A**) at rear of cylinder heads fit correctly to cylinder head sealing surface. Apply Three Bond® 1209 sealant at corners of half-moon cutouts (**B**).

– Remainder of installation is reverse of removal.

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VALVES

This section covers valve removal and reconditioning, including valve guides, seats, springs, and valve stem oil seals.

Valves, leak test

To test the valves for leakage, the cylinder head must be disassembled with camshafts and camshaft carriers removed. With valve assemblies and spark plugs installed, place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with a thin nonflammable liquid. After fifteen minutes, check the level of the fluid. If the fluid level in any cylinder drops, that cylinder is not sealing properly.

Valves, removing and installing

– Remove cylinder head as described in **113 Cylinder Head Removal and Installation**.

> ***CAUTION—***
> - *(M52 TU / M54 engines only) Do not let the hydraulic lifters fall out as the camshaft carrier is removed. Special suction cups are available from BMW to hold the hydraulic lifters in place during carrier removal.*
> - *Hydraulic cam lifters should be stored in an upright position. If necessary, use a magnetic tool to aid in removal of the lifters.*

– Remove valves using a valve spring compressor.

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

– Remove and discard valve stem oil seals from valve guides. See **Valve stem oil seals** later in this section.

– Valve installation is reverse of removal. Remove carbon deposits from the valves using a wire brush or wire wheel.

Valve specifications are listed in **Table c. Valve specifications**.

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Table c. Valve specifications

Specification	M52 engine (1997-1998)	M52 TU 2.8 engines (1999 - 2000), M54 2.5/3.0 engines (2001-2002)	M62, M62 TU engines (1997-2002)
Valve head diameter			
Intake	33.0 mm	33.0 mm	35.0 mm
Exhaust	30.5 mm	30.5 mm	30.5 mm
Valve stem diameter - Standard			
Intake	6.0 mm $^{-0.025}_{-0.040}$	6.0 mm $^{-0.025}_{-0.040}$	6.0 mm $^{-0.025}_{-0.040}$
Exhaust	6.0 mm $^{-0.040}_{-0.055}$	6.0 mm $^{-0.040}_{-0.055}$	6.0 mm $^{-0.040}_{-0.055}$
Valve stem diameter - Oversize 1 (identified on stem as **R1**)			
Intake	6.1 mm $^{-0.025}_{-0.040}$	6.1 mm $^{-0.025}_{-0.040}$	6.1 mm $^{-0.025}_{-0.040}$
Exhaust	6.1 mm $^{-0.040}_{-0.055}$	6.1 mm $^{-0.040}_{-0.055}$	6.1 mm $^{-0.040}_{-0.055}$
Valve stem diameter - Oversize 2 (identified on stem as **R2**)			
Intake	6.2 mm $^{-0.025}_{-0.040}$	6.2 mm $^{-0.025}_{-0.040}$	6.2 mm $^{-0.025}_{-0.040}$
Exhaust	6.2 mm $^{-0.040}_{-0.055}$	6.2 mm $^{-0.040}_{-0.055}$	6.2 mm $^{-0.040}_{-0.055}$

Valve guides

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

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

NOTE—

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

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Table d. Valve guide specifications	
Specifications	**All engines (1997-2002)**
Valve guide wear, maximum (valve tilt clearance measured with new valve)	0.5 mm (0.020 in)
Valve guide inside diameter, installed (tolerance per ISO allowance H7)	
Standard	6.0 mm (0.236 in)
Oversize 1	6.1 mm (0.240 in)
Oversize 2	6.2 mm (0.244 in)

Valve stem oil seals

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

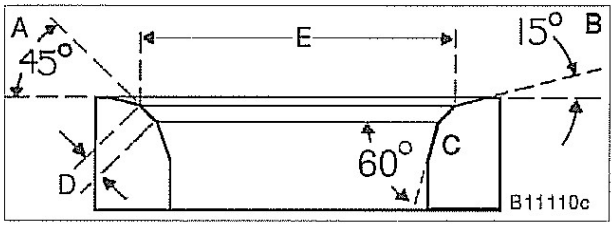
NOTE—
Valve stem oil seals should not be reused. If valves are removed, new valve stem oil seals should be installed.

Valve stem oil seal replacement requires that the cylinder head be disassembled and the valves removed as described above under **Valves, removing and installing**.

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

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

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Valve seats

The valve seats should be resurfaced whenever new valves or valve guides are installed. Cutters are required to resurface the seats. Always check the valves for leaks after reconditioning a valve seat as described above. **Table e. Valve seat specifications** lists valve seat dimensions.

Table e. Valve seat specifications (refer to figure)

Specification	All 6 cylinder engines (1997-2002)	All 8 cylinder engines (1997-2002)
A - Valve seat angle	45°	45°
B - Correction angle, outside	15°	15°
C - Correction angle, inside	60°	60°
D - Valve seat width		
intake	1.65 ±0.25 mm (0.065 ±0.010 in)	1.25 ±0.25 mm (0.049 ±0.010 in)
exhaust	1.65 ±0.25 mm (0.065 ±0.010 in)	1.65 ±0.35 mm (0.065 ±0.014 in)
E - Valve seat outside diameter		
intake	32.4 mm (1.276 in)	34.5 mm (1.358 in)
exhaust	• M52: 29.4 mm (1.157 in) • M52 TU, M54: 30.0 mm (1.181 in)	30.0 mm (1.181 in)

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

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Valve springs

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

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



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117 Camshaft Timing Chain

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GENERAL

This repair group covers timing chain and VANOS repair information for the following engines:

- M52 (Single VANOS 6-cylinder engine)
- M52 TU and M54 (Double VANOS engines)
- M62 (Non VANOS V-8 engine)

NOTE—
The M62 TU V-8 engine with VANOS Variable Camshaft Timing repair information is not included.

NOTE—
*See **100 Engine General** for engine code and application information.*

Worn timing chains and sprockets can lead to noisy operation and erratic valve timing. A faulty tensioner can also cause timing chain noises.

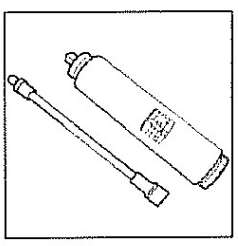
For specific repair procedures, refer to the appropriate repair group:

- **020 Maintenance**
- **113 Cylinder Head Removal and Installation**
- **119 Lubrication System**
- **121 Ignition System**
- **170 Radiator and Cooling System**

Special tools

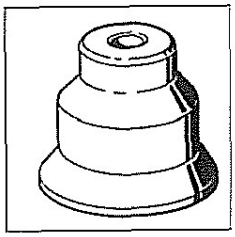
Special BMW service tools are needed to perform the service and repairs procedures covered in this repair group. Many of these tools are expensive and only available through an authorized BMW dealer. Be sure to read each procedure thoroughly before starting a job to determine which special tools will be necessary.

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

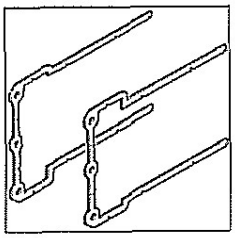


Torque wrench w/ flex extension
(Tool No. BMW 00 9 250)

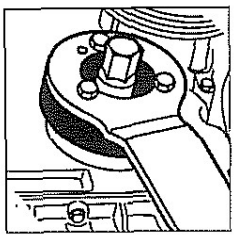
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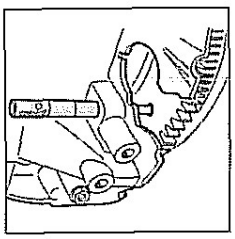
- Crankshaft seal installation bushing, V-8 (Tool No. BMW 11 1 220)



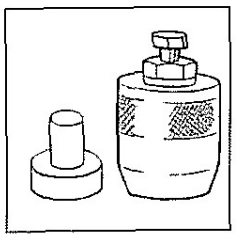
- Upper timing cover installation tool, V-8 (Tool No. BMW 11 1 411/412)



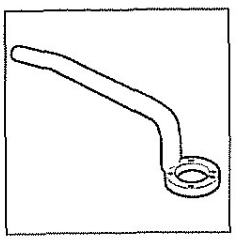
- Crankshaft hub locking tools (6-cylinder engine with 2 piece vibration dampener) (Tool No. BMW 11 2 150 /11 2 410)



- Crankshaft locking tool (Tool No. BMW 11 2 300)



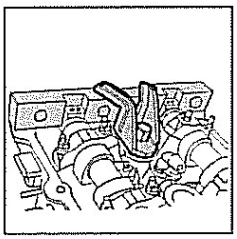
- Seal extractor tool set (Tool No. BMW 11 2 380)



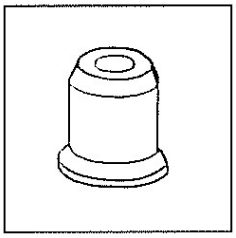
- Crankshaft holding tool (V-8 engines) (Tool No. BMW 11 2 450)

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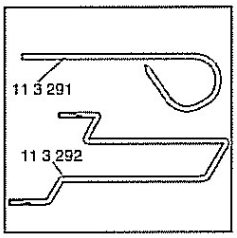
Camshaft Timing Chain



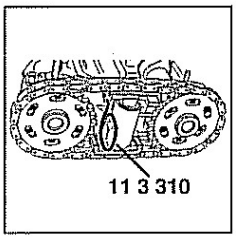
Camshaft locking tool set, 6–cylinder
(Tool No. BMW 11 3 240)



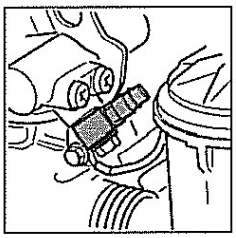
Crankshaft seal installation bushing, 6–cylinder
(Tool No. BMW 11 3 280)



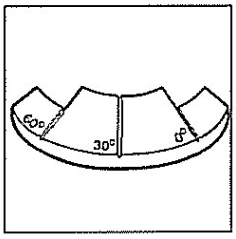
Secondary chain tensioner locking pin set, 6–cylinder
(Tool No. BMW 11 3 290)



Secondary chain tensioner locking pin, V-8
(Tool No. BMW 11 3 310)

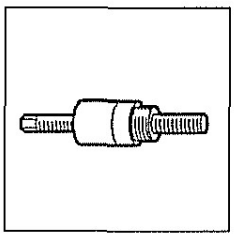


Air line fitting
(Tool No. BMW 11 3 450)

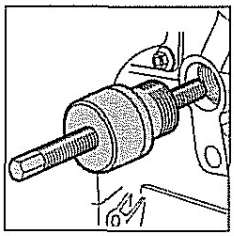


Protractor
(Tool No. BMW 11 3 460)

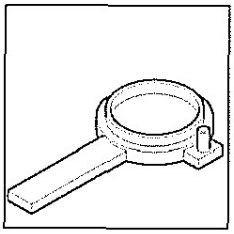
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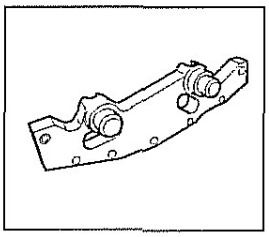
Primary chain tensioner tool, V-8
(Tool No. BMW 11 3 390)



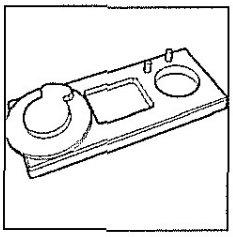
Primary chain tensioner tool, 6–cylinder
(Tool No. BMW 11 4 220)



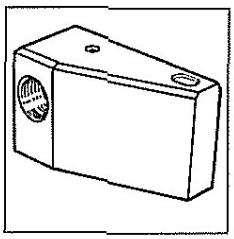
VANOS sprocket wrench
(Tool No. BMW 11 5 490)



Double VANOS setup bracket, M52 TU/M54 6–cylinder
(Tool No. BMW 11 6 150)

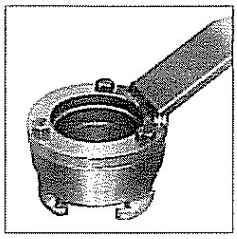


Double VANOS sprocket setup tool, M52 TU/M54 6–cylinder
(Tool No. BMW 11 6 180)

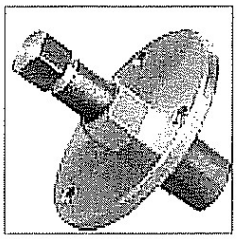


Tensioner bracket, V-8
(Tool No. 11 7 380)

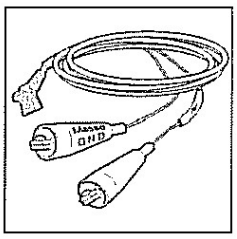
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Crankshaft hub locking tool, M54 engine
(Tool No. BMW 11 8 190 /11 8 200)



Puller for crankshaft hub
(Tool No. BMW 11 8 219)



VANOS test lead, M52 6–cylinder
(Tool No. BMW 12 6 410)

CRANKSHAFT OIL SEAL, FRONT

Crankshaft oil seal, front, replacing (M52 engine)

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

– Disconnect negative (-) cable from battery.

CAUTION—
- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

– Remove splash guard from beneath engine.

– Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

NOTE—
Cooling fan nut (32 mm wrench) has left-hand threads.

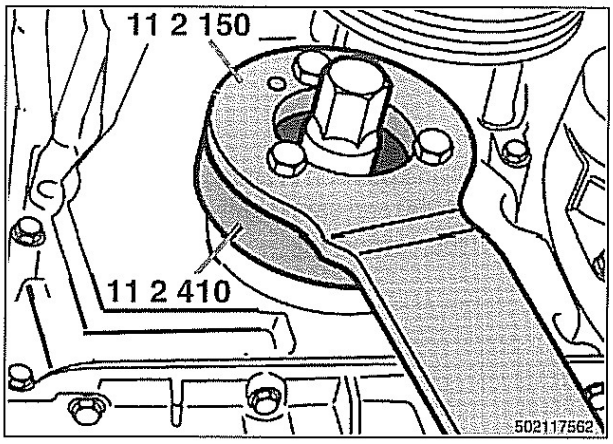
– Remove drive belts. See **020 Maintenance**.

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NOTE—
Mark direction of belt rotation if reusing belt.

– Remove vibration damper mounting bolts and remove vibration damper and pulley from hub.

NOTE—
The M52 6–cylinder engine uses a 2–piece vibration damper and hub assembly.



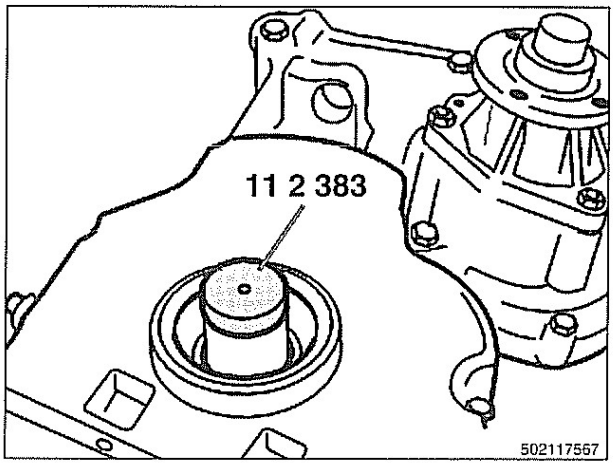
Install crankshaft holder (BMW special tools 11 2 150 and 11 2 410).

NOTE—
Be careful while aligning locator pin hole in special tool 11 2 410 with vibration damper locator pin.

– While counterholding crankshaft, loosen and remove crankshaft center bolt.

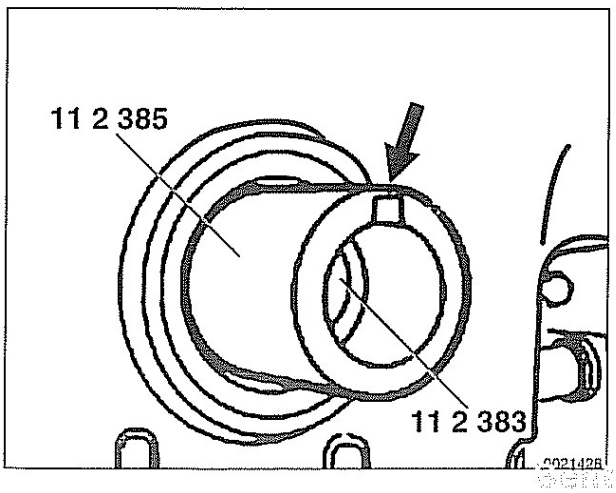
> ***CAUTION—***
> *Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*

NOTE—
The crankshaft hub center bolt is torqued to 410 Nm (300 ft-lb).



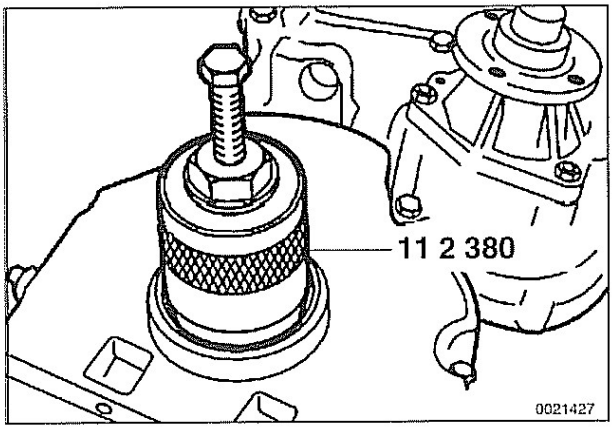
– Remove damper hub and special tools.

Install cap (BMW special tool 11 2 383) on end of crankshaft.

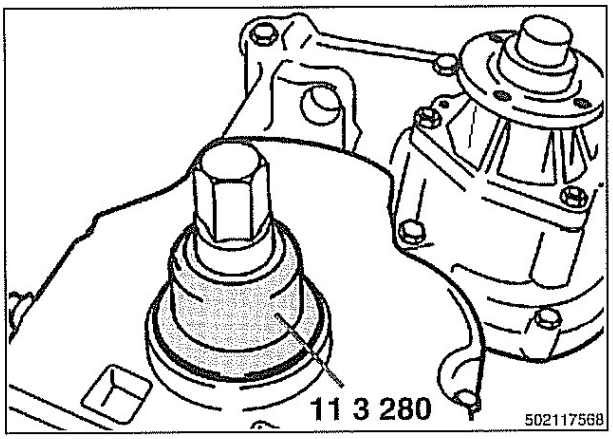


Install seal guide (BMW special tool 11 2 385) over end of crankshaft. Be sure to align tool with keyway on crankshaft (**arrow**).

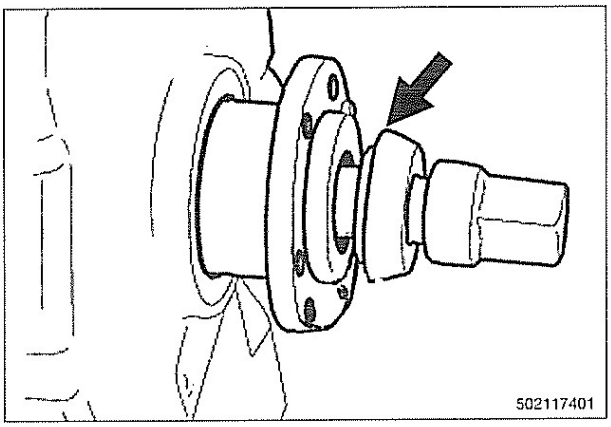
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➢ Install oil seal puller (BMW special tool 11 2 380) and screw in body of puller until it contacts seal. Tighten center screw to draw seal out of cover.



➢ Coat new seal with oil and position in timing chain cover. Use BMW special tool 11 3 280 and crankshaft center bolt to draw seal in flush with timing case cover.



➢ Align hub with keyway and tap into place. Insert **new** center bolt with washer shoulder (**arrow**) facing hub.

> ***CAUTION—***
> *Inspect woodruff key for damage before installing hub.*

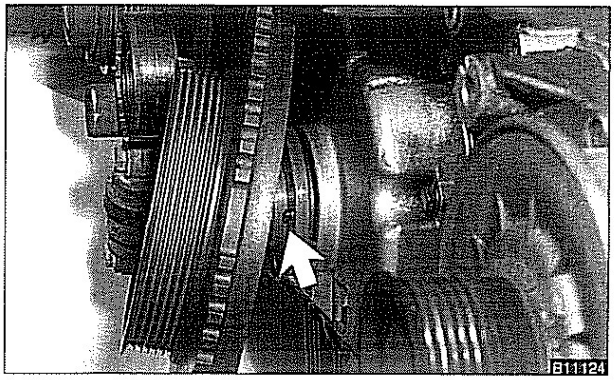
– Reinstall crankshaft holder tool.

NOTE—
Be careful while aligning locator pin hole in special tool 11 2 410 with vibration damper locator pin.

– While counterholding crankshaft, tighten crankshaft center bolt.

Tightening torque	
Vibration damper hub to crankshaft	410 Nm (302 ft-lb)

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Install vibration damper mounting bolts. Note hub locating dowel (**arrow**).

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

– Installation is reverse of removal noting the following:
  - Installing drive belts. See **020 Maintenance**.
  - Install cooling fan. See **170 Radiator and Cooling System**.

Crankshaft oil seal, replacing (M52 TU and M54 engines)

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

– Disconnect negative (-) cable from battery.

> ***CAUTION—***
> - *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
> - *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

– Remove splash guard from beneath engine.

– Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

> ***NOTE—***
> *Cooling fan nut (32 mm wrench) has left-hand threads.*

– Remove drive belts. See **020 Maintenance**.

> ***NOTE—***
> *Mark direction of belt rotation if reusing belt.*

– Install crankshaft holding tool (BMW special tool 11 8 190/11 8 200). Make sure tool locks into place in openings in damper assembly. While counterholding crankshaft with special tool, remove crankshaft center bolt.

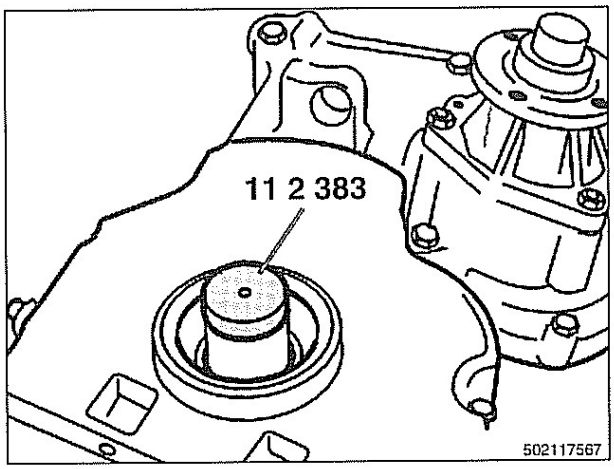
> ***CAUTION—***
> - *Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*
> - *Use care when removing damper/hub assembly, as it is easy to damage the radiator.*

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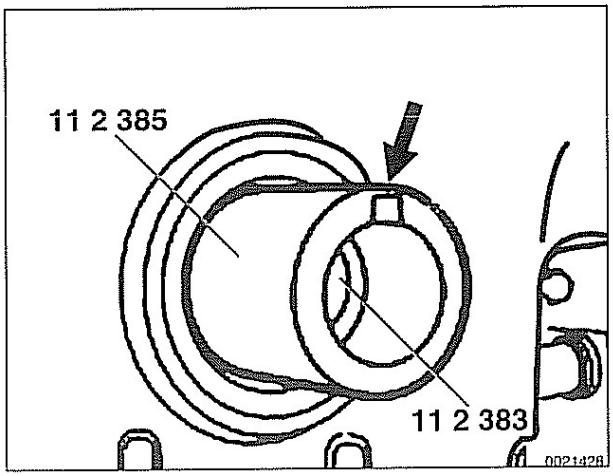
NOTE—
The crankshaft hub center bolt is torqued to 410 Nm (300 ft-lb).

– Install crankshaft damper puller (BMW special tool 11 8 210) to 11 8 200. Use bolt to remove damper from crankshaft.

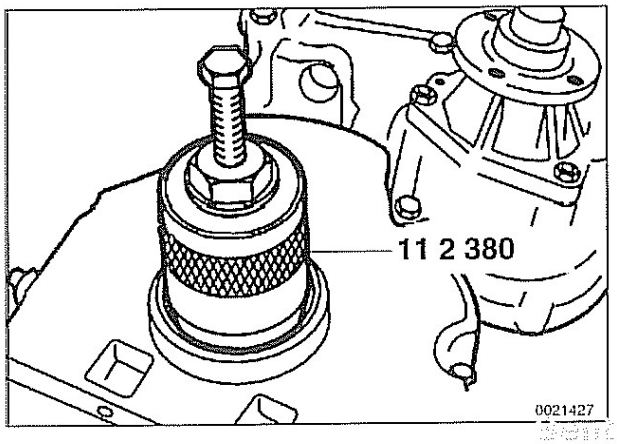
– **Oil seal replacement:**



➢ Install cap (BMW special tool 11 2 383) on end of crankshaft.

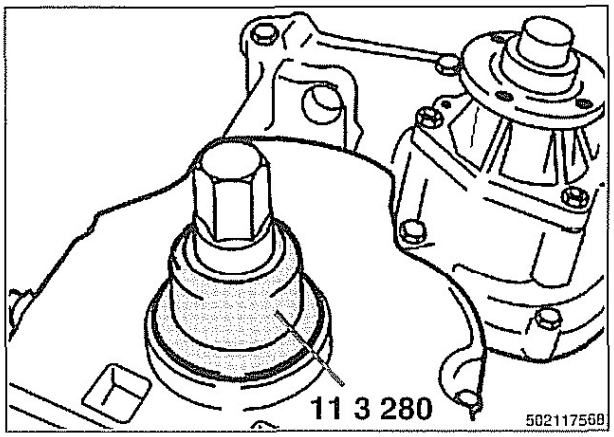


➢ Install seal guide (BMW special tool 11 2 385) over end of crankshaft. Be sure to align groove with keyway on crankshaft (**arrow**).



➢ Install oil seal puller (BMW special tool 11 2 380) and screw in body of puller until it contacts seal. Tighten screw in center of tool to draw seal out of cover.

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- Coat new seal with oil and position in timing chain cover. Use BMW special tool 11 3 280 and crankshaft center bolt to draw seal in flush with timing case cover.
- Align vibration damper assembly with keyway and tap into place. Insert new center bolt with washer.

> ***CAUTION—***
> *Inspect woodruff key for damage before installing hub assembly.*

- Install crankshaft holding tool making sure tool locks into place in openings in damper assembly. While counterholding crankshaft, tighten crankshaft center bolt.
- Attach special tools 11 8 200/11 8 190 to damper assembly. Counterhold damper with 11 8 190 while tightening center bolt.

Tightening torque	
Vibration damper hub to crankshaft	410 Nm (302 ft-lb)

- Installation is reverse of removal noting the following:
  - Install drive belts. See **020 Maintenance**.
  - Install cooling fan. See **170 Radiator and Cooling System**.

Crankshaft oil seal, replacing (M62 and M62 TU engines)

- Disconnect negative (-) cable from battery.

> ***CAUTION—***
> - *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
> - *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General cautions and warnings**.*

- Remove splash guard from beneath engine.
- Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

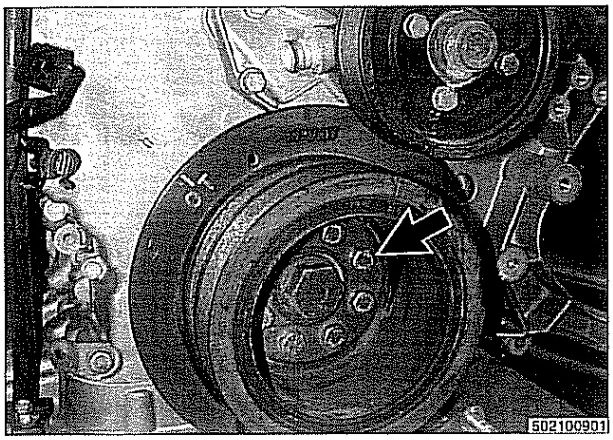
> ***NOTE—***
> *Cooling fan nut (32 mm wrench) has left-hand threads.*

- Remove drive belts. See **020 Maintenance**.

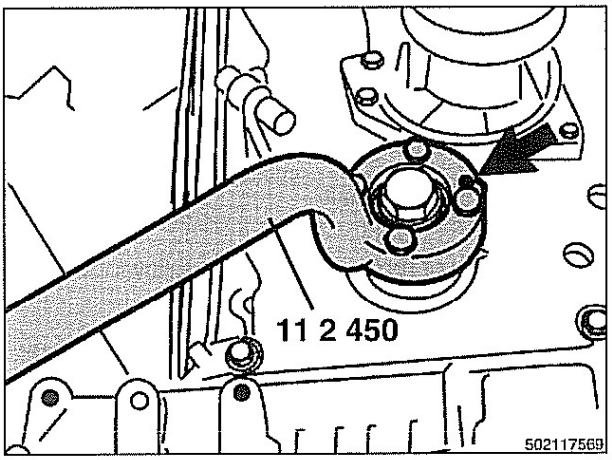
> ***NOTE—***
> *Mark direction of belt rotation if reusing belt.*

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Camshaft Timing Chain



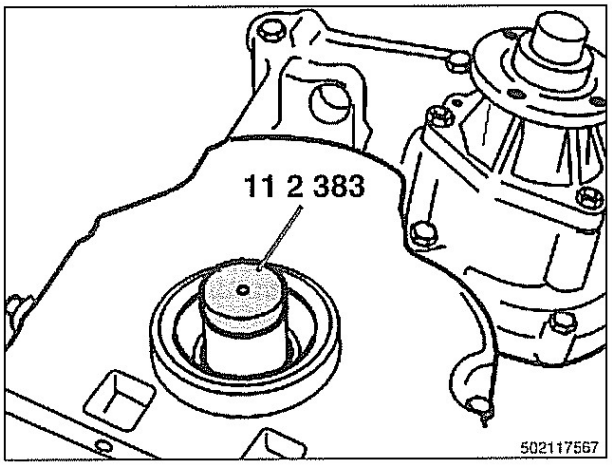
- Remove all vibration damper perimeter mounting bolts (**arrow**) and remove vibration damper.



- Install crankshaft holding tool (BMW special tool 11 2 450) and remove and discard crankshaft center bolt.

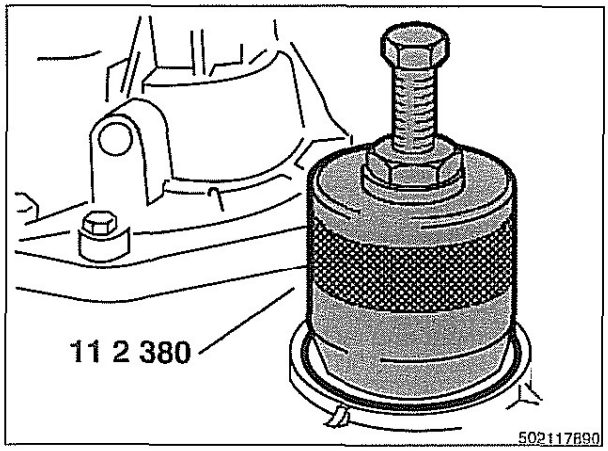
  NOTE—
  *Be careful to align hub locator pin to hole (**arrow**) in special tool 11 2 450.*

– If needed, use a puller (BMW 11 8 219) to remove hub from end of crankshaft.

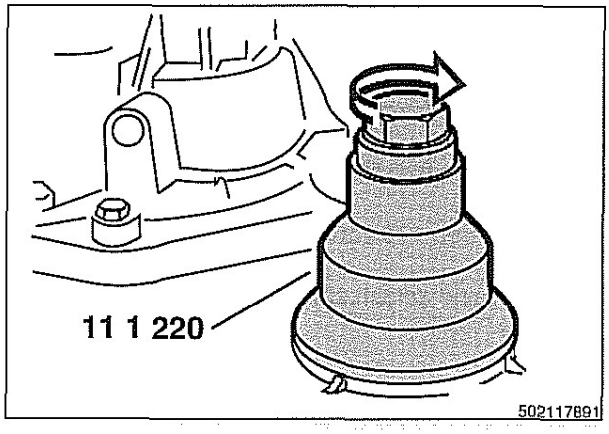


- Install end cap (BMW special tool 11 2 383) on end of crankshaft.

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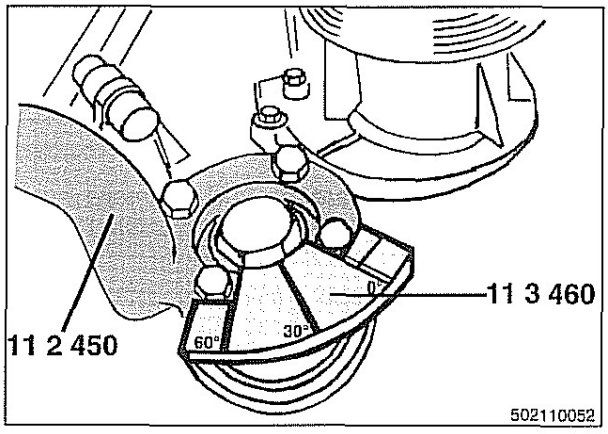


➢ Install seal removing tool (BMW special tool 11 2 380) and screw in body of puller until it makes firm contact with seal. Tighten center screw in end of tool to draw out seal.



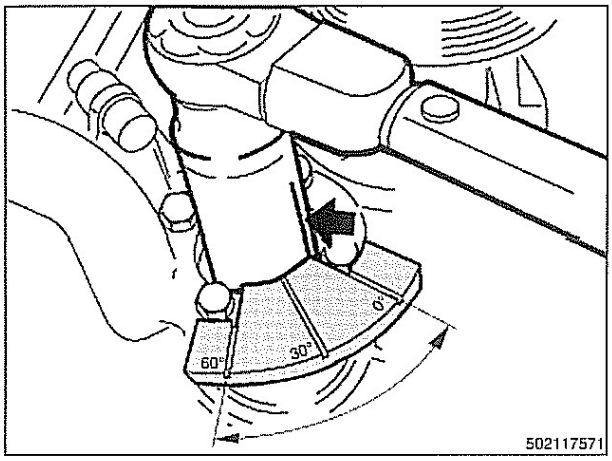
➢ Coat new seal with oil, and use BMW special tool 11 1 220 and crankshaft center bolt to draw seal in flush with timing case cover.

– Install damper hub and tighten new center bolt finger tight.



➢ Install angle gauge BMW special tool 11 3 460 as shown.

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➢ Mark 0° location on socket (**arrow**). Tighten hub bolt in four stages.

Tightening torque	
Vibration damper hub to crankshaft	
Stage 1	100 Nm (74 ft-lb)
Stage 2	60° Torque angle
Stage 3	60° Torque angle
Stage 4	30° Torque angle

– Install vibration damper and mounting bolts.

NOTE—
Make sure to align vibration damper with locating dowel pin in hub.

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

– Install drive belts. See **020 Maintenance**.

– Install cooling fan. See **170 Radiator and Cooling System**.

– Replace under engine splash shield, then reconnect negative battery cable.

VANOS Control Unit and Timing Chain (M52 engine)

VANOS control unit, removing (M52 engine)

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

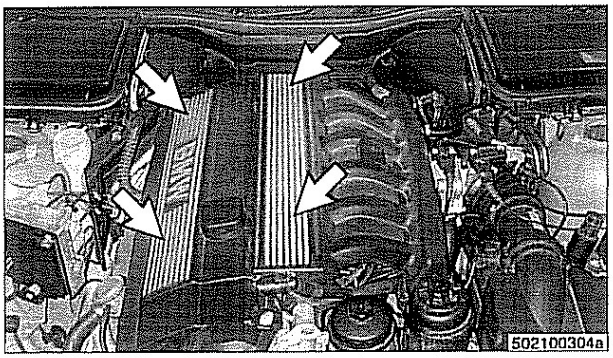
– Disconnect negative (-) cable from battery.

CAUTION—
- *Disconnecting the battery may erase fault code(s) stored in control module memory. Prior to disconnecting the battery, check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

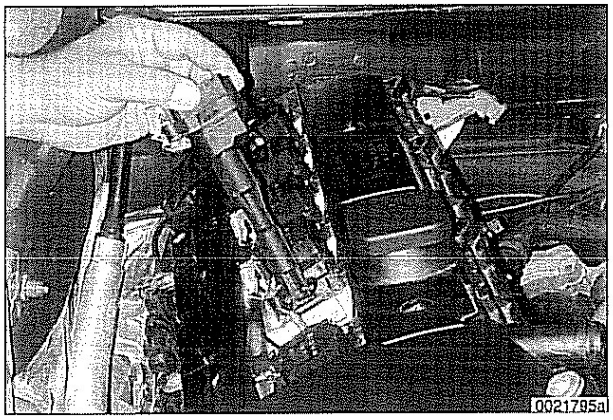
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– Remove viscous clutch cooling fan. See **170 Radiator and Cooling System.**

> ***CAUTION—***
> *The radiator cooling fan nut (32mm wrench) has left—hand threads.*

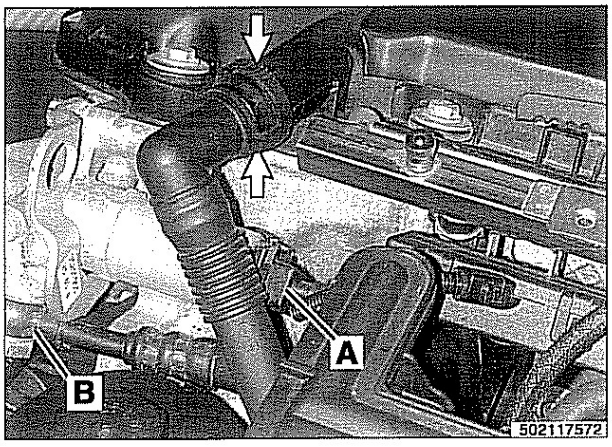


➢ Remove engine trim covers:
- Pry out plastic trim caps (arrows).
- Remove cover fasteners and covers.



➢ Remove ignition coils:
- Disconnect ignition coil electrical harness connectors.
- Remove coil mounting fasteners and remove coils.
- Remove spark plugs.

NOTE—
Make note of ignition coil ground strap locations.



➢ Disconnect VANOS electrical harness connector (**A**) and oil line fitting (**B**) from VANOS control unit.

NOTE—
Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.

– Disconnect crankcase breather by squeezing at arrows.

– Remove cylinder cover mounting fasteners and remove cylinder head cover.

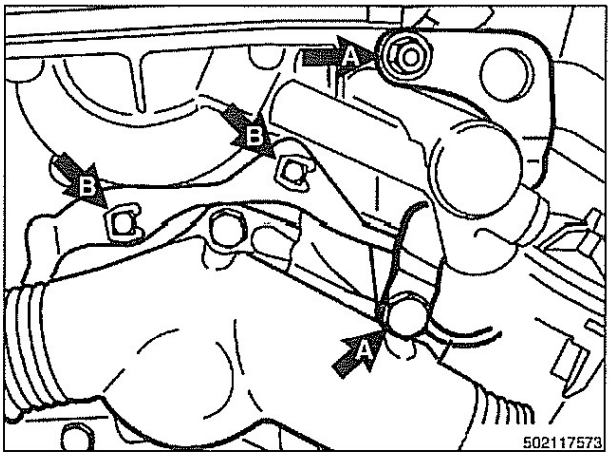
NOTE—
The cylinder head cover mounting bolt insulators and gaskets should be reinstalled in their original positions. Make note of their arrangement during removal.

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Camshaft Timing Chain

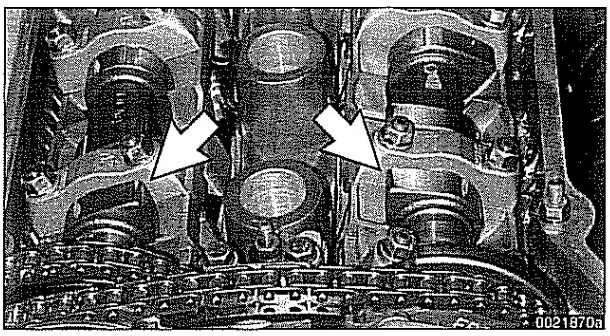


- Remove oil baffle cover from intake camshaft.

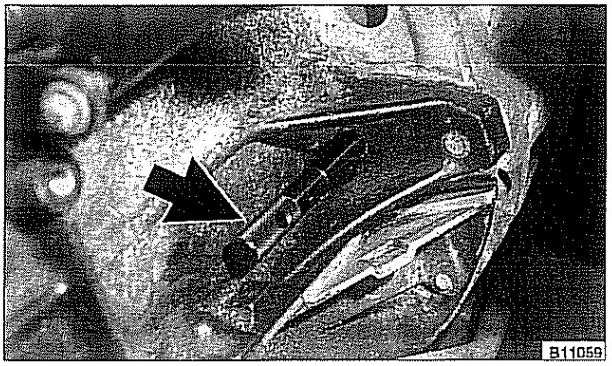


- Remove front engine lifting bracket fasteners (**arrows A**) and remove bracket.

– Remove cable duct clips (**arrows B**) from front of VANOS control unit.

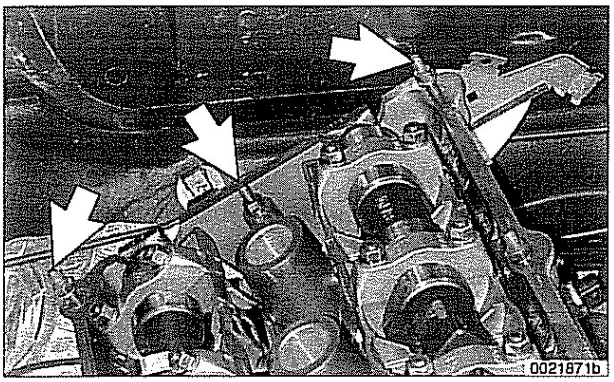


- Rotate engine clockwise and set camshafts to Top Dead Center (TDC). Cylinder 1 camshaft lobes will point towards each other (**arrows**).

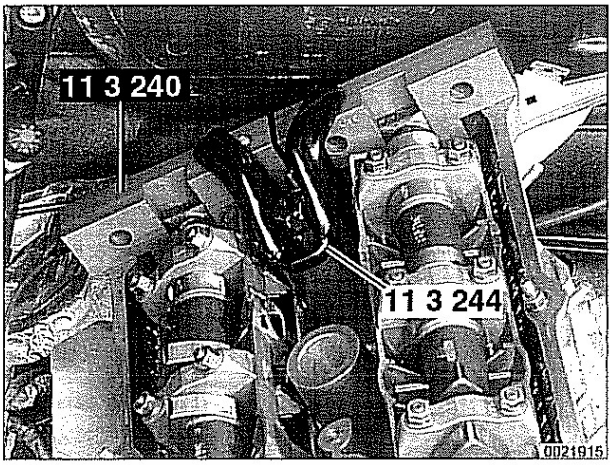


- Remove plug from below starter and install crankshaft locking tool (BMW special tool 11 2 300).

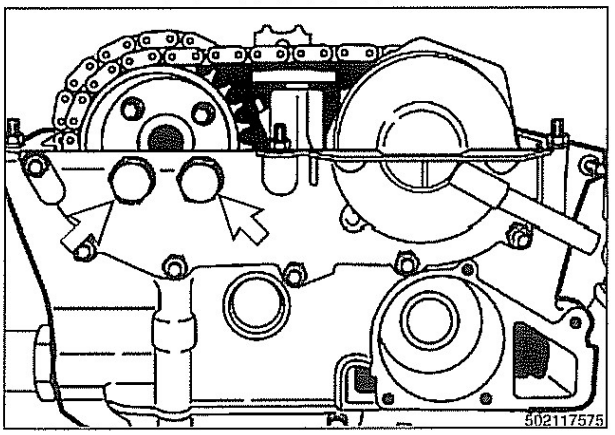
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- Unscrew and remove cylinder head cover studs (**arrows**) at rear of cylinder head.



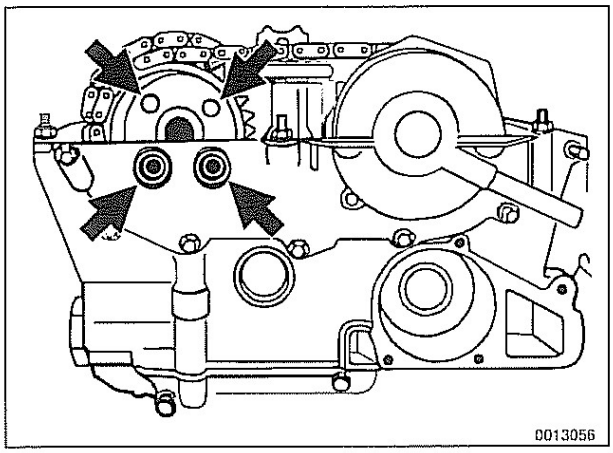
- Secure camshafts in TDC position using BMW special tool set 11 3 240.



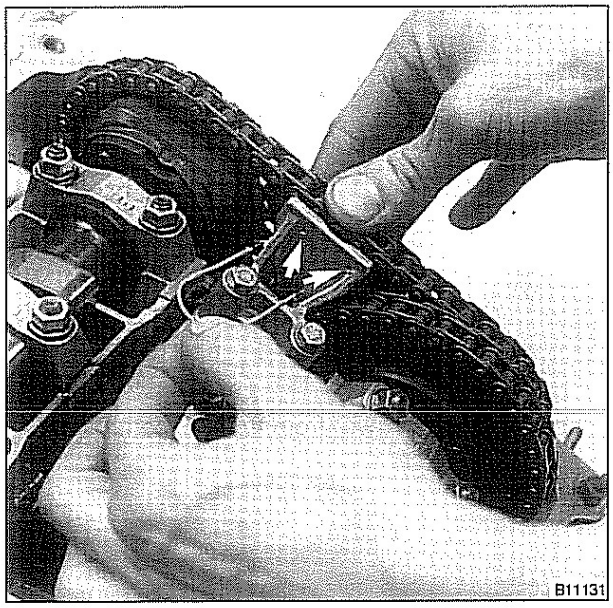
- Remove access plugs (**arrows**) from VANOS control unit.

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Camshaft Timing Chain



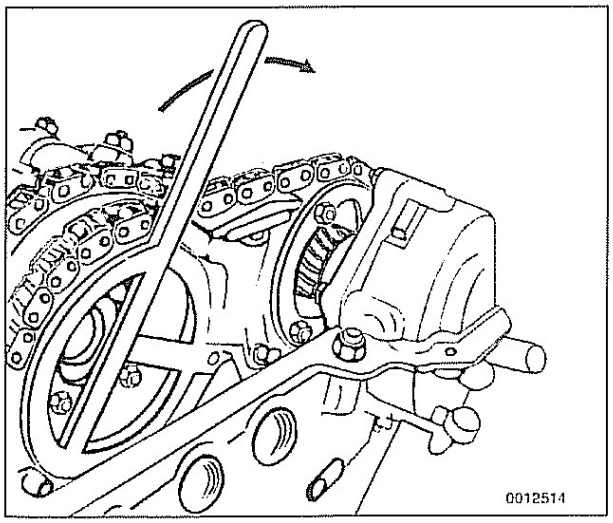
- Loosen 4 bolts (arrows) from exhaust camshaft sprocket (Torx E10).



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

NOTE —
Two types of secondary timing chain tensioners are used; one with two holes, and one with a single hole for the locking pin tool.

– Remove VANOS control unit mounting fasteners at front of cylinder head.



- Install sprocket rotating tool (BMW special tool 11 5 490) on exhaust camshaft.

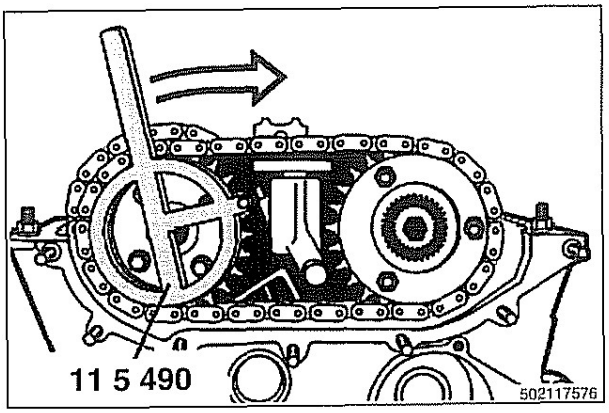
– Rotate exhaust camshaft sprocket clockwise while sliding VANOS control unit forward to remove from cylinder head.

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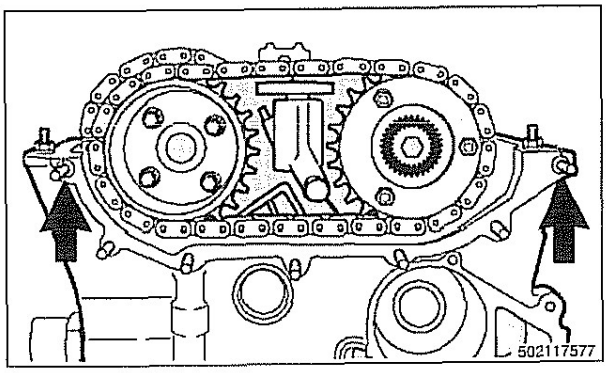
VANOS control unit, installing (M52 engine)

CAUTION—
Incorrect installation of the VANOS control unit may result in damage to the engine.

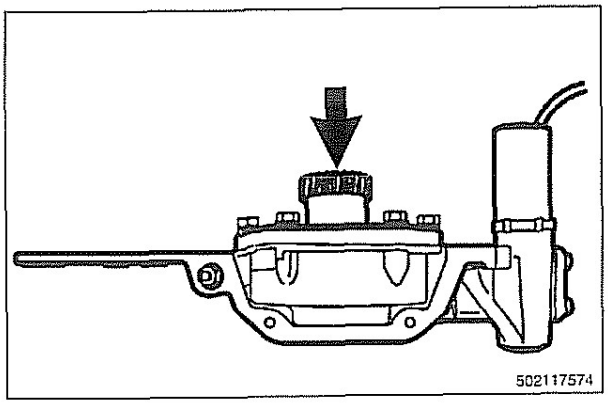
– Make sure camshafts and crankshaft are locked in TDC position with BMW special tools as described during VANOS removal.



➢ Rotate exhaust camshaft sprocket clockwise (as viewed from front of engine) using BMW special tool 11 5 490, until detent position stop is reached.

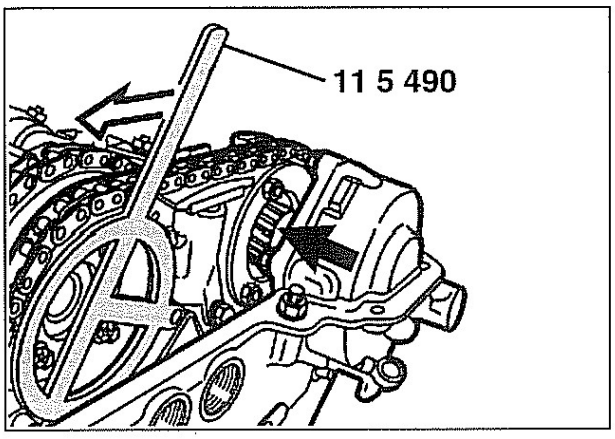


➢ Apply a small amount of liquid gasket sealer (Three Bond 1209 ® or equivalent) to VANOS housing alignment dowels on front of cylinder head. Install a new gasket.



➢ Push VANOS piston gear cup (**arrow**) into VANOS housing until it bottoms out. Position VANOS control unit in front of camshafts, but do not engage splines on gear cup.

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➢ Install BMW special tool 11 5 490 on exhaust camshaft.

– Insert the helical-toothed splined shaft (**arrow**) into the helical-toothed sprocket while rotating gears and chain counterclockwise with special tool.

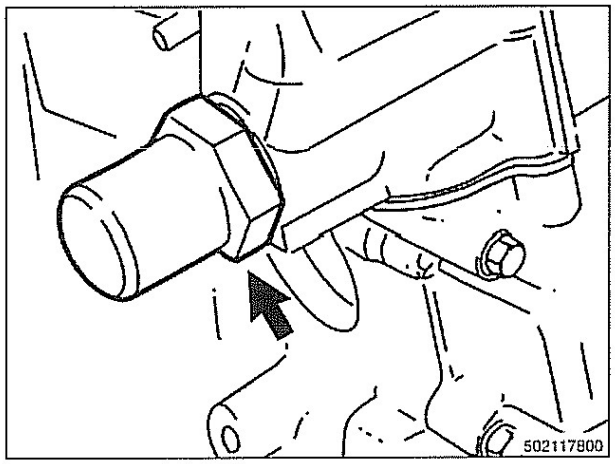
> ***CAUTION—***
> *Ensure that the first available tooth engages. It is important that the exhaust camshaft sprocket be turned only the minimum amount necessary to engage the gear cup. If this procedure is done incorrectly, the VANOS system may not fully function.*

– Install and tighten down VANOS control unit fasteners.

Tightening torques

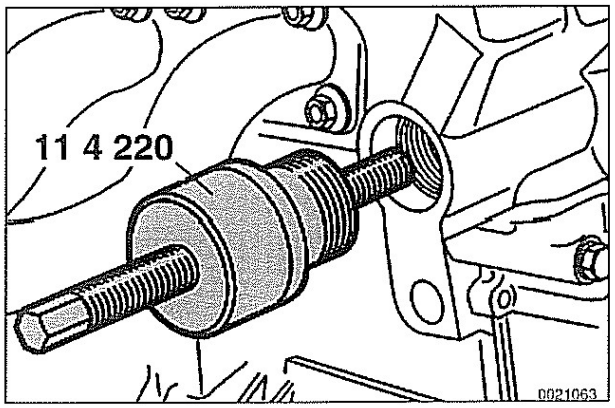
VANOS control unit to cylinder head	
M6 nuts	10 Nm (89 in-lb)
M8 bolts	22 Nm (17 ft-lb)

– Press down on secondary timing chain tensioner and remove lock tool.



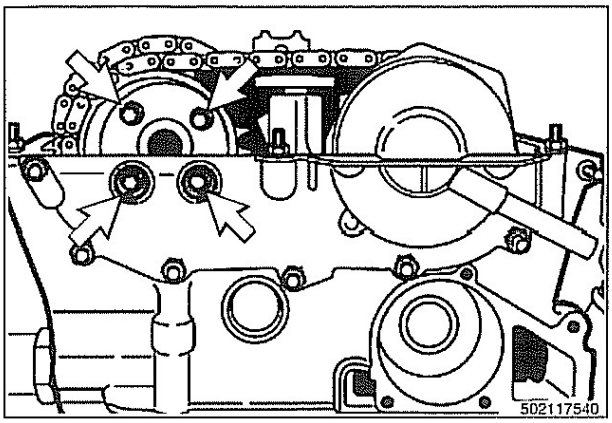
➢ Remove primary timing chain tensioner (**arrow**).

> ***CAUTION—***
> *Timing chain tensioner is under spring tension.*



➢ Install adjustable primary chain tensioner (BMW special tool 11 4 220) and preload timing chain by tightening to 1.3 Nm (11 in-lb).

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➢ Tighten exhaust camshaft sprocket mounting bolts (**arrows**) alternately in two stages.

Tightening torques

Secondary timing chain sprockets to camshafts

Stage 1	5 Nm (44 in-lb)
Stage 2	22 Nm (17 ft-lb)

– Remove crankshaft locking tool and camshaft locking tool set.

– Install camshaft gear bolt access plugs using new sealing washers and tighten.

– Remove timing chain tensioning tool from side of cylinder head. Install primary chain tensioner with new sealing washer and tighten.

Tightening torques

Access plugs to VANOS control unit	50 Nm (37 ft-lb)
Primary timing chain tensioner plug to tensioner sleeve	70 Nm (52 ft-lb)

– Check adjustment VANOS system, see **VANOS timing, checking and adjusting (M52 engine)**.

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VANOS timing, checking and adjusting (M52 engine)

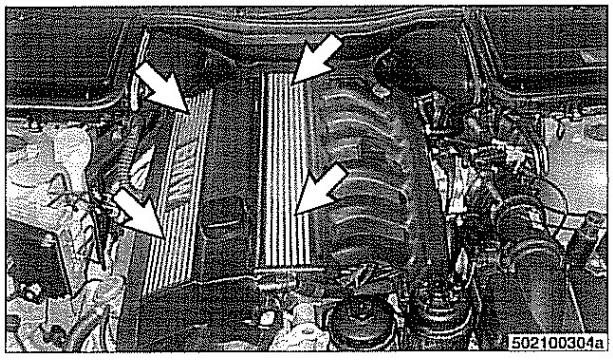
NOTE—
- *Special BMW service tools are required to remove and install the VANOS control unit. Read the procedure through before starting the job.*
- *If the camshafts are not properly timed, the pistons can contact the valves.*

– Disconnect negative (-) cable from battery.

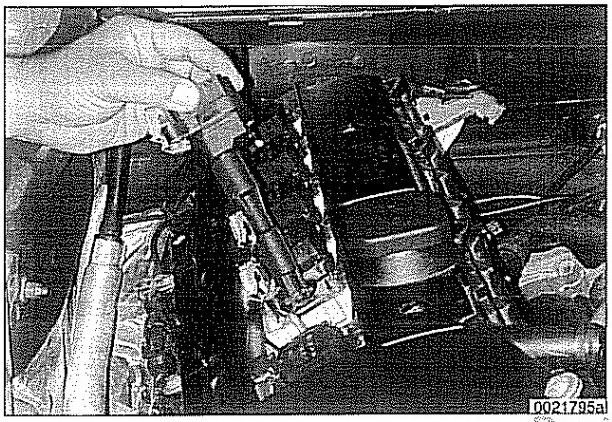
> ***CAUTION—***
> - *Disconnecting the battery may erase fault code(s) stored in control module memory. Prior to disconnecting the battery, check for fault codes using special BMW diagnostic equipment.*
> - *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings.***

– Remove viscous clutch cooling fan. See **170 Radiator and Cooling System**.

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



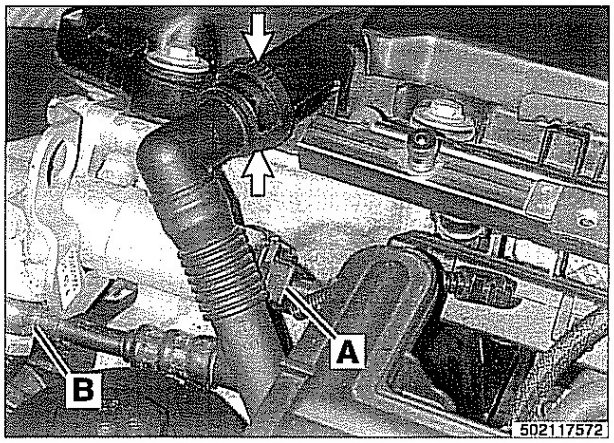
Remove engine trim covers:
- Pry out plastic trim caps (**arrows**).
- Remove cover fasteners and covers.



Remove ignition coils:
- Disconnect ignition coil electrical harness connectors.
- Remove coil mounting fasteners and remove coils.
- Remove spark plugs.

NOTE—
Make note of ignition coil ground strap locations.

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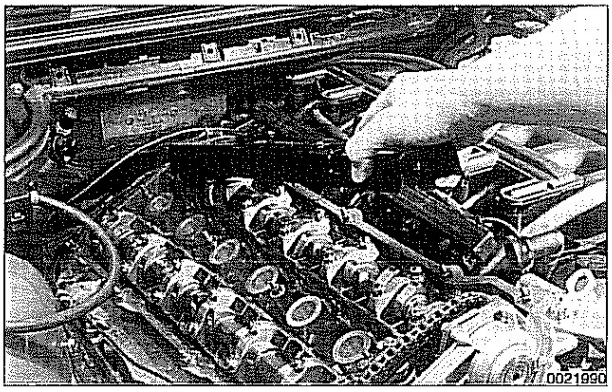
- Disconnect VANOS electrical harness connector (**A**) and oil line fitting (**B**) from VANOS control unit.

NOTE —
Wrap the VANOS oil line fitting with a shop rag to absorb leaking oil.

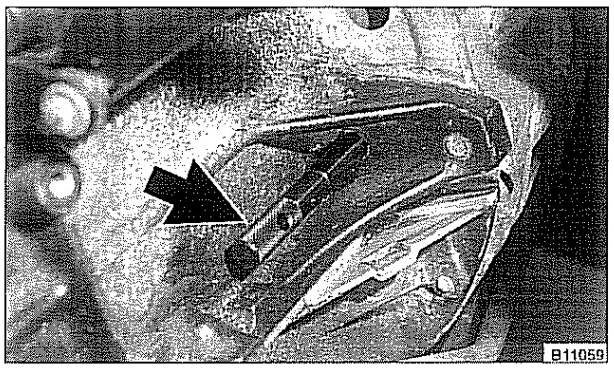
- Disconnect crankcase breather by squeezing at arrows.

– Remove cylinder cover mounting fasteners and remove cylinder head cover.

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



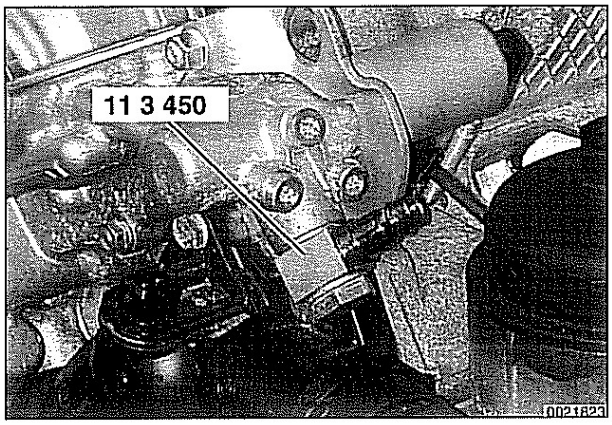
- Remove oil baffle cover from intake camshaft.



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

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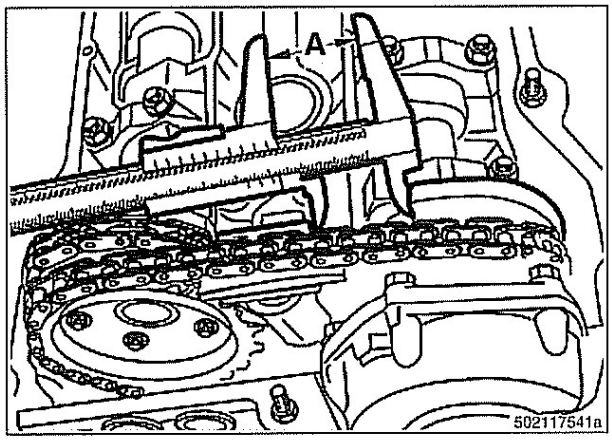
Camshaft Timing Chain



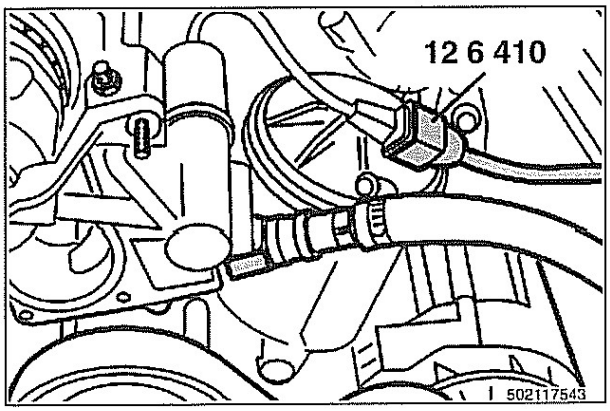
- Remove banjo bolt from VANOS unit oil feed line and install BMW special tool 11 3 450.

  NOTE—
  Oil will drain from oil feed line.

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



- Measure gap (**A**) between secondary timing chain tensioner and intake camshaft sensor wheel. Make note of distance.

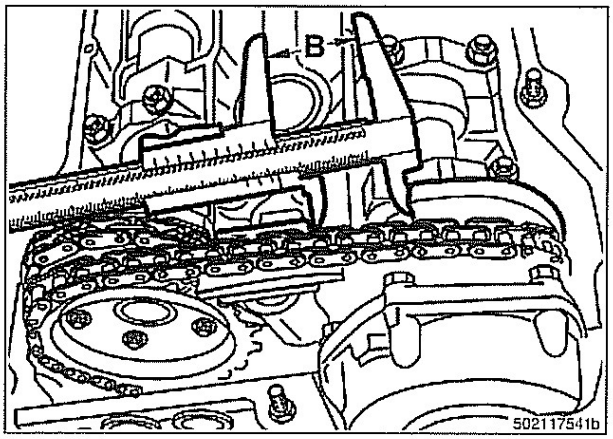


- Connect cable test (BMW special tool 11 6 410) to VANOS connector. Connect positive clip to positive battery terminal.

– Connect negative clip to battery negative terminal.

> ***CAUTION—***
> *Reversing terminals on special tool will damage diode on VANOS solenoid valve.*

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➢ Measure gap (**B**) between secondary timing chain tensioner and intake camshaft sensor wheel. Make note of distance.

– To determine VANOS control travel:
  - Distance B — distance A = a minimum of 8.5 mm.

> ***CAUTION—***
> *If the adjustment travel is less than 8.5 mm, the VANOS adjustment unit must be removed and readjusted. See* ***VANOS control unit, removing (M52 engine)*** *and* ***VANOS control unit, installing (M52 engine).***

– Remove special tools:
  - Crankshaft locking tool.
  - Camshaft locking tool set.
  - Air fitting.
  - VANOS cable adaptor.

– Install VANOS oil line with new seal.

– Install oil baffle cover above intake camshaft.

– Install cylinder head cover mounting studs to rear of head.

– Install cylinder head cover.

Tightening torques

Cylinder head cover	10 Nm (89 in-lb)
VANOS oil line	32 Nm (24 ft-lb)
VANOS solenoid to control unit	30 Nm (22 ft-lb)

– Installation of remaining parts is reverse of removal.

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Timing chains, removing (M52 engine)

Camshaft timing chain removal on M52 engines requires engine oil pan removal.

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

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

– Remove VANOS control unit. See **VANOS control unit, removing (M52 engine)**.

– Remove radiator cooling fan and shroud. See **170 Radiator and Cooling System**.

– Drain cooling system. See **170 Radiator and Cooling System**.

– Remove coolant hoses from thermostat housing and remove thermostat housing from front of cylinder head.

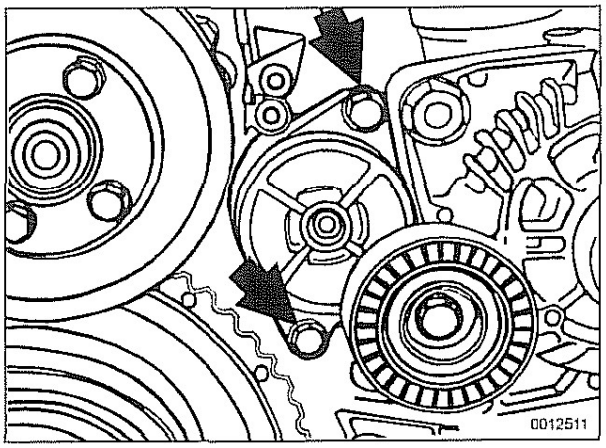
– Loosen bolts for coolant pump pulley.

– Remove drive belts for alternator and A/C compressor. See **020 Maintenance**.

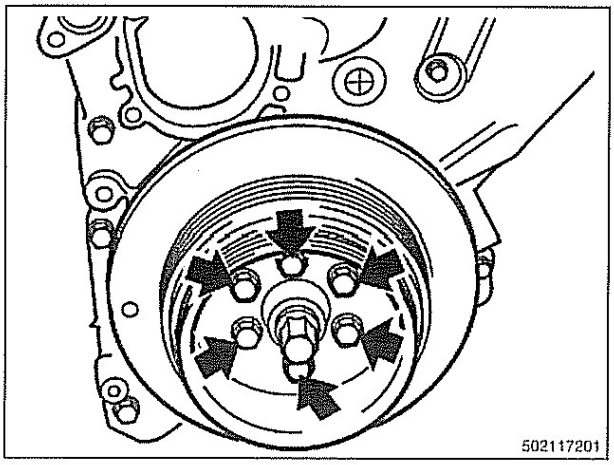
– Remove coolant pump pulley.

◁ Remove drive belt tensioner mounting bolts (**arrows**) and remove tensioner from front of engine.

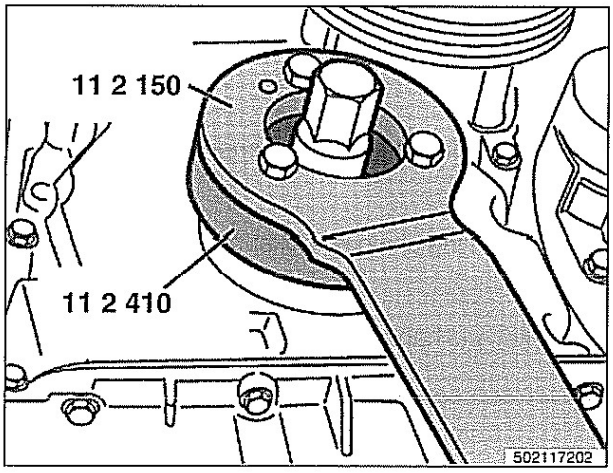
– Remove engine speed sensor from lower timing chain cover.



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➢ With crankshaft at TDC position, remove vibration damper bolts (**arrows**) and remove vibration damper.



➢ Mount crankshaft holding tool (BMW special tool 11 2 150 and 11 2 410) to crankshaft hub. Counter hold crankshaft and loosen crankshaft hub retaining bolt.

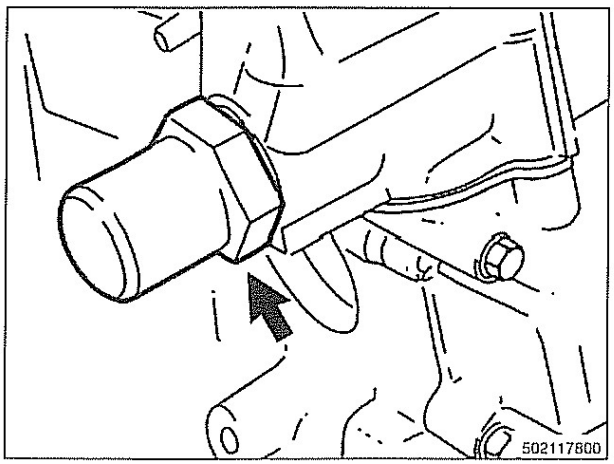
CAUTION—
Crankshaft hub retaining bolt is torqued to 410 Nm (300 ft-lb). Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.

– Remove crankshaft hub.

– Remove cylinder cover mounting fasteners and remove cylinder head cover.

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

– Drain engine oil, remove oil pan. See **119 Lubrication System**.



➢ Remove primary timing chain tensioner (**arrow**).

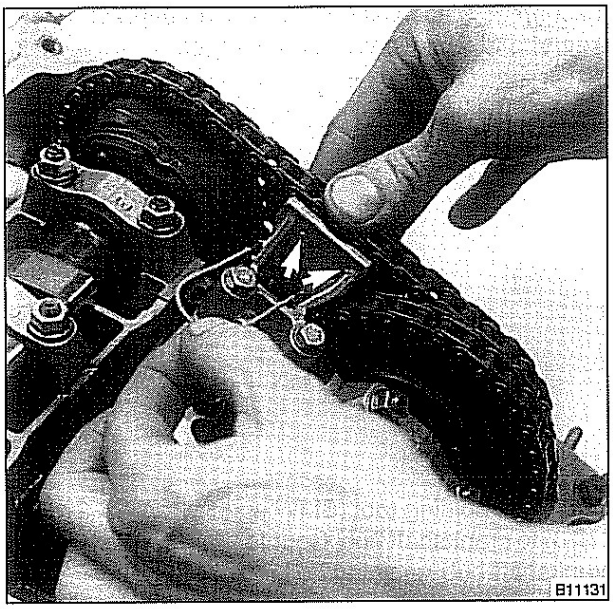
CAUTION—
Timing chain tensioner is under spring tension.

– Remove VANOS control unit. See **VANOS control unit, removing (M52 engine)**.

– Remove fasteners from intake and exhaust camshaft sprocket.

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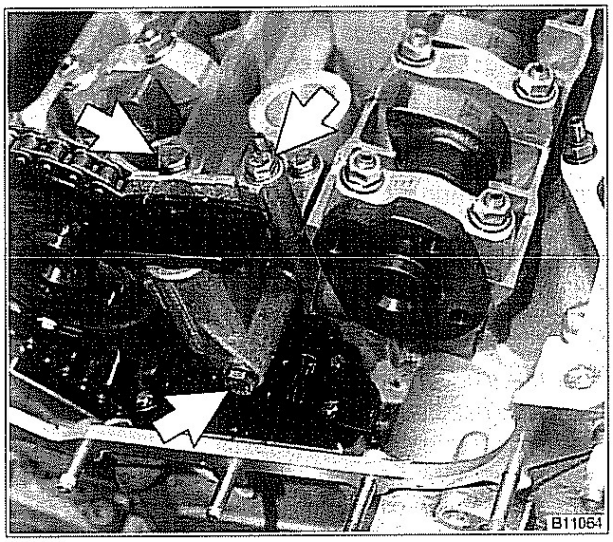
Camshaft Timing Chain



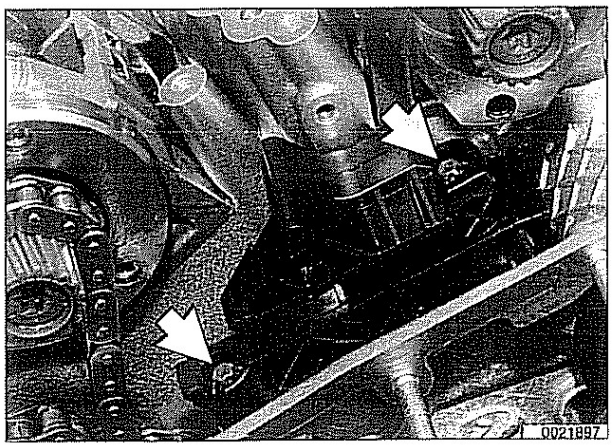
- While pressing down on secondary timing chain tensioner install locking tool (BMW 11 3 292) or a similar pin.

NOTE—
Two types of secondary timing chain tensioners are used, with either two holes (shown) or a single hole for the locking pin tool.

- Remove intake and exhaust sprockets together with secondary chain.

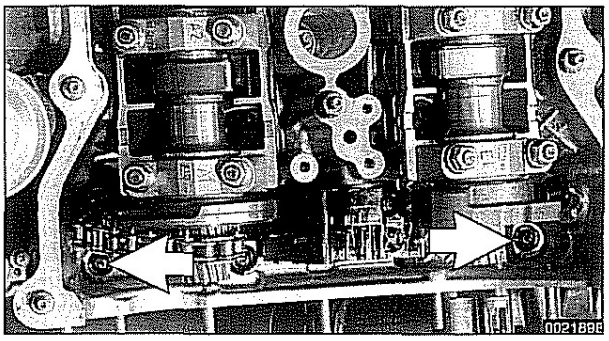


- Remove secondary timing chain tensioner bolts (**arrows**) and remove tensioner.
- Remove primary timing chain sprocket from exhaust camshaft.
- Remove sprocket and hang timing chain from end of exhaust camshaft.

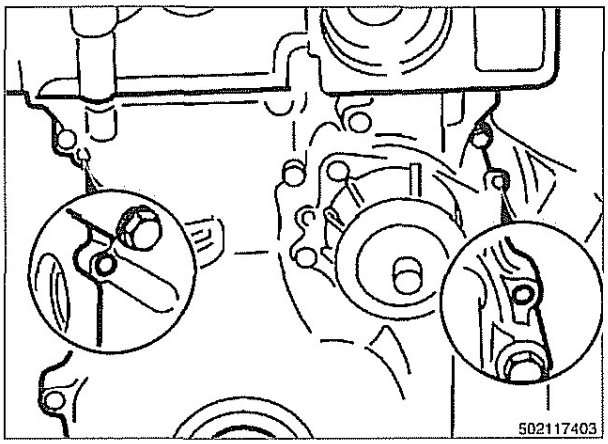


- Remove secondary chain guide bolts (**arrows**) and remove guide.

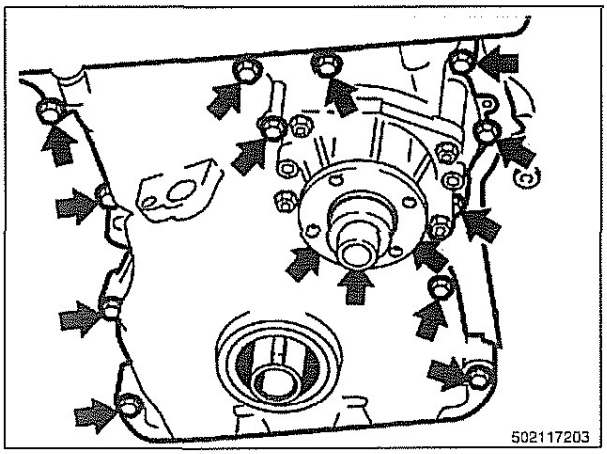
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➢ Remove lower timing chain cover to cylinder head bolts (**arrows**).



➢ Using a drift, drive two locating dowels (**arrows**) in lower timing cover toward rear of car.



➢ Remove timing cover mounting bolts (**arrows**).

- Carefully slide cover with water 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 and valvetrain**.*

– Remove timing cover locating dowels by driving them forward.

– Lift primary chain sprocket off crankshaft sprocket and remove chain.

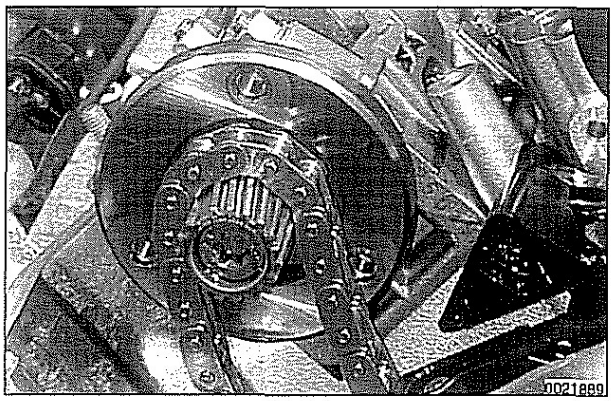
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Timing chain, installing (M52 engine)

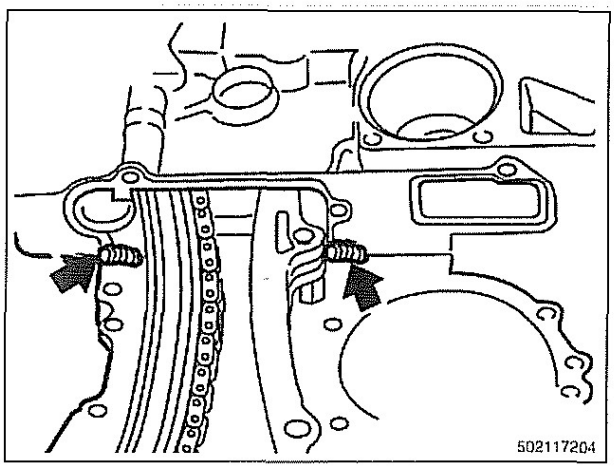
CAUTION—
The procedure outlined below assumes that the camshafts and the crankshaft are locked in the TDC position with BMW special tools.

– Inspect timing chain and sprockets and guide rails for wear. Replace worn parts.

NOTE—
If any of the sprockets are being replaced due to wear, the chain should also be replaced.

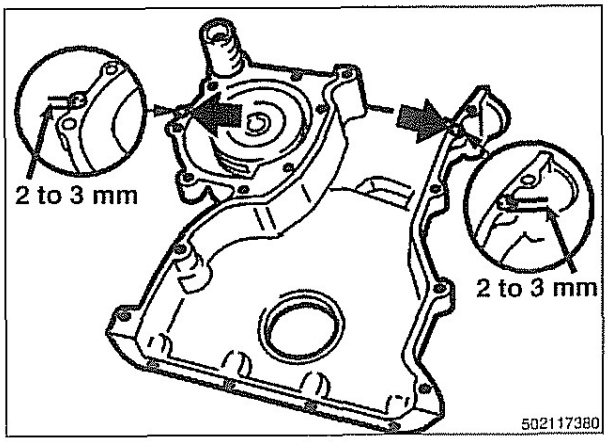


➢ Install primary timing chain to crankshaft sprocket and hang on exhaust camshaft.



➢ Apply a small bead of silicon sealer (Three Bond 1209 ® or equivalent) to corners where timing cover meets cylinder head (**arrows**).

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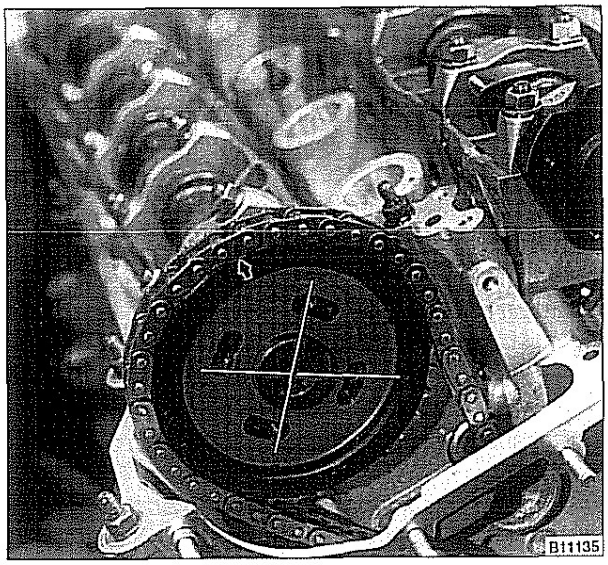
- Tap locating dowels into cover until they protrude 2 to 3 mm from sealing surface.

– Using new gaskets, install lower timing chain cover:
  - Tap cover into position to engage dowels.
  - Install timing chain cover fasteners and tighten to 5 Nm (44 in-lb).
  - Drive dowels in flush to front of cover.
  - Tighten cover mounting bolts alternately and in stages.
  - Install cylinder head to timing chain cover fasteners and tighten.

Tightening torques

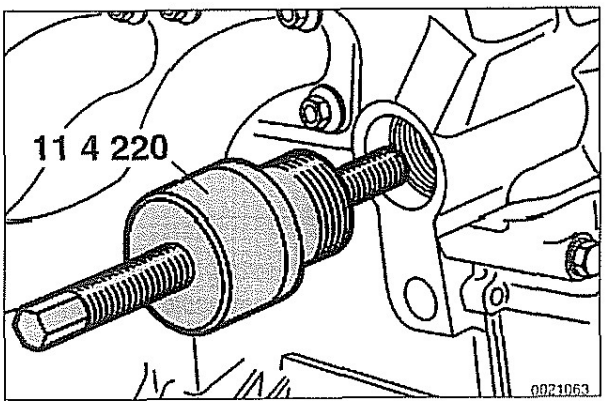
Lower timing chain cover to block	
M7	15 Nm (11 ft-lb)
M8	20 Nm (15 ft-lb)

– Replace front crankshaft radial seal. See **Crankshaft oil seal, front, replacing (M52 engine)**.



– Install engine oil pan using a new gasket. See **119 Lubrication System**.

- Mount primary timing chain sprocket to primary chain so that arrow on sprocket faces up. Mount sprocket to camshaft so that tapped holes in camshaft are on left side of elongated holes in sprocket.



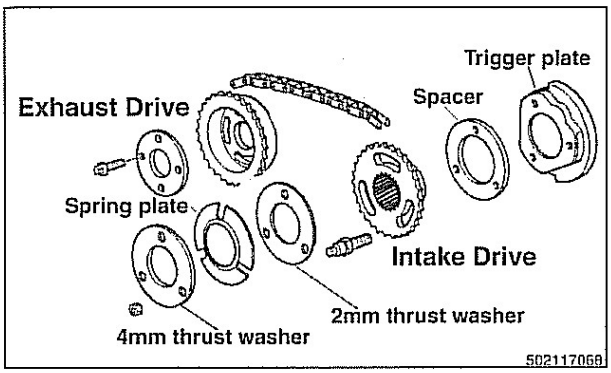
- Install adjustable timing chain tensioner (BMW special tool 11 4 220). Thread tool in finger tight until slack is removed from chain.

NOTE—
BMW special tool 11 4 220 is an adjustable timing chain tensioner that simulates the function of the hydraulic tensioner.

– Check that elongated holes in primary sprocket are centered to bolt holes in camshaft and chain is free of slack.

– Install secondary timing chain guide and secondary chain tensioner. Tighten mounting bolts (tensioner remains locked down).

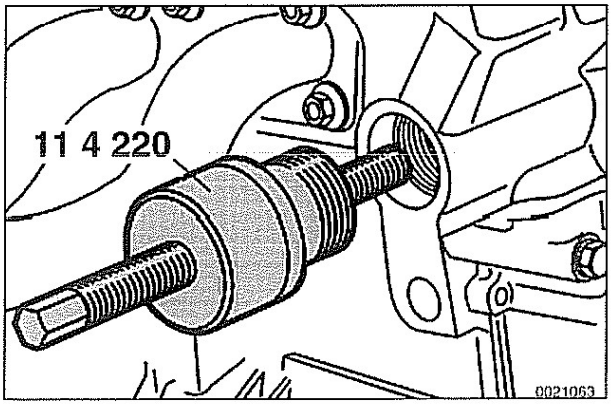
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- Install cylinder identification trigger plate to front of intake camshaft.
- Install spacer to front of intake camshaft.
- Install secondary chain sprockets and chain as an assembly so that arrows on sprockets are pointing up. Center mounting holes in sprockets to bolt holes in camshafts.
- Install thrust washers and spring plate to intake cam sprocket.
- Tighten intake camshaft sprocket nuts.
- Install VANOS control unit, see **VANOS control unit, installing (M52 engine)**.

Tightening torque	
Intake camshaft sprocket nuts to studs (M6)	10 ±1 Nm (89 ±9 in-lb)

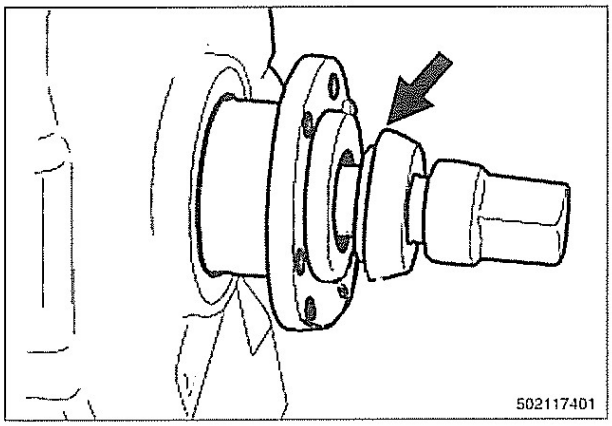
- Unlock and release secondary chain tensioner.



- Preload primary timing chain by torquing adjustable primary chain tensioner (BMW special tool 11 4 220) to 1.3 Nm (11 in-lb).
- Tighten exhaust camshaft sprocket bolts in two stages.

Tightening torque	
Exhaust camshaft sprocket bolts (M7)	
Stage 1	5 Nm (44 in-lb)
Stage 2	22 Nm (17 ft-lb)

- Remove crankshaft locking tool and camshaft locking tools.



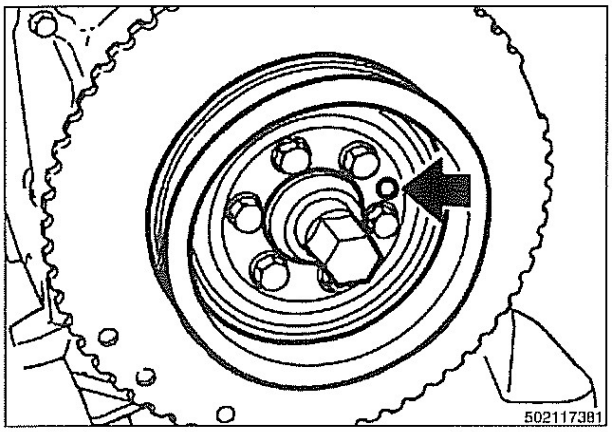
- Align hub with keyway and tap into place. Insert new center bolt with washer shoulder (**arrow**) facing hub.

> ***CAUTION—***
> *Inspect woodruff key for damage before installing hub.*

- Attach crankshaft holding tool (BMW special tools 11 2 150/11 2 410) to hub. Counterhold hub with tool while tightening center bolt.

> ***CAUTION—***
> *Do not use 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.*

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Tightening torque	
Vibration damper hub to crankshaft	410 Nm (300 ft-lb)

Install crankshaft hub and vibration damper while aligning locating hole (**arrow**) in damper with dowel pin in hub.

Tightening torque	
Vibration damper and pulley to crankshaft hub	22 Nm (17 ft-lb)

– Turn engine over by hand in direction of rotation at least two full rotations. Reinstall camshaft and crankshaft locking tools to recheck engine timing. Remove locking tools if no faults are found.

– Remove BMW special tool 11 3 390 (dummy tensioner) from side of cylinder head.

– Install primary chain tensioner so that cutout in tensioner piston engages chain rail.

Tightening torque	
Timing chain tensioner to tensioner sleeve	70 Nm (52 ft-lb)

– Install cylinder head cover mounting studs, camshaft cover, and cylinder head cover.

Tightening torque	
Cylinder head cover to cylinder head	
M6 nut	10 Nm (89 in-lb)
M8 bolt	22 Nm (17 ft-lb)

– Installation of remaining parts is reverse of removal, noting the following:

- When installing thermostat, make sure arrow or vent hole faces up, if applicable.
- Refill cooling system as described in **170 Radiator and Cooling System**.
- Fill engine with oil and install new oil filter as described in **020 Maintenance**.

Tightening torque	
Upper timing chain cover to cylinder head	
M6 nut	10 Nm (89 in-lb)
M8 bolt	22 Nm (17 ft-lb)
VANOS oil supply pipe to VANOS control unit banjo bolt	32 Nm (24 ft-lb)

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DOUBLE VANOS SYSTEM (M52 TU AND M54 ENGINES)

Double VANOS system function

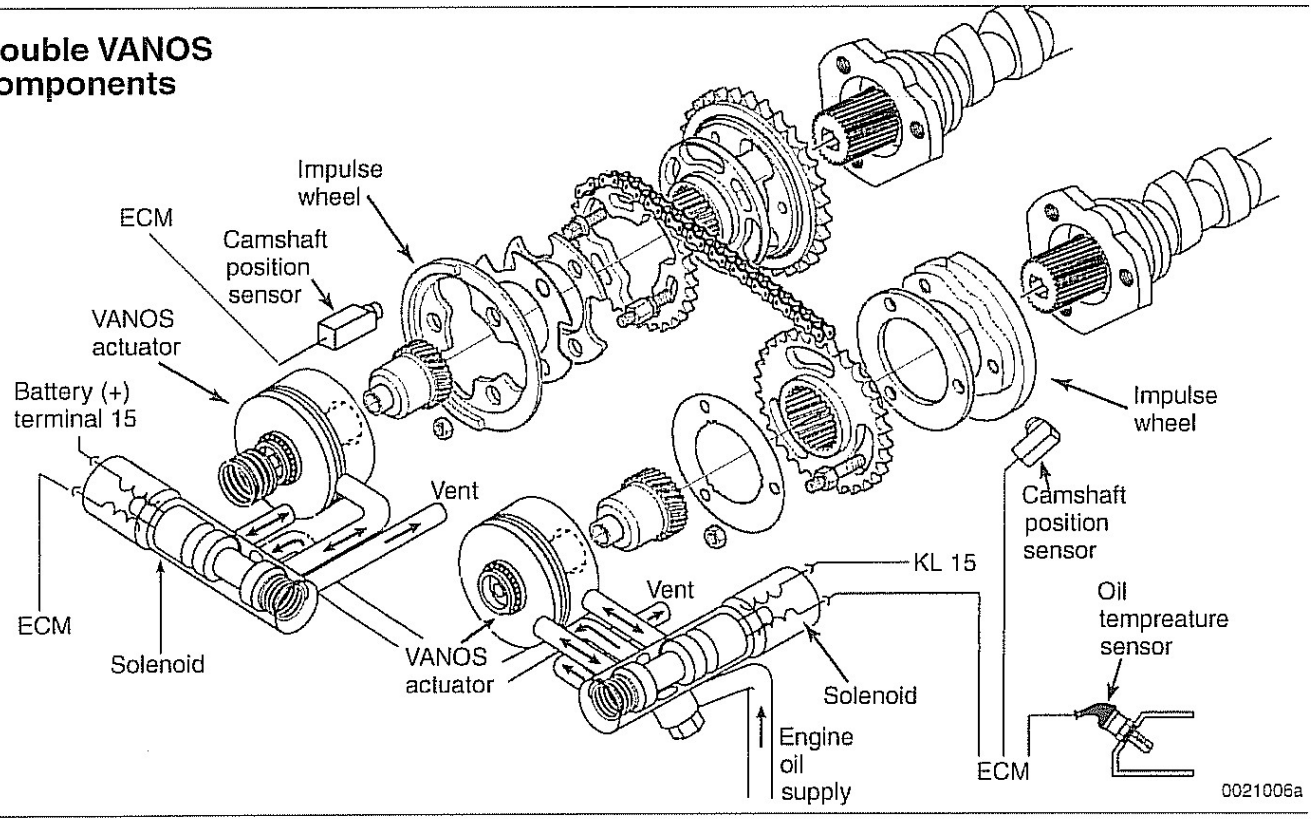
The M52 TU and M54 6-cylinder engines are equipped with a Double VANOS system that varies intake and exhaust camshaft timing.

The main components of the Double VANOS system are:

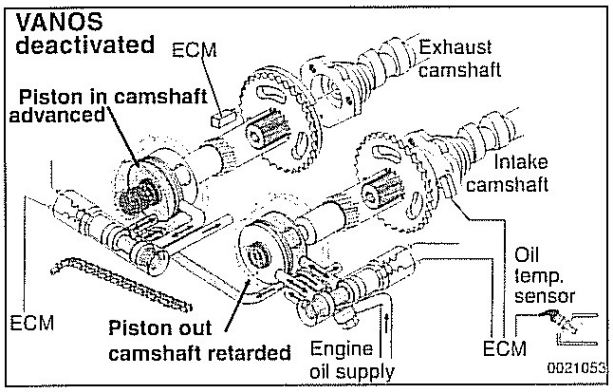
- Intake and exhaust camshafts with helical spline inserts.
- Camshaft sprockets with adjustable gears.
- VANOS actuators (two position piston housing with internal/external helical spline cup).
- Three-way solenoid switching valves.
- Camshaft position impulse wheels.
- Hall effect camshaft position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

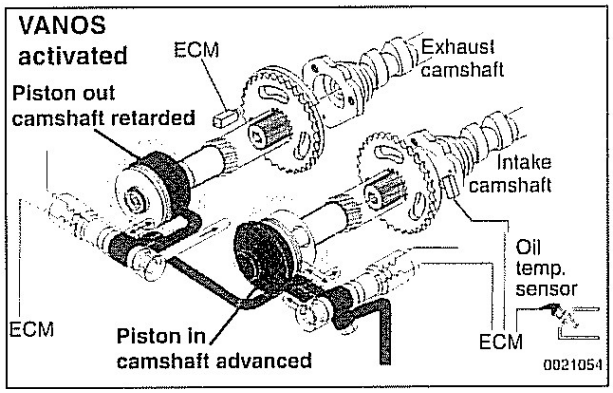
Camshaft position is varied based on engine rpm, throttle position signal, intake air and coolant temperature.

Double VANOS components



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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 and newer), the engine control module (ECM) detects camshaft position before the engine starts, thereby adjusting camshaft timing immediately upon start-up.

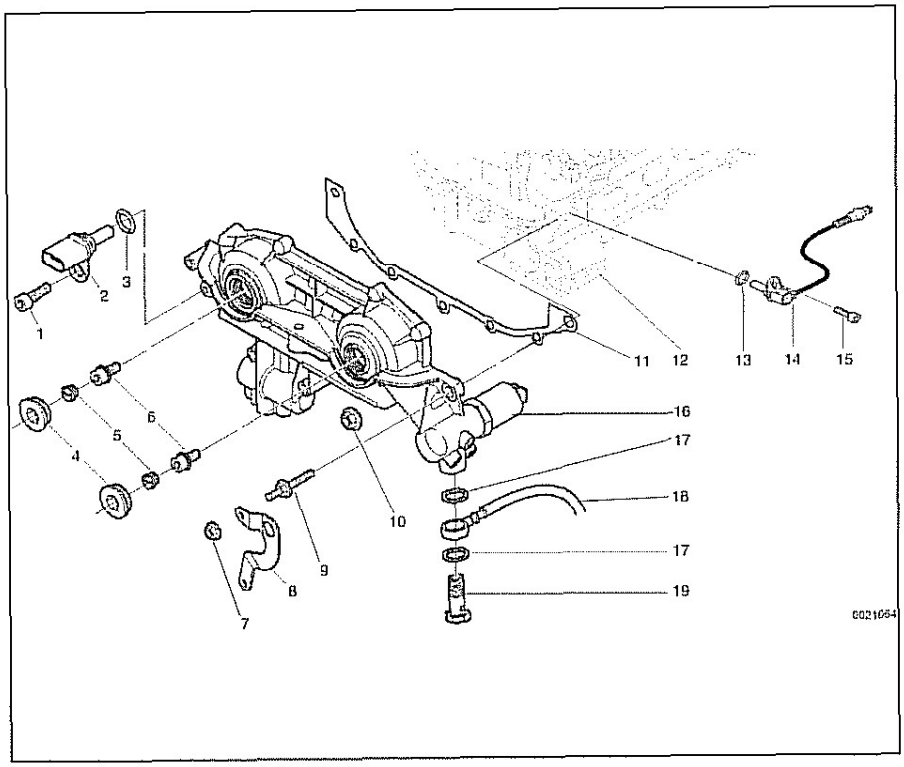
NOTE—

- *VANOS system troubleshooting and diagnostics is best accomplished using a scan tool.*
- *Diagnostic Trouble Codes (DTCs) pertaining to the VANOS system are listed in the following table. See also* ***OBD On-Board Diagnostics****.*
- *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.*

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

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Double 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 lb-in)
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)

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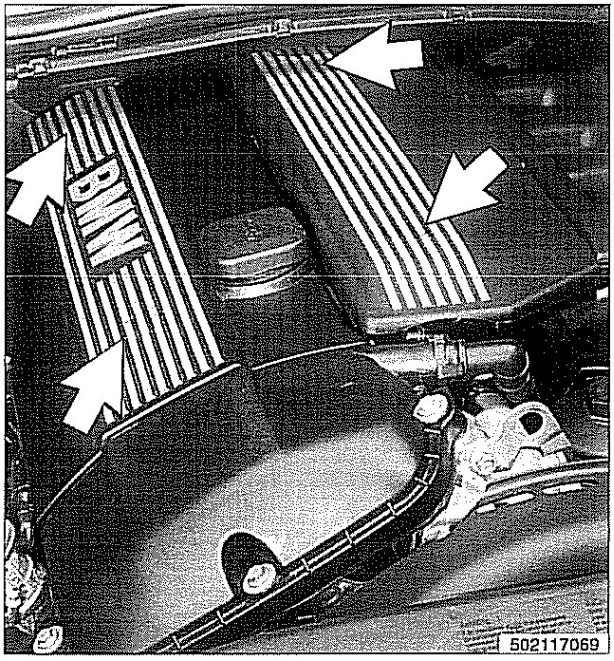
VANOS control unit, removing (M52 TU and M54 engines)

This procedure includes removal of the Double VANOS control unit.

NOTE—
If the Double VANOS control unit is being replaced, camshaft timing must be checked. This procedure requires multiple special tools. Be sure to read the procedures through before beginning the repair.

– Working inside luggage compartment, disconnect negative (-) battery cable.

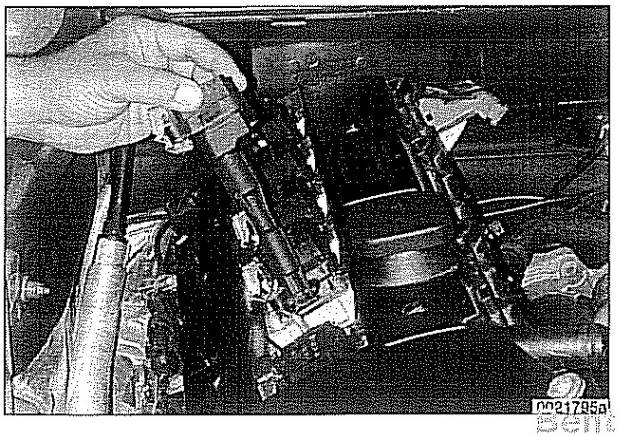
> *CAUTION—*
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*



– Remove engine cooling fan assembly. See **170 Radiator and Cooling System**.

➢ Remove engine trim covers.

- Pry out plastic trim caps (**arrows**).
- Remove cover fasteners, oil filler cap, and covers.



➢ Remove ignition coils:

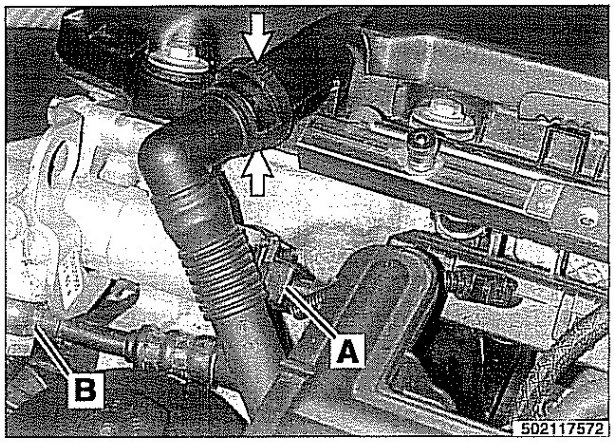
- Disconnect ignition coil electrical harness connectors.
- Remove coil mounting fasteners and coils.

NOTE—
Make note of ignition coil ground strap locations.

– Remove spark plugs.

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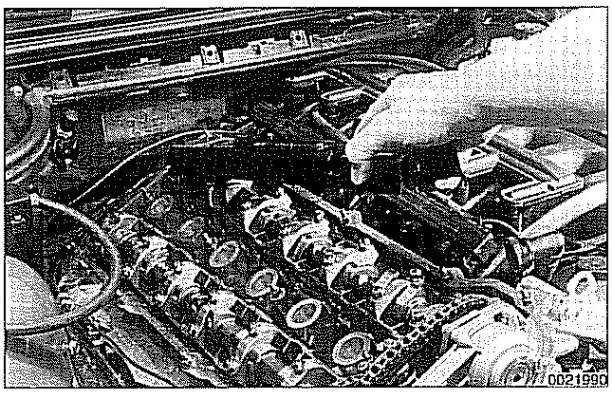
Camshaft Timing Chain



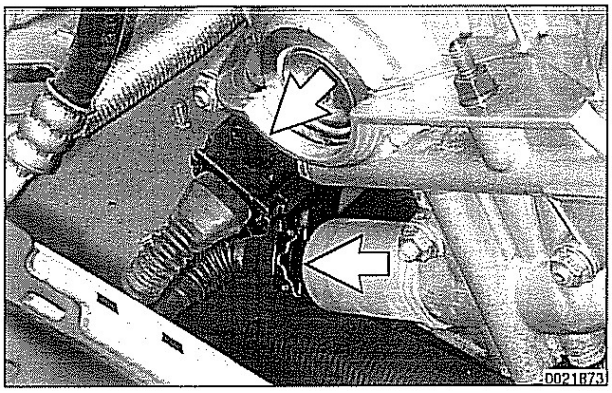
- Disconnect electrical harness connector (**A**), oil line fitting (**B**), and crankcase vent tube (squeeze at **arrows**).

  NOTE—
  Oil will drain from VANOS unit fitting. Use shop rags to keep oil off drive belts.

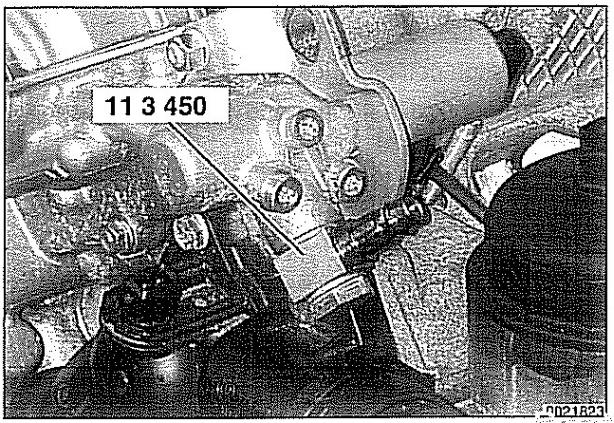
- Remove cylinder head cover fasteners, and cover.



- Remove oil baffle cover from intake camshaft.

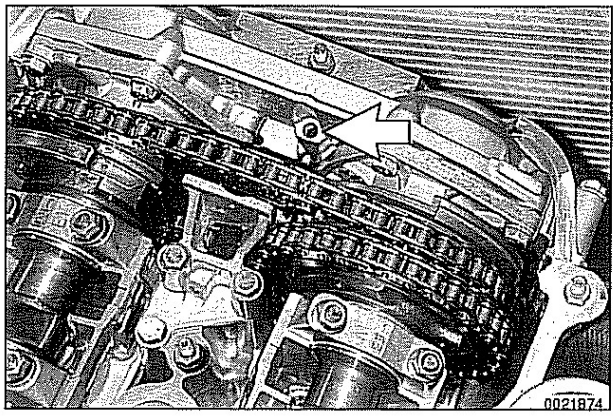


- Disconnect electrical connections from exhaust camshaft position sensor and VANOS control valve (**arrows**).



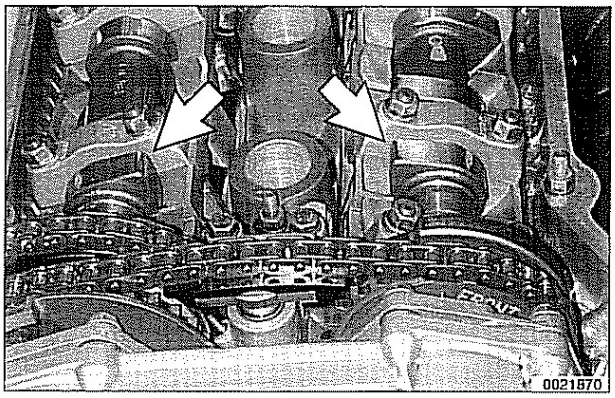
- Using banjo bolt from VANOS control unit oil line, install test fitting (BMW special tool 11 3 450) to VANOS control unit.

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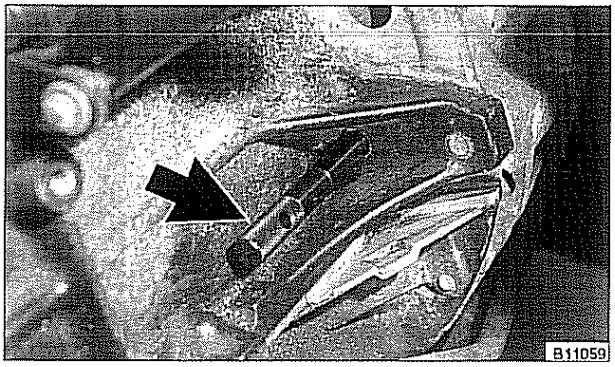
- Cover oil hole in VANOS control unit (**arrow**) with shop towel to capture oil which will spray when compressed air line is connected.

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

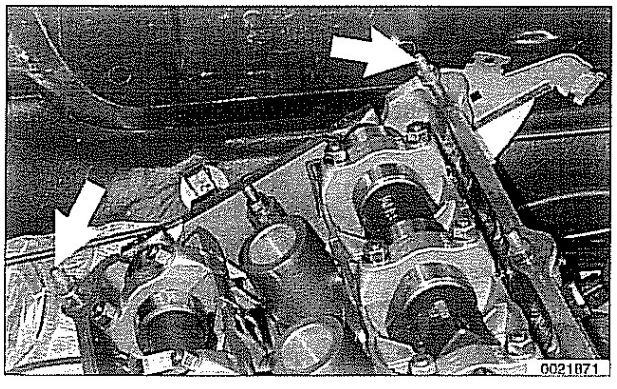


- With compressed air line connected, turn engine clockwise using crankshaft center bolt at least two rotations, until cylinder 1 is at (TDC) position (intake and exhaust camshaft lobes as shown **arrows**).

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



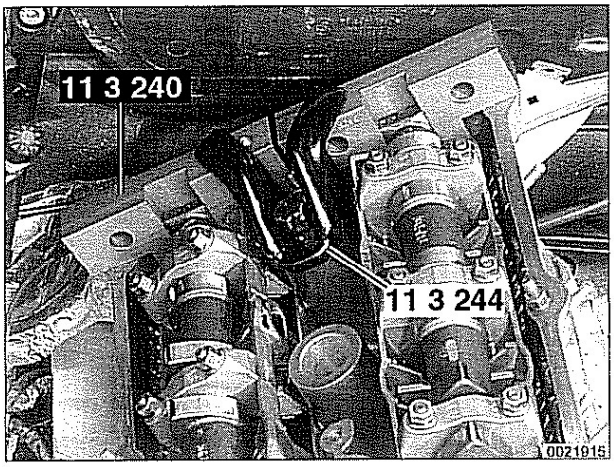
- Remove sealing plug from bore under starter. Lock crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).



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

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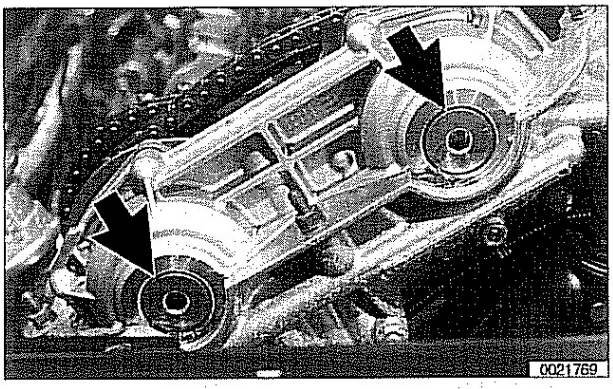
Camshaft Timing Chain



- Secure camshafts in TDC position using BMW special tool set 11 3 240.

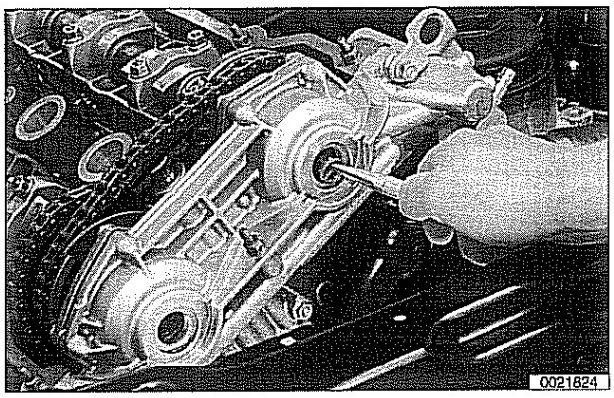
– Disconnect compressed air line, leaving compressed air fitting attached to VANOS control unit.

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



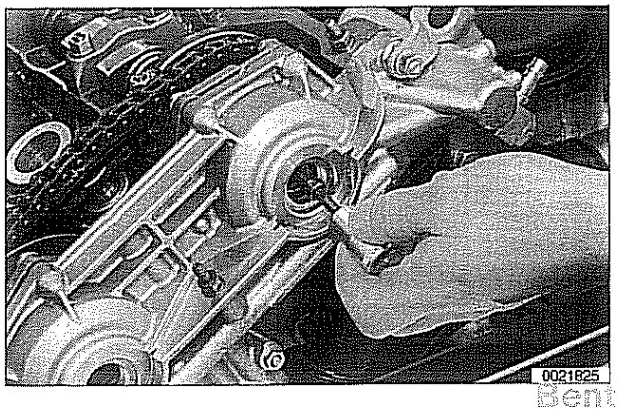
- Unscrew sealing plugs from VANOS control unit (**arrows**).

NOTE —
Oil will drain from sealing plug bores. Have a container and rags ready.



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

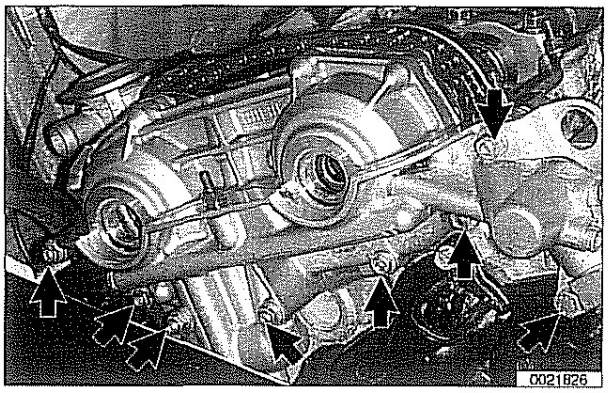
NOTE —
Additional oil may drain from VANOS control unit.



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

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

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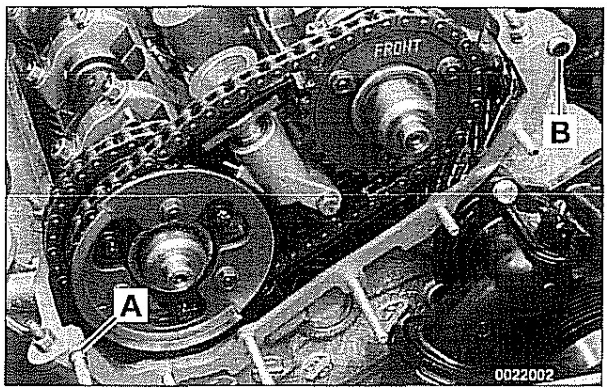


- Remove VANOS unit:
  - Remove fasteners from engine support eye.
  - Remove VANOS mounting nuts (**arrows**) from cylinder head. Slide VANOS control unit and metal gasket off.

NOTE—
- *The VANOS control unit will contain residual oil. Place shop towels beneath adjustment unit when removing.*
- *If the VANOS control unit is replaced, or if repair operations are completed that may change camshaft timing, the camshaft timing must be checked as described in **VANOS timing, checking and adjusting (M52 TU and M54 engines).***

CAUTION—
Do not crank the engine with VANOS unit removed. Piston/valve interference may result.

VANOS control unit, installing (M52 TU and M54 engines)



- Clean contact edges of cylinder head face and double VANOS control unit and apply a thin coat of sealing compound (Three 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.*
- *Check locating dowel (A) and dowel sleeve (B) at top of cylinder head for damage or incorrect installation.*

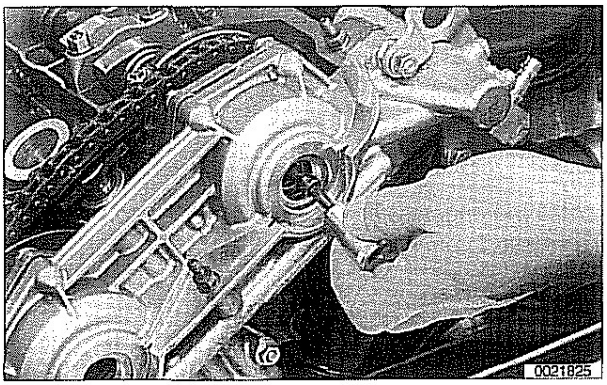
NOTE—
- *If the Double VANOS control unit is being replaced, be sure to check and adjust camshaft timing, see **VANOS timing, checking and adjusting (M52 TU and M54 engines).***
- *If work being carried out has no effect on camshaft timing, it is not necessary to recheck the timing. It is recommended, however, that the VANOS operation be checked using a compatible scan tool once the engine is running.*

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

Tightening torques

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

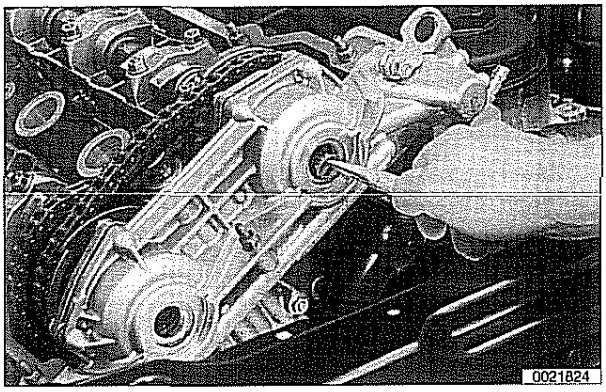


➢ Insert and tighten VANOS hydraulic piston set screws on intake and exhaust camshafts.

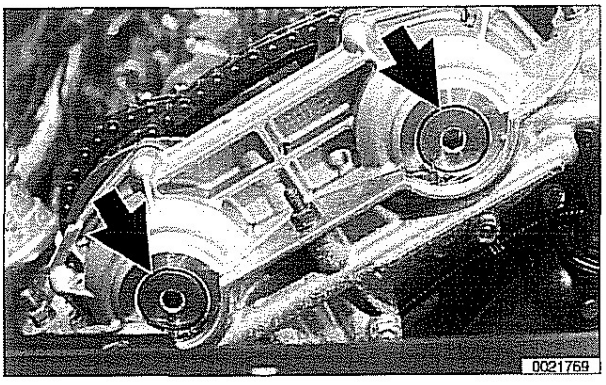
CAUTION—
Set screws have left hand thread. Tighten counterclockwise.

Tightening torque

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



➢ Replace sealing caps inside VANOS control 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 control unit	50 Nm (37 ft-lb)

– Remove compressed air fitting from VANOS control unit.

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

Tightening torque

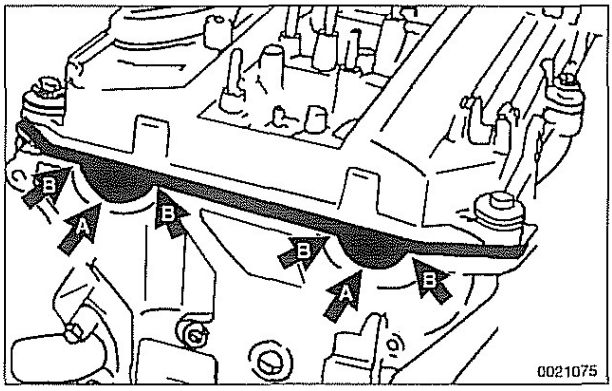
Oil line to VANOS control unit (banjo bolt)	32 Nm (24 ft-lb)

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– Connect electrical harness connectors to camshaft position sensors and VANOS solenoid valves.

– 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 Three 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 control unit.

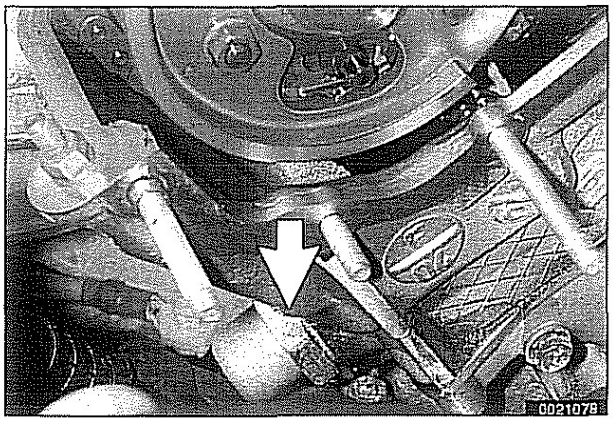
Tightening torque	
Cylinder head cover to cylinder head (M6)	10 Nm (89 in-lb)

– 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)

VANOS timing, checking and adjusting (M52 TU and M54 engines)

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. Also, be sure the cooling fan and the spark plugs have been removed.

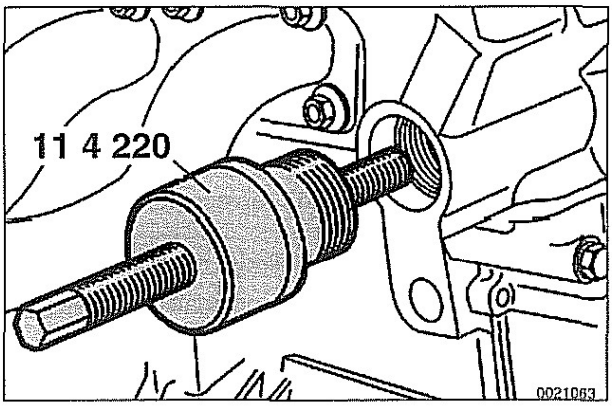


Remove primary camshaft chain tensioner cylinder (**arrow**).

> ***CAUTION—***
> *Primary camshaft chain tensioning piston is under spring pressure.*

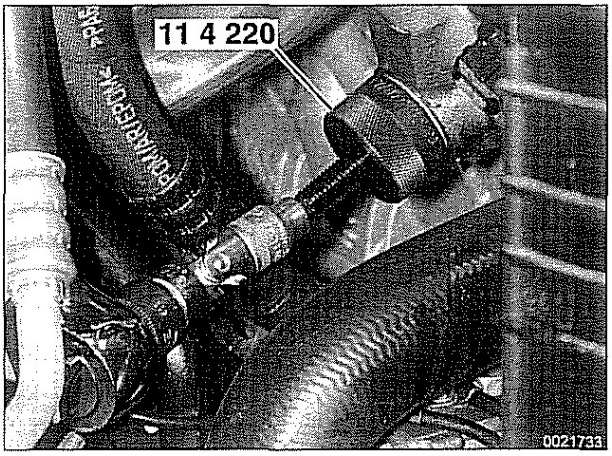
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Camshaft Timing Chain



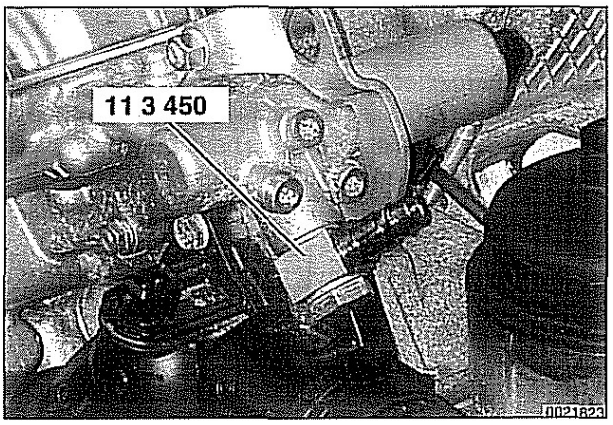
- Insert BMW special tool 11 4 220 in cylinder head and bring *adjustment screw into contact with tensioning rail.*

NOTE—
BMW special tool 11 4 220 is an adjustable primary chain tensioner that 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)

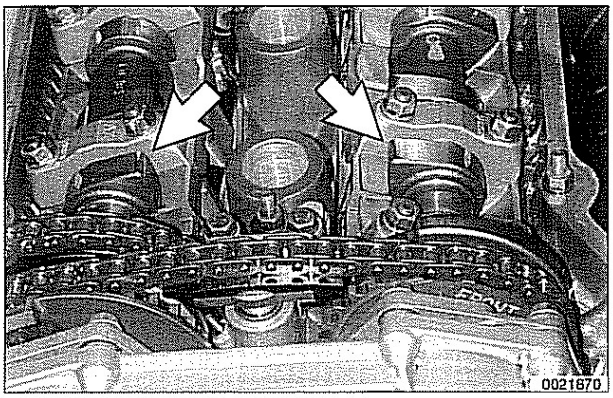


- Unscrew oil pressure pipe from VANOS control unit. Remove banjo bolt from oil pressure line and install BMW special tool 11 3 450.

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

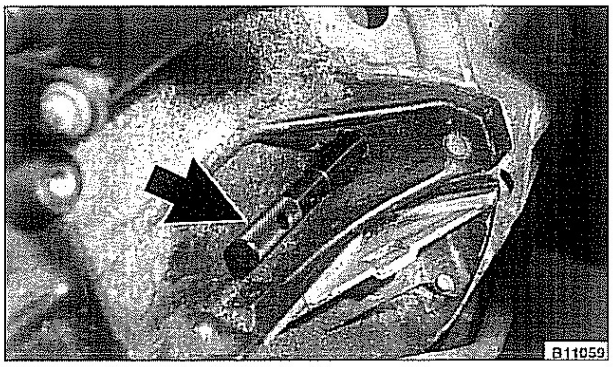
– Connect compressed air line to air fitting. Apply air pressure set to 2 - 8 bar (30 - 110 psi).

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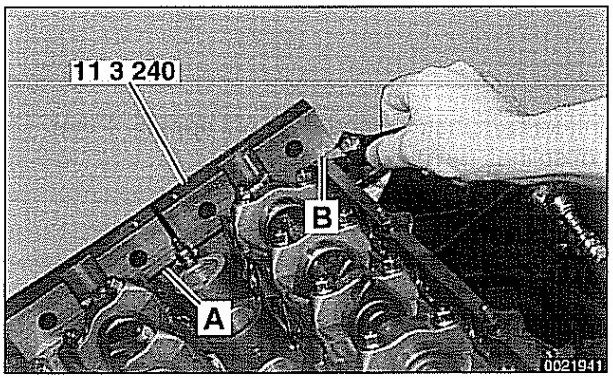
- With compressed air line connected, turn engine at least twice in direction of rotation until cylinder 1 intake and exhaust camshaft lobes (**arrows**) face each other.

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



- Remove sealing plug from bore at bellhousing. Secure crankshaft in TDC position with BMW special tool 11 2 300 (**arrow**).

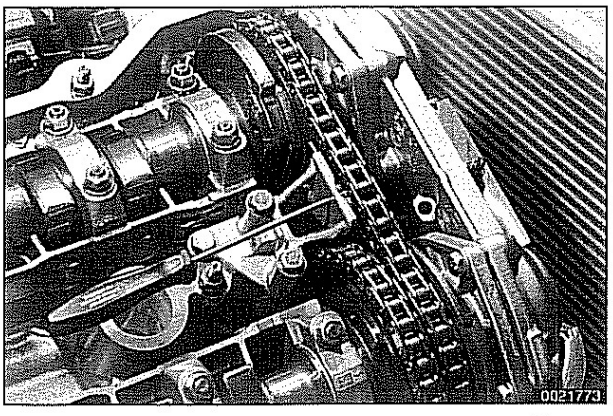
– Remove cylinder head cover studs at rear of cylinder head.



- 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, adjust camshaft timing as described below.*
- *Due to flexible sprocket design and VANOS control unit tolerances and play, 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, adjust camshaft timing as described below.*

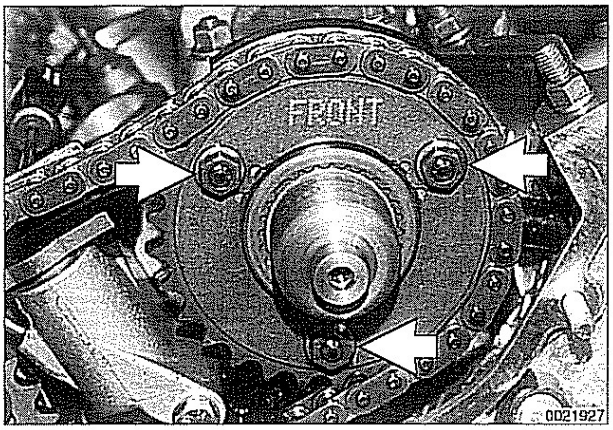
– Remove double VANOS control unit. See **VANOS control unit, removing (M52 TU and M54 engines)**.



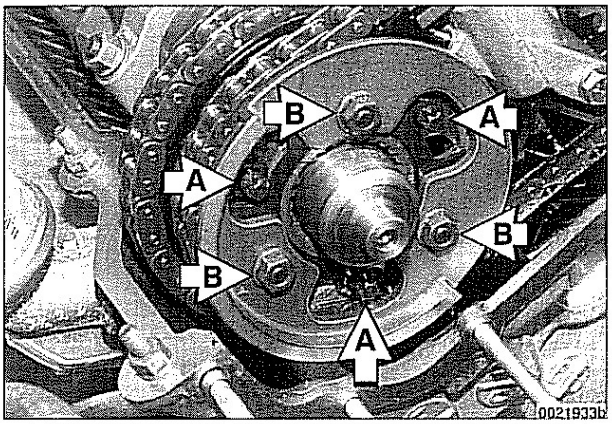
- Press down on secondary chain tensioner and lock into place using BMW special tool 11 3 292 or equivalent pin or drift.

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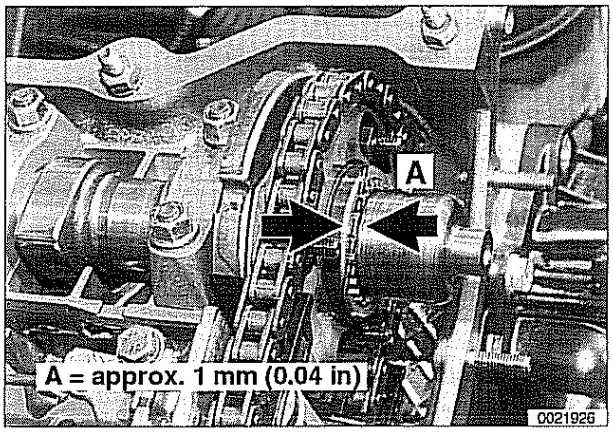
Camshaft Timing Chain



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

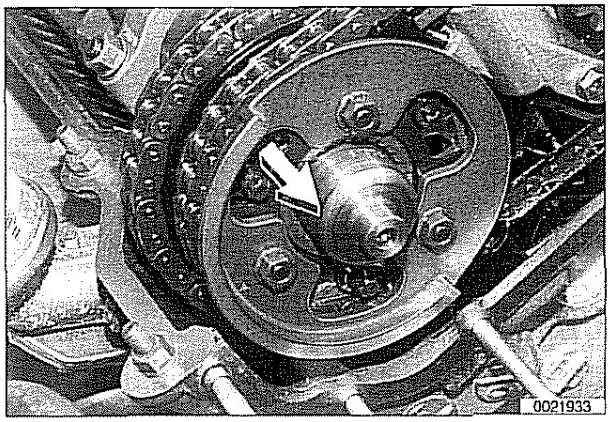


- Loosen exhaust camshaft sprocket mounting bolts:
  - Release bolts (**A**) 1/2 turn
  - Release nuts (**B**) 2 turns



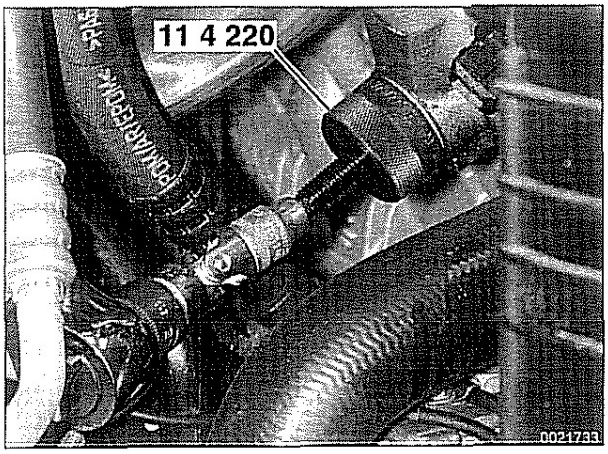
- Pull out intake camshaft splined shaft out approx. 1 mm (0.04 in) of splines (**arrows**) can be seen.

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➢ Pull out exhaust camshaft splined shaft to stop.

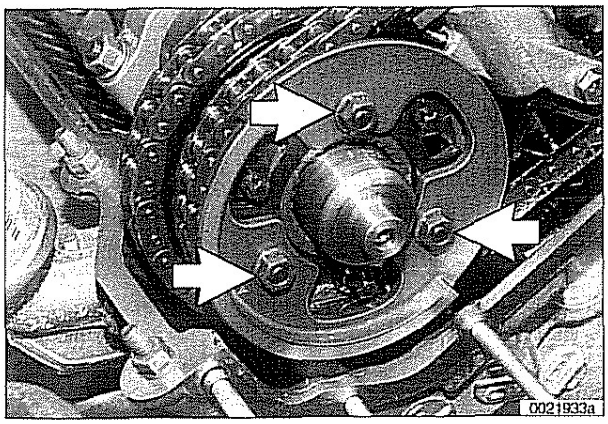
– Make sure camshafts are secured in TDC position using BMW special tools 11 3 240 and 11 3 244.



➢ Preload primary chain tensioning rail:

- Tighten adjusting screw on BMW special tool 11 4 220.

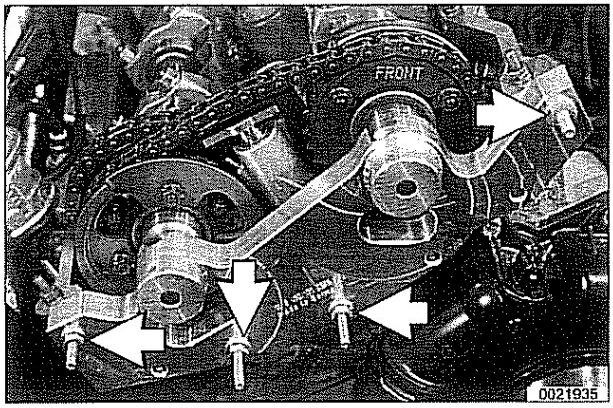
Tightening torque	
Primary chain tensioner preload	0.7 Nm (6 in-lb)



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

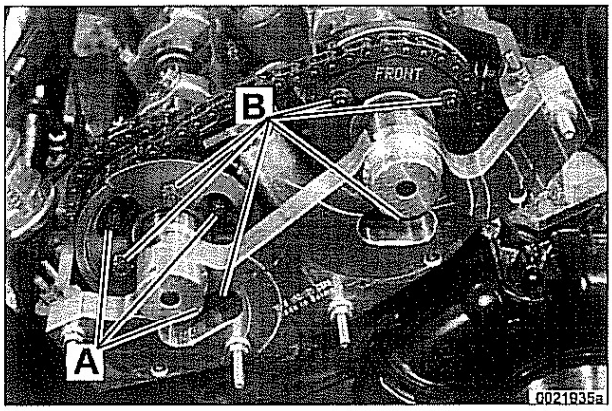
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Camshaft Timing Chain



- 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.*

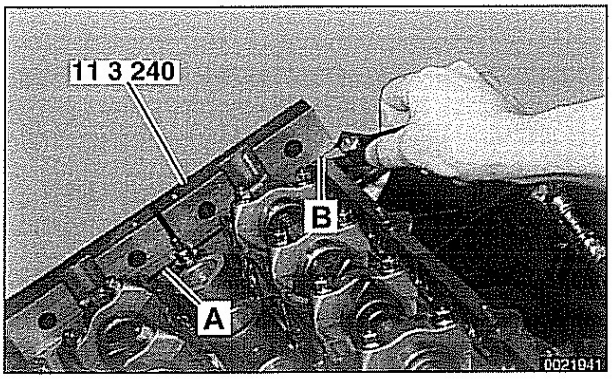


- Secure camshaft impulse sprockets and wheels:
  - Pretighten Torx screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Pretighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down Torx screws (**A**) and nuts (**B**)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

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- Remove camshaft locking tools from rear of camshafts.
- Remove BMW special tool 11 4 220 (adjustable primary chain tensioner). Reinstall primary chain tensioner.

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

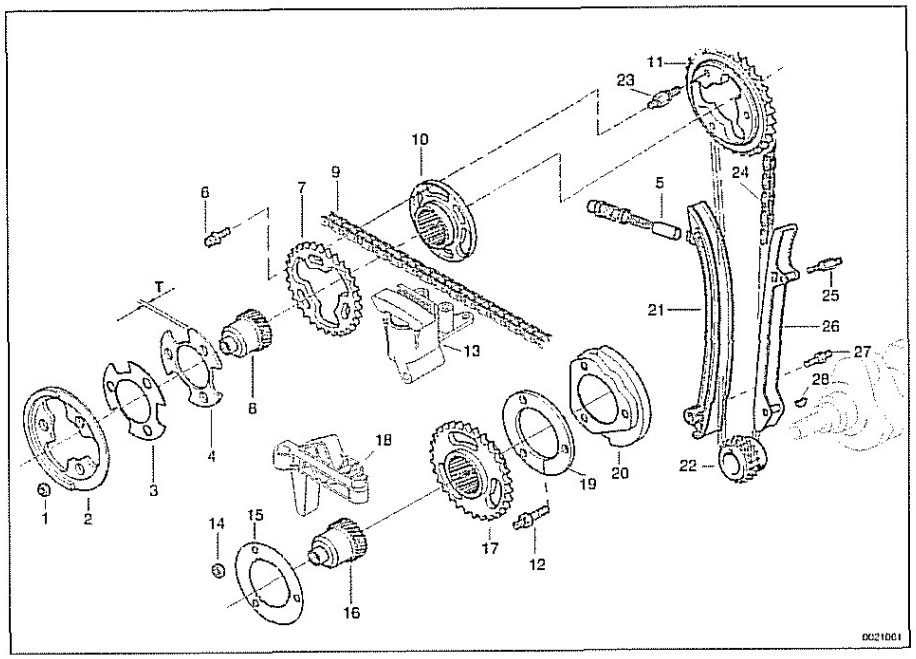
- Remove crankshaft locking tool from transmission bellhousing. Reinstall sealing plug.
- Remove VANOS setup bracket from front of cylinder head.
- Install VANOS control unit as described earlier in this group.
- Remove compressed air fitting (BMW special tool 11 3 450) from VANOS control unit.
- Fit VANOS oil line banjo bolt with new seals. Attach oil line to VANOS control unit.

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

- Remainder of installation is reverse of removal, noting 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 radiator cooling fan.
  - Install air filter housing and top engine cover.

Tightening torque	
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)

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Timing chains assembly (M52 TU and M54 engines)

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

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Timing chains, removing (M52 TU and M54 engines)

Camshaft timing chain removal requires that the oil pan be removed. See **119 Lubrication System**. Also required is removal of the VANOS control unit and disassembly of the intake and exhaust camshaft sprocket assemblies as described earlier in this repair group.

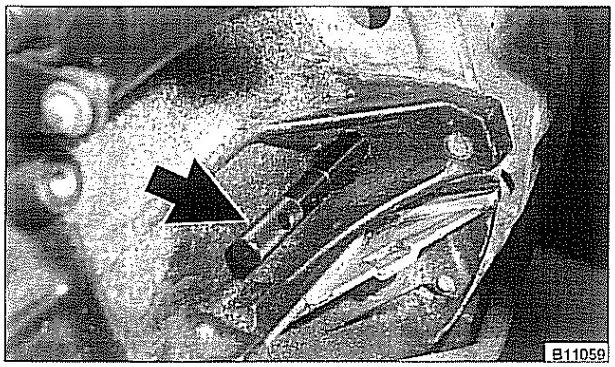
Special BMW service tools are needed for timing chain removal and installation. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

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

– Disconnect negative (-) cable from battery.

CAUTION—
- *Disconnecting the battery may erase fault code(s) stored in control module memory. Check for fault codes using special BMW diagnostic equipment.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

– Remove VANOS control unit. See **VANOS control unit, removing (M52 TU and M54 engines)**.


B11059

➢ Remove sealing plug from crankcase below starter and secure crankshaft with BMW special tool 11 2 300.

– Drain engine cooling system. See **170 Radiator and Cooling System**.

– Remove belt driven cooling fan, fan shroud, and thermostat housing. See **170 Radiator and Cooling System**.

– Remove drive belts. See **020 Maintenance**.

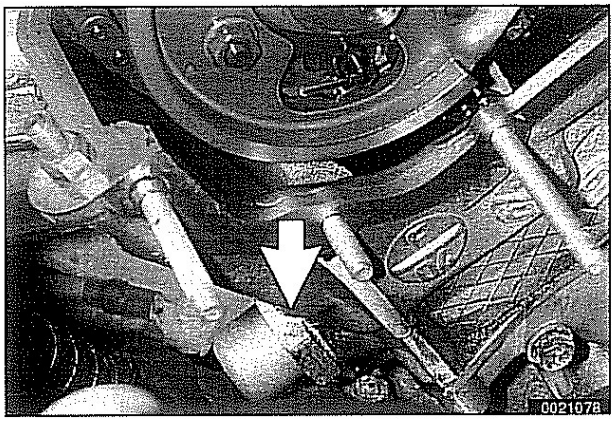
NOTE—
Mark direction of belt rotation if reusing belt.

– Remove water pump pulley fasteners and pulley.

– Drain engine oil and remove oil pan as described in **119 Lubrication System**.

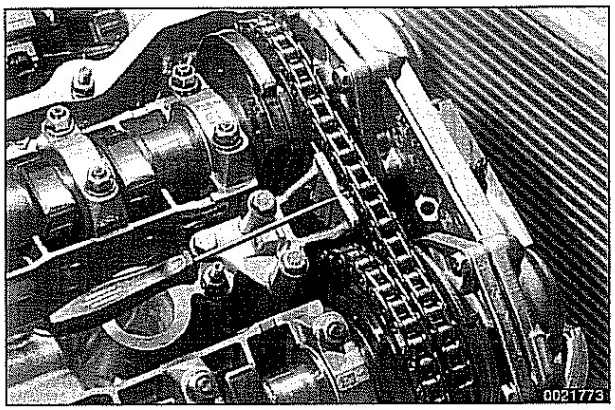
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Camshaft Timing Chain

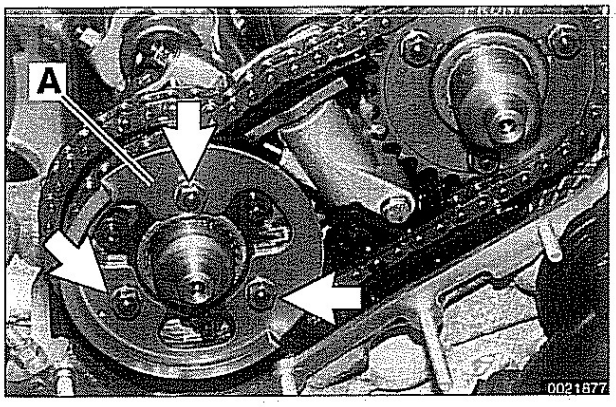


- Remove primary camshaft chain tensioner (**arrow**) from timing chain cover.

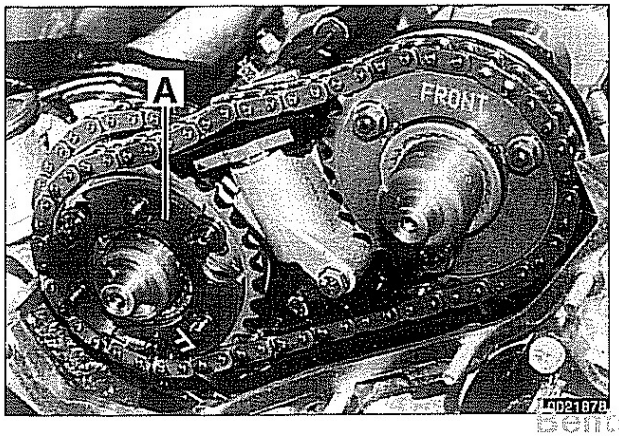
> ***CAUTION—***
> *Primary camshaft chain tensioning piston is under spring pressure.*



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

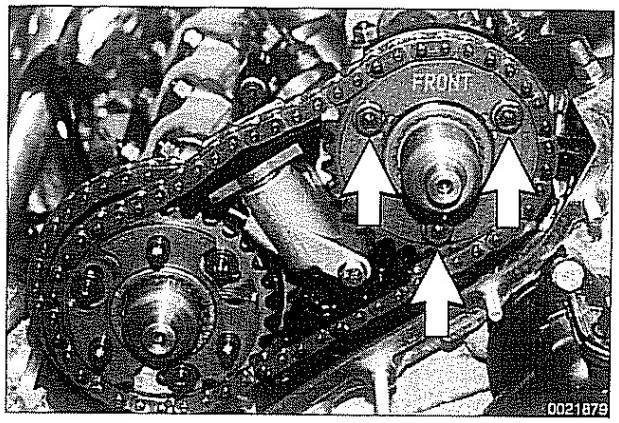


- Remove exhaust camshaft impulse wheel mounting nuts (**arrows**). Remove impulse wheel (**A**).

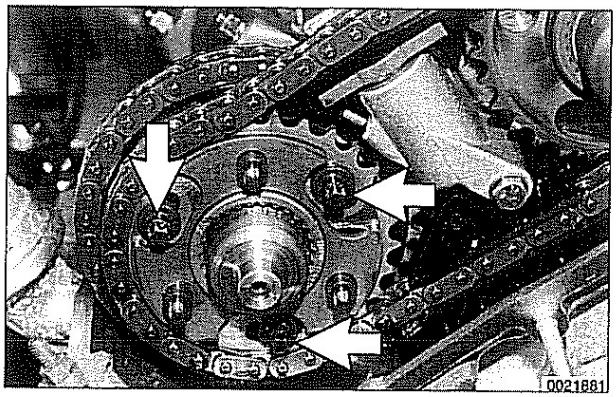


- Remove spring plate (**A**).

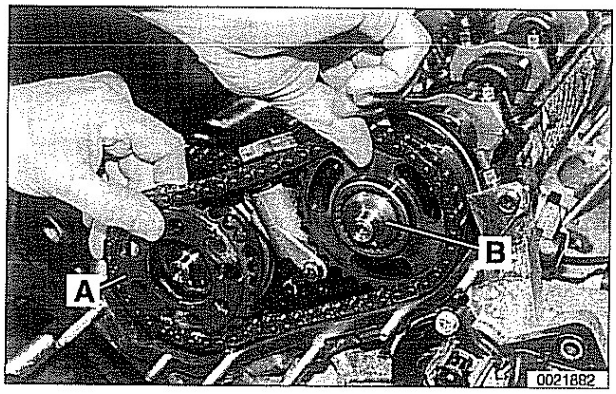
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- Remove intake camshaft sprocket mounting nuts (**arrows**) and remove spring plate (labelled **FRONT**).

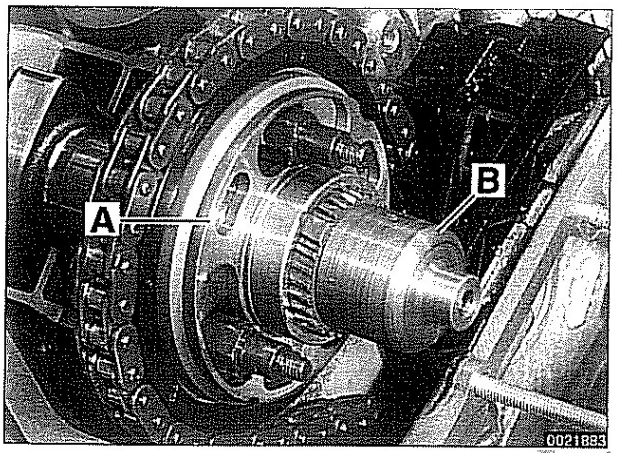


- Remove torx screws from exhaust camshaft sprocket (**arrows**).



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

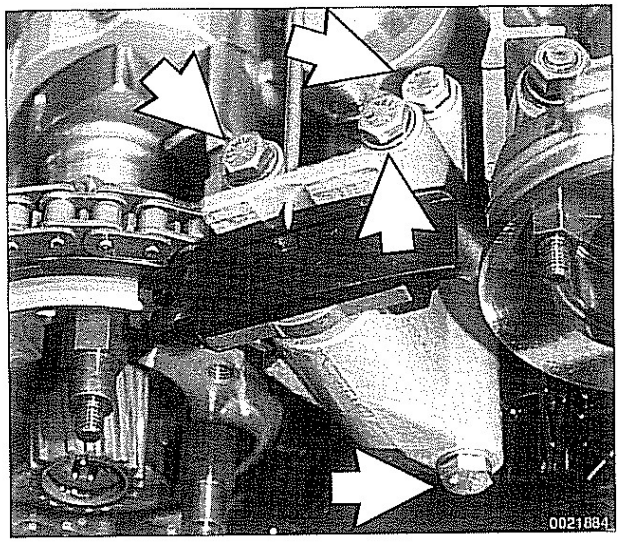
> ***CAUTION—***
> *Splined shafts for both intake and exhaust camshafts share the same part number. Remove and mark used splined shafts in order to reinstall in original locations.*



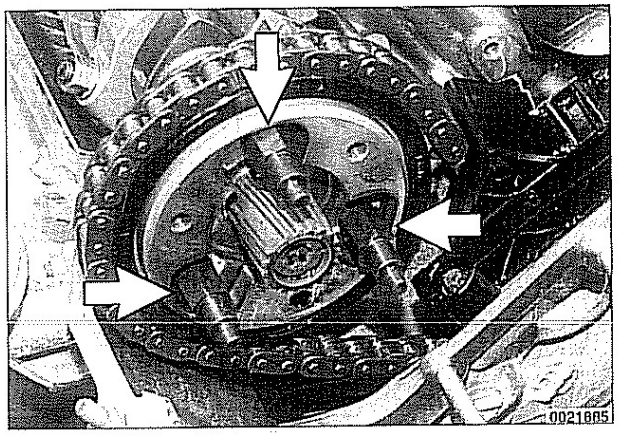
- Remove exhaust camshaft splined sleeve (**A**) and shaft (**B**).

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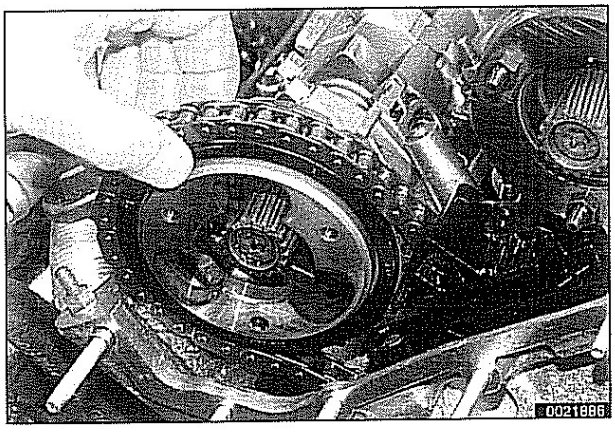
Camshaft Timing Chain



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

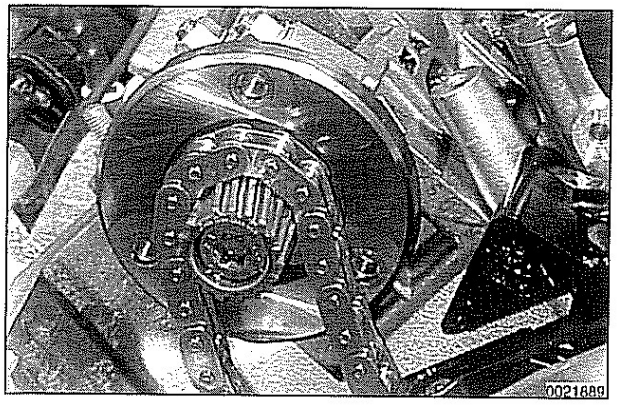


- Remove primary chain sprocket mounting studs (**arrows**) on exhaust camshaft.

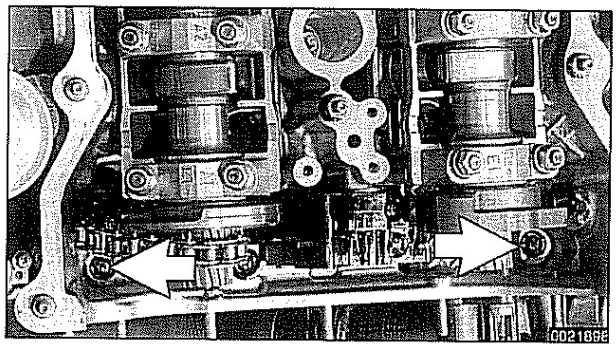


- Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain.

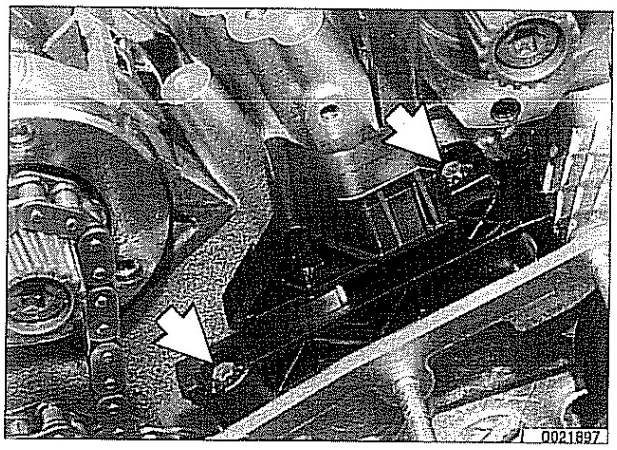
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➢ Set timing chain on exhaust camshaft end.



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



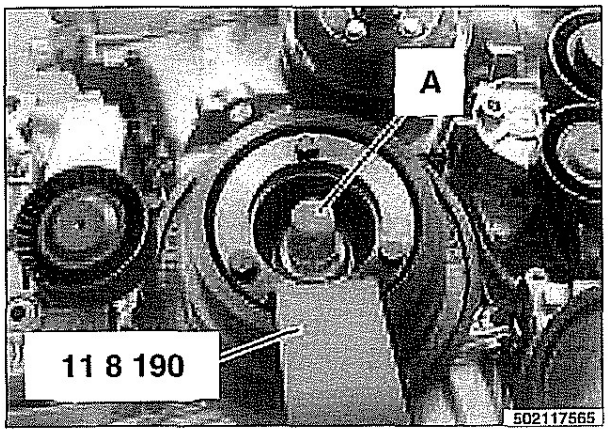
➢ Remove secondary chain lower guide bolts (**arrows**). Remove chain guide.

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

– Remove crankshaft locking tool from transmission bellhousing.

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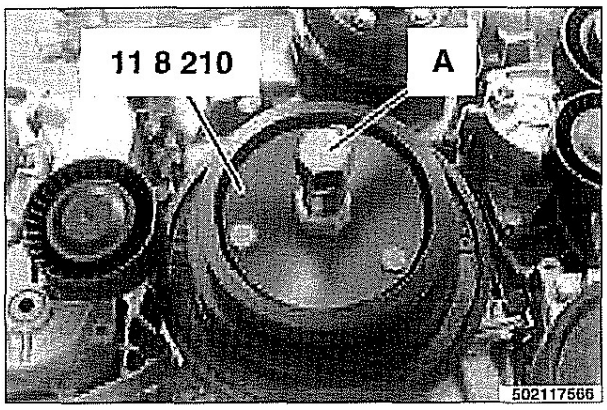
Camshaft Timing Chain



- Install crankshaft holding tool (BMW special tool 11 8 190/11 8 200). Make sure cut outs in tool engages openings in damper assembly. While counterholding crankshaft with special tool, remove crankshaft center bolt (**A**).

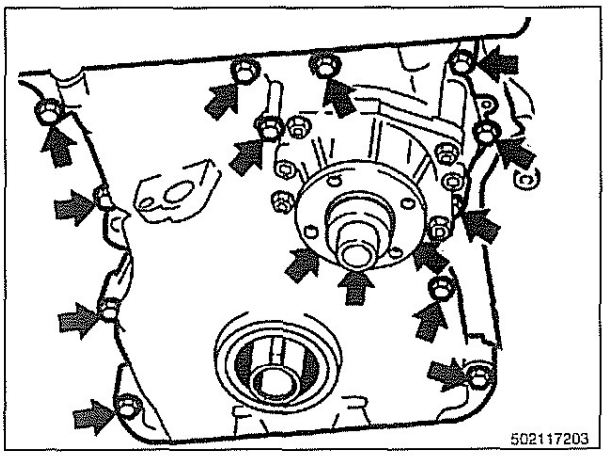
> ***CAUTION—***
> *Do not use flywheel locking tool to hold crankshaft stationary to loosen or tighten crankshaft hub center bolt. Use only the special tools specified, or equivalent hub holding tool.*

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



- Install crankshaft damper puller (BMW special tool 11 8 210) to 11 8 200. and (**A**) remove damper from crankshaft.

> ***CAUTION—***
> *The crankshaft must not be allowed to rotate when the timing chains are loosened or removed. The pistons can contact the valves. Use appropriate crankshaft holding tool when loosening crankshaft hub center bolt.*



- Using a drift of less than 5 mm diameter, drive two locating dowels in left and right sides of lower timing chain cover toward engine. 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.*
> - *If cylinder head gasket is damaged, remove cylinder head and replace head gasket. See **113 Cylinder head and valvetrain**.*

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.

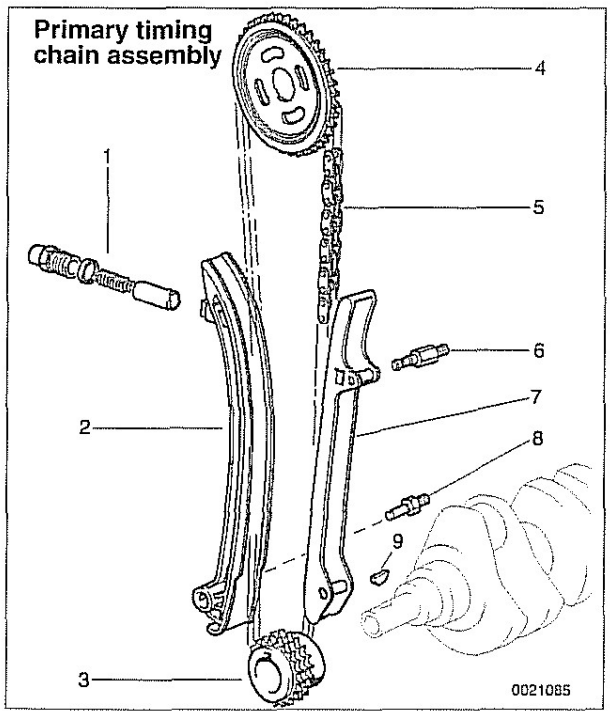
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Timing chains, installing (M52 TU and M54 engines)

CAUTION—
The procedure outlined below assumes that the camshafts 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 damage. Replace any part that is worn or damaged.

NOTE—
If any sprockets are being replaced due to wear, the chain should also be replaced.



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 radial seal in cover. See **Crankshaft oil seal, replacing (M52 TU and M54 engines)**.

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– To install lower timing case 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 timing cover dowels in until they just protrude slightly from sealing surface.
  - Apply a small bead of silicon sealer (Three 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 (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)

– Align damper assembly with keyway and tap into place. Insert new center bolt with washer.

CAUTION—
Inspect woodruff key for damage before installing hub assembly.

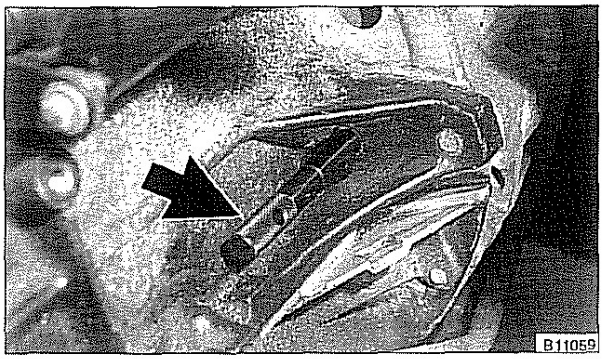
– Attach special tools 11 8 200/11 8 190 to damper assembly. Counterhold damper with 11 8 190 while tightening center bolt.

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

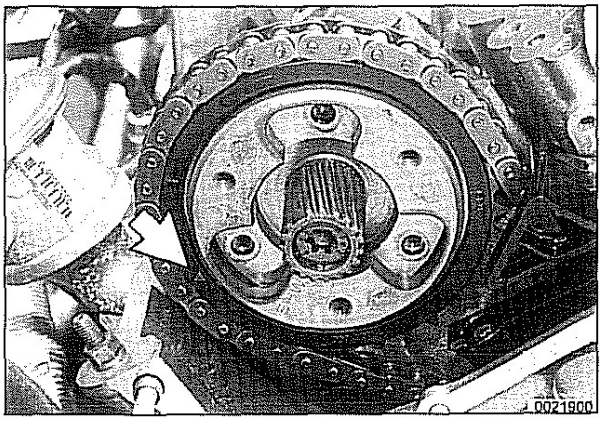
Tightening torque

Crankshaft hub to crankshaft	410 Nm (300 ft-lb)

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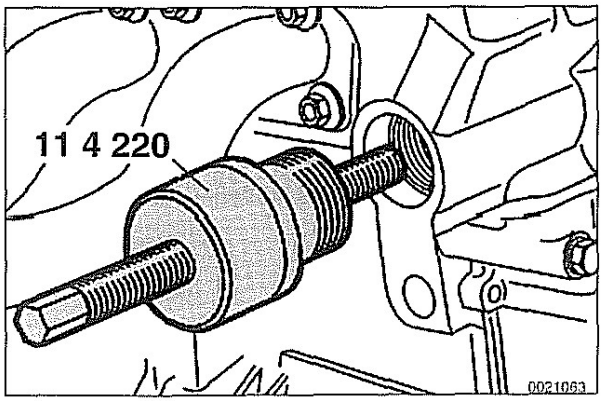


➢ Remove BMW special tool 11 2 300.



➢ 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.

– Position sprocket so that chain slack is on tensioner rail side.

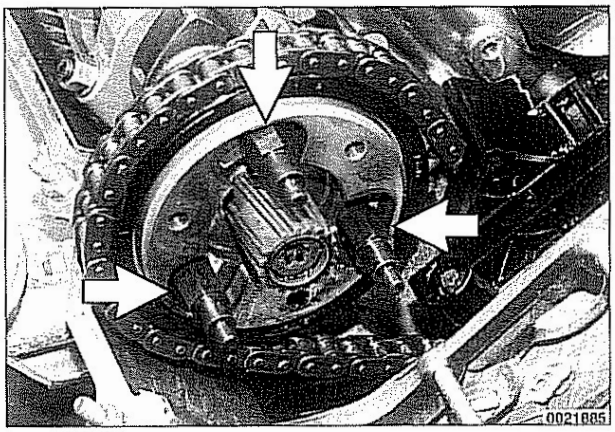


➢ Insert BMW special tool 11 4 220 in cylinder head and screw in adjustment screw by hand just until it contacts tensioning rail and chain slack is removed.

NOTE—
BMW special tool 11 4 220 is an adjustable primary chain tensioner that 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.

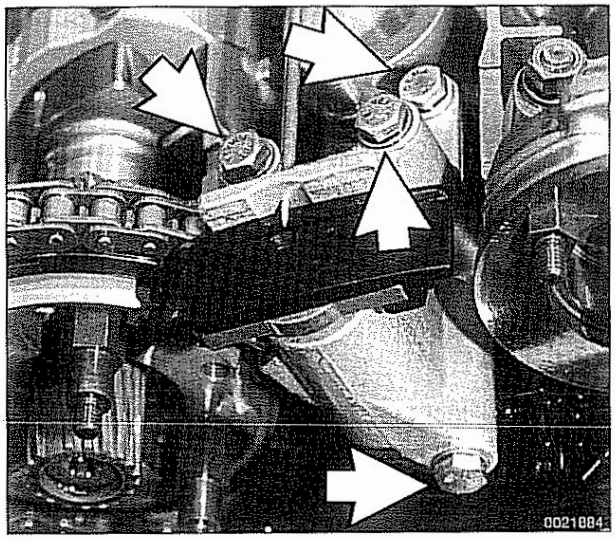
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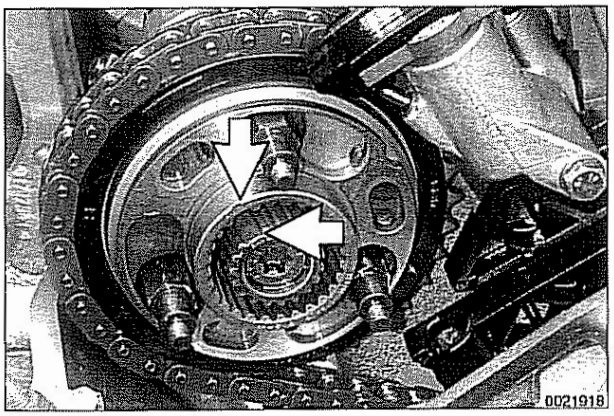
- Install and tighten down threaded locating studs (**arrows**) in end of exhaust camshaft.

Tightening torque

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

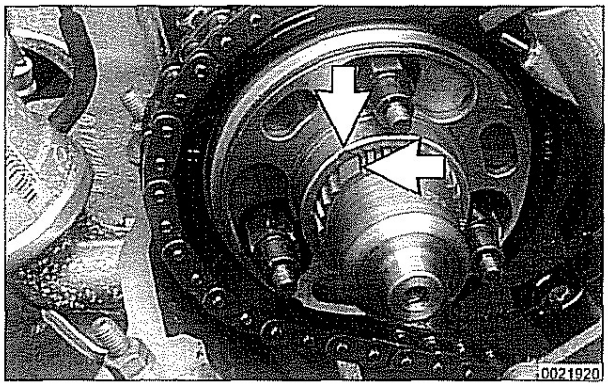


- Install secondary chain tensioner on cylinder head.
  - Make sure tensioner is locked in compressed position as described earlier.

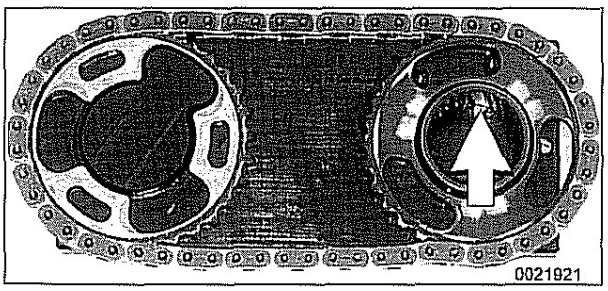


- Fit exhaust camshaft splined sleeve, aligning gap in sleeve splines with corresponding gap on camshaft splines (**arrows**).

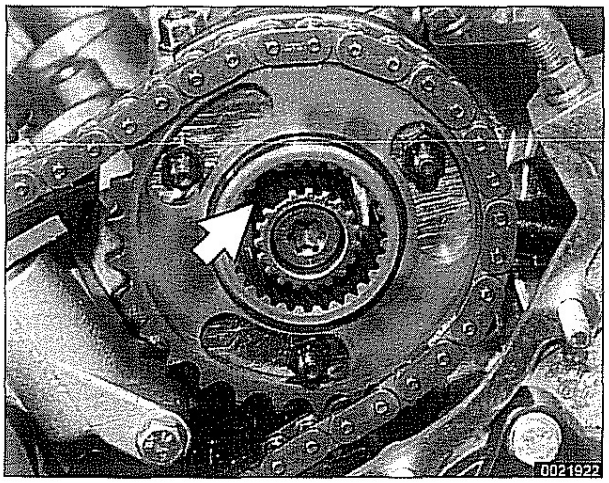
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- Slide splined shaft onto exhaust camshaft, aligning larger tooth with corresponding gap of splined sleeve (**arrows**).
  - Slide splined shaft in further until 3 small or elongated slots in splined sleeve are centered to 3 threaded holes in sprocket.

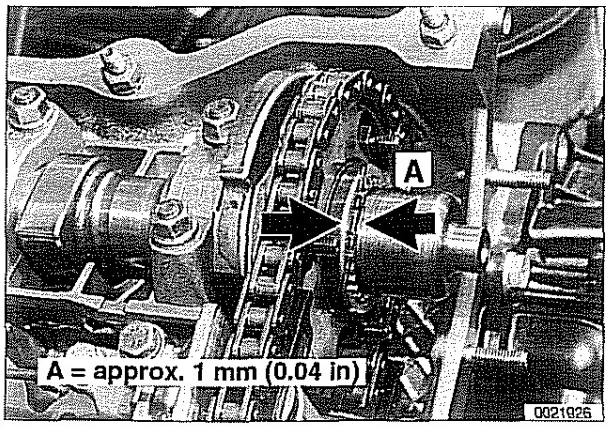


- Place intake and exhaust sprockets in BMW special tool 11 6 180. Position spline gap on intake sprocket (**arrow**) as shown and place secondary chain on sprockets.



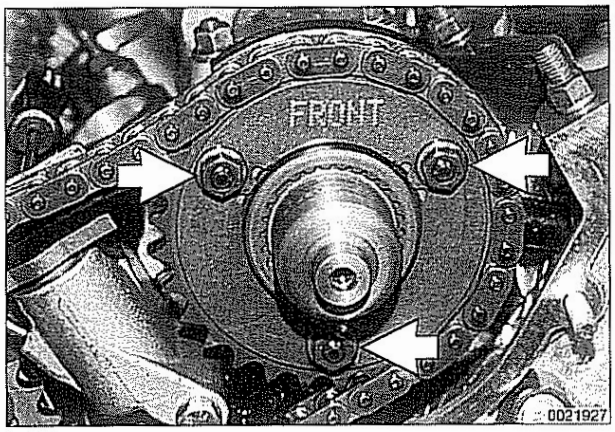
- Carefully remove chain and sprockets from tool and slide onto camshafts. Align gap in intake sprocket splines with corresponding gap in camshaft splines (**arrow**).

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

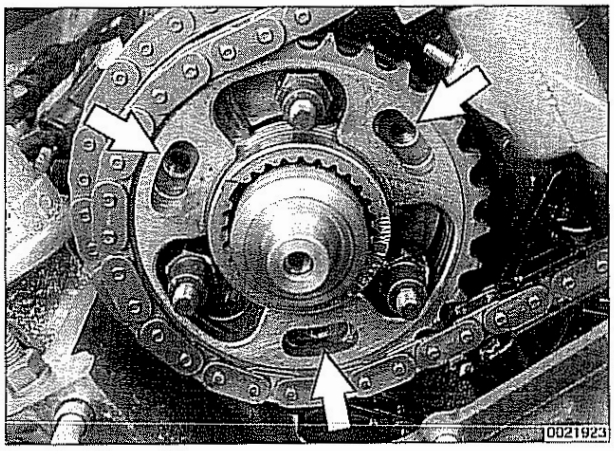


- Slide splined shaft onto intake camshaft until approx. 1 mm (0.04 in.) of splines can still be seen.

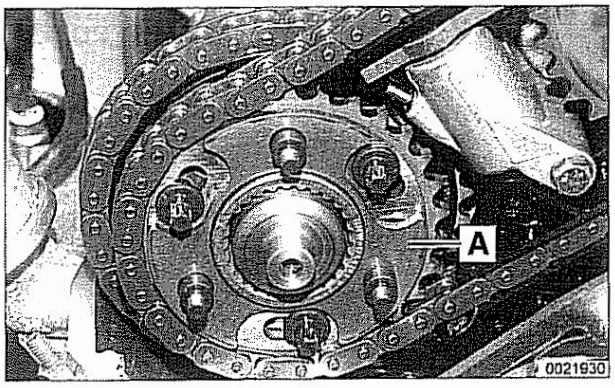
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- Install intake camshaft spring plate so that FRONT mark is visible. Install mounting nuts (**arrows**) finger tight.

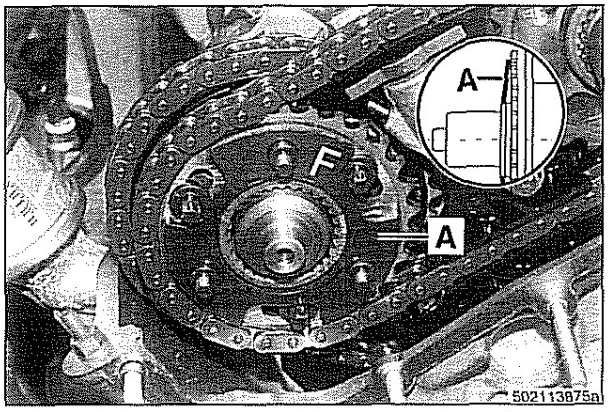


- Working at exhaust side, insert sprocket mounting Torx screws into threaded holes (**arrows**).
  - Initially tighten screws to approx. 5 Nm (44 in-lb), then back off one-half turn.



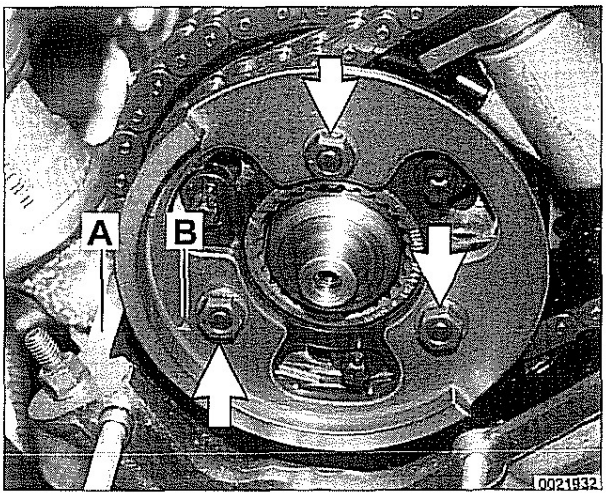
- Fit thrust spacer (**A**) on exhaust camshaft.

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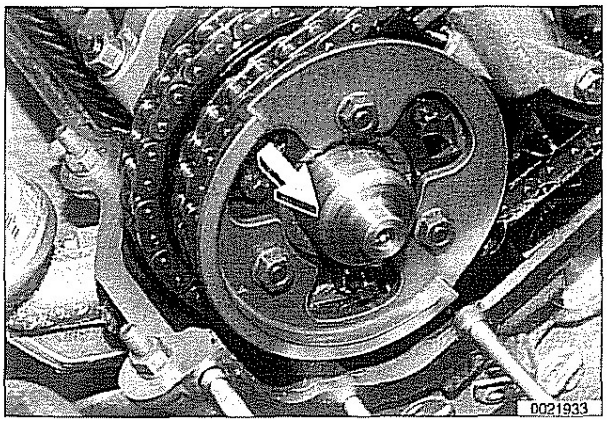


➢ Install spring plate (**A**) to exhaust camshaft. Make sure that **F** mark is visible.

NOTE—
*If **F** mark is no longer visible, install spring plate as shown.*



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

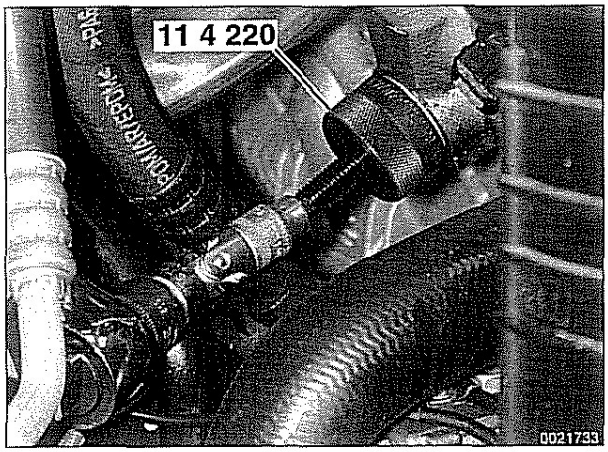


➢ Pull out exhaust splined shaft until it stops.

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

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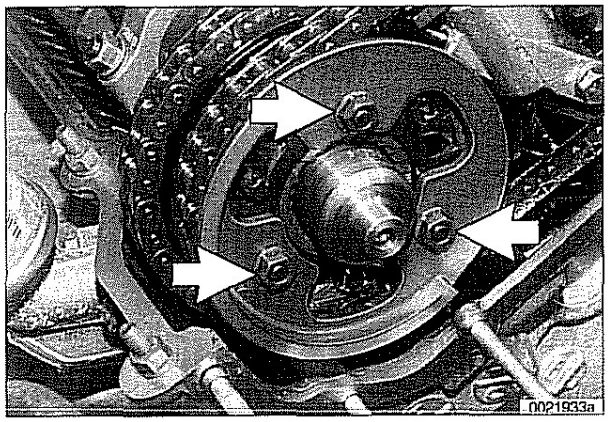
Camshaft Timing Chain



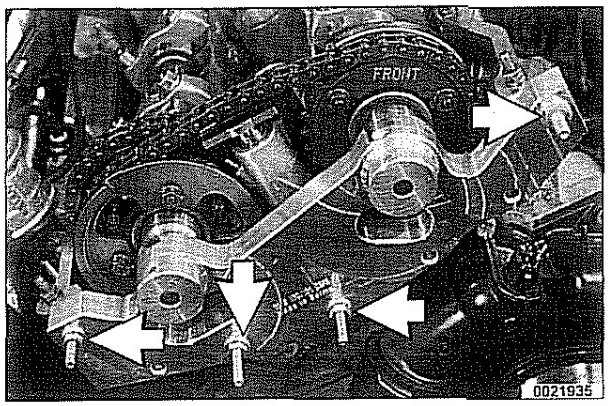
- Preload primary chain:
  - Tighten adjusting screw on BMW special tool 11 4 220 to specified torque.

Tightening torque

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



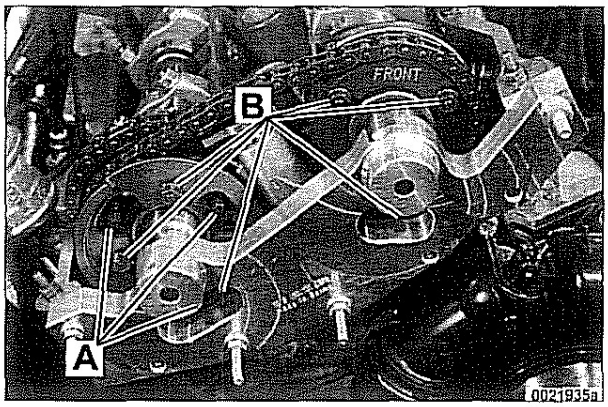
- Preload exhaust camshaft spring plate by pressing on impulse wheel while tightening mounting nuts (**arrows**) finger tight.



- *Install BMW special tool 11 6 150 (VANOS setup bracket) to front of cylinder head timing case.*
  - Tighten tool mounting nuts (**arrows**) by hand, 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.*

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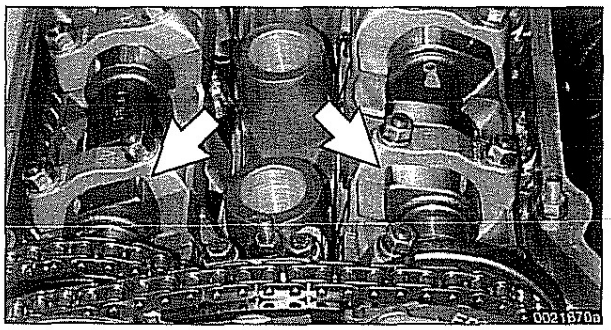


- Secure camshaft sprockets and impulse wheels:
  - Tighten mounting screws (**A**) on exhaust camshaft impulse wheel to approx. 5 Nm (44 in-lb).
  - Tighten mounting nuts (**B**) on exhaust and intake sprocket assemblies to approx. 5 Nm (44 in-lb).
  - Torque down mounting screws (**A**) and nuts (**B**)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

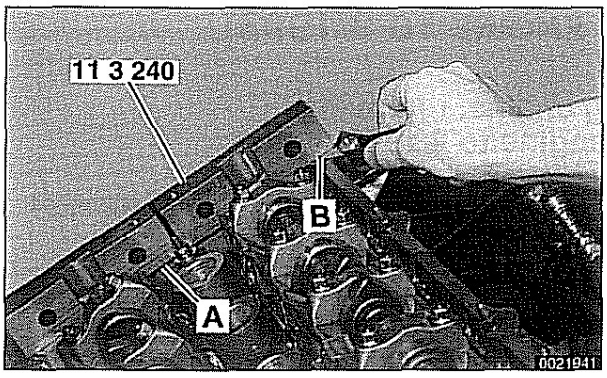
Tightening torques

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.

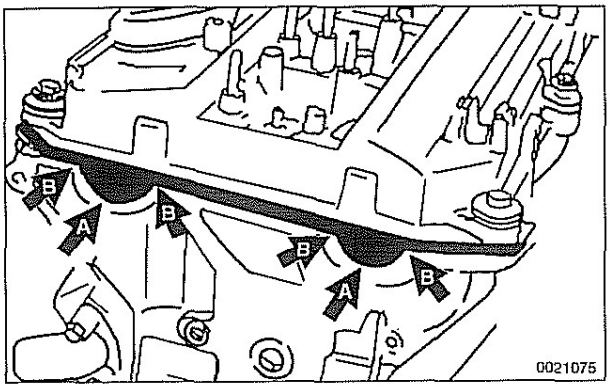


- Place BMW special tool 11 3 240 over camshaft ends and measure clearance of tool to cylinder head surface.

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 and VANOS control unit tolerances and play, 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 in **VANOS timing, checking and adjusting (M52 TU and M54 engines).***

- Remove VANOS setup bracket from front of cylinder head.
- Install VANOS control unit. See **VANOS control unit, installing (M52 TU and M54 engines).**
- Install intake camshaft oil baffle.

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Install cylinder head cover:

- Check for correct seating of half-moon seals (**A**) in back of cylinder head cover.
- Use a small amount of Three Bond 1209 ® or equivalent sealant at corners (**B**) of half-moon cutouts. Seal corners in front of cylinder head at VANOS control unit.

Tightening torque

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

– Remainder of reassembly 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 as described in **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 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 (300 ft-lb)

TIMING CHAIN (M62 ENGINE TO 9/1998)

Timing chains, removing (M62 engine to 9/1998)

Camshaft timing chain removal requires that the engine oil pan be removed.

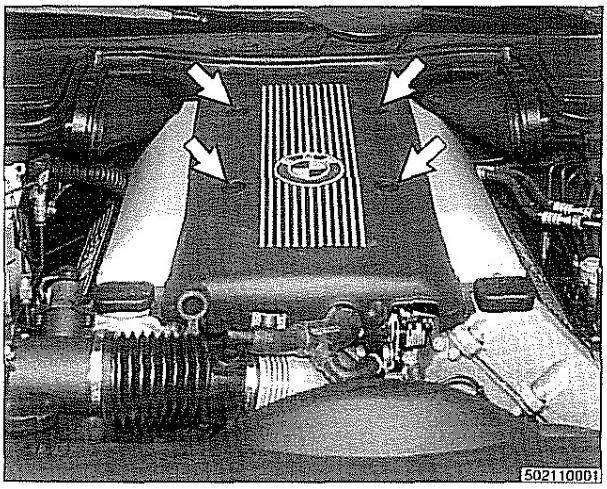
Special BMW service tools are needed for timing chain removal and installation procedures. The special tools assure proper timing of the valvetrain. Precise marks to set the timing on the camshafts are not provided for reassembly. Read the procedures through before beginning the job.

CAUTION—
Special BMW service tools are needed for this procedure. Read the procedure through before beginning the job. If the camshafts are not properly timed, the pistons can contact the valves.

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– Disconnect negative cable (-) from battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*



Removing top and side engine covers:

- Press down on locking pins (**arrows**) to release locks. Lift intake manifold cover straight up to remove.
- Pry out caps from side covers.
- Remove fasteners and covers.

NOTE—
Some early models use pry out trim caps and fasteners to hold the top cover in place.

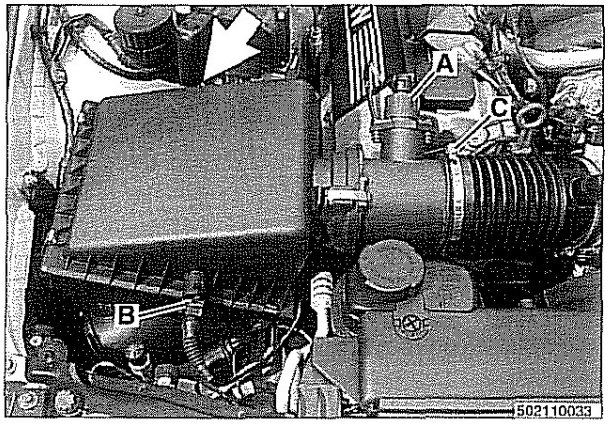
- Disconnect electrical harness connectors at ignition coils (**A**).
- Remove left and right side ignition coil mounting fasteners and coils.

NOTE—
*Make note of location of ground strap (**arrow**).*

- Remove spark plugs.

– Remove positive (+) terminal cable from left cylinder head cover.

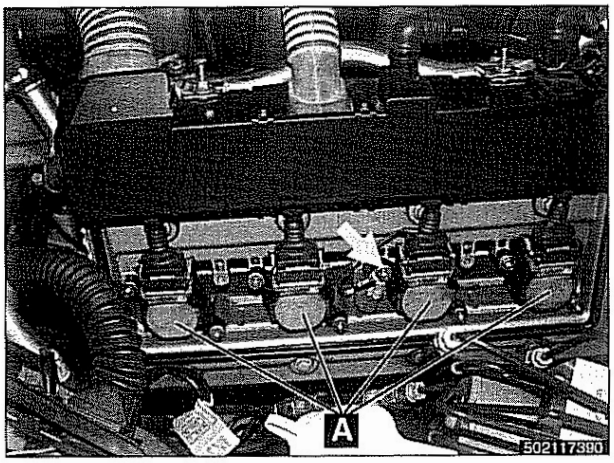
– Unbolt left and right side cable ducts from fuel rail.



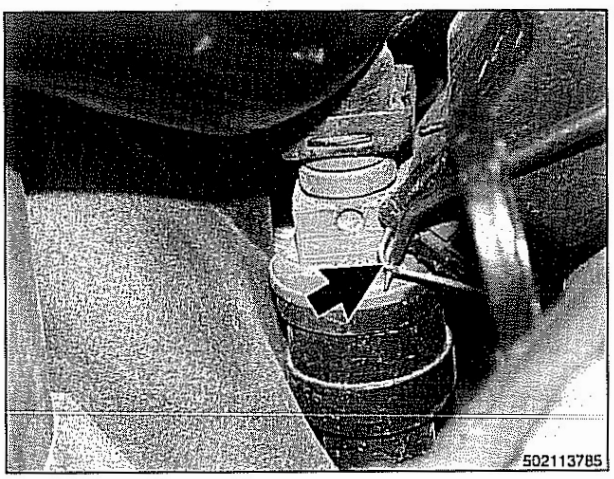
Remove air filter housing and mass air flow sensor:

- Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
- Remove air filter housing mounting fastener (**arrow**).
- Loosen intake hose clamp (**C**).
- Remove air filter housing with mass air sensor and intake duct from throttle body assembly.

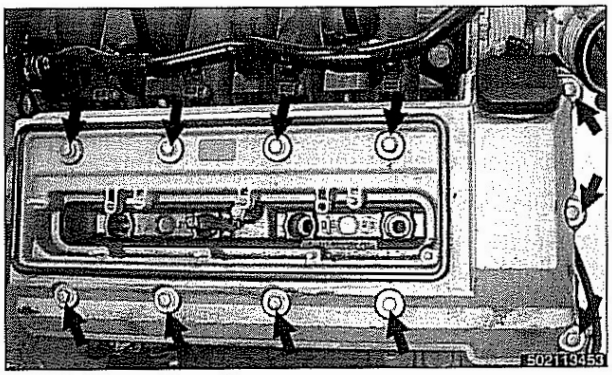
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- Remove left and right side ignition coils and spark plugs:
- – Remove positive (+) terminal cable from left cylinder head cover.
- – Unbolt left and right side cable ducts from fuel rail.

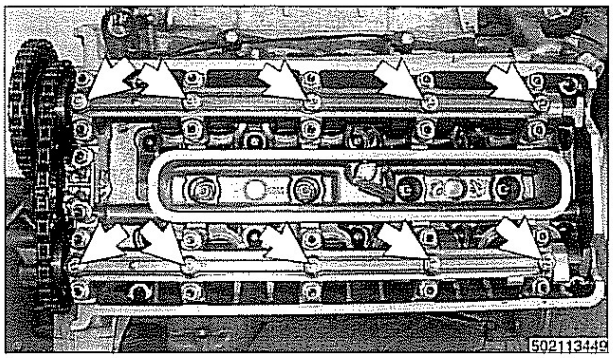


- Disconnect fuel injector electrical connectors:
  - Pry corner of wire lock clip to release connector from injector (**arrow**).
  - Repeat for all injectors.
  - Lift off wiring ducts.



- Remove Fasteners (**arrow**) from left and right cylinder head cover fasteners and remove covers.

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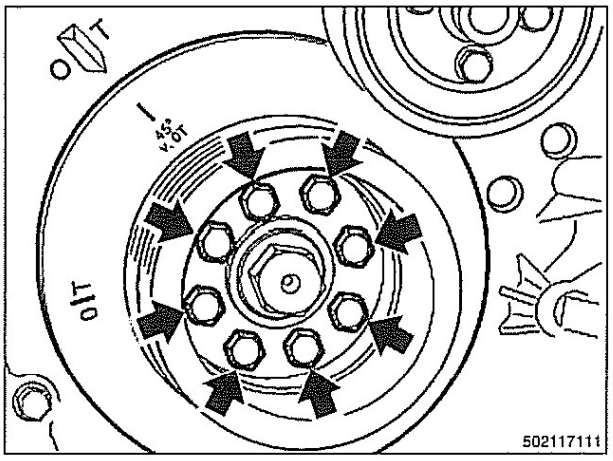


➢ Remove oil lines from camshaft supports (**arrows**).

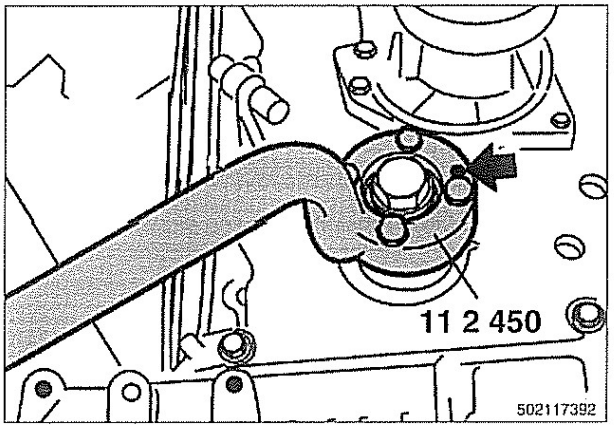
– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

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

– Remove engine drive belts alternator and A/C compressor. See **020 Maintenance**.



➢ Remove vibration damper bolts (**arrows**) and remove damper.



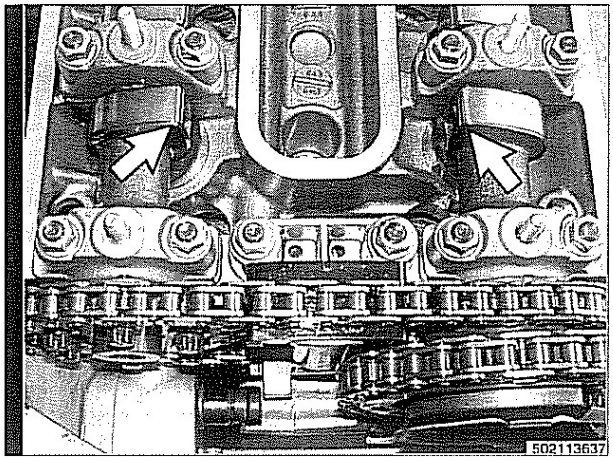
➢ Mount BMW special tool 11 2 450 to crankshaft hub while aligning damper locator pin with hole (**arrow**) in special tool.

CAUTION—
Crankshaft center bolt is torqued to 410 Nm (300 ft-lb) use BMW special tool 11 2 450 to secure crankshaft when removing center bolt.

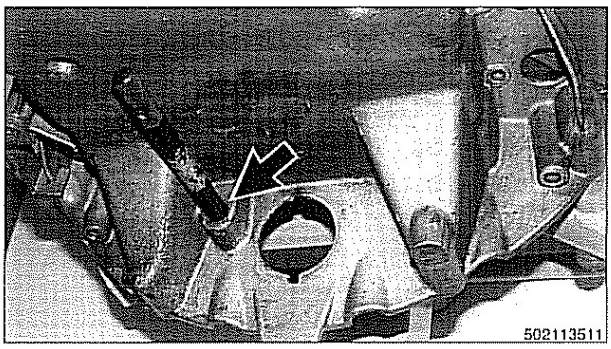
– Loosen and remove crankshaft center bolt.

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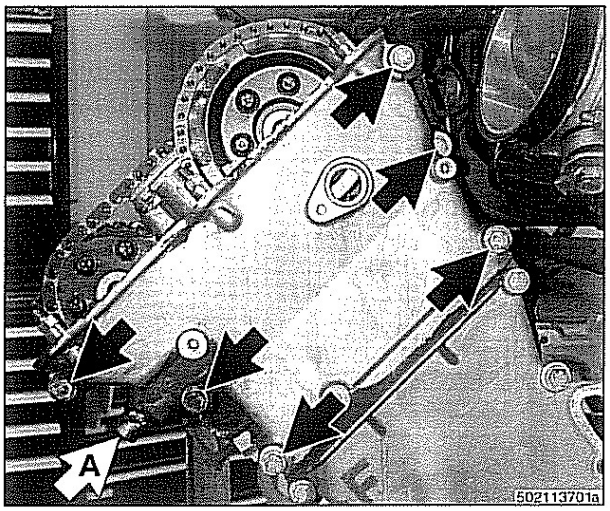
Camshaft Timing Chain



- Using special tool 11 2 450, rotate engine clockwise to TDC with number one cylinder cam lobes facing each other (**arrows**) as shown.



- Lock crankshaft in TDC position with BMW special tool 11 3 200 (**arrow**).
- Remove BMW special tool 11 2 450 and remove hub.
- Remove upper engine oil pan. See **119 Lubrication**.
- Remove alternator. See **121 Battery, Starter, Alternator**.
- Remove retaining bolt for oil dipstick tube from upper timing chain cover on right side.
- Remove camshaft position sensor from right upper timing chain cover.

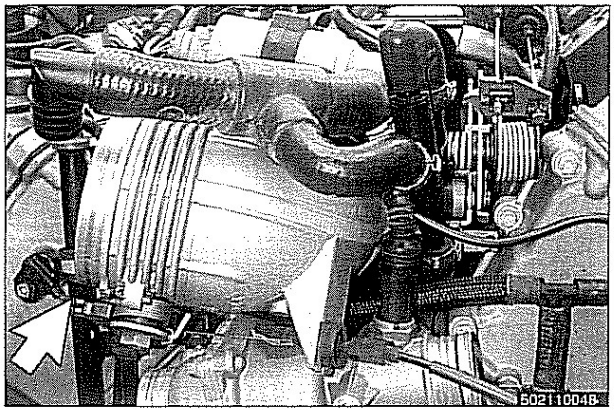


- Remove right upper timing chain cover:
  - Remove chain tensioner (**A**).

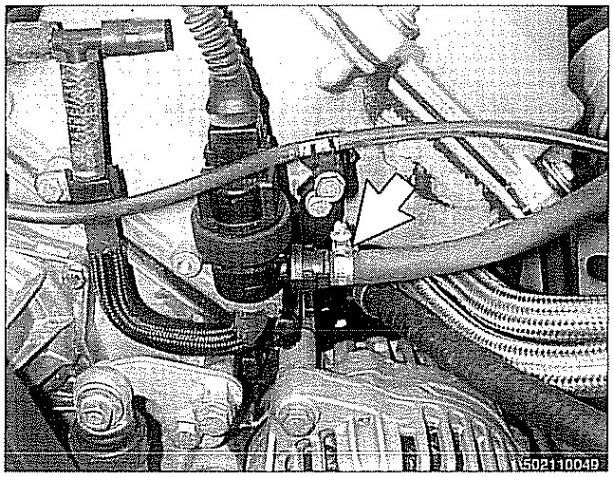
> ***CAUTION—***
> *Tensioner is under spring tension. Release slowly.*

  - Release fasteners (**arrows**) and remove cover.

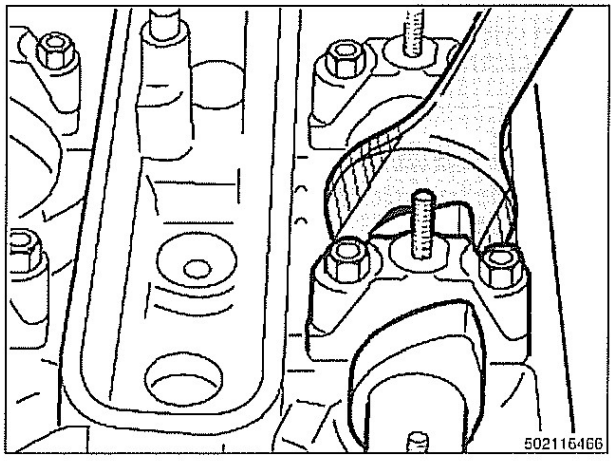
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- Remove Automatic Stability Control (ASC) throttle body:
  - Disconnect electrical harness from throttle position sensor.
  - Disconnect ASC actuator cable (**arrow**).
  - Remove 3 mounting fasteners and remove throttle body.



- Disconnect fuel tank vent valve line and cap off line (**arrow**).
- Drain engine coolant and remove hoses from thermostat housing. See **170 Radiator and Cooling System**.
- Remove water pump and thermostat housing. See **170 Radiator and Cooling System**.
- Remove left side upper timing chain cover retaining bolts and remove cover.

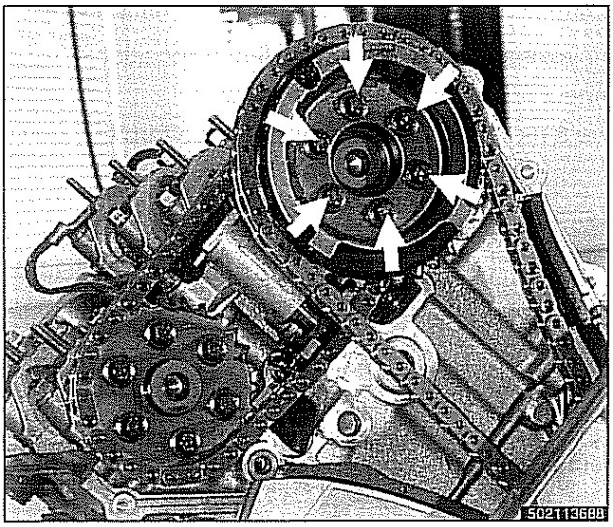


- Counter hold right intake camshaft.

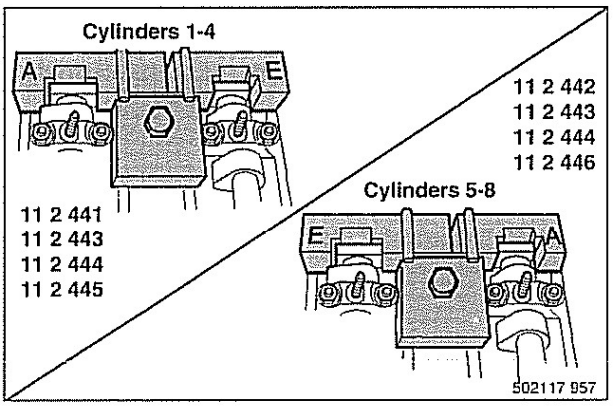
CAUTION—
Counter hold camshaft with a 27 mm open-end wrench while loosening sprocket bolts. Grind wrench if necessary to prevent damage to head.

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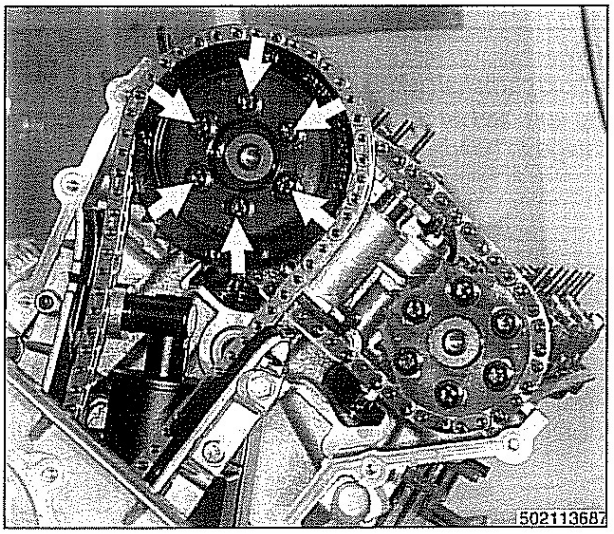
Camshaft Timing Chain



- Working at right side cylinder head loosen intake camshaft sprocket bolts (**arrows**).



- Secure left and right side camshafts in TDC position:
  - Use BMW special tool set 11 2 440.
  - If necessary, turn camshaft so that special tools are squarely seated on cylinder head.

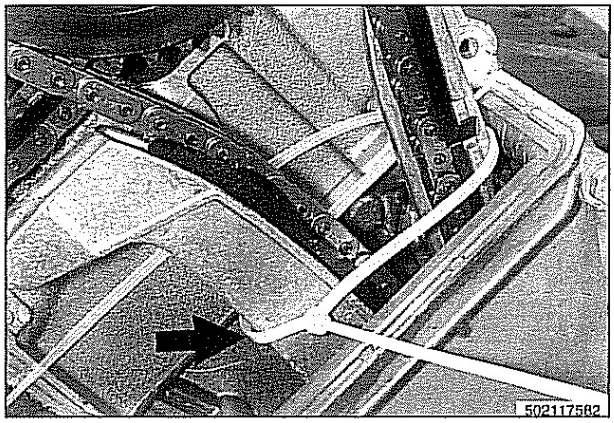


- Working at left cylinder head loosen intake camshaft sprocket bolts (**arrows**).

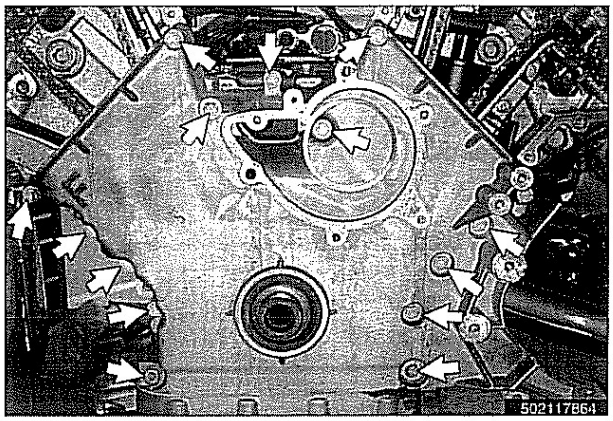
> ***CAUTION—***
> *Counter hold camshaft with a 27 mm open-end wrench while loosening sprocket bolts. Grind wrench if necessary to prevent damage to head.*

– Remove BMW special tool 11 2 300 from crankshaft locking tool bore.

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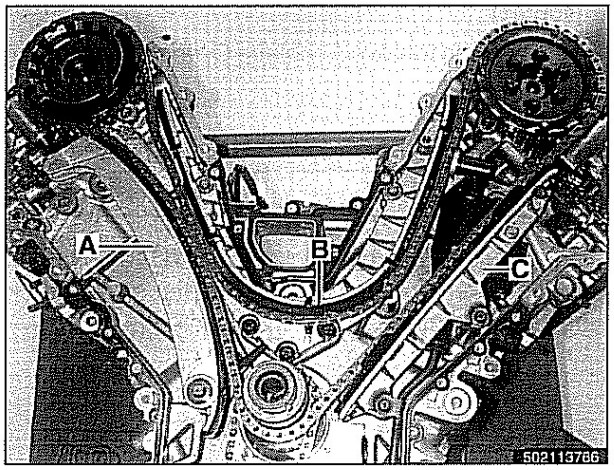


➢ Secure right side timing chain and guide rails together with a plastic wire ties (**arrow**).



➢ Remove lower timing chain cover bolts (**arrows**) and cover.

– Remove wire ties supporting guide rails.

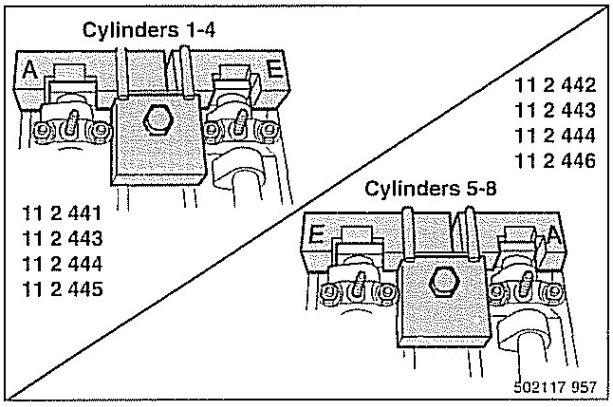


➢ Remove sprocket from intake camshafts and remove timing chain.

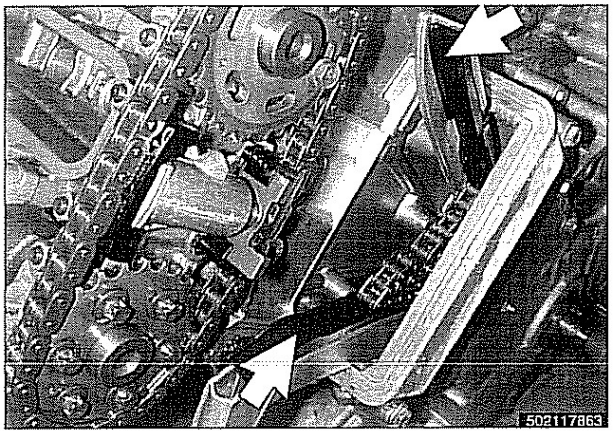
- If necessary, remove tensioning rail (**A**), reversing rail (**B**), and guide rail (**C**) to remove timing chain.

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Timing chains, installing (M62 engine to 9/1998)



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



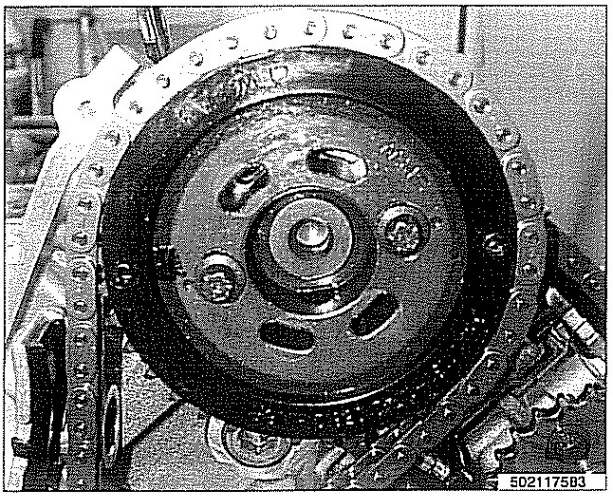
Inspect timing chain sprockets and chain. Inspect guide rail and tensioner rail (**arrows**) for grooves caused by chain contact. Replace any part that is worn or damaged.

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.*

– If removed, reinstall timing chain tensioning rail, reversing rail, and guide rail.
  - If tensioning rail was removed, replace O-ring at tensioning rail oil guide.

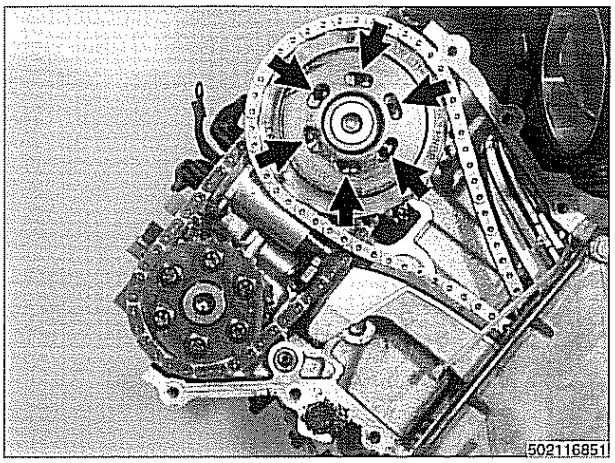
Tightening torque

Reversing rail to engine block	14 Nm (10 ft-lb)



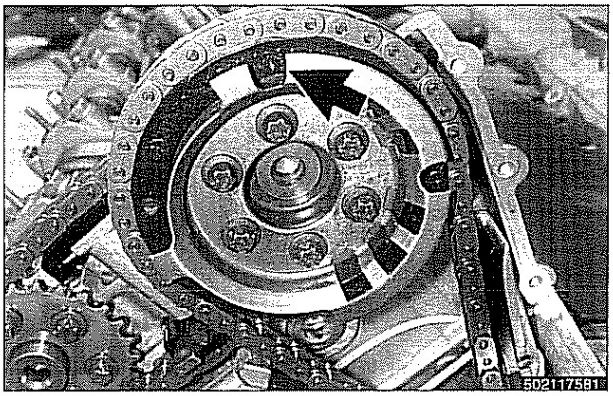
Install timing chain and intake sprocket to intake camshaft on left cylinder head. Center bores of camshaft flange in sprocket mounting slots. Install two mounting bolts finger tight.

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- Install timing chain and intake sprocket to intake camshaft on right cylinder head. While pressing in on chain tensioner rail, confirm camshaft flange bores (**arrows**) are centered in sprocket mounting slots.

NOTE—
Pressing in on rail will remove slack and reposition sprockets. If necessary, remove sprockets and align bores centrally.



- Install intake camshaft sensor gear with notch upward (**arrow**) at right cylinder head.

– Finger tighten mounting screws.

– Install remaining sprocket bolts to intake camshaft finger tight at left cylinder head.

– Press timing chain tensioning rail against timing chain. Install plastic wire tie, to hold rail against chain.

– Install lower timing chain cover:
  - Clean sealing surfaces and check sleeves are properly seated.
  - Apply a thin coat of Three Bond 1209 ® to front and back of new seal. Also coat joints where block meets cylinder heads and oil pan.
  - Initially hand tighten bolts in alternate sequence to firmly seat cover.
  - Tighten fasteners to final specification in alternate sequence.

Tightening torques

Lower timing cover	
M6 bolts	10 Nm (89 in-lb)
M7 bolts	15 Nm (11 ft-lb)
M8 bolts	22 Nm (16 ft-lb)
M10 bolts	47 Nm (35 ft-lb)

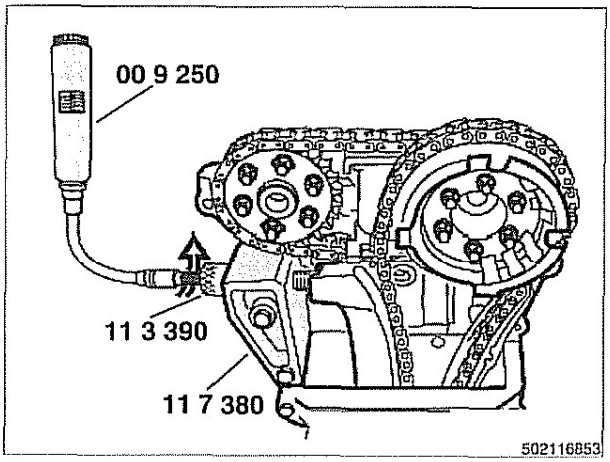
– Replace radial seal in lower timing chain cover, then reinstall crankshaft hub, center bolt, and vibration damper. See **Crankshaft oil seal, replacing (M62 and M62 TU engines)**.

– Install oil pan with new gasket. See **119 Lubrication System**.

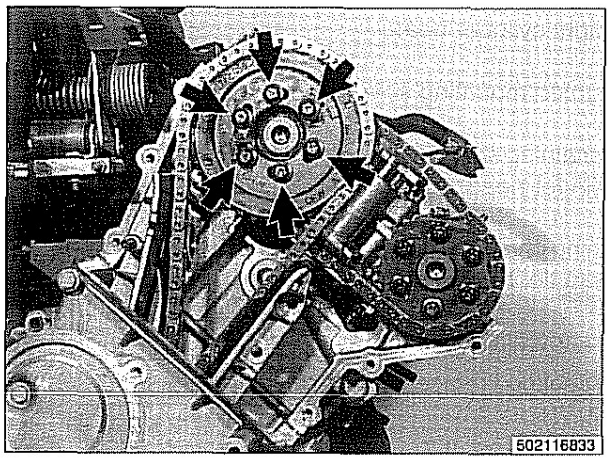
– Lock crankshaft in place with BMW special tool 11 2 300.

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Camshaft Timing Chain



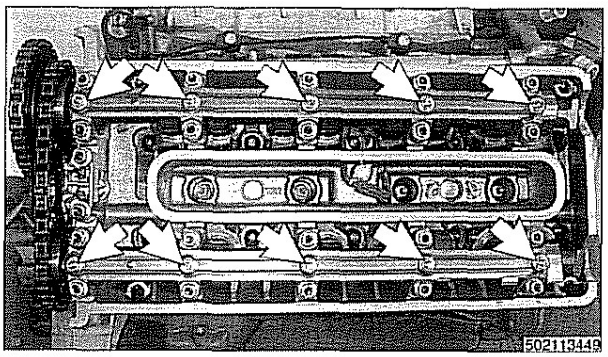
- Attach BMW special tool 11 7 380 to right side cylinder head. Install special tool 11 3 390 and 00 9 250 into 11 7 380. Tighten to 0.7 Nm (0.5 ft-lb).



- Secure sprocket to intake camshaft flange on left cylinder head.
  - Repeat for intake sprocket on right cylinder head.

Tightening torque	
Sprocket to camshaft flange	15 Nm (11 ft-lb)

- Remove BMW special tools 11 2 444/ 443/ 441/ 445 from right cylinder head.
- Remove BMW special tools 11 2 444/ 443/ 421/ 446 from left cylinder head.

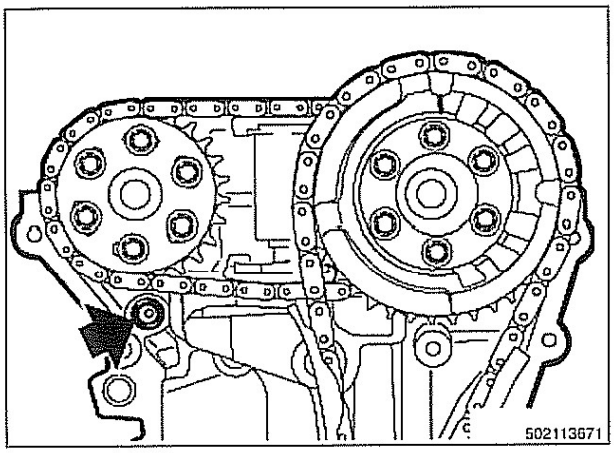


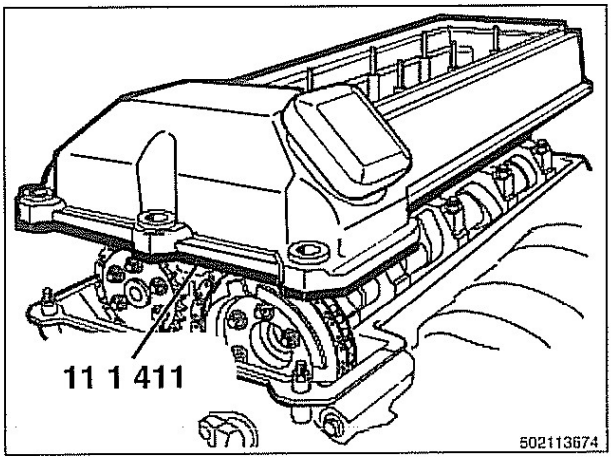
- Install oil lines on left and right cylinder head.

Tightening torque	
Oil lines to camshaft bearing caps	6 Nm (4 ft-lb)

- Relieve load on BMW special tool 11 3 390 and remove along with special tool 11 7 380.
- Remove BMW special tool 11 2 300 from bore at transmission bellhousing and release crankshaft.

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- Replace primary timing chain tensioner oil supply seal (**arrow**) in right cylinder head.

– Install right upper timing chain cover to engine:
  - Remove old gasket from left timing cover.
  - Clean gasket groove and install new gasket.
  - Apply Three Bond 1209 ® sealant to joint between cylinder head and timing cover.
  - Fit timing cover into position on engine and install lower inside cover retaining bolt
  - Timing cover retaining bolts finger tight.

- Remove cylinder head cover sealing gaskets from right cylinder head cover. Install BMW special tool 11 1 411 into gasket groove of cylinder head cover.
  - Install right cylinder head cover with BMW special tool 11 1 411 to right cylinder head. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 1 and 2 (first two cylinders on right side cylinder bank).
  - Tighten nuts uniformly in $^1/_2$ turn steps.

NOTE—
BMW special tool 11 1 411 presses upper timing cover to cylinder head to aid in proper sealing of timing chain cover to the cylinder head gasket.

Tightening torque

Timing case cover to head	15 Nm (11 ft-lb)

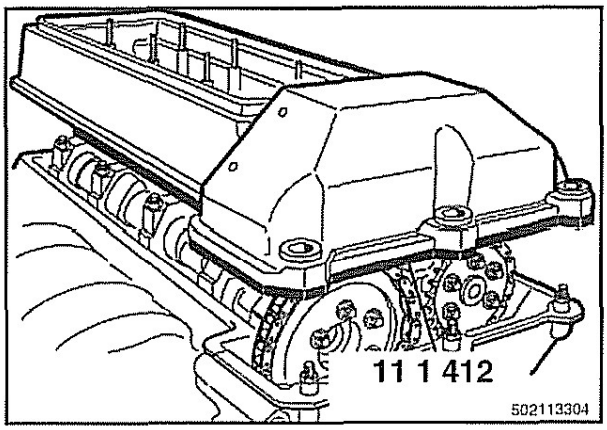
– Remove special tool 11 1 411 and install new gaskets to cylinder head cover:
  - Clean gasket groove and install new gasket.
  - Apply Three Bond 1209 ® sealant to joint between cylinder head and timing cover and at half-moon shaped cut-outs.
  - Tighten cylinder head cover nuts.

Tightening torque

Cylinder head cover to head	15 Nm (11 ft-lb)

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Camshaft Timing Chain



Remove cylinder head cover sealing gaskets from left cylinder head cover. Install BMW special tool 11 1 412 into gasket groove of cylinder head cover.

- Install left cylinder head cover. Fit cylinder head cover retaining nuts to cylinder head cover studs at cylinders 5 and 6 (first two cylinders on left side cylinder bank).
- Tighten nuts uniformly in $^1/_2$ turn steps.

Tightening torque

Timing case cover to head	15 Nm (11 ft-lb)

– Remove special tool 11 1 412 and install new gaskets to cylinder head cover:

- Clean gasket groove and install new gasket.
- Apply Three Bond 1209® sealant to joint between cylinder head and timing cover and at half-moon shaped cut-outs.
- Tighten cylinder head cover nuts.

Tightening torque

Cylinder head cover to head	15 Nm (11 ft-lb)

– Remainder of installation is reverse of removal, noting the following:

- Where applicable remove protective film from gaskets.
- Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from center out.
- Ground straps for ignition coil harnesses are at cylinders no. 3 and no. 7. See **120 Ignition System**.
- Refill and bleed cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance**.

CAUTION—
To prevent damaging engine electrical systems, be sure to install all ground wires previously removed.

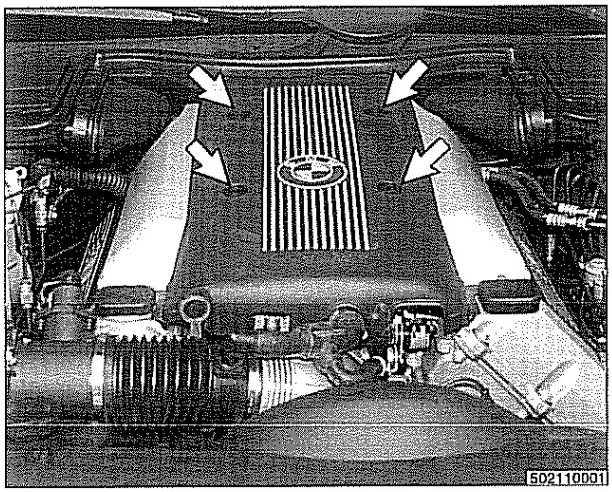
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Camshaft timing, checking and adjusting (M62 engine)

> ***WARNING —***
> *Allow engine to cool before beginning this procedure.*

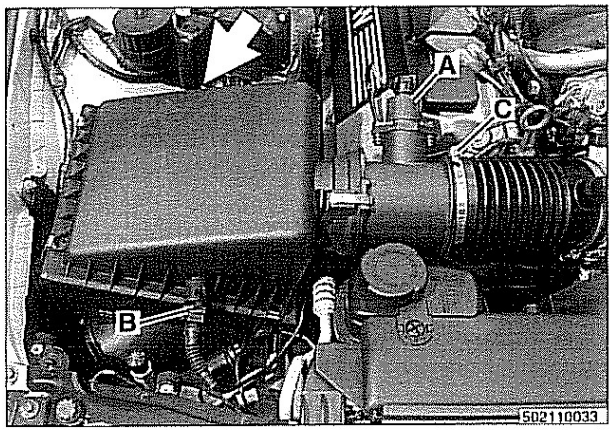
– Working inside luggage compartment, disconnect negative battery cable.

> ***CAUTION—***
> *Prior to disconnecting battery cable, read the battery disconnection cautions given in **001 General Cautions and Warnings.***



➢ Removing plastic top covers:

- Press down on locking pins (**arrows**) to release locks. Lift intake manifold cover straight up to remove.
- Pry out caps from side covers.
- Remove fasteners from beneath caps. Lift off covers.



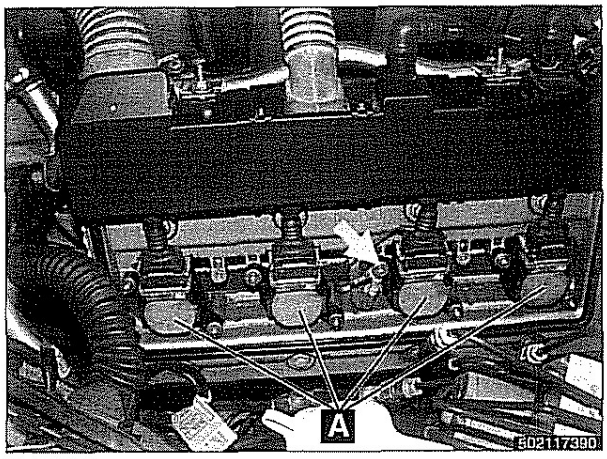
➢ Remove air filter housing and ducts:

- Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
- Remove air filter housing mounting fastener (**arrow**).
- Release hose clamp at intake air duct on base of air filter housing.
- Loosen intake hose clamp (**C**) and release hose from mass air flow sensor.
- Remove hose at idle air stabilizer.
- Release hose clamp at throttle body and remove hose.
- Remove upper air filter housing with mass air flow sensor.

– Unbolt left and right side cable ducts from fuel rail.

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Camshaft Timing Chain



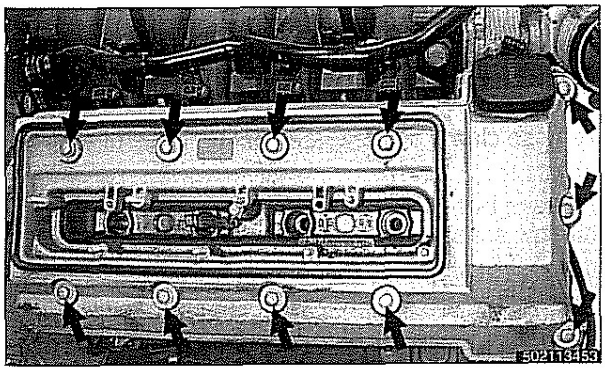
- Remove left and right side ignition coils and spark plugs:
  - Disconnect electrical harness connectors at ignition coils (**A**).
  - Remove left and right side ignition coil mounting fasteners and coils.

  NOTE—
  *Make note of location of ground strap (**arrow**).*

  - Remove spark plugs.
- Remove positive (+) terminal cable from left cylinder head cover.
- Unbolt cable ducts from fuel rail at left and right sides.

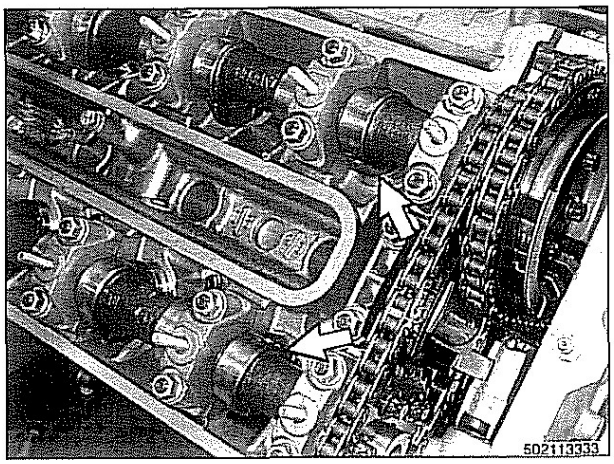


- Disconnect fuel injector electrical connectors from injectors:
  - Pry corner of wire lock clip (**arrow**) to release connector.
  - Repeat for remaining injectors.
  - Lift off wiring ducts.



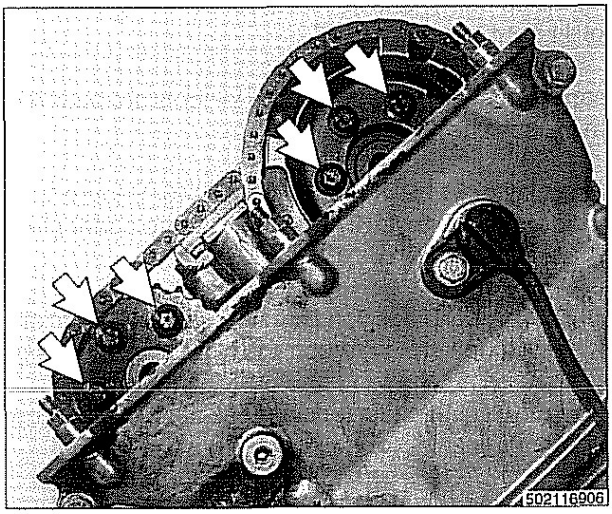
- Remove right and left cylinder head cover fasteners (**arrows**) and remove covers.
- Remove viscous clutch cooling fan, see **170 Radiator and Cooling System**.

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- Using crankshaft center bolt, turn engine clockwise until number one cylinder (right head) is in TDC overlap position, as shown (**arrows**).

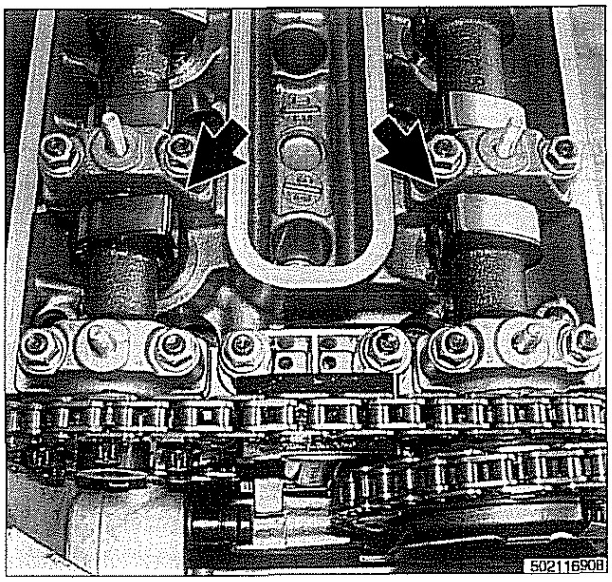
NOTE —
Number one cylinder is at valve overlap when both the intake and exhaust valves are starting to open.



- Loosen accessible bolts (**arrows**) on right exhaust and intake camshafts (cylinders 1–4) approximately $^{1}/_{2}$ turn.

NOTE —
When loosening bolts on camshaft sprocket, counterhold camshaft using an 27 mm open-end wrench. If necessary, machine wrench accordingly to prevent damage to head.

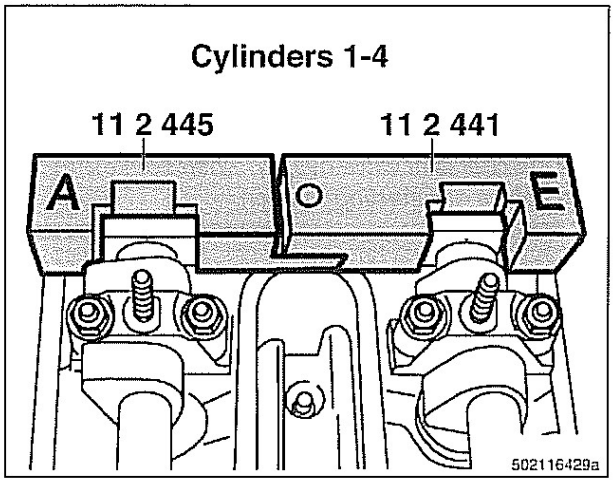
  - Repeat for accessible bolts of left exhaust and intake camshafts (cylinders 5–8).



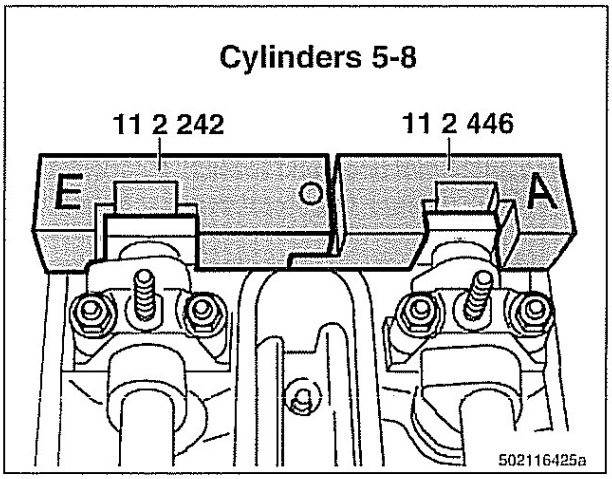
- Using crankshaft center bolt, rotate engine one complete rotation to TDC position. Lobes of camshafts for right cylinder head (cylinders 1–4) should point to each other (**arrows**).

– Loosen remaining intake and exhaust camshaft sprocket bolts approximately $^{1}/_{2}$ turn.

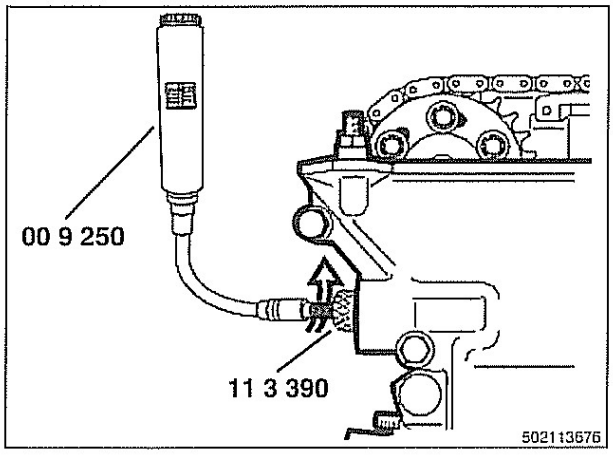
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- Secure right side camshafts in TDC position using special BMW tool 11 2 445 and 11 2 441.
- If necessary, turn camshaft with 27 mm wrench so that special tools are squarely seated on cylinder head.
- Fit BMW special tool 11 2 443 to 11 2 441/445. Secure 11 2 443 to cylinder head with 11 2 444 installed into spark plug bore.



- Secure right side camshafts in TDC position using special BMW tool 11 2 442 and 11 2 446.
- If necessary, turn camshaft so that special tools are squarely seated on cylinder head.
- Fit BMW special tool 11 2 443 to 11 2 442/446. Secure 11 2 443 to cylinder head with 11 2 444 installed into spark plug bore.
- Lock crankshaft in TDC position by inserting BMW special tool 11 3 200 through tool bore at transmission bellhousing.
- Remove primary timing chain tensioner piston from right cylinder head upper timing cover.



- Attach BMW special tool 11 3 390 into right cylinder head in place of primary chain tensioner.
  - Using BMW special tool 00 9 250, tighten adjusting screw on 11 3 390 to 0.7 Nm (6.3 in-lb).

NOTE—
BMW special tool 00 9 250 is a flexible shaft torque wrench.

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– Tighten accessible sprocket retaining bolts in the following order:
  - Left exhaust camshaft
  - Right exhaust camshaft
  - Left intake camshaft
  - Right intake camshaft

Tightening torque	
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

– Remove BMW special tool 11 2 300 from tool bore at bell-housing and remove camshaft locking tools from cylinder heads.
  - Using crankshaft center bolt, turn engine over clockwise at least one complete rotation so that remaining camshaft sprocket retaining bolts are accessible.

– Tighten remaining camshaft sprocket retaining bolts.

Tightening torque	
Sprocket bolts to camshaft flange	15 Nm (11 ft-lb)

– Remove BMW special tool 11 3 390 from primary timing chain tensioner bore and reinstall primary chain tensioner.

– Remainder of installation is reverse or removal, noting the following:
  - Remove gasket residue from cylinder head sealing surface.
  - Apply a thin bead of Three Bond 1209 ® sealing compound to joints at cylinder head cover and timing case cover and at half-moon sections at rear of cylinder heads.
  - Replace cylinder head cover gaskets if necessary.



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GENERAL

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

In 6-cylinder models, removal of the oil pan requires the removal of the exhaust system and some front suspension components. Those procedures are fully covered in:

- **180 Exhaust System**
- **210 Clutch**
- **230 Manual Transmission**
- **240 Automatic Transmission**
- **310 Front Suspension**
- **320 Steering and Wheel Alignment**

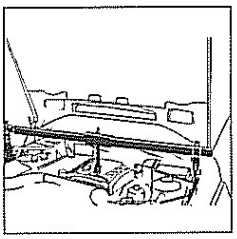
NOTE—
*Oil change procedure and oil filter replacement are covered in **020 Maintenance**.*

CAUTION—
***V8 engines:** The oil pump fasteners (including the sprocket retaining nut) are known to vibrate loose. This can result in oil starvation and engine failure. Be sure to check oil bolts and nut tightness whenever the oil pump is accessible. If any fasteners are found to be loose, remove them and reinstall with Loctite ® and torque to specifications.*

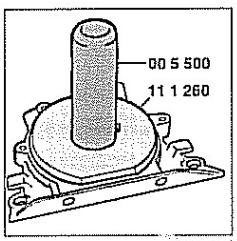
Special tools

The engine needs to be properly supported while the front suspension subframe is lowered to access the oil pan.

A standard oil pressure gauge may be used for measuring oil pressure.

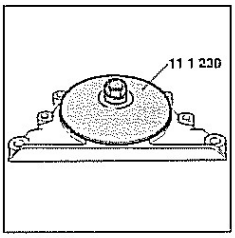


Engine support bracket
(Tool No. BMW 00 0 200/201/202/204/208)

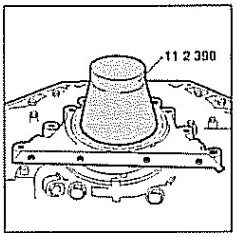


6-cylinder crankshaft rear main seal tools
(Tool No. BMW 00 5 500/11 1 260)

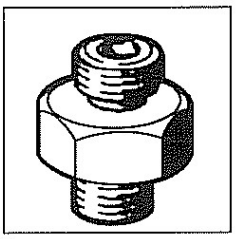
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- V-8 crankshaft rear main seal tool (Tool No. BMW 11 1 230)



- V-8 crankshaft rear main seal guide (Tool No. BMW 11 2 390)



- Adapter for BMW oil pressure gauge (Tool No. 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.

Table a. Engine oil capacity (includes oil filter replacement)

6-cylinder	6.5 liters (6.9 US qt)
V-8	7.5 liters (7.9 US qt)

TROUBLESHOOTING

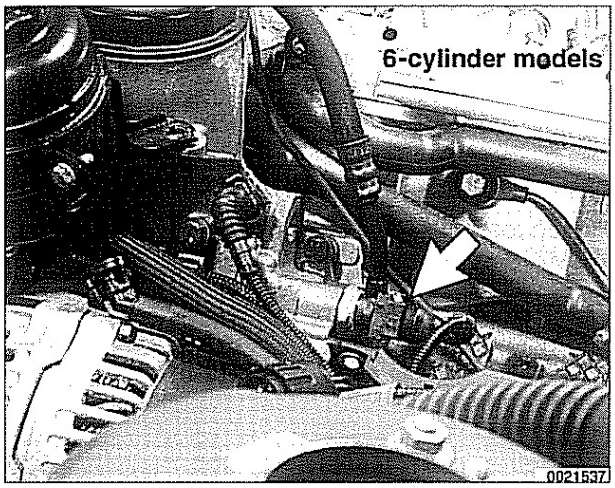
The oil pressure warning system consists of an oil pressure switch mounted in the oil circuit and an instrument panel warning light. Other safety features include:

- 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. Stop the engine immediately and make arrangements to test oil pressure.

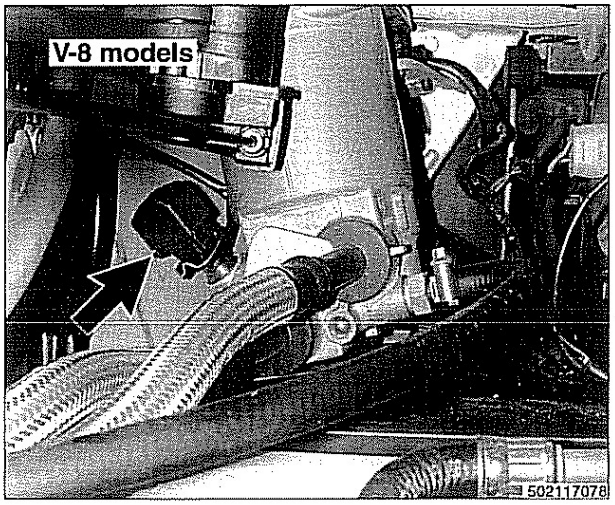
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Oil pressure, checking



The oil pressure warning switch is located at the base of the oil filter housing.

➢ In 6-cylinder engines access to oil pressure warning switch connector (**arrow**) is extremely restricted (intake manifold removed for the purpose of illustration).



➢ V-8 engine oil pressure warning switch (**arrow**) is at base of oil filter housing on left engine compartment inner fender.

Oil pressure is tested by removing oil pressure switch and installing oil pressure gauge in its place.

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

– Disconnect harness connector from oil pressure switch and remove switch.

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

– Install pressure gauge in place of oil pressure switch.

– With gauge installed, start engine and allow to reach operating temperature. Check oil pressure. See **Table b**.

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

Table b. Engine oil pressure

At idle	0.5 bar (7 psi)
At elevated speed	
6-cylinder engine	4.0 bar (59 psi)
V-8 engine	4.5 bar (66 psi)

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– Remove pressure gauge and reinstall pressure switch with new sealing washer.

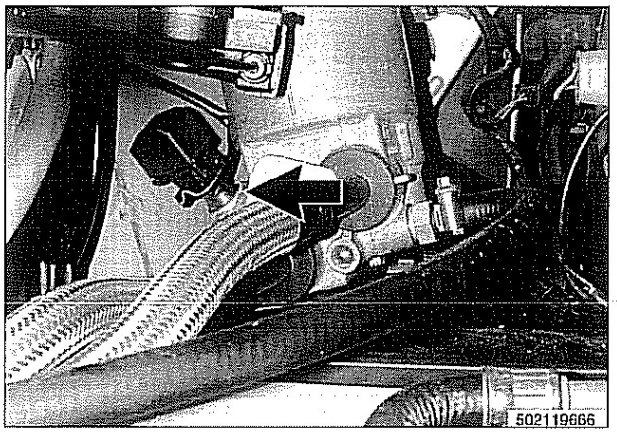
Tightening torque	
Oil pressure switch to oil filter housing	27 Nm (20 ft-lb)

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

- Worn or faulty oil pump or faulty pump pressure relief valve
- Worn or damaged engine bearings
- Severe engine wear

Any 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 (**arrow**) contact 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.

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 **ELE Electrical Wiring Diagrams** 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. The oil pressure warning light should come on.

NOTE—
If there are two wires to the oil pressure switch, ground the brown/green wire that carries the signal to the warning light.

– 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.

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To test switch, connect an ohmmeter between terminal in switch body (**arrow**) 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.

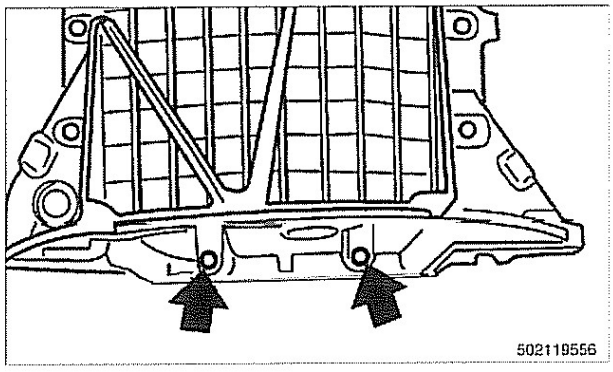
CAUTION—
Keep in mind that low oil pressure may be preventing the switch from turning the light out. If the light remains on while the engine is running, check the oil pressure as described earlier. Do not drive the car until the problem is corrected. The engine may be severely damaged.

CRANKSHAFT REAR MAIN SEAL

Crankshaft rear main seal replacement requires removal of the transmission and flywheel.

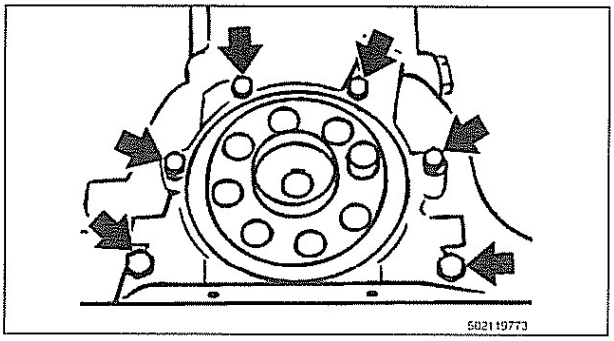
Crankshaft rear main seal, replacing (6-cylinder)

- Remove transmission. See **230 Manual Transmission** or **240 Automatic Transmission**.
- Manual transmission vehicles: Remove clutch pressure plate and disc. See **210 Clutch**.
- Remove flywheel. See **210 Clutch** or **240 Automatic Transmission**.
- Drain engine oil.



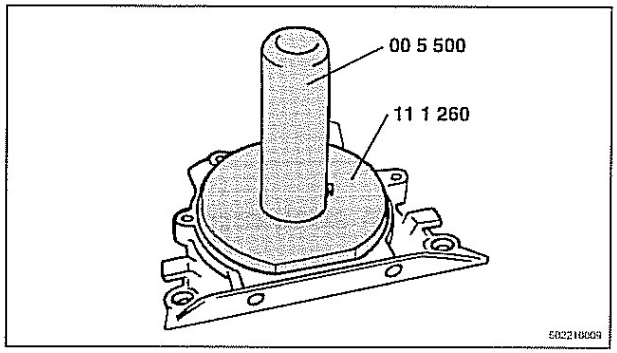
Remove seal carrier bolts from oil pan (**arrows**). Loosen all oil pan bolts.

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➢ Remove remaining seal carrier bolts (**arrows**) and carefully remove seal carrier without damaging the oil pan gasket.

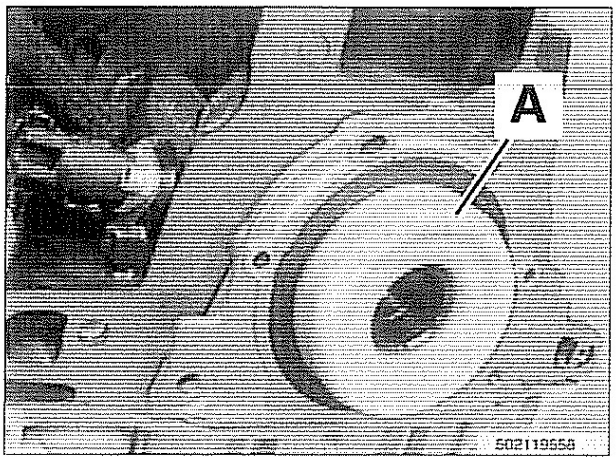
> ***CAUTION—***
> *After removing seal carrier, check oil pan gasket for damage. If gasket is damaged during removal, remove oil pan (as described later) and replace gasket.*



➢ Remove old seal and install new seal into seal carrier using BMW special tools 11 1 260 and 00 5 500.

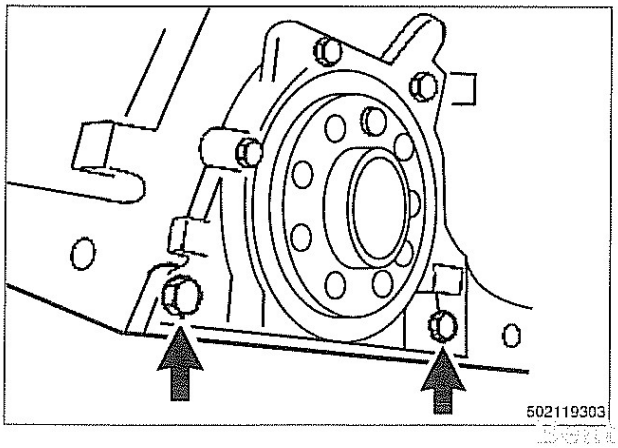
NOTE—
- *A new radial seal is used from 4/98 production, and is the only version available from BMW as a replacement. The new seal no longer uses a spring to support the sealing lip. Do not kink or damage the sealing lip. Do not touch with fingers.*
- *BMW offers the rear main seal carrier and seal in a kit. A plastic support bushing, required for sliding the seal over the crankshaft, is included with the kit.*

> ***CAUTION—***
> *Do not use BMW special tool 11 2 213 (installation guide) with the new style seal. Use only the special tool supplied with the seal kit.*



– When reinstalling seal carrier to crankcase:
  - Check locating sleeves for damage.
  - Replace gasket between rear main seal carrier and crankcase.
  - Apply thin coat of 3 Bond ® 1209 or equivalent sealant to oil pan gasket sealing surfaces.
  - Lubricate crankshaft seal contact surface.

➢ Use plastic support bushing (**A**) that comes with seal kit as an installation guide, fitting seal over end of crankshaft. Use care to push seal carrier and support bushing on straight, without tilting sideways. Remove support bushing.



– Install seal carrier bolts and torque to specifications.

➢ Use new bolts (**arrows**) at base of seal carrier. Coat threads with sealing compound before installing.

– Install and tighten oil pan bolts.

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– Remainder of assembly is reverse of disassembly.
  - Install flywheel, clutch or torque converter and transmission.
  - Fill engine with oil.
  - Run engine and check for leaks.

Tightening torques

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 (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Rear main seal carrier to crankcase	
M6	10 Nm (89 in-lb)
M8	22 Nm (16 ft-lb)

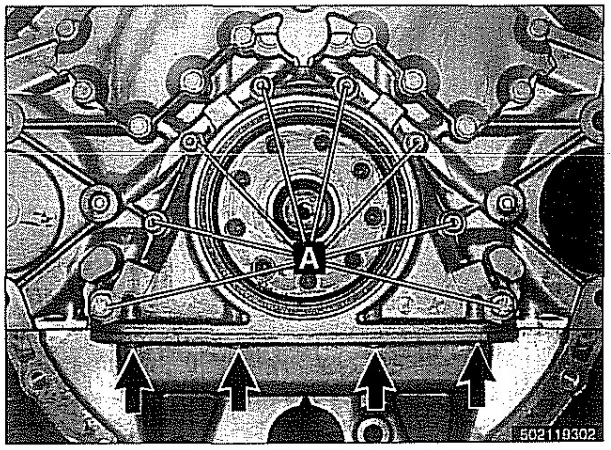
Crankshaft rear main seal, replacing (V-8)

– Remove transmission. See **230 Manual Transmission** or **240 Automatic Transmission**.

– Manual transmission vehicles: Remove clutch pressure plate and disc. See **210 Clutch**.

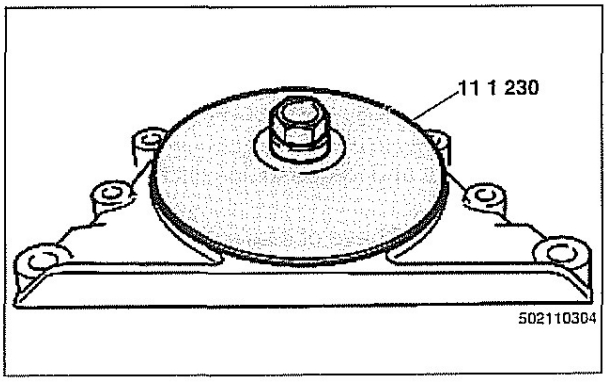
– Remove flywheel. See **210 Clutch**.

– Drain engine oil.



Remove bolts (**A**) retaining rear main seal carrier, including bolts at (**arrows**) oil pan.
  - Carefully separate seal carrier from oil pan gasket and remove carrier.

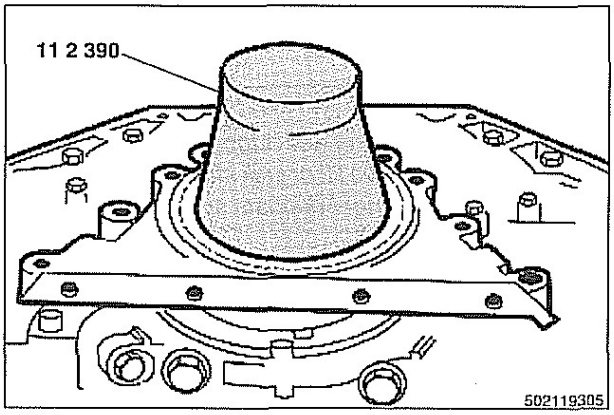
CAUTION—
Do not damage oil pan gasket.



Remove old seal and reinstall new seal into seal carrier using BMW special tools 11 1 230 and 00 5 500.

NOTE—
BMW offers the rear main seal carrier and seal in a kit.

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– When reinstalling seal carrier to crankcase:
  - Check locating sleeves for damage.
  - Replace gasket between rear main seal carrier and crankcase.
  - Apply thin coat of 3 Bond ® 1209 or equivalent sealant to oil pan gasket sealing surfaces.
  - Lubricate crankshaft and seal contact surfaces.

Use BMW special tool 11 2 390 as an installation guide in fitting seal over end of crankshaft. Use care to push seal carrier and support bushing on straight, without tilting. Remove installation guide carefully.

– Replace sealing washers under seal carrier mounting bolts.

– Install seal carrier mounting bolts and torque to specifications.

– Install oil pan bolts.

– Remainder of assembly is reverse of disassembly.
  - Install flywheel using new bolts,
  - Install clutch or torque converter and transmission.
  - Fill engine with oil.
  - Run engine and check for leaks.

Tightening torques

Flywheel to crankshaft (use new bolts)	120 Nm (89 ft-lb)
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 (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Rear main seal carrier to crankcase	
M6	10 Nm (89 in-lb)
M8	22 Nm (16 ft-lb)

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Engine Oil Pan

Oil pan, removing and installing (6-cylinder)

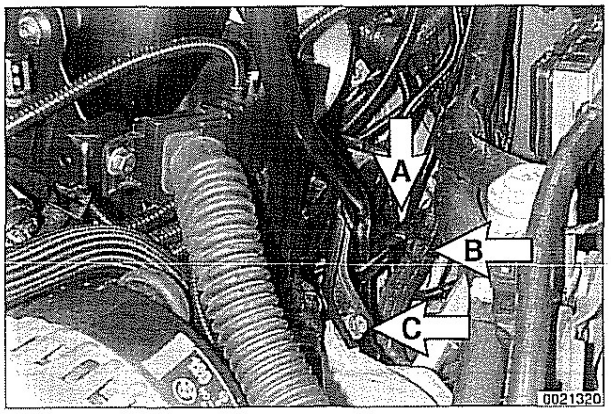
The engine oil pan removal procedure requires that the engine be supported from the top and the front suspension subframe be lowered.

– 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**.

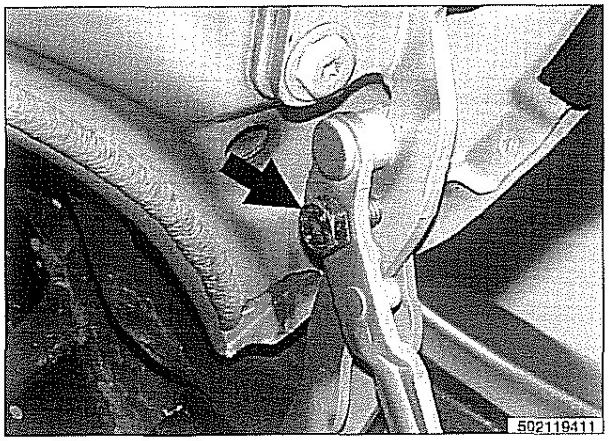


Remove oil dipstick guide tube:

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

NOTE —

- *If necessary, remove air filter assembly for better access to dipstick tube.*
- *The dipstick guide tube is sealed in the block using an O-ring. Check that the O-ring comes out with the tube.*

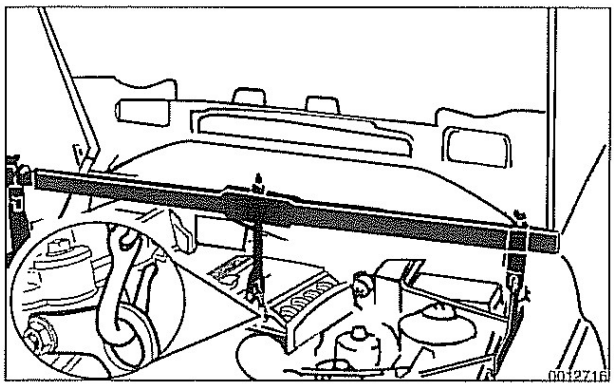


Lift hood into assembly position:

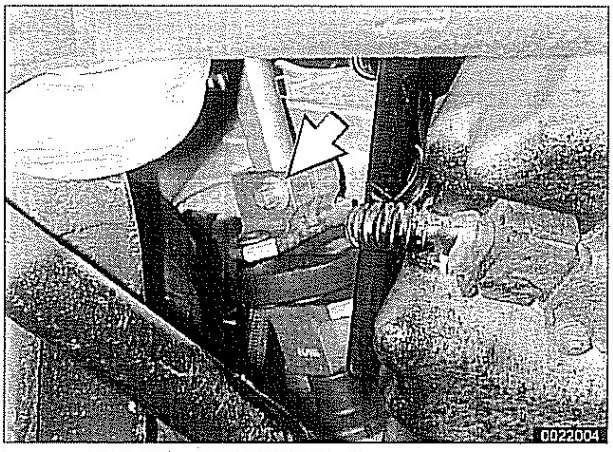
- While supporting the hood, disconnect hood support struts.
- Raise hood and install locking bolts (**arrow**) in right and left hinges.

> ***WARNING —***
> *Be sure to support hood while disconnecting support struts.*

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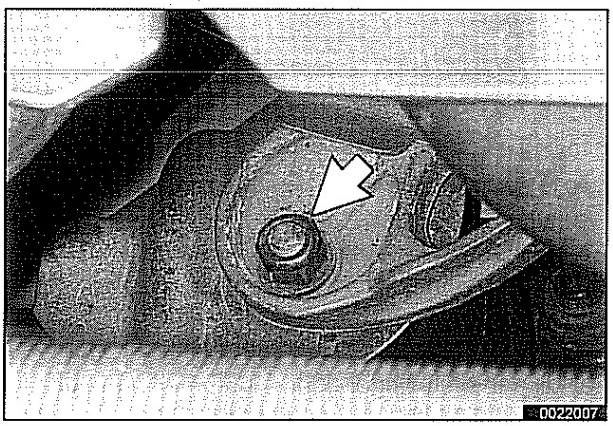


- Install engine lifting tool at front of engine and raise engine approximately 5 mm (1/4 in).

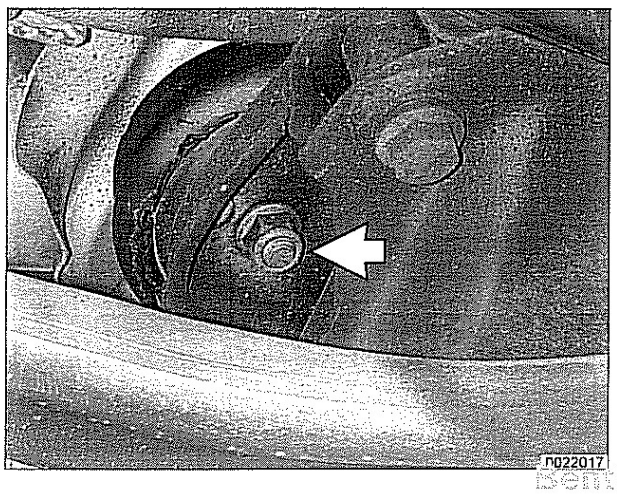


- Remove pinch bolt (**arrow**) at steering column universal joint near steering rack. See **320 Steering and Alignment**.
- Remove power steering pump, leaving hydraulic lines connected to pump. Suspend pump using strong wire. See **320 Steering and Wheel Alignment**.

NOTE—
For better access to power steering assembly, unbolt fluid reservoir and suspend with wire.

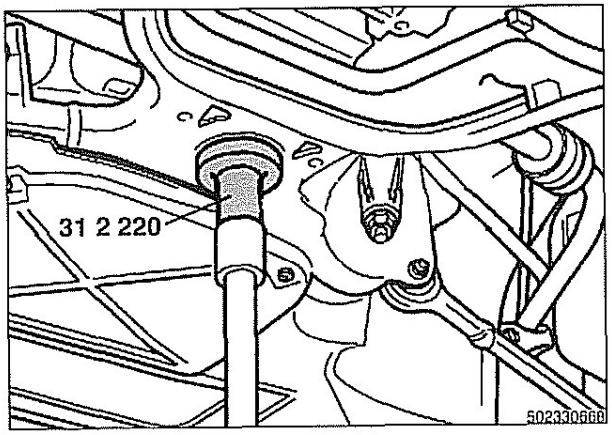


- Loosen upper nuts (**arrow**) in right and left engine mounts.

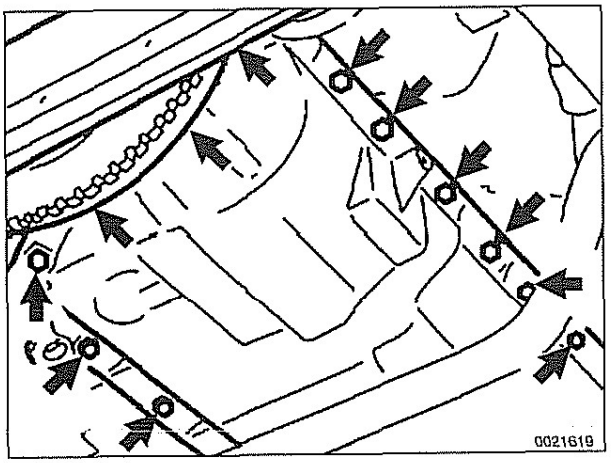


- Remove right and left lower engine mount nuts (**arrow**).
- On cars with automatic transmission, remove ATF cooler line brackets from engine oil pan.
- Disconnect electrical harness connector at oil level sensor on oil pan.

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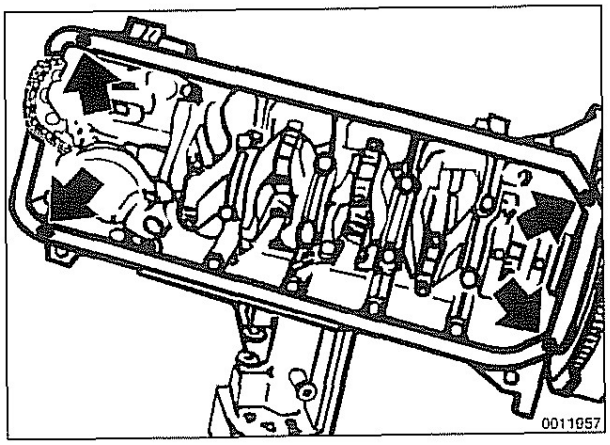
- Support subframe from below using BMW special tool 31 2 220 and appropriate shop lift. Remove subframe mounting bolts and lower subframe as far as possible.



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

NOTE—
If oil pan will not slide backwards, disconnect stabilizer bar links and lower front axle support further.

> ***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.
  - Install all oil pan bolts finger tight. Tighten oil pan bolts toward front of engine first, then pan bolts at transmission end.

Tightening torques

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 (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)

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– Remainder of installation is reverse of removal.
  - Replace self-locking nuts when reinstalling front suspension components.
  - Use new oil dipstick tube sealing O-ring.
  - After adding engine oil, start and run engine. Raise engine speed to 2,500 rpm until oil pressure warning light goes out (about 5 seconds).

NOTE—
BMW does not specify a front end alignment following this procedure.

Tightening torques

Front subframe to body rail (M12, use new bolts)	
8.8 grade	77 Nm (57 ft-lb)
10.9 grade	105 Nm (77 ft-lb)
12.9 grade	110 Nm (81 ft-lb)
Stabilizer bar link to stabilizer bar	65 Nm (48 ft-lb)
Steering shaft universal joint clamping bolt (use new bolt)	19 Nm (14 ft-lb)

Lower oil pan, removing and installing (V-8)

– The V-8 engine is equipped with a 2-piece oil pan. The fasteners in V-8 engine oil pump assembly, including the sprocket retaining nut, are known to loosen and fall off into the oil pan. Be sure to install these fasteners with Loctite ® or equivalent thread locking product and torque to specifications.

> ***CAUTION—***
> *It is recommended that the oil pump retaining bolts and oil pump drive sprocket retaining nut tightening torque be checked any time the oil pan is removed.*

– Raise car and place securely on jack stands.

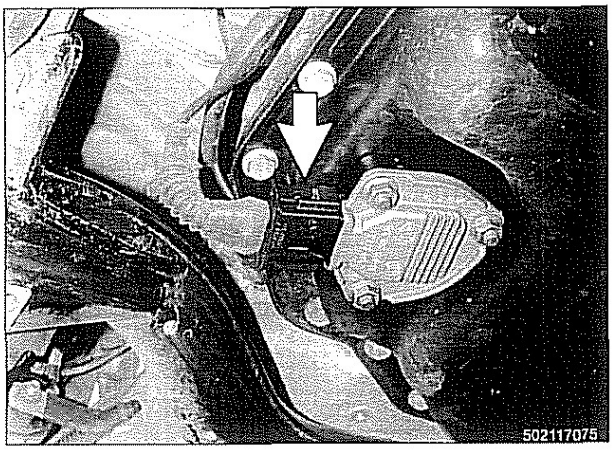
> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove splash shield from under engine.

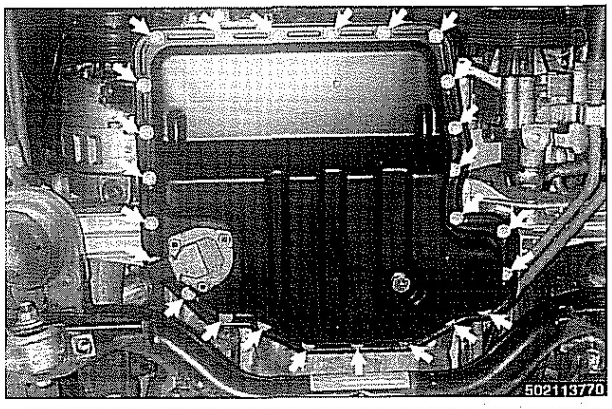
– Drain engine oil.

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

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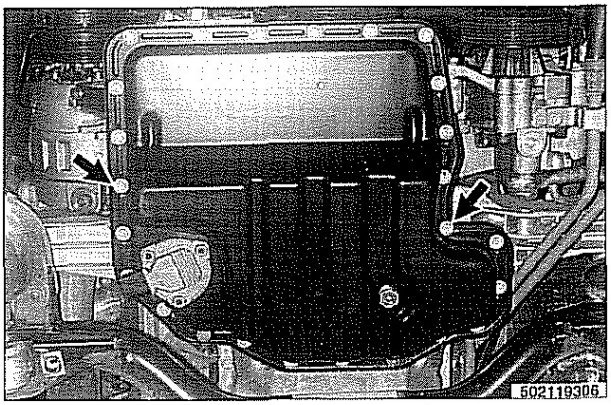
- Disconnect electrical harness connector (**arrow**) at oil level sensor.



- Remove lower oil pan mounting bolts (**arrows**).

> ***CAUTION—***
> *If the lower pan does not separate easily from upper pan, 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.



- Install threaded guide studs at locations marked by **arrows** to guide new oil pan gasket and oil pan into position and to prevent damage to sealing lip.
  - Install new oil pan mounting bolts (threads coated with sealer).
  - Remove guide studs and install remainder of oil pan bolts.

– Remainder of reassembly is reverse of disassembly.

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

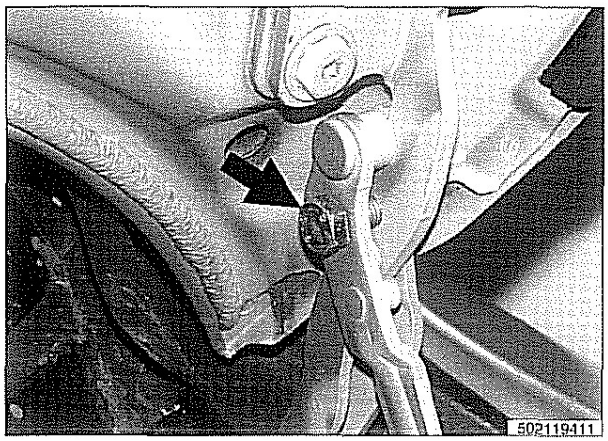
Tightening torques

Lower oil pan to upper oil pan	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)

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Upper oil pan, removing and installing (V-8)

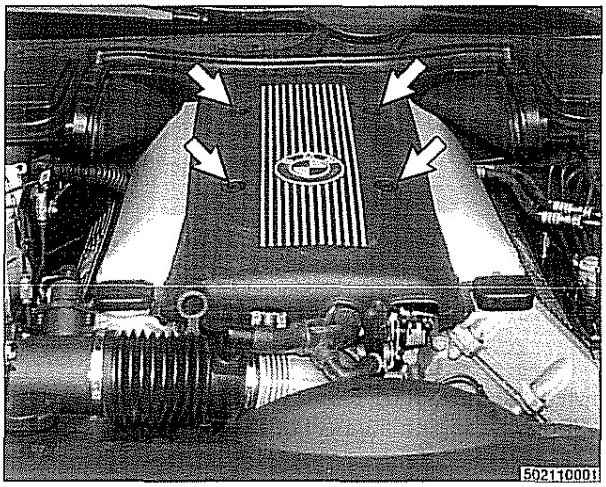
The engine oil pan removal procedure requires that the engine be supported from the top and the front suspension subframe be lowered.



– Disconnect negative (-) battery cable.

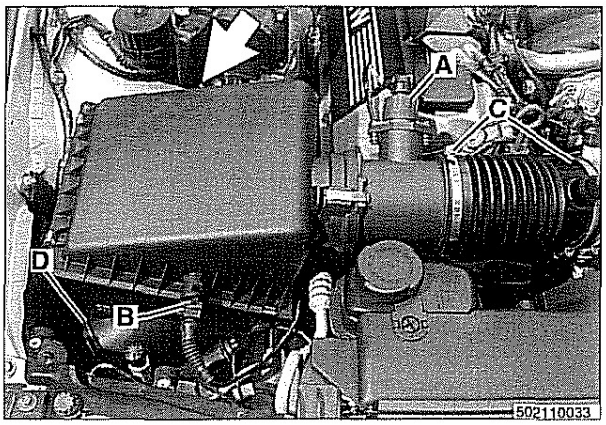
⮜ Lift hood into assembly position.

- While supporting hood, disconnect support struts.
- Open hood fully and lock in place by installing bolts (**arrow**) in left and right hinges to lock hood in place.



⮜ Remove engine top cover:

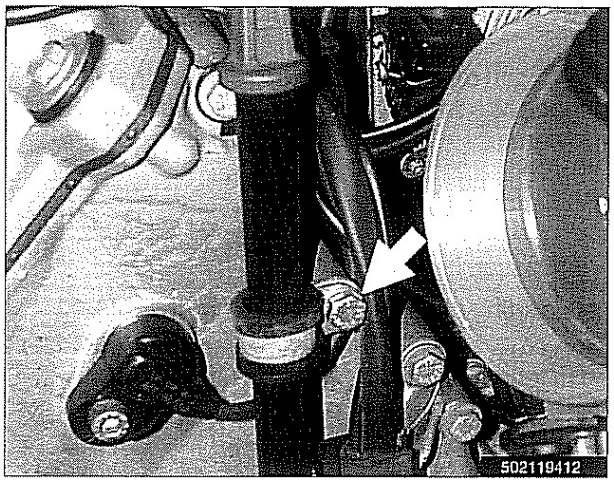
- Early version: Pry off caps (**arrows**) and remove fasteners.
- Late version: Depress fasteners (**arrows**) and lift cover.



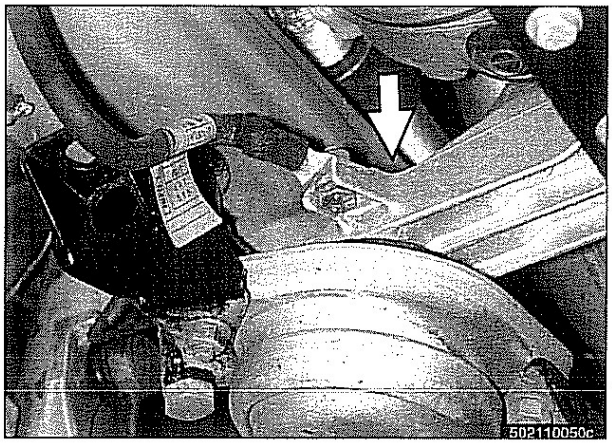
⮜ Remove air filter housing and mass air flow sensor:

- Disconnect mass air flow sensor (**A**) and intake air temperature sensor (**B**) electrical harness connectors.
- Remove air filter housing mounting fastener (**arrow**).
- Loosen intake hose clamps (**C** and **D**).
- Remove air filter housing with mass air flow sensor.
- Remove intake hose from throttle body.

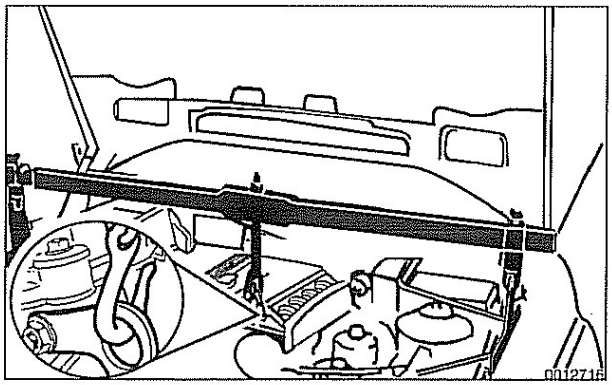
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- Remove oil dipstick support from right cylinder head.

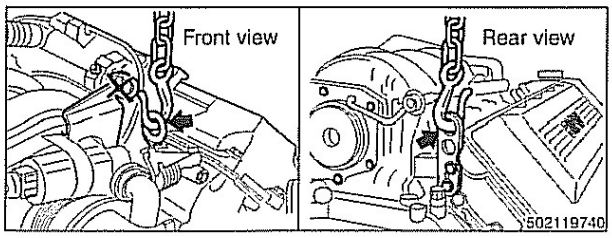


- Remove upper nuts (**arrow**) from left and right motor mounts.



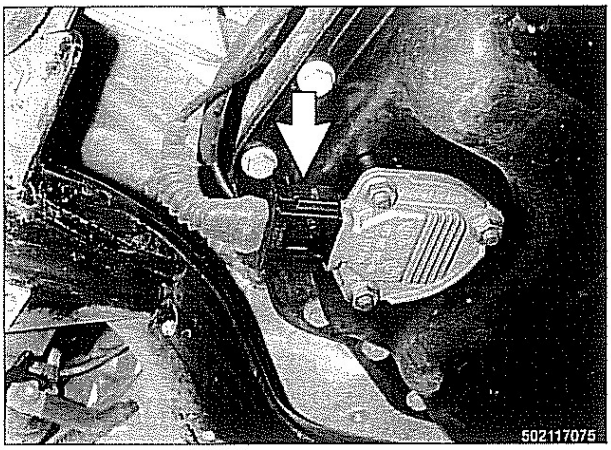
- Attach BMW special tool 00 0 200 with tools 201/202/204/208 (engine support bracket).

NOTE—
Side support members (BMW special tool 00 0 208) must make contact with fender mounting bolts.

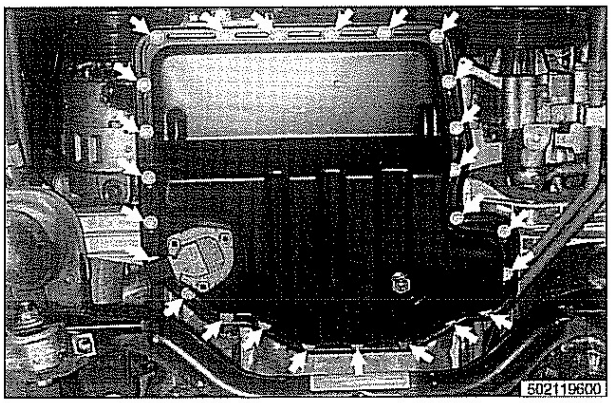


- Attach engine lifting chains to front and rear lifting eyes.
- Lift engine approximately 6-8 mm (0.25-0.32 in).
- Loosen oil filter cover, then drain engine oil. See **020 Maintenance**.

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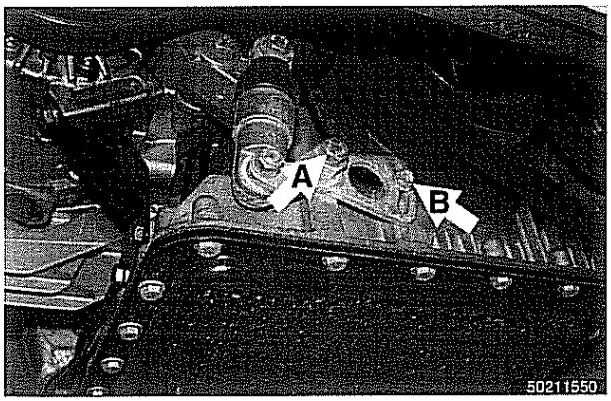


- Disconnect electrical harness connector (**arrow**) at oil level sensor.



- Remove lower oil pan bolts (**arrows**) and pan.

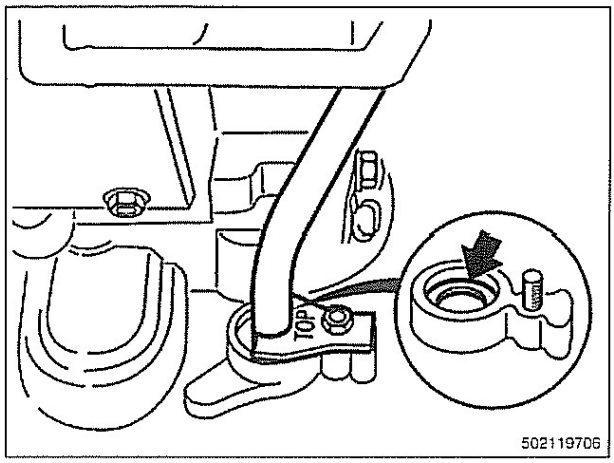
> ***CAUTION—***
> *If the lower pan does not separate easily from upper pan, a few taps with a rubber mallet should break it free. Do not pry the oil pan loose.*



- Remove A/C drive belt tensioner.
  - Remove adjustment bolt (**B**).
  - Remove retaining bolt (**A**) and remove tensioner from oil pan.

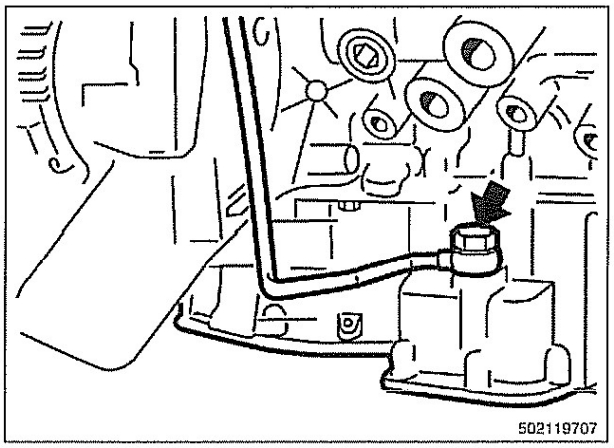
– Remove power steering pump from engine block, leaving hydraulic lines connected. Suspend from chassis using stiff wire. See **320 Steering and Wheel Alignment**.

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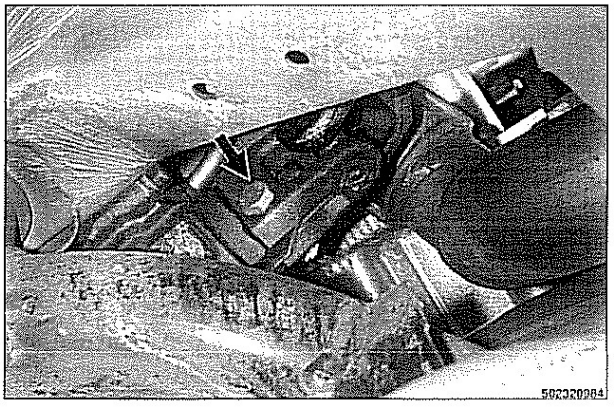


- Working at left side of engine, remove oil dipstick guide tube mounting bracket and remove dipstick tube.

  NOTE—
  Replace dipstick O-ring seal.



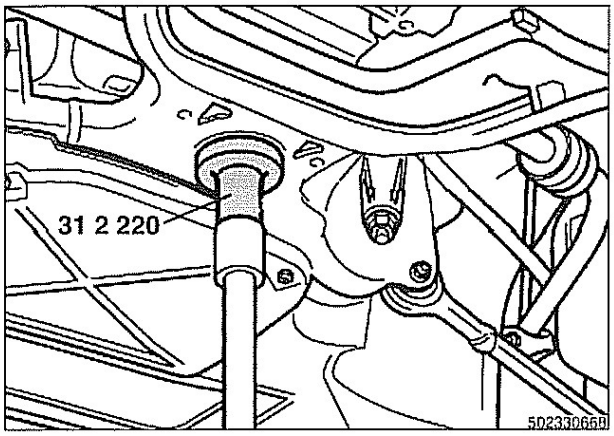
- Working at right side of engine, remove oil return line from upper section of oil pan.



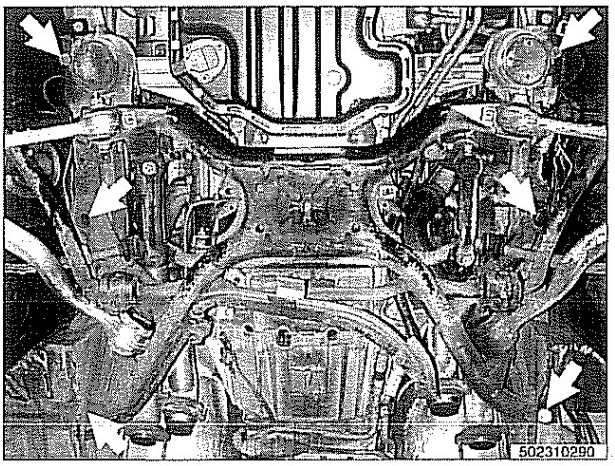
- Separate lower steering column from steering box:
  - Remove retaining bolt (**arrow**) from lower steering column universal joint.
  - Slide lower steering column up and off of connection at steering box.

– Remove support bracket for hydraulic line at subframe.

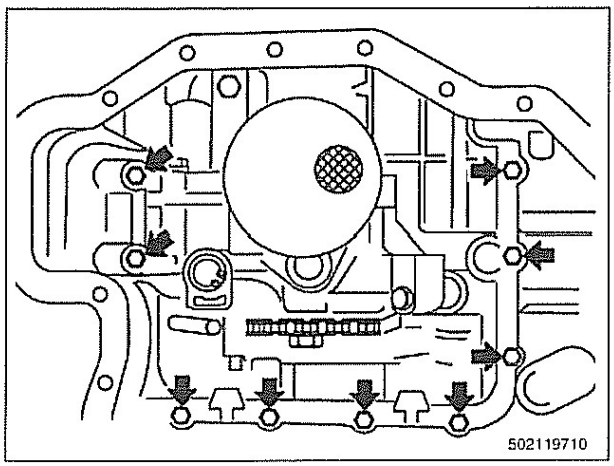
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- Support subframe from below using BMW special tool 31 2 220 and appropriate shop lift.

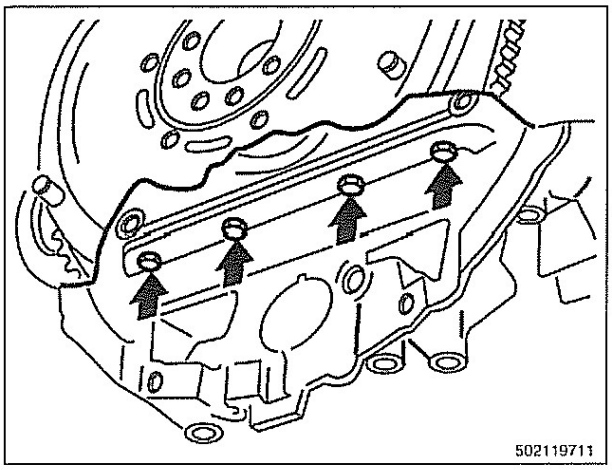


- Remove subframe mounting bolts (**arrows**) and lower subframe as far as possible.



- Working through lower oil pan opening, remove pump mounting bolts (**arrows**).
  - Remove oil pump. See **Oil pump, removing and installing (V-8)**.

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➢ Working at lower rear of engine, remove oil pan retaining bolts (**arrows**).

– If necessary, remove oil cooler bracket from oil pan.

– Remove remaining oil pan bolts. Slide upper section of oil pan forward to remove.

– Installation is reverse of removal, noting the following:
  - Clean sealing surfaces of debris.
  - Coat joints with Three Bond 1209 ® sealant.
  - Use new gaskets.
  - Install all oil pan bolts first, installing bolts at transmission end without preload.
  - Tighten oil pan bolts at front end, then tighten bolts at rear of engine.

> ***CAUTION—***
> *Be sure to reinstall all oil pump fasteners, including the sprocket retaining nut, using Loctite ® or equivalent thread locking product. Torque to specifications.*

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

Tightening torques

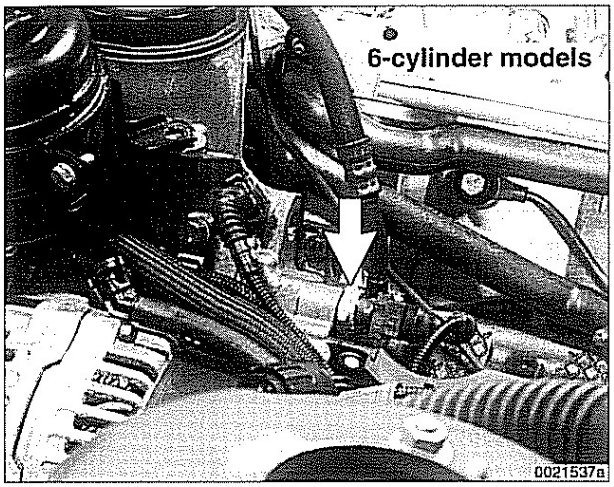
A/C drive belt tensioner	
M6	10 Nm (7.5 ft-lb)
M8	24 Nm (18 ft-lb)
Front axle subframe to chassis (Use new fasteners)	77 Nm (57 ft-lb)
Oil drain line to upper oil pan	30 Nm (22 ft-lb)
Oil pump to crankcase	34 Nm (25 ft-lb)
Oil pan fasteners (upper/lower)	
M6 8.8	10 Nm (7.5 ft-lb)
M6 10.9 (replace)	12 Nm (9 ft-lb)
M8 8.8	22 Nm (16 ft-lb)
Steering column universal joint to steering box (replace)	19 Nm (14 ft-lb)

COMPONENT REPLACEMENT

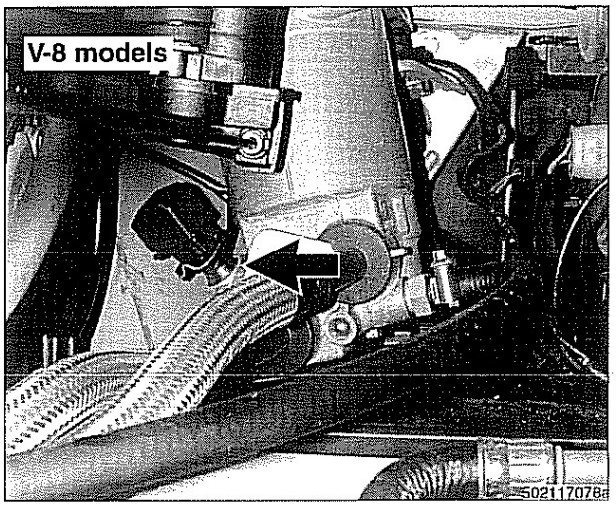
Oil pressure warning switch, replacing (6-cylinder and V-8)

– In all models, the oil pressure warning switch is located at the base of the oil filter housing.

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- 6-cylinder models: Remove intake manifold to access oil pressure switch (**arrow**).

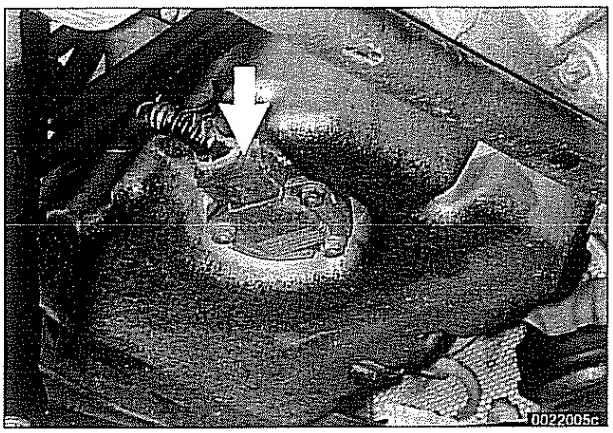


- V-8 models: Oil pressure warning switch (**arrow**) is located under oil filter housing mounted to left inner fender panel.

NOTE—
Any time the oil pressure warning switch is removed, be sure to replace the sealing washer.

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

Oil level warning switch, replacing (6-cylinder and V-8)



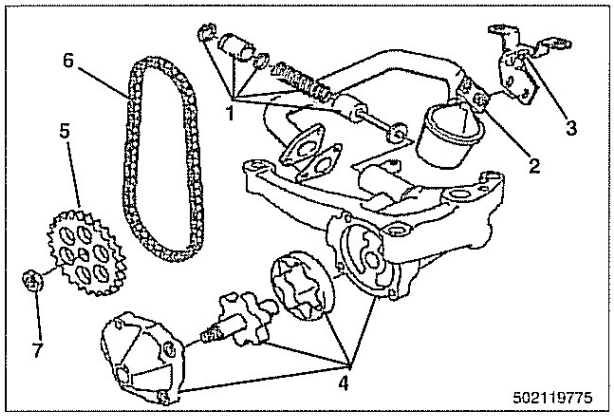
- Oil level warning switch is located at bottom of the engine oil pan.
  - Drain engine oil before attempting to remove level warning switch.
  - Be sure to refill engine and check for leaks after work is completed.

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

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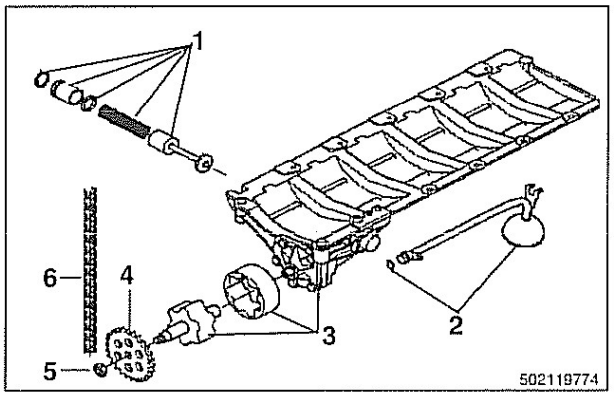
Oil pump, removing and installing (6-cylinder)

CAUTION—
Oil pump sprocket nut has left-hand threads. Turn clockwise to loosen.



Version 1, M52 oil pump assembly.

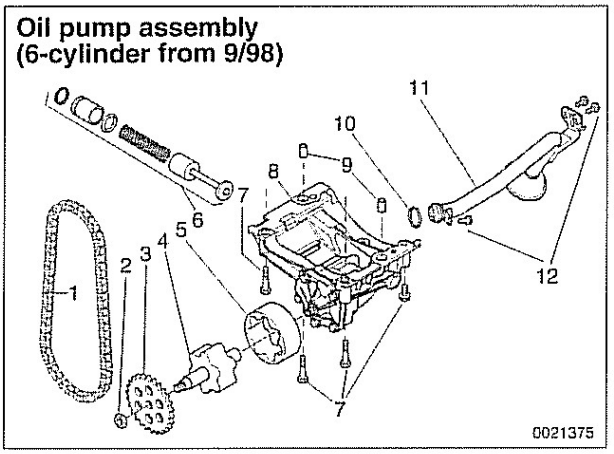
1. Oil pump pressure relief control valve
2. Oil pump suction tube
3. Suction tube support bracket
4. Oil pump assembly
5. Oil pump drive sprocket
6. Oil pump drive chain
7. Oil pump drive sprocket nut (left hand threads)



Version 2, M52 TU oil pump assembly.

1. Oil pump pressure relief control valve assembly
2. Oil pump suction pick-up and seal
3. Oil pump
4. Oil pump drive sprocket
5. Oil pump shaft locking nut (left-hand thread)
6. Oil pump drive chain

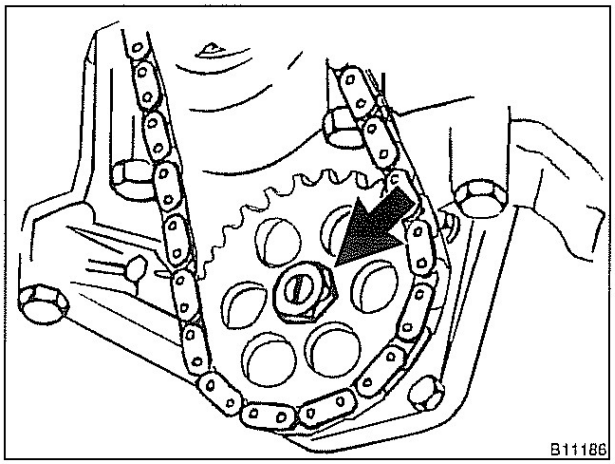
Oil pump assembly (6-cylinder from 9/98)



Version 3, M54 oil pump assembly.

1. Drive chain
2. M10 x 1 nut
   Tighten to 25 Nm (18 ft-lb)
3. Oil pump sprocket
4. Inner pump rotor
5. Outer pump rotor
6. Oil pressure relief valve assembly
7. M8 bolt.
   Tighten to 23 Nm (17 ft-lb)
8. Oil pump housing
9. Locating dowels
10. Pickup tube sealing O-ring
11. Pickup tube
12. M6 pickup tube mounting bolts
    Tighten to 10 Nm (89 in-lb)

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– Lower front suspension and remove oil pan, as described earlier, to gain access to oil pump.

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

- Engines produced to 9/98: Remove oil pump with pick-up tube. Pick-up tube is bolted to side of oil pump.
- Engines produced from 9/98 to 01/00: Remove pick-up tube, scraper tray and oil pump as a unit.
- Engines produced from 01/00: Remove oil pump pick-up tube bolts and remove pick-up tube before removing pump.
- Remove mounting bolts from oil pump. Withdraw pump.

NOTE—
- *Record location of any spacers between pump and engine block. Note positions of locating dowels.*

– Remove cover from oil pump and check for wear or scoring. Spin oil pump shaft and check that gears turn smoothly. Replace pump if gears spin with difficulty or any wear is present.

– Inspect oil pressure relief valve as described later.

– Installation is reverse of removal, noting the following:
- Replace pick-up tube O-ring (if applicable).
- Align sprocket splines to oil pump shaft splines before tightening sprocket nut.

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

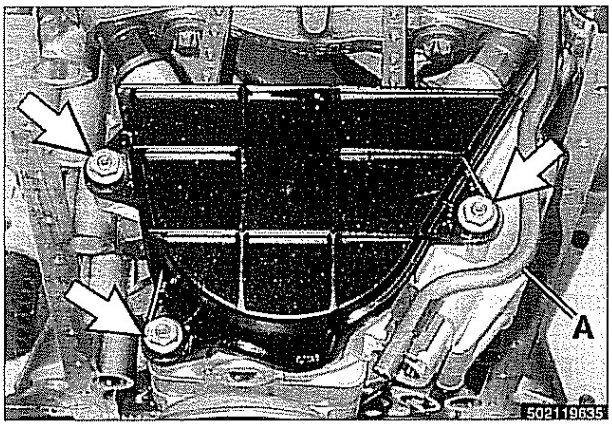
Tightening torques

Oil drain plug to oil pan	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 (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil pump sprocket to oil pump shaft (M10 x 1) (left hand thread)	25 Nm (18 ft-lb)
Oil pump to crankcase (M8)	22 Nm (16 ft-lb)
Oil pump pickup tube to crankcase (M6)	10 Nm (89 in-lb)

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Oil pump, removing and installing (V-8)

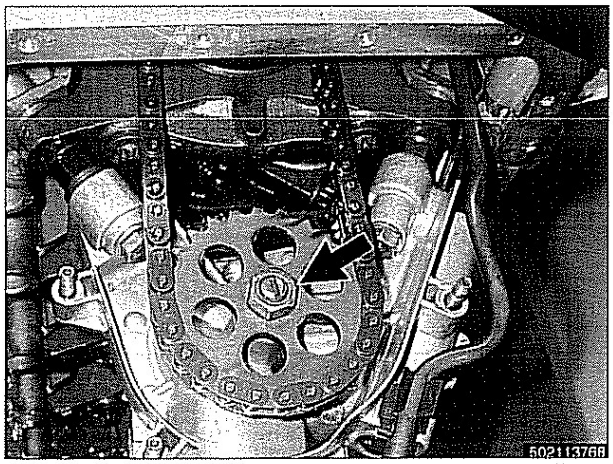
CAUTION—
V8 engines: *The oil pump fasteners (including the sprocket retaining nut) are known to vibrate loose. This can result in oil starvation and engine failure. Be sure to check oil bolts and nut tighness whenever the oil pump is accessible. If any fasteners are found to be loose, remove them and reinstall with Loctite ® and torque to specifications.*



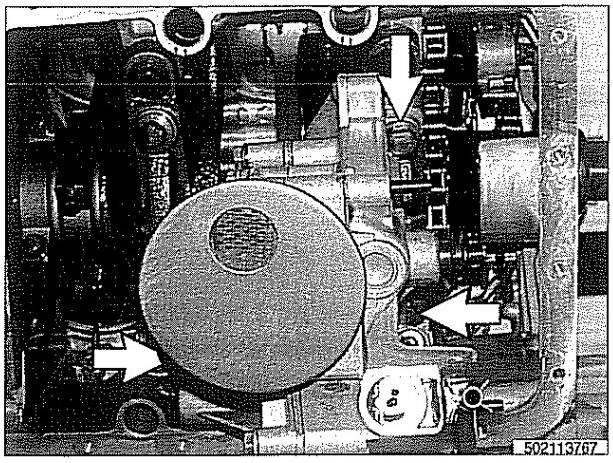
– Remove upper oil pan, as described earlier, to gain access to oil pump.

➢ If fitted, remove oil pump sprocket cover fasteners (**arrows**). Remove cover.

- Unclip oil return line (**A**).



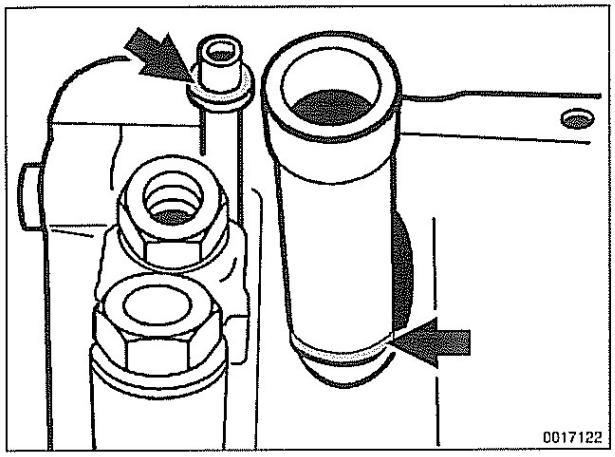
➢ Remove oil pump sprocket nut (**arrow**) and sprocket together with drive chain.



➢ Unbolt oil pump mounting fasteners (**arrows**) and remove pump.

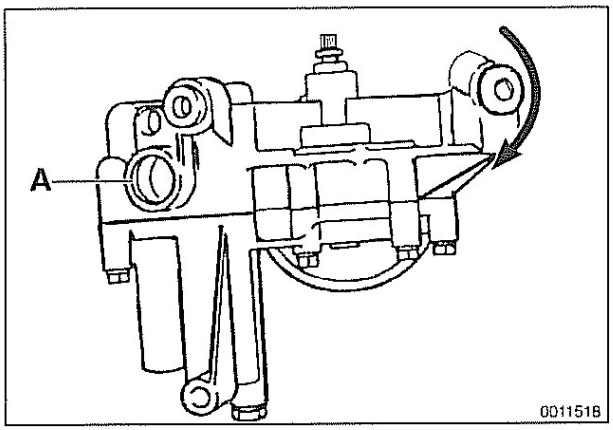
– Remove oil pressure relief valve and inspect as described later.

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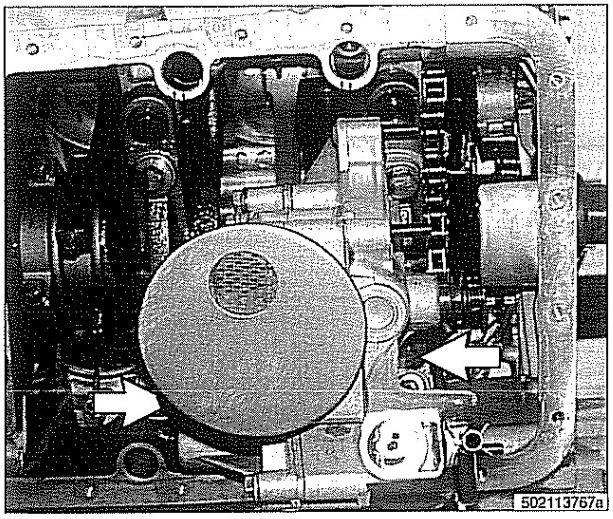


- Replace O-ring seals (**arrows**) on engine oil pipes. Oil seals lightly.

> ***CAUTION—***
> *During reinstallation, do not damage O-rings on sharp edges of engine block.*



- Replace sealing O-ring (**A**) in oil pump.
  - Turn threaded spacer on pump fully to stop (**arrow**).



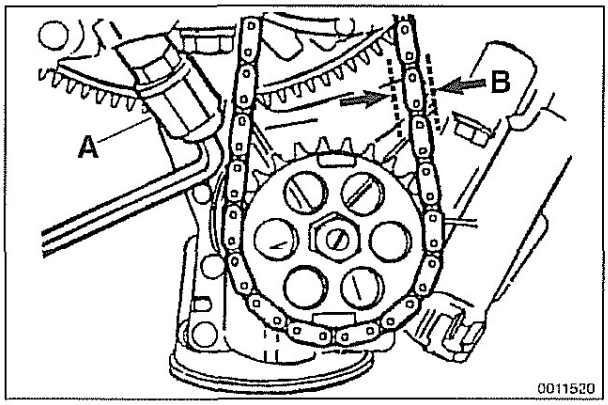
- Reinstall pump. Coat pump mounting fasteners (**arrows**) with Loctite ® or equivalent thread locking product. Install and tighten.

– Coat pump sprocket shaft threads with Loctite ®. Reinstall pump sprocket with drive chain and tighten mounting nut.

Tightening torques

Oil pump cover to oil pump (M6)	10 Nm (89 in-lb)
Oil pump sprocket to shaft (M10)	45 Nm (33 ft-lb)
Oil pump to engine block M8 (8.8 grade)	22 Nm (16 ft-lb)

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Use Allen wrench to adjust chain slack (**B**) by turning threaded spacer (**A**).

Oil pump chain adjustment	
Slack **B**	10 ±2 mm (0.394 ±0.079 in)

– Coat remaining oil pump mounting fastener with Loctite ®. Install and tighten.

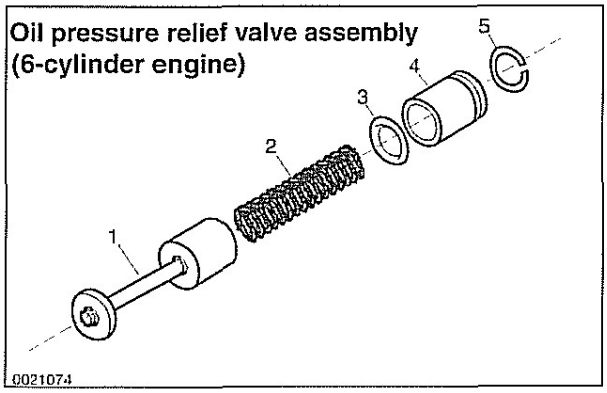
– Remainder of assembly is reverse of disassembly.

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

Tightening torques	
Lower oil pan to upper oil pan	
M6 (8.8 grade)	10 Nm (89 in-lb)
M6 (10.9 grade)	12 Nm (9 ft-lb)
M8 (8.8 grade)	22 Nm (16 ft-lb)
Oil drain plug to oil pan (M12)	25 Nm (18 ft-lb)
Oil pump cover to oil pump (M6)	10 Nm (89 in-lb)
Oil pump sprocket to shaft (M10)	45 Nm (33 ft-lb)
Oil pump to engine block M8 (8.8 grade)	22 Nm (16 ft-lb)

Oil pressure relief valve (6-cylinder)

Remove oil pump as described earlier. The oil pump pressure relief valve is held in the side of the oil pump with a circlip.



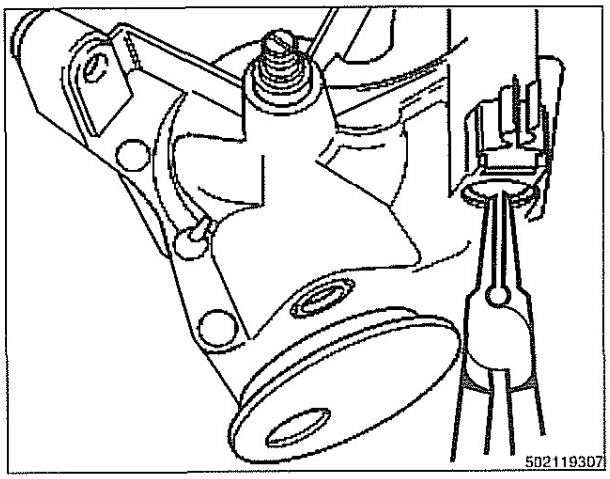
Inspect oil pump relief valve components and bore for scoring or other damage.

1. Control plunger
2. Spring
3. Sealing O-ring
4. Sleeve
5. Circlip

– Install using a new circlip.

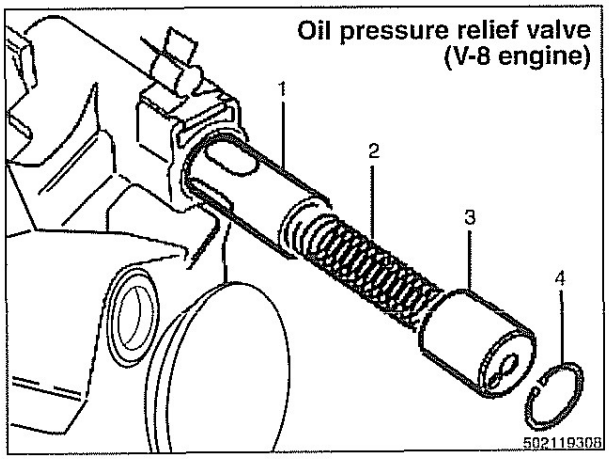
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Oil pressure relief valve (V-8)



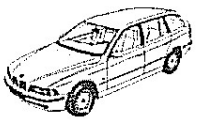
- Remove oil pressure relief valve retaining circlip.
  - Use a suitable drift to remove relief valve assembly from pump.

> ***CAUTION—***
> *There is high spring pressure in the relief valve.*



- Inspect oil pump relief valve components and bore for scoring or other damage.
  1. Control plunger
  2. Spring
  3. Sleeve
  4. Circlip

– Install using a new circlip.



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120 Ignition System

General 120-2
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Engine management 120-3
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GENERAL

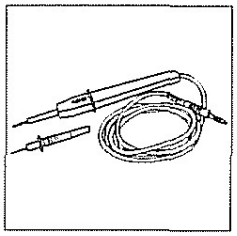
This repair group covers component troubleshooting and replacement information for the ignition system.

When diagnosing engine management problems, including on-board diagnostics (OBD II) fault code analysis, also refer to these repair groups:

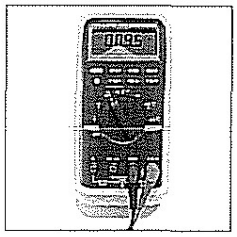
- **130 Fuel Injection**
- **ELE Electrical Wiring Diagrams**
- **OBD On-Board Diagnostics**

Special tools

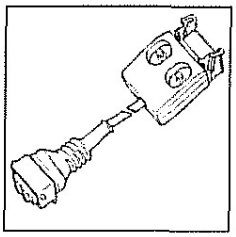
System diagnosis and testing of the ignition system requires special test equipment.



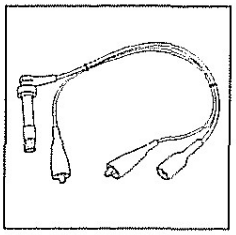
LED test light
(Tool No. Baum 1115)



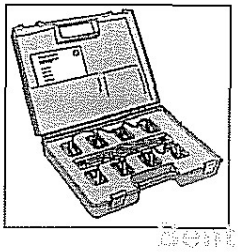
Automotive digital multimeter



Primary voltage test harness
(Tool No. BMW 12 7 020)



Secondary voltage test harness
(Tool No. BMW 12 7 030)



Ignition coil test adapters
(Tool No. BMW 12 7 040)

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Warnings and cautions

The ignition system produces dangerous high voltage. In addition the sensitive electronic components can be damaged if proper precautions are not adhered to.

WARNING —

- *Do not touch or disconnect any cables from the coils while the engine is running or being cranked by the starter.*
- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is OFF.*
- *Before operating the starter without starting the engine (for example when making a compression test) always disable the ignition.*

CAUTION—

- *Do not attempt to disable the ignition by removing the coils from the spark plugs.*
- *Connect or disconnect ignition system wires, multiple wire connectors, and ignition test equipment leads only while the ignition is off. Switch multimeter functions or measurement ranges only with the test probes disconnected.*
- *Do not disconnect the battery while the engine is running.*
- *A high impedance digital multimeter should be used for all voltage and resistance tests. An LED test light should be used in place of an incandescent-type test lamp.*
- *In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument manufacturer.*

Engine management

BMW E39 engines use an advanced engine management system known as Digital Motor Electronics (DME). DME incorporates on-board diagnostics, fuel injection, ignition and other engine control functions. DME variants are listed in **Table a. Engine management systems**.

Second generation On-Board Diagnostics (OBD II) is incorporated into the engine management systems used on the cars covered by this manual. Use a BMW-specific electronic scan tool, or a "Generic" OBD II scan tool to access Diagnostic Trouble Codes (DTCs). DTCs can help pinpoint ignition and other engine management problems.

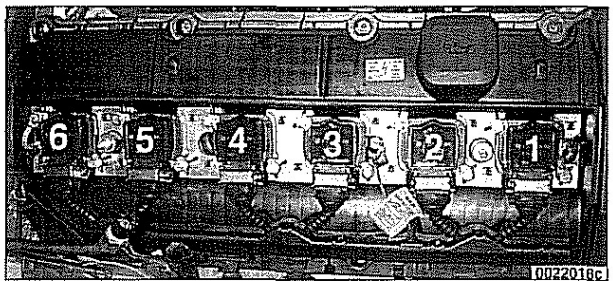
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Additional information about DTCs and engine management system electronic system diagnosis is provided in **OBD On-Board Diagnostics.**

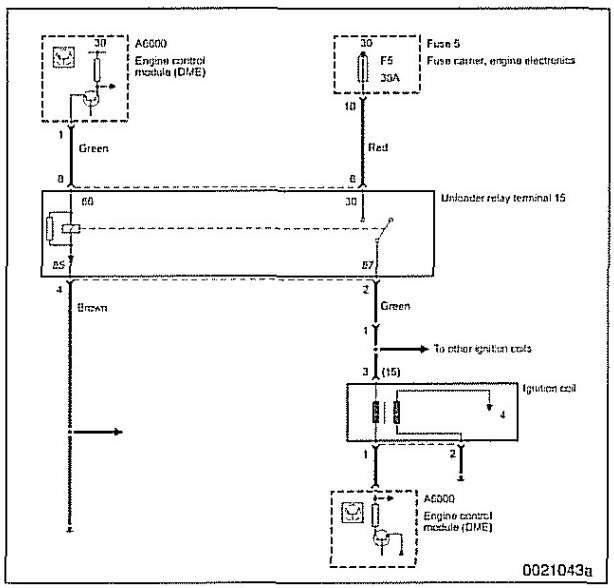
Table a. Engine management systems

Year	Engine	Engine type	DME system
1997-1998	M52	6–cylinder	Siemens MS 41.1
1999-2000	M52 TU	6–cylinder	Siemens MS 42.0
2001-2002	M54	6–cylinder	Siemens MS 43.0
1997	M62	V-8	Bosch M 5.2
1998	M62	V-8	Bosch M 5.2.1
1999-2002	M62 TU	V-8	Bosch ME 7.2

Ignition system

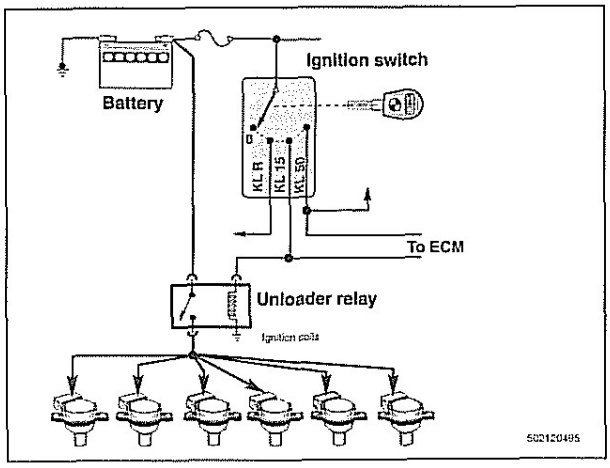


All engines use a distributorless ignition system with individual ignition coils for each cylinder. There is no distributor cap or ignition rotor.



Each coil is controlled and monitored by the Engine Control Module (ECM) on a cylinder-by-cylinder basis.

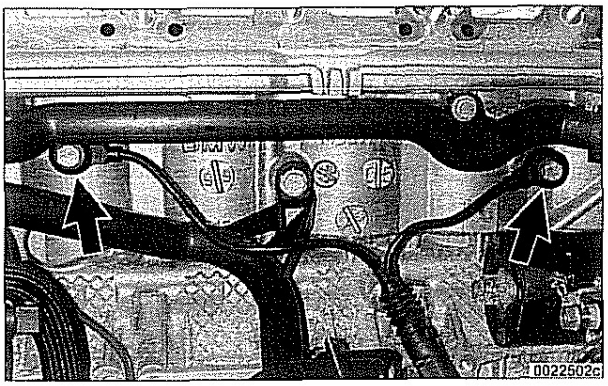
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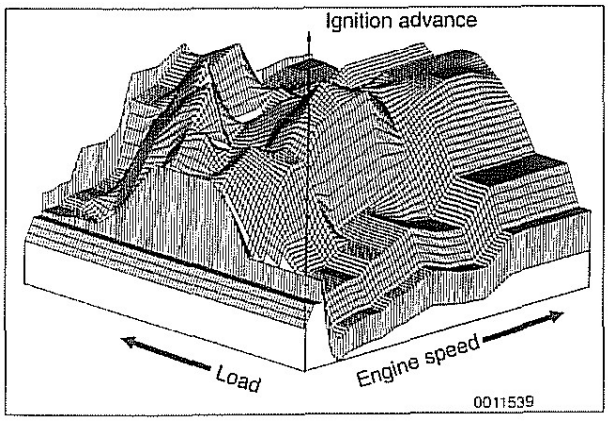
The positive (+) power supply to the ignition coils comes to the ignition switch via an unloader relay. When the ignition switch is turned on, the relay closes, to provide voltage to the ignition coils. The coils are then actuated at the negative side by the engine control module.

NOTE—
*Schematic diagrams shown are for illustrative purposes only. See **ELE Electrical Wiring Diagrams** for engine management specific wiring information.*

WARNING—
- *Do not touch or disconnect any cables from the coils while the engine is running or being cranked by the starter.*
- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is OFF.*
- *Before operating the starter without starting the engine (for example when making a compression test), always disable the ignition.*



Knock sensors (**arrows**) monitor the combustion chamber for engine-damaging knock. Six-cylinder models (shown) use two sensors with each sensor monitoring three cylinders. V–8 models use four sensors, each monitoring two cylinders. If engine knock is detected, the ignition point is retarded by the ECM.



Ignition timing is electronically mapped and not adjustable. The ECM uses engine load, engine speed, coolant temperature, knock detection, and intake air temperature as the basic inputs for timing control. A three dimensional map similar to the one shown is digitally stored in the ECM.

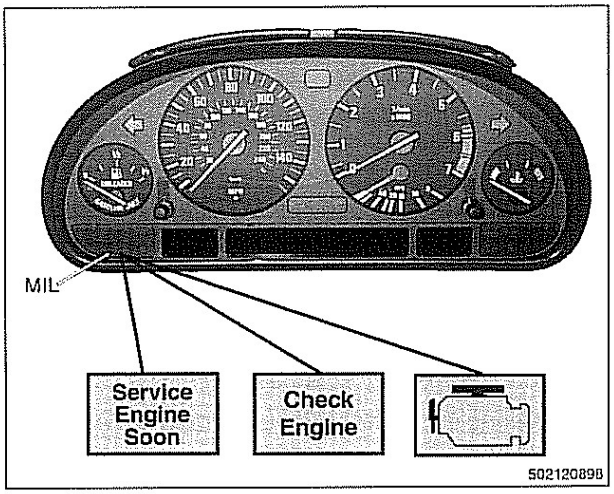
– The initial ignition point is determined by the crankshaft speed sensor during cranking. Once the engine is running, timing is continually adjusted based on operating conditions.

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Ignition system, troubleshooting

Troubleshooting ignition system faults should begin with an interrogation of the On-Board Diagnostics (OBD II) system. The OBD II system detects ignition system misfire and other related faults. When faults are detected, the OBD II system stores a Diagnostic Trouble Code (DTC) in the Engine Control Module (ECM) along with other pertinent fault information.

In addition, the Malfunction Indicator Light (MIL) will come on if an emissions related fault is detected. Additional OBD II information, including a DTC lookup table, can be found in **OBD On-Board Diagnostics.**



NOTE—
BMW models covered in this manual were equipped with one of three versions of MIL warning lights (as shown).

Misfire detection

Engine misfire in one or more cylinders, may be caused by a variety of malfunctions in various subsystems. The OBD II system incorporated into the engine management systems is designed to detect and warn of misfire faults during engine operation. See **OBD On Board Diagnostics.**

WARNING—
Ignition misfires can cause high hydrocarbon exhaust emissions and catalytic converter damage. For this reason, if a severe misfire is detected, the fuel injector will be turned off to the specific cylinder and the MIL will be illuminated. A misfire may also produce an overheated catalytic converter, which can be a fire hazard.

Oscilloscope diagnostic diagrams

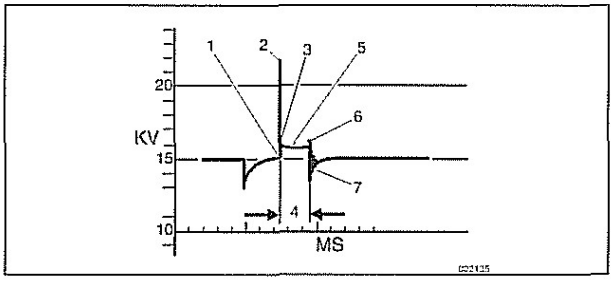
One way to diagnose a faulty coil is to use an oscilloscope to analyze spark quality with the engine running.

See **Table b. Ignition secondary voltage diagnostics** for list of common ignition coil voltage faults and related causes.

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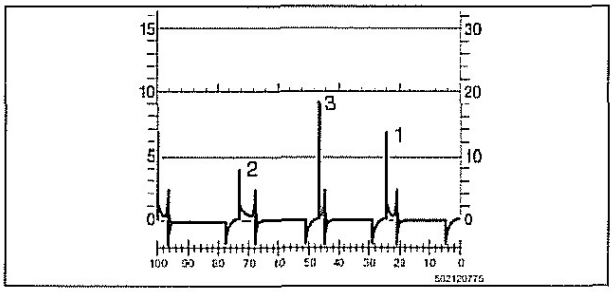
Table b. Ignition secondary voltage diagnostics

	Secondary voltage low	Secondary voltage high
Spark plug electrode gap	Too small	Too big
Spark plug electrode condition		Worn/burnt
Spark plug electrode temperature	Too high	Too low
Engine compression	Too low	Too high
Spark plug wires		Faulty
Fuel air mixture		Too lean



The illustration shows normal scope trace of spark at idle.

1. Start of ignition voltage peak
2. Level of ignition voltage
3. Level of combustion voltage
4. Period of combustion
5. Combustion curve characteristics
6. Start of decay process
7. Termination oscillations

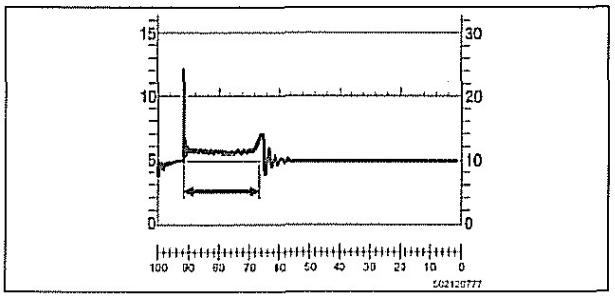


Ignition spark at idle speed.

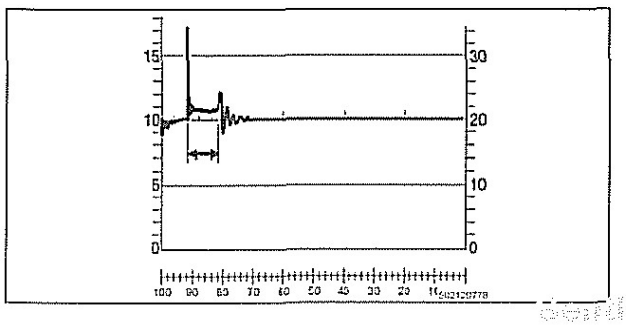
A - Normal ignition voltage peak (spark plug is good).

B - L ow voltage peak is an indication of a closed plug gap.

C - High voltage peak indicates an open plug gap.

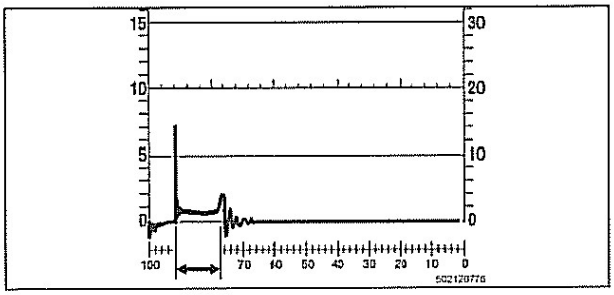


Long combustion period (indicates small spark plug gap).

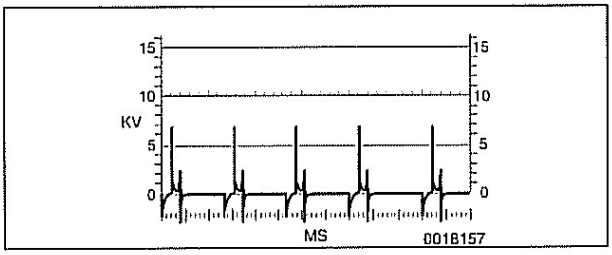


Short combustion period (indicates large spark plug gap).

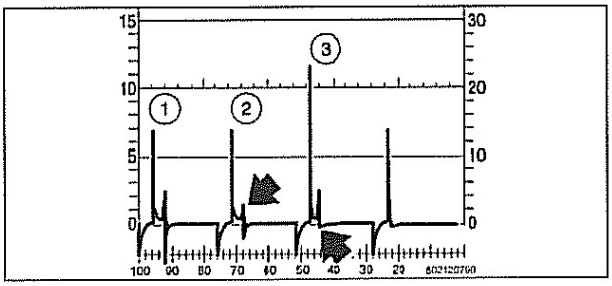
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Normal combustion period at idle.

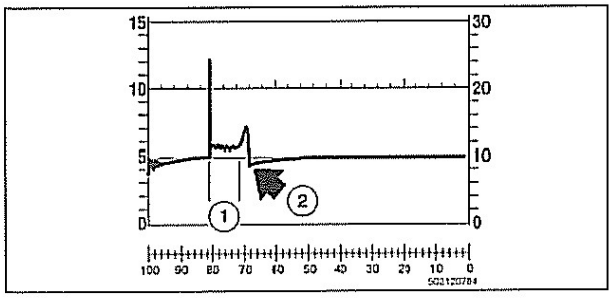


Normal oscilloscope pattern for ignition system at idle.



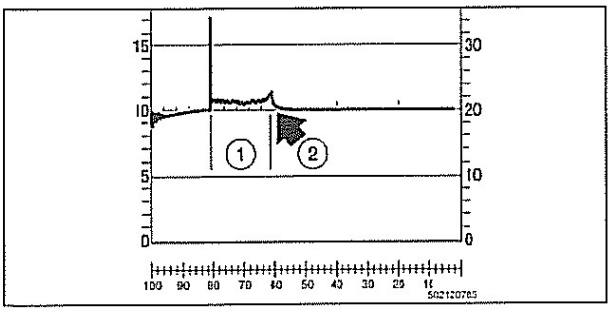
Ignition voltage peaks at idle.

1. Normal ignition peaks.
2. Downward peak (**arrow**) is shortened (ignition coil is defective).
3. Downward peak (**arrow**) is missing completely (ignition coil is defective).



Defective ignition coil.

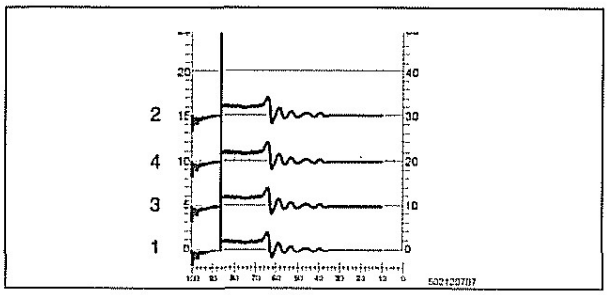
1. Short spark period.
2. The spark voltage line (**arrow**) is very slight.



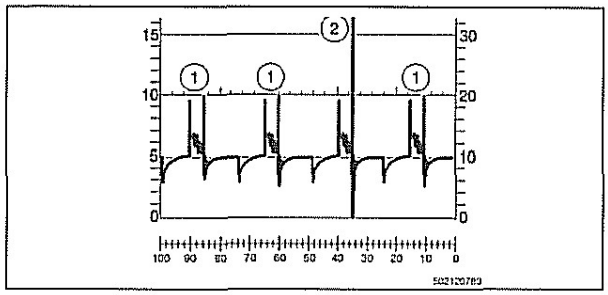
Defective ignition coil.

1. Normal combustion period.
2. Absence of spark voltage line (**arrow**).

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Normal secondary voltage patterns (4–cylinder pattern shown).

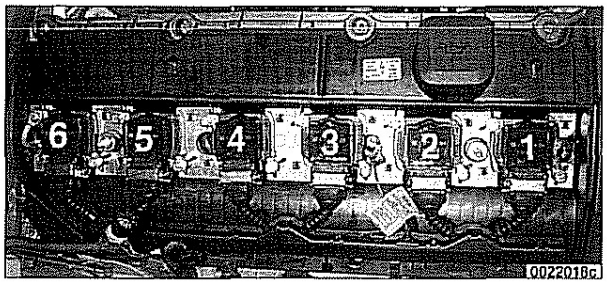


Ignition voltage peaks in response to sudden acceleration load:

1. Normal ignition pattern. Beginning of dying out pattern is not much higher than ignition voltage peak.
2. Beginning of dying out pattern considerably higher than ignition voltage peak. Fault in injection system:
   - Lean fuel mixture
   - Defective fuel injector
   - Low compression in cylinder

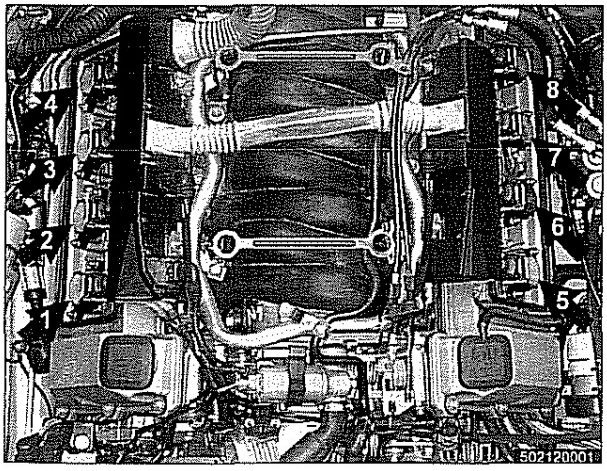
IGNITION SYSTEM SERVICE

Ignition firing order



Each ignition coil is mounted above the corresponding spark plug.

– Number one cylinder is located at the front on 6–cylinder models.



Number one cylinder is located at the right (passenger side) front on V–8 models. Cylinder firing order is shown.

Firing order	
M52 - M52 TU - M54 6–cylinder	1-5-3-6-2-4
M62 - M62 TU V-8	1-5-4-8-6-3-7-2

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Disabling ignition system

The ignition system operates in a lethal voltage range and should be disabled any time engine service or repair work is being done that requires the ignition to be switched on.

The engine management system can be disabled by removing the DME main relay. The relay is located in the electronics box (E-box) in the left rear of the engine compartment, beneath the interior microfilter housing.

CAUTION—
*Relay locations may vary. Use care when identifying relays. See **610 Electrical Component Locations**.*

Checking for spark

CAUTION—
If a spark test is done incorrectly, damage to the Engine Control Module (ECM) or the ignition coils may result.

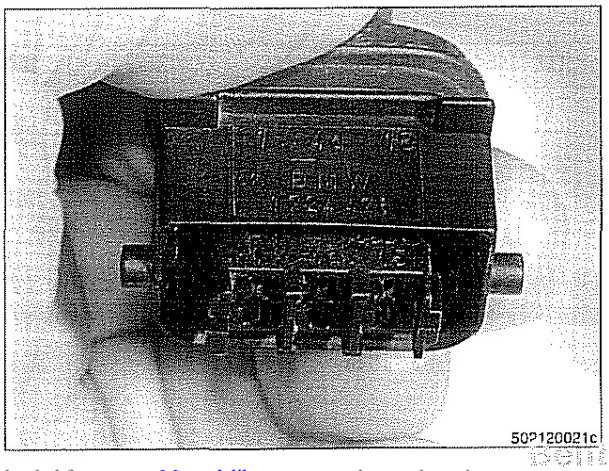
NOTE—
*Spark plug replacement is covered in **020 Maintenance**.*

Checking for spark is difficult on engines with distributorless ignition systems.

Try removing the spark plugs and inspecting for differences between them. A poor-firing plug may be wet with fuel and/or black and sooty, but not always. If a coil is not operating, the engine management system will electrically disable the fuel injector to that cylinder. The key is to look for differences between cylinders.

Ignition coil assembly, testing and replacing

CAUTION—
Use a digital multimeter for the following tests.



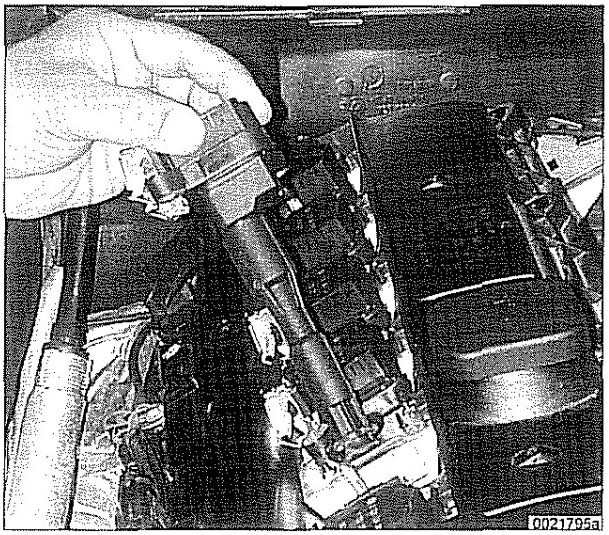
- Remove plastic engine cover from top of valve cover by prying off bolt covers and removing cover mounting bolts.
- Raise car slowly while constantly checking position of jack and car.
- Disconnect harness connector from coil. Connect multimeter between terminal 15 (+) in connector and ground.

➢ Terminal identification are typically molded into connector. In photo, terminals are from left to right: 1, 4a, 15.

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– Turn ignition on and check for battery voltage.
  - If battery voltage is not present, check wire between terminal 15 and the unloader relay. See **ELE Electrical Wiring Diagrams.**

– Turn ignition off.



Remove coil and inspect coil housing for hairline cracks or leaking casting material. Replace any cracked or leaking coil.

NOTE—
A leaky coil may indicate a faulty Engine Control Module (ECM). Check ECM before installing a new coil.

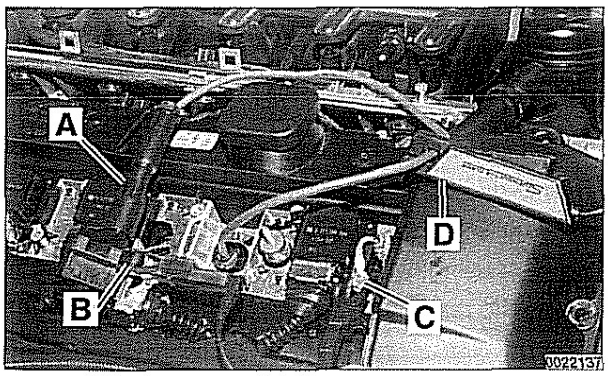
> ***CAUTION—***
> *Note location of coil ground straps before coil removal; reinstall in the same location.*

– Use a multimeter to test:
  - Coil primary resistance at coil terminals.
  - Spark plug connector resistance.
  - Compare results to specification in **Table c. Ignition coil resistance.**

Table c. Ignition coil resistance

Component	Terminal	Resistance
Coil primary resistance	1 (-) and 15 (+)	0.8 ohms
Coil secondary resistance	N/A	N/A
Spark plug connector: Bosch Beru		 1.0 k ohm ± 20% 1.8 k ohm ± 20%

– Replace ignition coil or spark plug connector if resistance readings do not meet specifications.



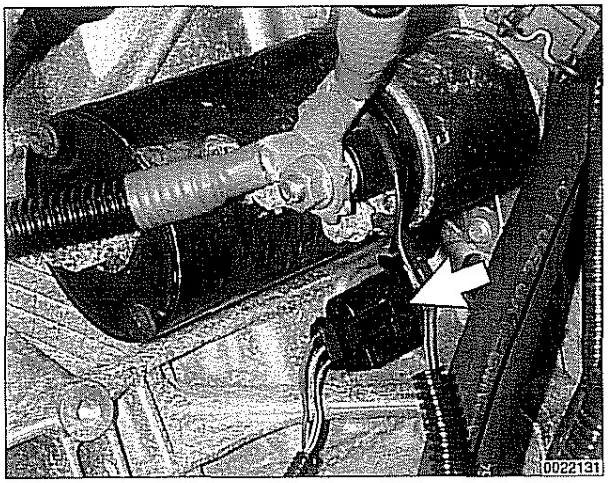
Remove ignition coil to be tested.
- Install BMW special tool 12 7 030 (**A**) on coil to be tested.
- Connect ground jumper between coil mounting point (**B**) and engine ground point (**C**).
- Clip scope high pick-up lead (**D**) around ignition lead.
- Start engine.
- Compare scope pattern with diagrams in **Oscilloscope diagnostic diagrams.**

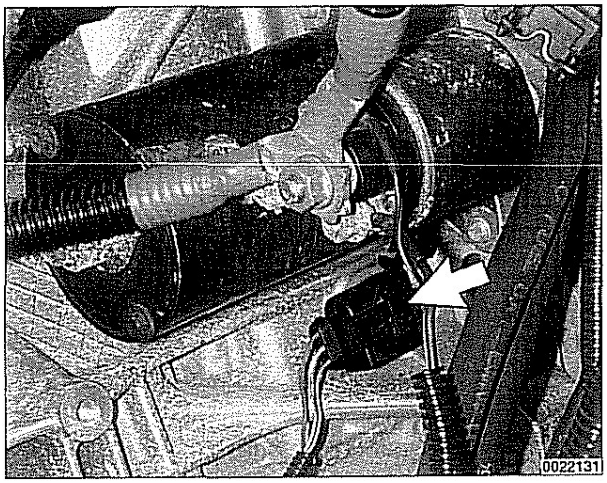
NOTE—
When replacing ignition coils, ensure that the replacements are from the same manufacturer with the same part/code numbers. If individual coils with the correct specifications are not available, all coils should be replaced.

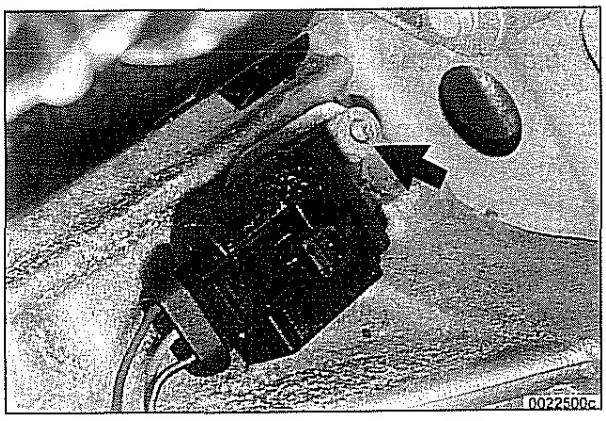
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Crankshaft speed sensor

Crankshaft speed sensor, replacing (M52, M52 TU and M54 engines)







- Crankshaft speed sensor for 6–cylinder engine is mounted in the left rear side of the cylinder block below the starter (**arrow**). The sensor reads a toothed pulse wheel mounted to the end of the crankshaft.

– If the Engine Control Module (ECM) does not receive a signal from the crankshaft speed sensor during cranking, the engine will not start.

– If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in crankshaft speed sensor components, the Check Engine light (Malfunction Indicator Light or MIL) will be illuminated.

NOTE —
If the crankshaft speed sensor pulse wheel is damaged, the engine will have to be disassembled down to the crankshaft to replace the wheel.

– Make certain ignition has been turned off.

– Raise car and support in a safe manner.

> ***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 under engine splash guard.

- Working underneath starter:
  - Cut off wire tie securing crankshaft speed sensor harness connector (**arrow**) to sensor.
  - Disconnect harness connector.

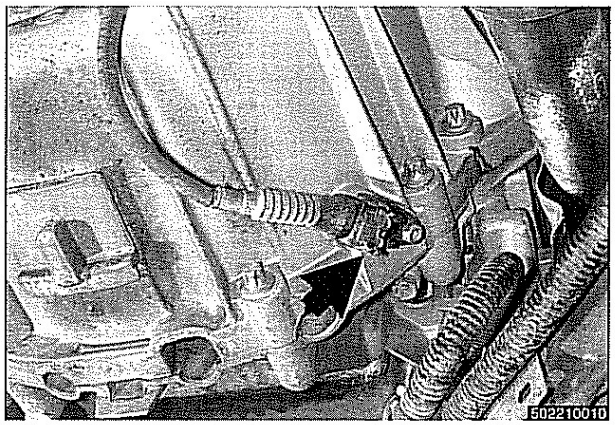
- Remove sensor mounting fastener (**arrow**) and remove sensor from cylinder block.

– Installation is reverse of removal, noting the following:
  - Use a new O-ring when installing sensor.
  - Be sure wiring is routed in same orientation.
  - Secure sensor using new wire ties.
  - Use scan tool to read out and clear ECM fault memory.

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Crankshaft speed sensor, replacing (M62 and M62 TU engines)

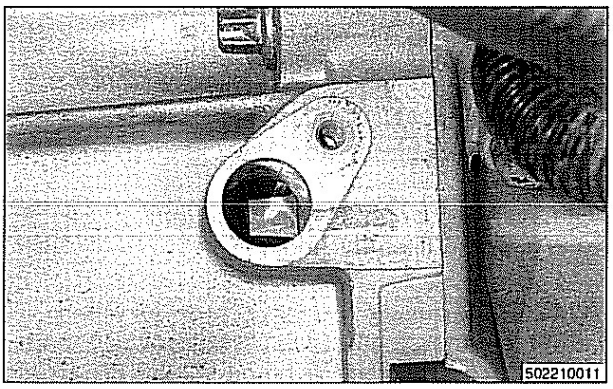
The crankshaft speed sensor reads a toothed pulse wheel mounted on the flywheel. If the Engine Control Module (ECM) does not receive an impulse signal from the crankshaft speed sensor during cranking, the engine will not start. If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in the crankshaft speed sensor components, the Check Engine light (Malfunction Indicator Light or MIL) will be illuminated.



➢ The crankshaft speed sensor (**arrow**) is mounted in the right lower side of the bell housing.

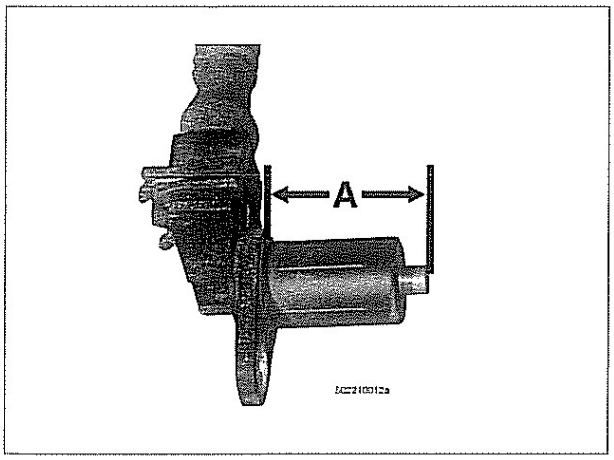
– Remove speed sensor by disconnecting electrical harness connector and unbolting sensor from bell housing. Do not discard shims, if present.

– Installation is the reverse of removal. Clean mounting surface before installing new sensor, and install shims, if present.



➢ If the flywheel was replaced, the speed sensor must be checked for correct installation depth.

- Crank engine in direction of rotation using crankshaft bolt until a full pulse tooth is centered in the opening for the removed speed sensor.
- Measure depth to top of tooth from speed sensor pulse generator mounting surface on transmission.



➢ Measure length of pulse generator from mounting surface to end (**A**).

– Subtract length of pulse generator (**A**) from distance to pulse tooth from mounting area on transmission. This measurement is the gap between the pulse sensor and flywheel. Use shims available from BMW to increase gap as needed to reach specification.

Pulse sensor gap

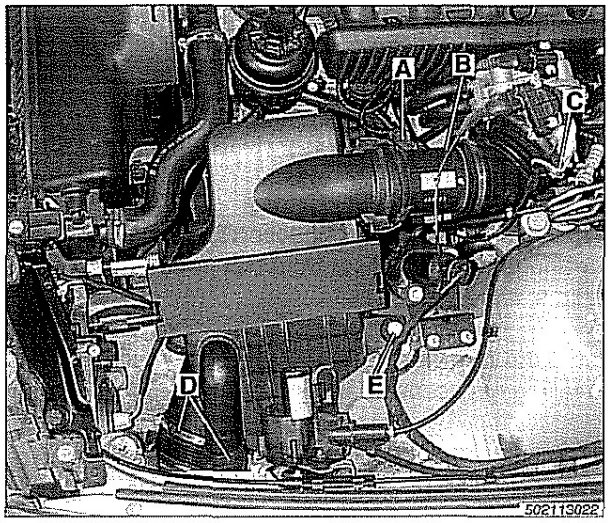
End of sensor to flywheel teeth	0.55 ± 0.2 mm (0.0217 ± 0.008 in)

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Camshaft position sensors

The camshaft position sensors are used by the engine management system for VANOS control, sequential fuel injection and knock control.

Intake camshaft position sensor, replacing (M52, M52 TU and M54 engines)



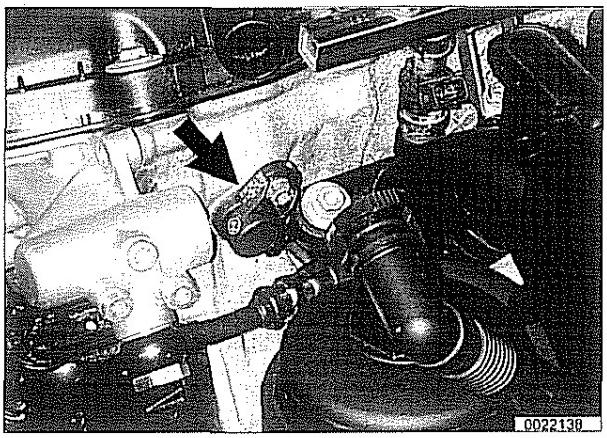
– Make certain ignition has been turned off.

– Remove plastic cover from above fuel injectors by prying off bolt covers and removing cover mounting bolts.

➢ Remove complete air filter housing:

- Disconnect electrical harness connector on mass air flow sensor (**A**).
- Detach vacuum line at intake boot (**B**).
- Loosen hose clamp at intake boot and detach air duct connections (**C**).
- Disconnect cold air duct tube (**D**).
- Remove filter housing mounting screws (**E**).

– Disconnect harness connector from VANOS solenoid and unscrew solenoid from VANOS control unit. Be prepared with shop rags to catch oil released from VANOS unit.



➢ Remove camshaft sensor (**arrow**) from left front of cylinder head, next to top of oil filter housing.

– Disconnect camshaft sensor harness from under intake manifold. Prior to removal, attach a stiff piece of wire to the harness connector end to preserve proper routing of harness for reinstallation.

– Installation is reverse of removal, noting the following:

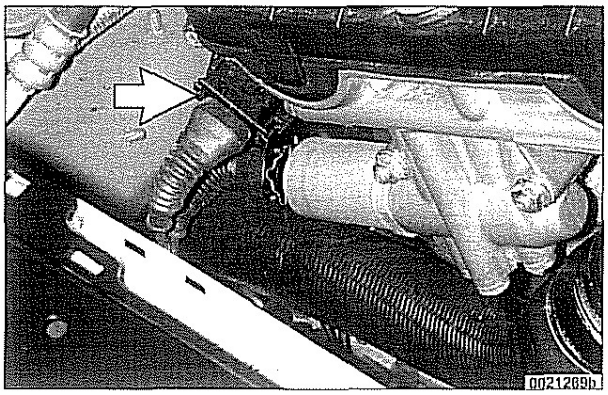
- Use new O-rings when installing sensor and solenoid.
- Be sure wiring is rerouted in same orientation.
- Use scan tool to read out and clear ECM fault memory.

Tightening torques

Intake camshaft sensor to cylinder head	10 Nm (7 ft-lb)
VANOS solenoid to VANOS control unit	30 Nm (22 ft-lb)

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Exhaust camshaft position sensor, replacing (M52 TU and M54 engines)



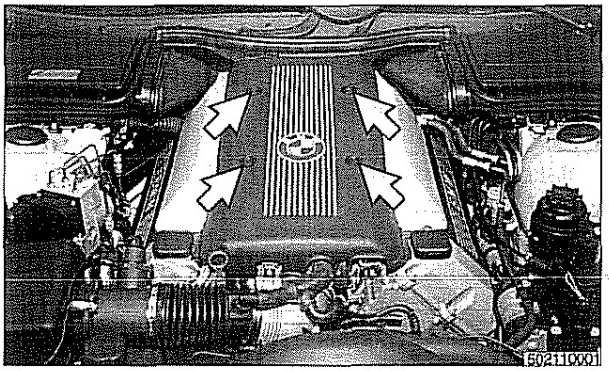
– Make sure ignition has been turned off.

➢ Working at front of engine on exhaust (right) side, detach exhaust camshaft position sensor electrical harness connector (**arrow**) and remove sensor.

– Installation is reverse of removal, noting the following:
  - Use a new O-ring when installing sensor.
  - Use scan tool to read out and clear ECM fault memory.

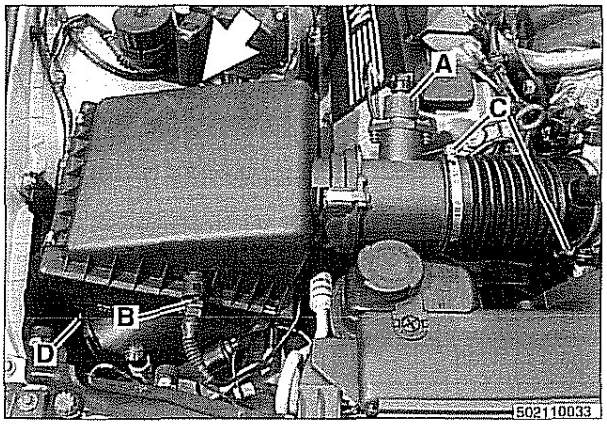
Tightening torque	
Exhaust camshaft sensor to cylinder head	10 Nm (7 ft-lb)

Intake camshaft position sensor, replacing (M62 and M62 TU engines)



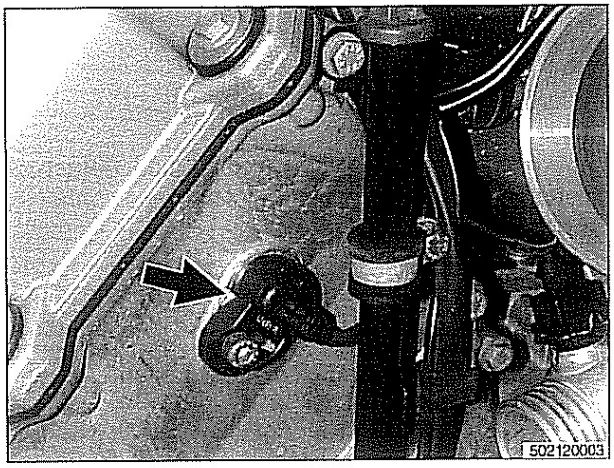
– Make sure ignition has been turned off.

➢ Remove top engine cover by releasing quick release fasteners (**arrows**) by pressing down.



➢ Remove air filter housing and mass air flow sensor:
  - Disconnect mass air flow sensor and intake air temperature sensor electrical harnesses (**A** and **B**).
  - Remove air filter housing mounting fastener (**arrow**).
  - Loosen hose clamps (**C** and **D**).
  - Remove hose at idle air stabilizer.
  - Remove air filter housing with mass air flow sensor.
  - Remove intake hose from throttle body.

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- Remove camshaft sensor (**arrow**) from front of right cylinder head.
- Disconnect camshaft sensor harness from cable duct above right cylinder head.
- Installation is reverse of removal, noting the following:
  - Use new O-ring when installing sensor.
  - Be sure wiring is rerouted in same orientation.
  - Use scan tool to read out and clear ECM fault memory.

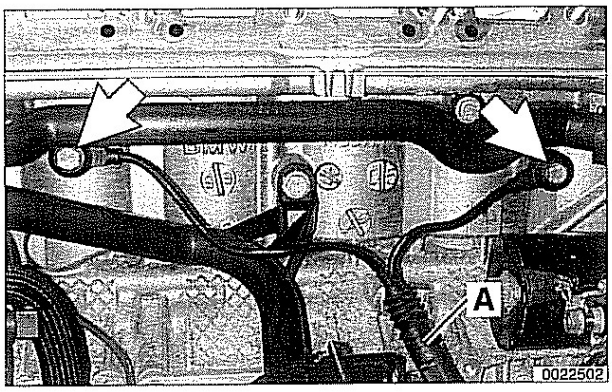
Tightening torque	
Intake camshaft sensor to timing chain cover	5 Nm (3.5 ft-lb)

Knock sensors

Knock sensors, replacing (M52, M52 TU and M54 engines)

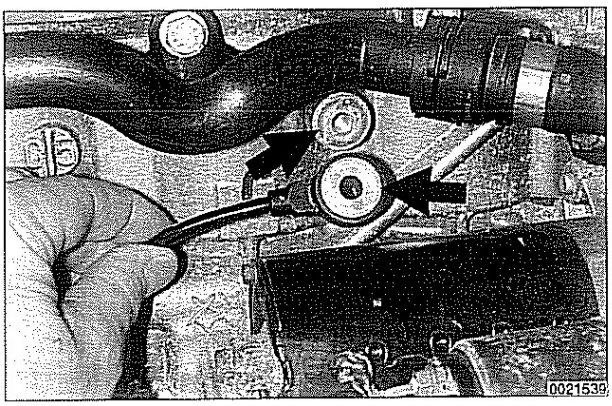
The knock sensors are bolted to the left side of the cylinder block under the intake manifold.

- Remove intake manifold as described in **113 Cylinder Head Removal and Installation.**



- Disconnect knock sensor electrical harness connector (**A**) on left side of engine cylinder block.
  - Remove knock sensor mounting bolts (**arrows**) on side of cylinder block. Remove sensors.

> ***CAUTION—***
> *Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.*



- Clean knock sensor contact surface on engine block and sensor (**arrows**) before installing knock sensor.

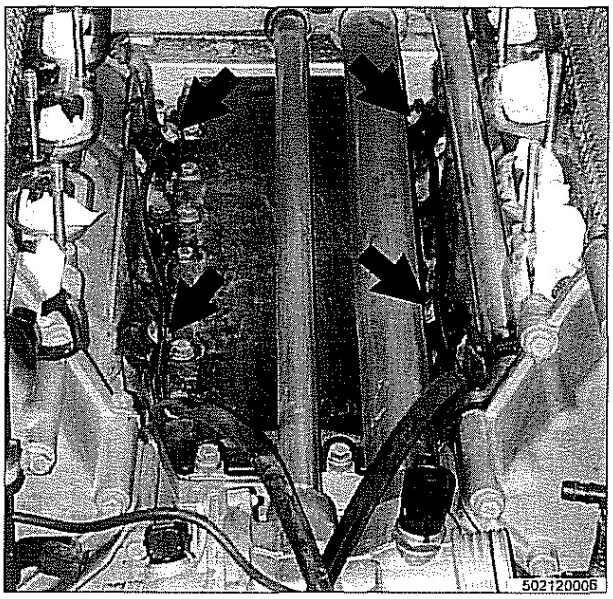
Tightening torque	
Knock sensor to head	20 Nm (15 ft-lb)

- Use scan tool to read out and clear ECM fault memory.

Knock sensors, replacing (M62 and M62 TU engines)

The knock sensors are bolted to the side of the cylinder block under the intake manifold.

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– Remove intake manifold as described in **113 Cylinder Head Removal and Installation.**

➢ Remove knock sensor mounting bolts (**arrows**) on side of cylinder block. Remove sensors.

> ***CAUTION—***
> *Note the installed angle of the knock sensors on the block before removal it. Reinstall the sensors in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolts.*

– Clean knock sensor contact surfaces on engine block and sensors before installing.

Tightening torque	
Knock sensor to engine block	20 Nm (15 ft-lb)

– Use scan tool to read out and clear ECM fault memory.

– Installation is reverse of removal.



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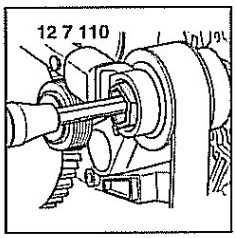
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GENERAL

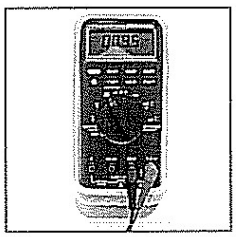
This section covers the battery, alternator, starter and associated components of the electrical system.

Troubleshooting information for these components is found in **Table a. Battery, alternator and starter troubleshooting.** For additional electrical troubleshooting information, see **600 Electrical System–General.**

Special tools

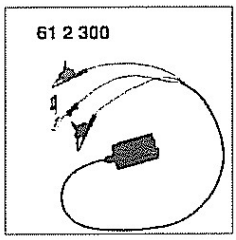


- Alternator pulley nut removal tool (Tool No. BMW 12 7 110)



- Automotive digital multimeter

> ***CAUTION—***
> *Only use a digital multimeter when testing automotive electrical components.*



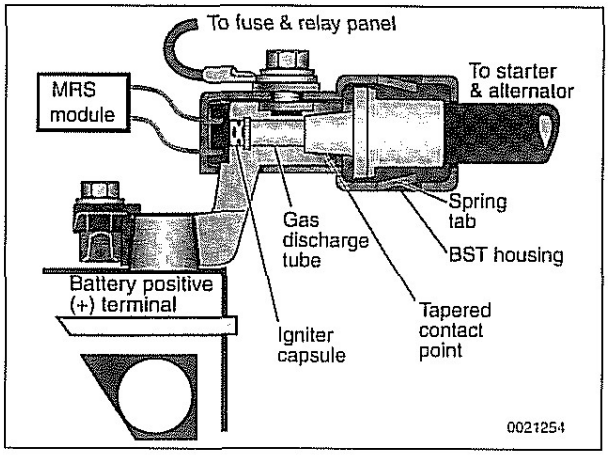
- Closed-circuit current measurement adaptor (Tool No. BMW 61 2 300)

Engine electrical system

The alternator and starter are wired directly to the battery. To prevent accidental shorts that might blow a fuse or damage wires and electrical components, always disconnect the negative (–) battery cable before working on the electrical system.

Various versions of alternators, voltage regulators, starters, and batteries are used in E39 cars. Replace components according to the original equipment specification.

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Battery Safety Terminal

A Battery Safety Terminal (BST) controlled by the Multiple Restraint System (MRS) control unit was introduced for model year 1998 vehicles. The system will disconnect electrical power to the engine compartment in the event of a significant impact. The MRS system fires an encapsulated pyrotechnic device in the positive (+) battery terminal that disconnects power to the engine compartment, but maintains power to the exterior lights and interior of the vehicle.

Table a. Battery, alternator and starter troubleshooting

Symptom	Probable cause	Corrective action
Engine does not crank	Fault in immobilizer system (EWS)	Try another ignition key. If problem persists, contact your authorized BMW dealer.
Engine cranks slowly or not at all, solenoid clicks when starter is operated.	Battery cables loose, dirty or corroded.	Clean or replace cables. See **020 Maintenance.**
	Battery discharged.	Charge battery and test. Replace if necessary.
	Battery to body ground cable in trunk loose, dirty or corroded	Inspect ground cable. Clean, tighten or replace if necessary.
	Poor connection at starter motor terminal 30.	Check connections, test for voltage at starter. Test for voltage at neutral safety or clutch interlock switch.
	Starter motor or solenoid faulty.	Test starter.
Battery will not stay charged more than a few days.	Short circuit draining battery.	Test for excessive current drain with everything electrical off.
	Short driving trips and high electrical drain on charging system does not allow battery to recharge.	Evaluate driving style. Where possible, reduce electrical consumption when making short trips.
	Drive belt(s) loose, worn or damaged.	Inspect or replace ribbed belt(s). See **020 Maintenance.**
	Battery faulty.	Test battery and replace if necessary.
	Battery cables loose, dirty or corroded.	Clean or replace cables. See **020 Maintenance.**
	Alternator or voltage regulator faulty.	Test alternator and voltage regulator.

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Warnings and cautions

WARNING—

- *Wear goggles, rubber gloves, and a rubber apron when working around the battery or battery acid (electrolyte).*
- *Battery acid contains sulfuric acid and can cause skin irritation and burning. If acid is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, flush them with large quantities of clean water for several minutes and call a physician.*
- *Batteries that are being charged or are fully charged give off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.*

CAUTION—

- *Only use a digital multimeter when testing automotive electrical components.*
- *If a repair procedure specifies disconnecting the battery, follow the instruction for safety reasons.*
- *Prior to disconnecting the battery, read the battery disconnection cautions in **001 General Cautions and Warnings**.*
- *Models with MS43 engine management: Allow at least 3 minutes to elapse after turning ignition key to OFF position before disconnecting battery. This will allow sufficient time to complete the DMTL (fuel tank pressure) test.*
- *Disconnecting the battery cables may erase fault codes stored in ECM memory.*
- *Always disconnect the negative (–) battery cable first and reconnect it last. Cover the battery post with an insulating material whenever the cable is removed.*
- *Do not disconnect battery, alternator or starter wires while the engine is running.*
- *Never reverse the battery cables. Even a momentary wrong connection can damage the alternator or other electrical components.*
- *Do not depend on the color of insulation to tell battery positive and negative cables apart. Label cables before removing.*
- *The slide-tilt sunroof may fail to function properly after disconnecting and reconnecting the battery. Reinitialize sunroof as described in **540 Sunroof**.*

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BATTERY

The battery is mounted in the right side of the luggage compartment, concealed behind a trim panel. Battery capacity is determined by the amount of current needed to start the vehicle and by the amount of current consumed by the electrical system. This will vary from model to model.



BMW batteries are rated by ampere/hours (Ah) and cold cranking amps (CCA) rating, which are listed on the battery. The Ah rating is determined by the average amount of current the battery can deliver over time without dropping below a specified voltage. The CCA is determined by the battery's ability to deliver starting current at 0° F (-18° C) without dropping below a specified voltage. Always replace the battery with one having the same or higher ratings.

Battery testing

Battery testing determines the state of battery charge. On conventional or low-maintenance batteries, the most common method of testing the battery is that of checking the specific gravity of the electrolyte using a hydrometer. Before testing the battery, check that the cables are tight and free of corrosion.

Hydrometer testing

Before hydrometer testing, load the battery with 15 amperes for one minute. If the battery is installed in the vehicle, this can be done by turning on the headlights without the engine running. The state of battery charge based on specific gravity values are given in **Table b. Specific gravity of battery electrolyte at 27° C (80° F).**

The hydrometer indicates the specific gravity of the electrolyte. The more dense the concentration of sulfuric acid in the electrolyte, the higher the state of charge.

NOTE —
Electrolyte temperature affects hydrometer reading. Check the electrolyte temperature with a thermometer. Add 0.004 to the hydrometer reading for every 6°C (10°F) that the electrolyte is above 27°C (80°F). Subtract 0.004 from the reading for every 6°C (10°F) that the electrolyte is below 27°C (80°F).

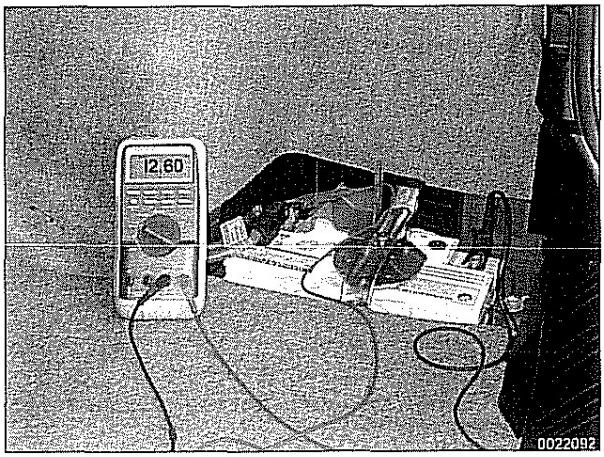
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Table b. Specific gravity of battery electrolyte at 27° C (80° F)

Specific gravity	State of charge
1.265	Fully charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Fully discharged

If the specific gravity is at or above 1.225, but the battery lacks power for starting, determine the battery's service condition with a load voltage test. If the average specific gravity of the six cells is below 1.225, remove the battery from the luggage compartment and recharge.

Battery open-circuit voltage test



- Before testing, load battery with 15 amperes for one minute with battery load-tester or turn on headlights for about one minute without engine running. Connect digital voltmeter across battery terminals. Open-circuit voltage levels are given in **Table c. Open-circuit voltage and battery charge.**

- If open-circuit voltage is OK but battery still lacks power for starting, perform a load voltage test.

- If open-circuit voltage is below 12.4 volts, recharge battery and retest.

Table c. Open-circuit voltage and battery charge

Open-circuit voltage	State of charge
12.6 V or more	Fully charged
12.4 V	75% charged
12.2 V	50% charged
12.0 V	25% charged
11.7 V or less	Fully discharged

Battery load voltage test

A battery load tester is required for a load voltage test. The test is made by applying a high resistive load to the battery terminals and then measuring battery voltage. The battery should be fully charged for the most accurate results. The battery cables must be disconnected before making the test. Replace the battery if the voltage is below that listed in **Table d. Battery load test - minimum voltage.**

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> ***WARNING —***
> *Always wear protective goggles and clothing when performing a load test.*

Table d. Battery load test - minimum voltage

Ambient temperature	Voltage*
27 °C (80° F)	9.6 V
16° C (60° F)	9.5 V
4° C (40° F)	9.3 V
-7° C (20° F)	8.9 V
-18° C (0° F)	8.5 V

* Measure after applying a 200 amp load for 15 seconds.

Closed-circuit current measurement

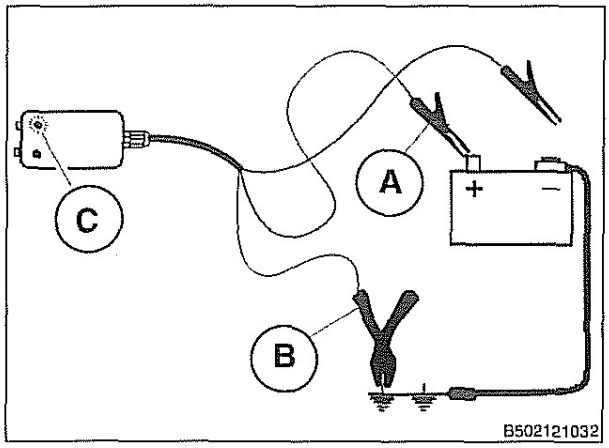
If the vehicle battery is discharged for an unknown reason, perform a closed-circuit current measurement as the first test. For diagnostic purposes, it is important to not disconnect the battery. Disconnecting the battery may reset a faulty control unit, preventing proper diagnosis.

The following test is generally completed overnight using a multimeter with a closed circuit current measurement adaptor with a recording function.

- Check that battery voltage is 12 volts or higher. If lower, recharge battery.
- Switch off electrical consumers (interior lights, telephone, aftermarket equipment, or others).
- Open luggage compartment and remove battery trim panel. Use screwdriver to lock latch on trunk lid or hatch, simulating closed luggage compartment. Close other doors.
- Open driver's door, then close it, simulating driver entering vehicle.
- Switch ignition to RUN position for at least five seconds, then turn ignition to OFF position. This simulates driving vehicle.
- Open and close driver's door, simulating driver leaving vehicle.
- Lock car and arm alarm.
- Wait at least 16 minutes for consumer cut-off.

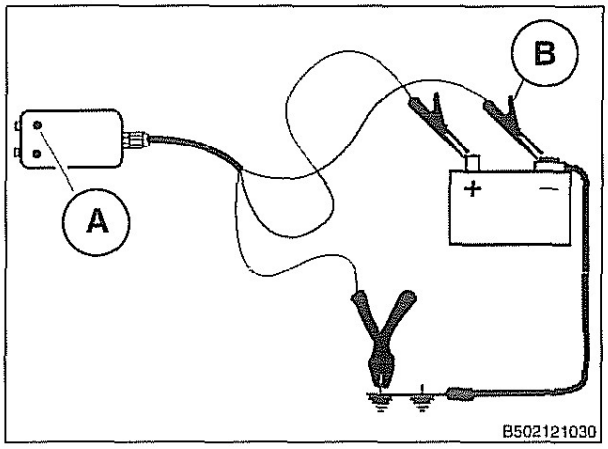
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NOTE—
Automatic transmission cars: amber shifter LED will go out at consumer cut-off.



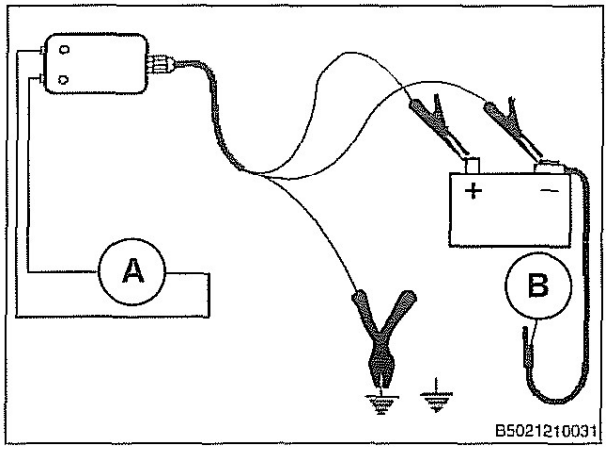
- Attach closed-circuit current measurement adaptor (BMW special tool 61 2 300):
  - Connect red clamp (marked **A** -BATT (+)) to positive battery terminal.
  - Connect black clamp (marked **B** -CHASSIS) to chassis ground point.

NOTE—
Green LED will light up to indicate correct installation of closed-circuit current measurement adaptor.



- Connect black clamp (marked **B** - BATT (-)) to negative battery terminal. Green LED light will go out.

NOTE—
Any electrical overloading will be indicated at this point by lighting the red LED. If the red LED lights up, check the adaptor connections.



- Set multimeter (**A**) to 10 amp measuring range and connect it to adaptor.

NOTE—
- *Set multimeter to record average readings.*
- *If possible, turn off powersaving features of multimeter which prevent a long term (overnight) test by automatically powering down meter.*

– Disconnect battery ground strap (**B**) at chassis mounting point.

– Measure closed-circuit current using multimeter.

– Typical average closed-circuit current for E39 vehicles is 40 mA. Readings over 50 mA must be further investigated.

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Battery charging

Discharged batteries can be recharged using a battery charger. Remove the battery from the trunk during charging.

Prolonged charging causes electrolyte evaporation to a level that can damage the battery. It is best to use a low-current charger (6 amperes or less) to prevent battery damage caused by overheating.

WARNING —
Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.

CAUTION—
- *Battery electrolyte (sulfuric acid) can damage the car. If electrolyte is spilled, clean the area with a solution of baking soda and water.*
- *Always allow a frozen battery to thaw before attempting to recharge it.*
- *Always disconnect both battery cables and remove battery from vehicle during battery charging. Do not exceed 16.5 charging voltage at the battery.*

Battery safety terminal, replacing

If the battery safety terminal has been triggered, investigate and correct the cause prior to replacement.

– Working in right side of luggage compartment, remove battery trim panel.

– Disconnect negative (–) battery terminal and cover with insulator.

– Disconnect positive (+) cable from battery.

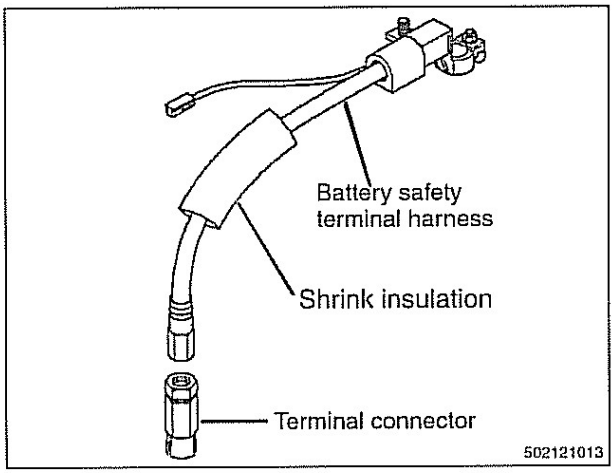
– Release positive (+) cable from cable brackets on luggage compartment wall. Lay new repair cable parallel to positive cable.

– Mark off length of new cable on old cable. Allow 10 cm (2.5 in) of slack.

– Saw through old cable.

CAUTION—
Do not use bolt cutters or similar tools to cut through cable. A cable end that has been squashed flat will not fit into the clamping sleeve of the new cable.

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– Strip approximately 15 mm (0.6 in) of insulation from cable end.

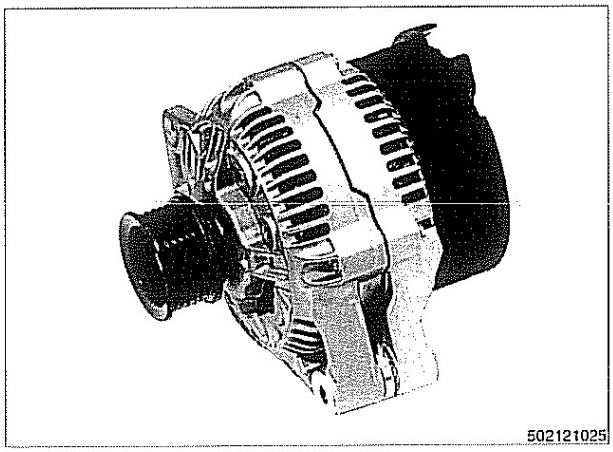
➢ Push terminal connector of new cable over stripped end of old cable. Tighten clamp.

– Slip shrink-fit insulation over positive cable. Attach new safety harness to end of positive cable. Shrink insulation with hot air blower.

– Reinstall cable in cable bracket and attach to battery.

– Reattach negative battery cable. Reinstall luggage compartment trim pieces.

– Use BMW scan tool DISplus or equivalent to read out airbag control module fault memory. Correct faults, then clear memory.



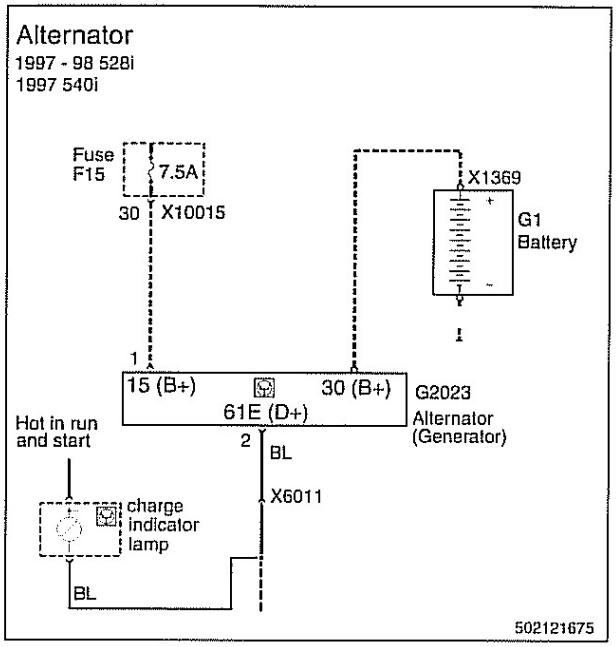
ALTERNATOR (GENERATOR)

➢ Various versions of alternators have been used in E39 vehicles. See **Table e**.

Table e. Alternator application chart

Model	Alternator type
528i	
1997–1998	Air cooled, 90 amp or 120 amp
1999–2000	Air cooled, with multi-function control (MFR), 120 amp or 140 amp
525i, 530i	Air cooled with multi-function control (MFR), 120 amp or 140 amp
540i	
1997	Air cooled, 120 amp or 140amp
1998	Air cooled, with integrated multi-function control (MFR), 120 amp 140 amp
1999–2002	Water cooled, with integrated multi-function control (MFR), 90–150 amp (variable output)

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Alternator, basic

On 1997–1998 6–cylinder and 1997 V-8 models, the charging system indicator light is supplied voltage (+) to one side of the light bulb, and the other side of the bulb is connected to the voltage regulator.

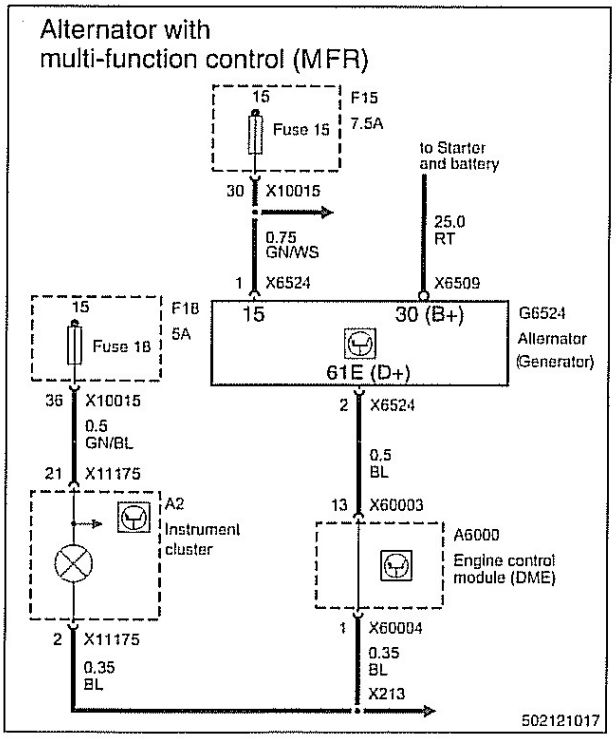
With the engine off and the key in the run position, voltage from the ignition switch flows through the regulator to ground, completing the circuit and illuminating the charge indicator bulb.

When the vehicle is started and the alternator begins to produce voltage, the output of the diode trio increases and the light is turned off.

Alternator with multi-function control (MFR)

The multi-function controlled alternator is used on:

- 1999–2002 6–cylinder models
- 1998–2002 V-8 models

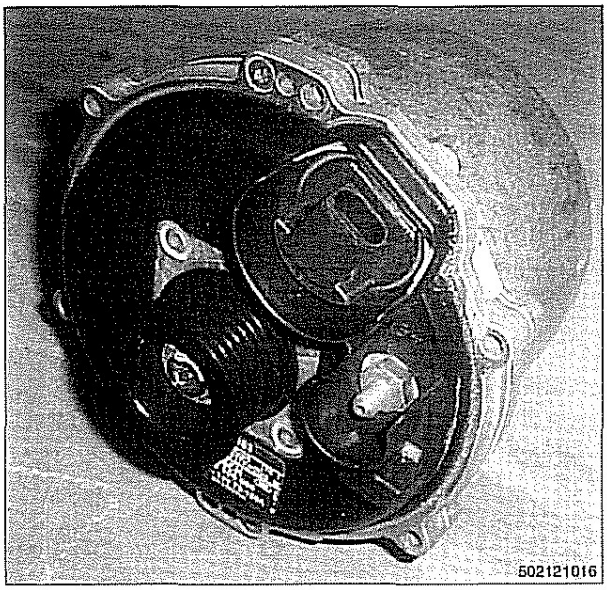


On cars with multi-function control alternator, the charge indicator lamp is activated by means of an electronic switch integrated in the alternator controller. This switch receives its voltage supply from terminal 15 on the 3–pin connector at the rear of the alternator. The controller measures internally the voltage difference between terminal 30 and terminal 15 and signals the DME ECM to turn the charge indicator lamp on.

The controller features integrated fault detection. The battery charge indicator lamp will come on in the event of:

- Failure of belt drive
- No charge due to an electrical/electronic fault
- Interruption in excitation circuit
- Over-voltage due to a defective controller output stage
- Fault or break in charge line
- No charge due to alternator fault

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Water-cooled alternator

The water-cooled alternator, used on 1999 and later M62 TU engines, is a sealed unit housed inside the engine block water jacket. It is cooled via the engine cooling system. It is a "brushless" sealed unit that cannot be serviced. Maintaining consistent alternator temperatures increases the life span of the alternator, and elimination of the alternator cooling fan reduces alternator noise significantly.

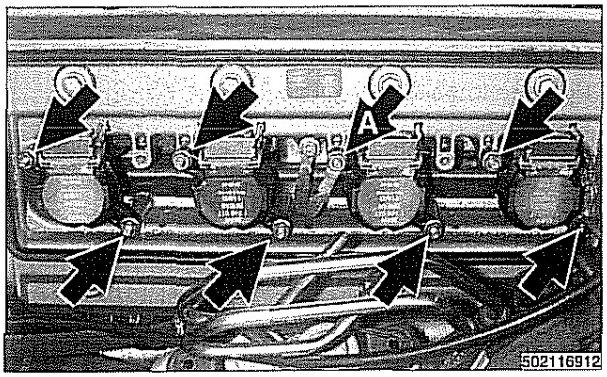
The M62 TU water-cooled alternator incorporates load start reduction. This function is intended to shorten the duration of engine starting, particularly at low ambient temperatures. The current load is limited to 20 amps during starting in order to reduce alternator braking torque on the engine. Following the current limiting phase, full power output is then progressively reached.

CHARGING SYSTEM TROUBLESHOOTING

Charging system diagnostics requires special test equipment. If the test equipment is not available, charging system fault diagnosis can be performed by an authorized BMW dealer or other qualified repair shop. See **Table a. Battery, alternator and starter troubleshooting** for general electrical component troubleshooting.

Before checking the alternator, make sure the battery is fully charged and capable of holding a charge. Check that the battery terminals are clean and tight and the alternator drive belt is properly tensioned and not severely worn.

NOTE—
Some model require up to 15 second to reach full alternator output.



CAUTION—
*If the charge indicator light in the instrument cluster remains on, the charge warning circuit in the instrument cluster may be faulty. Check that the ground lead is securely attached to the grounding stud on the cylinder head (**A**). Replacing the instrument cluster before repairing the ground lead will both damage the instrument cluster and cause the failure to reoccur.*

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Charging system quick-check

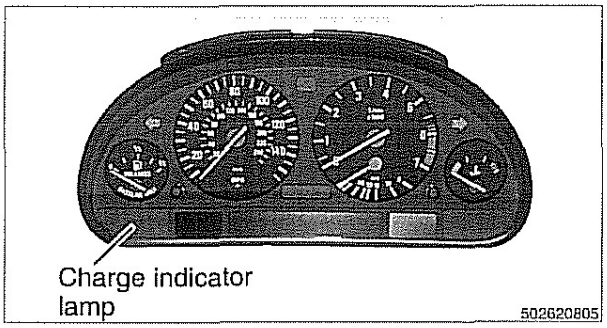
Use a digital multimeter to measure voltage across the battery terminals with key off and then again with engine running. Battery voltage should be about 12.6 volts with key off and between 13.5 and 14.5 volts with engine running.

NOTE—
The regulated voltage (engine running) should be between 13.2 and 14.5, depending on temperature and operating conditions. If the voltage is higher than 14.8, the voltage regulator or mulitfunction controller is most likely faulty.

Check for clean and tight battery cables. Check ground cable running from negative (–) battery terminal to chassis and ground cable running from engine to chassis. Check alternator drive belt condition and tension.

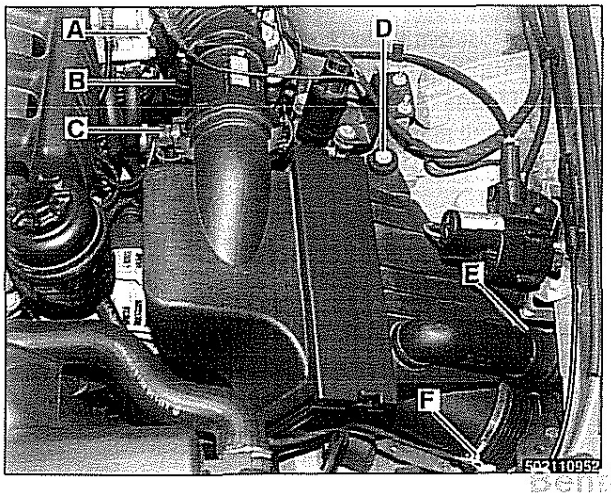
Charging system, checking

CAUTION—
- *Do not disconnect the battery while the engine is running. Damage to the alternator and/or engine electronic systems may result.*
- *Only use a digital multimeter when testing charging system components.*



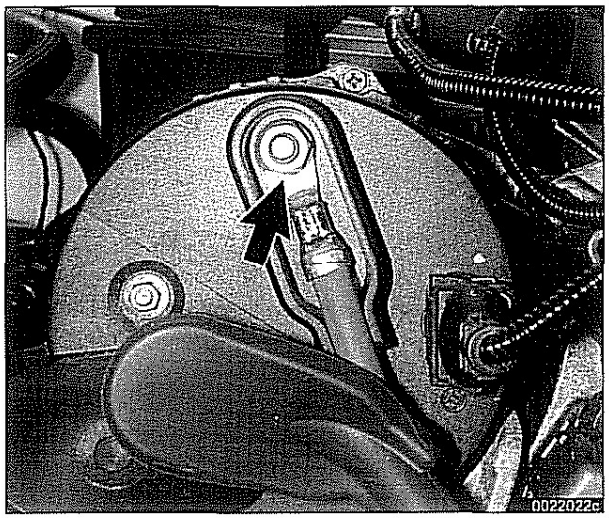
Turn ignition key on. Check that battery warning light comes on.

NOTE—
If the warning light does not come on, repair bulb or wiring faults before continuing to check the charging system.



6–cylinder engines only, remove complete air filter housing:
- Loosen intake duct hose clamp (**A**) at throttle assembly.
- Loosen clamp and remove idle control hose from intake duct (**B**) and disconnect idle speed control valve electrical harness connector.
- Disconnect electrical harness connector (**C**) from mass air flow sensor.
- Remove air filter housing mounting screw (**D**).
- Disconnect vent tube (**E**).
- Loosen air intake duct clamp (**F**).
- Carefully lift air filter housing out of engine bay.

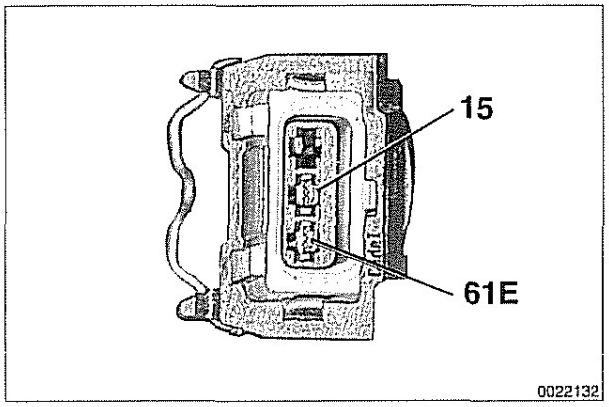
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➢ *Check for battery voltage at alternator terminal 30 (B+) (arrow):*

- Pull back rubber insulating cover at terminal 30 at rear of alternator.
- Connect voltmeter between terminal 30 and ground and check for battery voltage. If voltage is not present, check wiring for faults.

NOTE—
On V-8 engines, access to the rear of the alternator is limited. Check for battery voltage between the jump start post on the left cylinder head and ground.



➢ Disconnect harness connector from alternator. Turn ignition on and check for battery voltage between terminal **15** and ground. If voltage is not present, check wiring and fuses for faults.

– Reconnect connector to alternator.

– *Locate the blue wire coming from terminal* ***61E*** *of the alternator connector. Carefully connect the positive (+) test lead to the wire using a piercing test lead end.*

– Turn ignition key on and check for voltage. Voltage should be less than 1.5 VDC and charge indicator lamp should light.

– Making sure all test equipment and tools are clear, start engine. *Voltage should increase to 8.0 VDC or higher. The* charge indicator light should go out.

- If voltage does not increase and system is not charging, the fault is in alternator.
- If voltage does not increase, but system is charging, interrogate system for faults using an appropriate BMW scan tool and reset fault memory.

– If a load tester is not available, a quick alternator output test can be done by running engine at about 2000 rpm and turning on electrical loads (fans, lights, rear window defroster, and wipers). With all accessories on, battery voltage should be above 12.6 V.

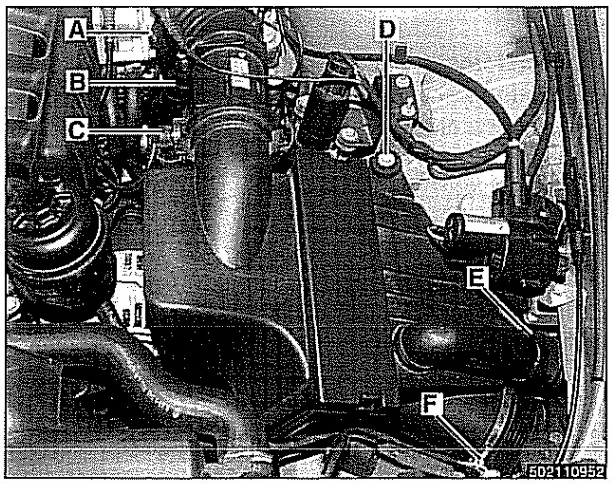
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Alternator, removing and installing (6–cylinder engine)

A replacement alternator should have the same rating as the original. Alternator manufacturer and ampere rating are normally marked on the alternator housing.

– Disconnect negative (–) battery cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.*



➢ Remove complete air filter housing:

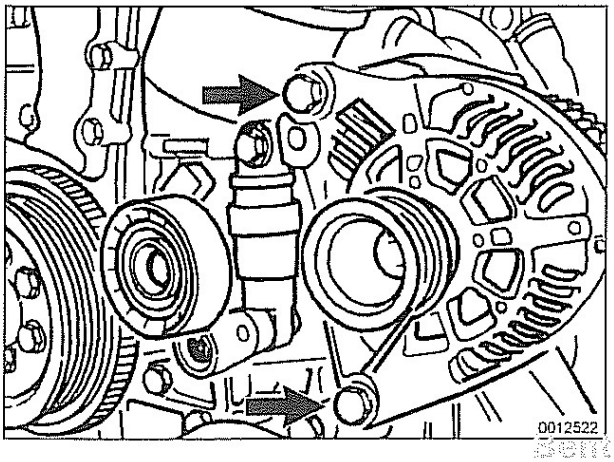
- Loosen intake duct hose clamp (**A**) at throttle assembly.
- Loosen clamp and remove idle control hose from intake duct (**B**) and disconnect idle speed control valve electrical harness connector.
- Disconnect electrical harness connector (**C**) from mass air flow sensor.
- Remove air filter housing mounting screw (**D**).
- Disconnect vent tube (**E**).
- Loosen air intake duct clamp (**F**).
- Carefully lift air filter housing out of engine bay.

– Remove alternator drive belt. See belt removal procedures in **020 Maintenance**.

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

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

– Unbolt power steering fluid reservoir and bracket. Suspend to one side without detaching fluid hoses.



– Disconnect alternator air cooling tube.

– Disconnect wiring from rear of alternator.

➢ Remove upper and lower mounting bolts (**arrows**) and lift out alternator.

NOTE—
If idler pulley for belt interferes, remove pulley cover and retaining bolt to remove pulley.

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– Installation is reverse of removal.

Tightening torques

Belt tensioner to engine block M8 (8.8 grade)	22 Nm (16 ft-lb)
Fan clutch to coolant pump with BMW special tool 11 5 040 without BMW special tool 11 5 040	 30 Nm (22 ft-lb) 40 Nm (29 ft-lb)
Pulley to alternator	70 Nm (44 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)

Alternator, removing and installing (M62 engine, air cooled)

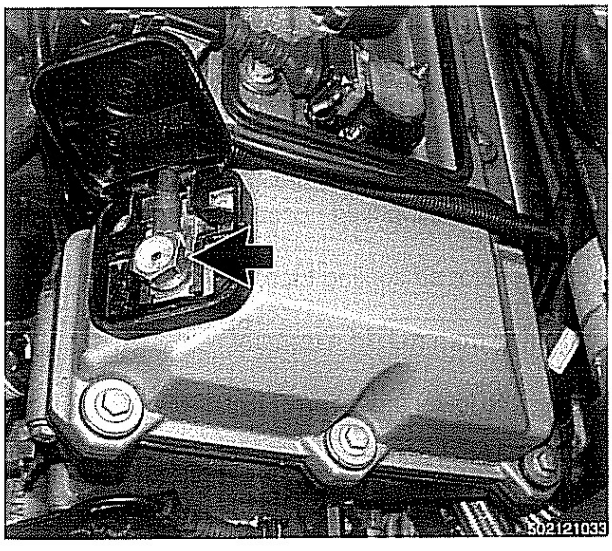
A replacement alternator should have the same rating as the original. Alternator manufacturer and ampere rating are normally marked on the alternator housing.

– Disconnect negative (–) battery cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions* ***001 General Warnings and Cautions.***

– Remove cooling fan and alternator drive belt. See **020 Maintenance.**

– Pry out trim caps and remove fasteners from plastic cover on left head. Lift off cover.



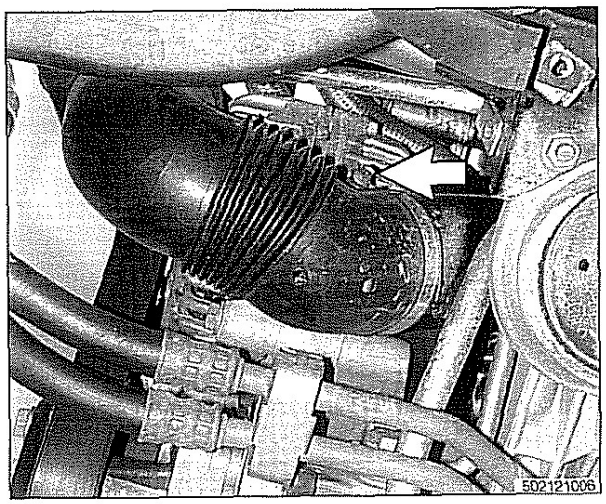
➢ Disconnect positive (+) lead from jump start post (**arrow**).

– Raise car and support in a safe manner.

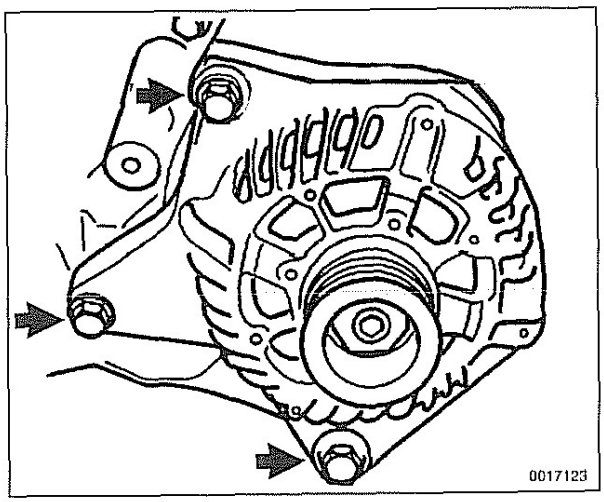
> ***WARNING—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

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– Remove engine splash shield from underneath car.



➢ Working underneath car at rear of alternator, loosen alternator air cooling duct clamp (**arrow**) and remove duct.



➢ Remove three alternator mounting fasteners (**arrows**).

– Pull alternator forward and disconnect wiring from rear of alternator.
  - Release clip retaining wiring harness to alternator.

– Rotate alternator forward and then up and out of engine compartment, using care to not damage radiator.

> ***CAUTION—***
> *Protect radiator with heavy cardboard or sheet metal.*

– Installation is reverse of removal.

Tightening torques

Fan clutch to coolant pump	
with BMW special tool 11 5 040	30 Nm (22 ft-lb)
without BMW special tool 11 5 040	40 Nm (29 ft-lb)
Pulley to alternator	70 Nm (44 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)

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Alternator, removing and installing (M62 TU engine, water cooled)

V–8 models produced after 9/98 are equipped with a water cooled alternator.

> ***CAUTION—***
> *Allow engine to cool before removing alternator as coolant will escape from the alternator water jacket.*

– Disconnect negative (–) battery cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.*

– Remove radiator cooling fan and fan shroud. See **170 Radiator and Cooling System**.

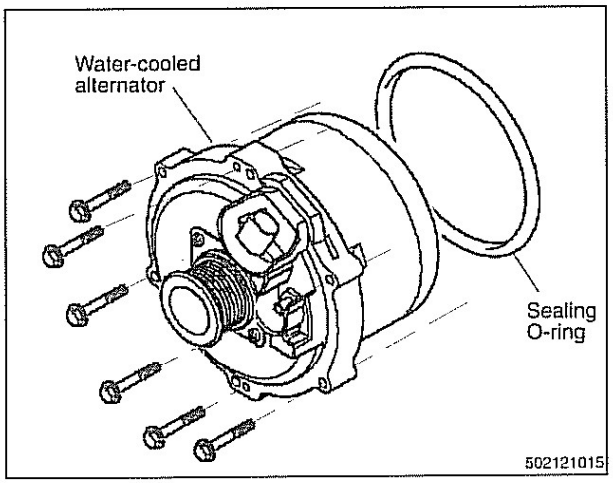
– Drain engine cooling system. See **170 Radiator and Cooling System**.

– Remove alternator drive belt. See **020 Maintenance**.

– Disconnect battery lead (terminal 30 or B+) and two-pin harness connector from front of alternator.

➢ Remove bolts securing alternator to water jacket and remove alternator.

NOTE—
- *If necessary, raise car and remove engine compartment splash shield to access lower alternator mounting bolts.*
- *The upper coolant hose can also be removed to assist alternator removal.*



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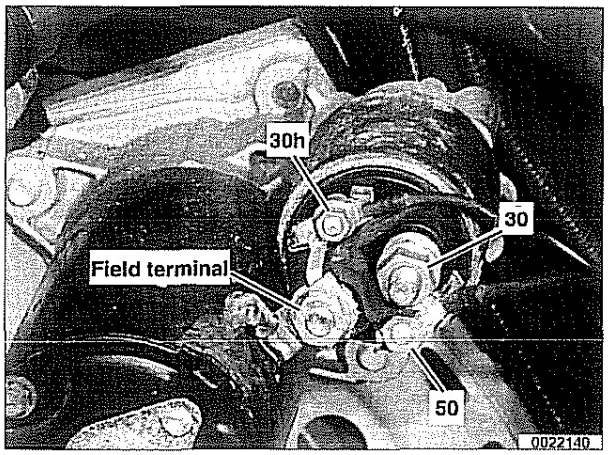
– Installation is reverse of removal, noting the following:
  - Replace alternator rubber sealing O-ring.
  - Fill and bleed cooling system as described in **170 Radiator and Cooling System.**

Tightening torques

Fan clutch to coolant pump	
with BMW special tool 11 5 040	30 Nm (22 ft-lb)
without BMW special tool 11 5 040	40 Nm (29 ft-lb)
Terminal 30 (B+) wire to alternator (M8)	13 Nm (10 ft-lb)

STARTER

Starter troubleshooting



Typical starter wiring terminal identification is shown. Large wire at terminal 30 (not shown in photo) is direct battery voltage. Smaller wire at terminal 50 operates starter solenoid via ignition switch.

– If starter turns engine slowly when ignition is in start position:
  - Check battery state of charge.
  - Inspect starter wires, terminals, and ground connections for good contact. In particular, make sure ground connections between battery, body and engine are completely clean and tight.
  - If no faults are found, starter may be faulty and should be replaced.

– If starter fails to operate, check EWS (drive-away protection system). Try another ignition key. If no faults can be found, have the EWS system checked using BMW scan tool equipment.
  - Check clutch pedal operated starter lock-out switch or gear position switch (automatic).

NOTE—
- *A factory-installed drive-away protection system, also referred to as EWS, is used on E39 cars. This system prevents operation of the starter if a specially coded ignition key is not used.*
- *On cars with automatic transmission, the transmission gear position switch signals EWS to prevent the engine from starting in gear positions other than PARK or NEUTRAL.*
- *On cars with manual transmissions, a starter immobilization switch at the clutch pedal is used to prevent the starter from operating unless the clutch pedal is pushed fully to the floor.*

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– Check for battery voltage at terminal 50 of starter motor with key in start position. If voltage is not present, check wiring between ignition switch and starter terminal. Check the EWS system and other inputs that disrupt terminal 56 to the starter. See **ELE Electrical Wiring Diagrams**. If voltage is present and no other visible wiring faults can be found, problem is most likely in starter motor.

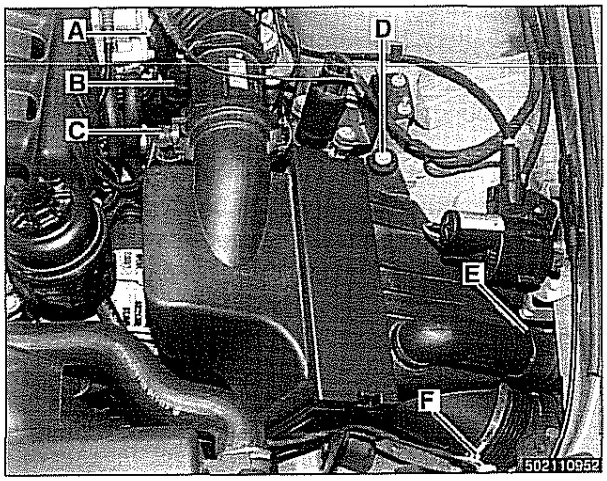
Starter, removing and installing (6–cylinder engine)

The starter is removed from below. Access to starter bolts is difficult. Be sure to have the proper tools on hand before proceeding.

NOTE—
Access to the starter wiring is very limited. For better access, it may be necessary to remove the intake manifold.

– Disconnect negative (–) battery cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in **001General Cautions and Warnings**.*



– Remove complete air filter housing:
- Loosen intake duct hose clamp (**A**) at throttle assembly.
- Loosen clamp and remove idle control hose from intake duct (**B**) and disconnect idle speed control valve electrical harness connector.
- Disconnect electrical harness connector (**C**) from mass air flow sensor.
- Remove air filter housing mounting screw (**D**).
- Disconnect vent tube (**E**).
- Loosen air intake duct clamp (**F**).
- Carefully lift air filter housing out of engine bay.

– Disconnect throttle cable.

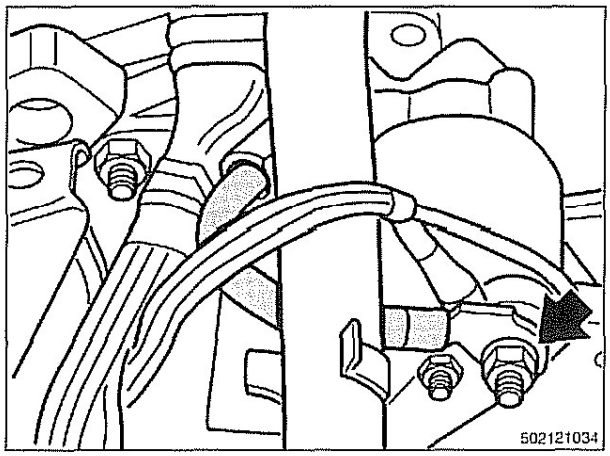
– Raise vehicle and support safely.

> ***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.*

– Working underneath car, remove engine splash shield.

– Disconnect fuel lines and harness connectors from retaining brackets, as necessary.

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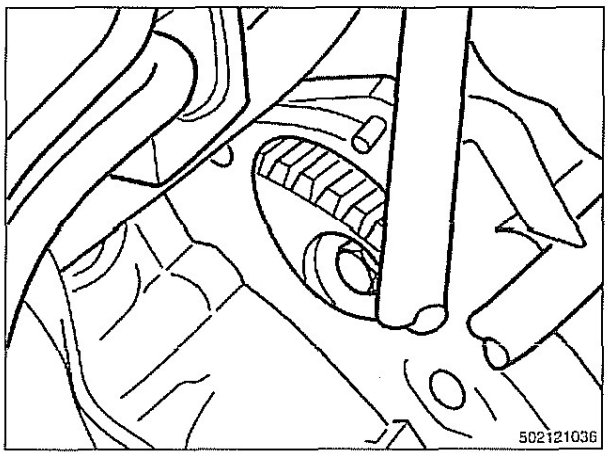


– Disconnect wiring from starter.

➢ Note routing for cables. Routing varies depending on model and transmission. When reinstalling, make sure cables do not chafe.

– Using a long extension and universal joint from output end of transmission, remove bolts fastening starter to transmission bell housing and engine block.

– Remove starter from below.



➢ Check starter pinion gear and flywheel teeth for damage.

– Installation is reverse of removal.

Tightening torques	
Starter to engine	47 Nm (35 ft-lb)
Starter support bracket to starter	5 Nm (44 in-lb)
Starter support bracket to engine	47 Nm (35 ft-lb)
Wire terminals to starter	
M5	5 Nm (44 in-lb)
M6	7 Nm (62 in-lb)
M8	13 Nm (10 ft-lb)

Starter, removing and installing (V-8 engine)

The starter is on the right (passenger) side of the engine, and is removed from below. Access to starter bolts is difficult. Be sure to have the proper tools on hand before proceeding.

– Disconnect negative (–) battery cable.

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

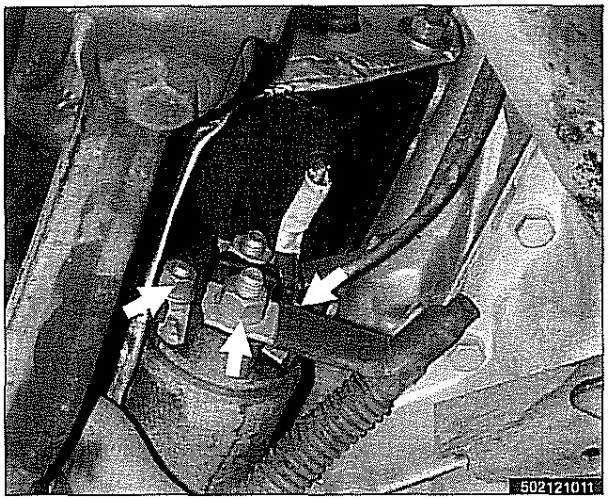
– Raise vehicle and support safely.

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.

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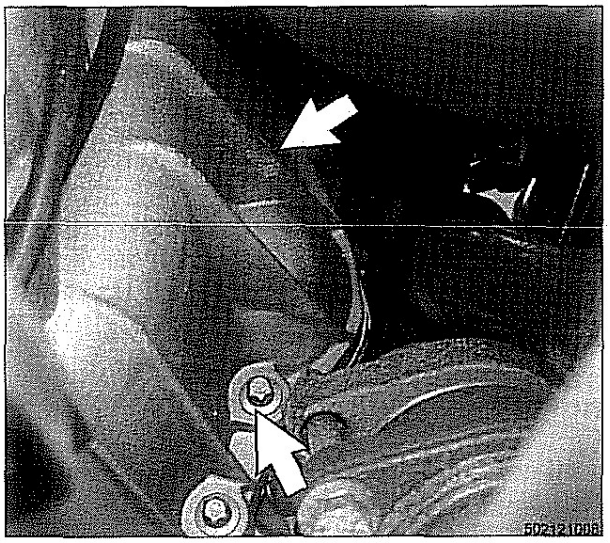
– *Working underneath car, remove engine splash shield.*

– Remove heat shield from starter.



➢ *Remove starter wire mounting nuts* (**arrows**). Disconnect wires from starter terminals and retaining clip.

- Disconnect main positive cable and bracket from suspension.
- If necessary for access, remove right side oxygen sensor harness connector from retaining clip.



➢ Working from end of transmission, use suitable extensions and universal joint to remove starter mounting bolts (**arrows**) at transmission bellhousing.

– Remove starter from below.

– Check starter pinion gear and flywheel teeth for damage.

– Installation is reverse of removal.

Tightening torques

Starter to engine	47 Nm (35 ft-lb)
Wire terminals to starter	
M5	5 Nm (44 in-lb)
M6	7 Nm (62 in-lb)
M8	13 Nm (10 ft-lb)

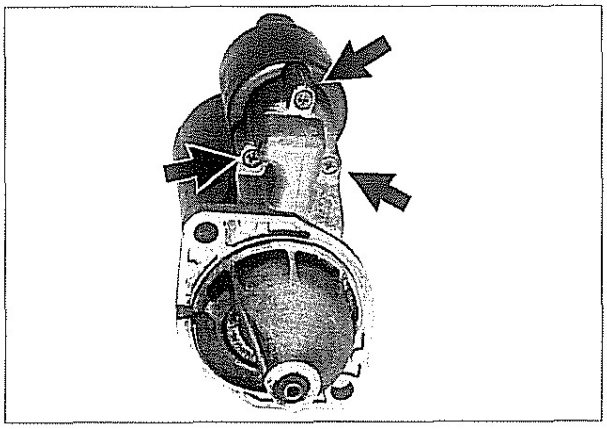
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Solenoid switch, removing and installing

– Remove starter as described previously.

– Disconnect field winding strap between starter motor and solenoid switch.

NOTE—
If the field winding strap is damaged or burned, a new or rebuilt starter motor is needed.



➢ Remove solenoid switch mounting screws (**arrows**), and separate solenoid from starter.

- Unhook solenoid plunger from lever in starter drive.

– Installation is reverse of removal. Lubricate solenoid piston with light grease.

CAUTION—
When installing field winding strap to starter, position it so that it does not contact the starter body.

Tightening torque	
Field strap to starter	13 Nm (10 ft-lb)



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GENERAL

This repair group covers service and repair of the Bosch and Siemens engine management systems used on 1997 through 2002 E39 models. Additional engine management service and repair information may also be found in the following repair groups:

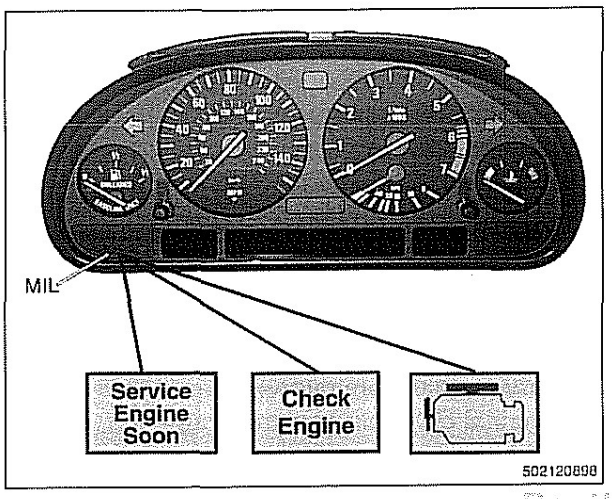
- **020 Maintenance**
- **120 Ignition System**
- **160 Fuel Tank and Fuel Pump**
- **610 Electrical Component Locations**
- **OBD On Board Diagnostics**

NOTE—
Camshaft position sensor, crankshaft speed sensor and knock sensors are covered in **120 Ignition System**.

Table a. Engine management system applications

Model/model year	Engine	DME System
528i, 1997-1998	M52, 2.8 liter	Siemens MS 41.1
528i, 1999-2000	M52 TU, 2.8 liter	Siemens MS 42.0
525i, 2001-2002	M54, 2.5 liter	Siemens MS 43.0
530i, 2001-2002	M54, 3.0 liter	Siemens MS 43.0
540i, 1997	M62, 4.4 liter	Bosch M5.2
540i, 1998	M62, 4.4 liter	Bosch M5.2.1
540i, 1999-2001	M62 TU, 4.4 liter	Bosch ME 7.2

OBD II software and hardware is incorporated in the engine management control systems. The OBD II system monitors components that influence exhaust and evaporative emissions. If a problem is detected, the OBD II system stores the associated fault code and condition.



If vehicle emission levels exceed 1.5 times Federally mandated criteria, the OBD II system illuminates a malfunction indicator light (MIL) in the instrument cluster.

NOTE—
- *For the E39 cars covered by this manual, three different MIL symbols were used, depending on year and model. See illustration.*

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours

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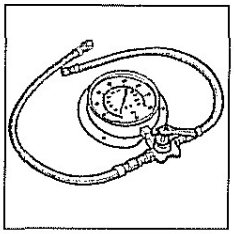
of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

NOTE—

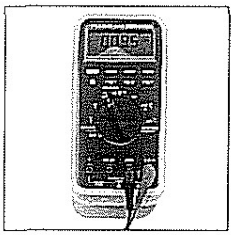
- *Professional diagnostic scan tools available at the time of this printing include the BMW factory tools and a small number of aftermarket BMW-specific tools. The CS2000 from Baum Tools Unlimited, the Retriever from Assenmacher Specialty Tools, and the MT2500 from Snap-on are three examples.*
- *In addition to the BMW-specific professional line of scan tools, there are inexpensive generic OBD II scan tool software programs and handheld units available. Although these tools have limited capabilities as compared to the dedicated tools, they are powerful diagnostic tools.*
- *For the DIY owner, simple aftermarket DTC reader is available through* http://www.peakeresearch.com. *This tool is capable of checking for DTCs as well as turning off the illuminated MIL and resetting the service indicator lights.*

Tools and test equipment

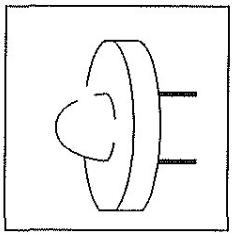
If the equipment required to do the job is unavailable, it is recommended that these repairs be left to an authorized BMW dealer or other qualified BMW repair facility.



- Fuel pressure gauge (Tool No. Baum 1318)

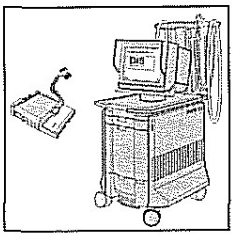


- Automotive digital multimeter

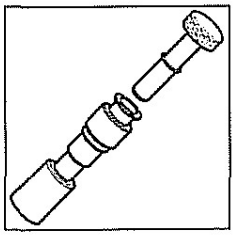


- Low current test light ("noid") (Tool No. Baum 1115a)

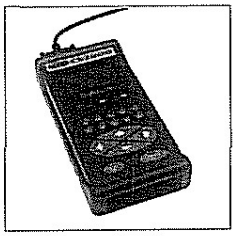
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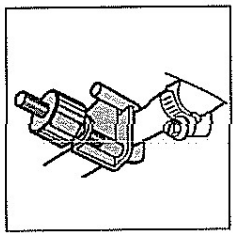
- Factory DTC scan tool
  (Tool No. BMW DISplus / GT1 / MoDiC III)



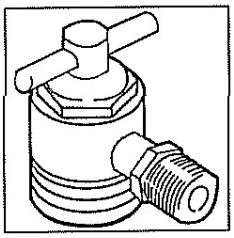
- Fuel line plugs
  (Tool No. BMW 13 5 281 / 13 5 282)



- Aftermarket DTC scan tool
  (Tool No. Baum CS2000)



- Fuel line clamp
  (Tool No. BMW 13 3 010)



- Fuel rail to pressure gauge fitting
  (Tool No. BMW 13 5 220)

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Warnings and cautions

For personal safety, as well as the protection of sensitive electronic components, adhere to the warnings and cautions on the following pages.

WARNING—

- *Gasoline is highly flammable and its vapors are explosive. Do not smoke or work on a car near heaters or other fire hazards when diagnosing and repairing fuel system problems. Have a fire extinguisher available in case of an emergency.*
- *Renew fuel system hoses, clamps and O-rings any time they are removed.*
- *When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.*
- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*

CAUTION—

- *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables. Read the battery disconnection cautions in* ***001 General Warnings and Cautions****.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.*
- *Wait at least 1 minute after turning off the ignition before removing the engine control module (ECM) connector. If the connector is removed before this time, residual power in the system relay may damage the control module.*
- *Fuel system cleaners and other chemical additives other than those specifically recommended by BMW may damage the catalytic converter, the oxygen sensor or other fuel supply components.*
- *Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow may damage the ECM. In general, connect test equipment only as specified by BMW or the equipment maker.*
- *Only use a digital multimeter for electrical tests. Only use an LED test light for quick tests.*

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Fuel Supply

Fuel supply to the injection system is provided by a high pressure electric pump mounted inside the fuel tank. The pump is powered via the fuel pump relay. If the relay is faulty, the fuel pump will not run and the engine will not start.

NOTE—
- *Fuel delivery volume and fuel pressure are critical to proper operation. Fuel pressure directly influences fuel delivery.*
- *Fuel pump relay, fuel pressure and fuel volume tests are given in* **160 Fuel Tank and Fuel Pump**.

Relieving system fuel pressure

The fuel system retains fuel pressure in the system when the engine is off. To prevent fuel from spraying on a hot engine, system fuel pressure should be relieved before disconnecting fuel lines. One method is to tightly wrap a shop towel around a fuel line fitting and loosen or disconnect the fitting. Cleanliness is essential when working with fuel components. Thoroughly clean the unions before disconnecting fuel lines.

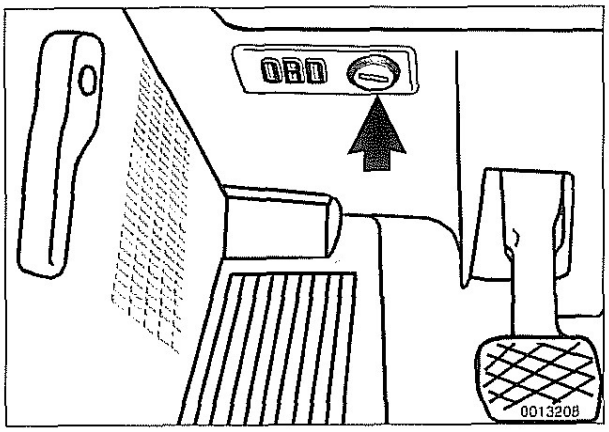
Siemens MS 41.1

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

CAUTION—
- *The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See* **OBD On-Board Diagnostics**.
- *Only use a digital multimeter for electrical tests.*
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in* **ELE Electrical Wiring Diagrams**.

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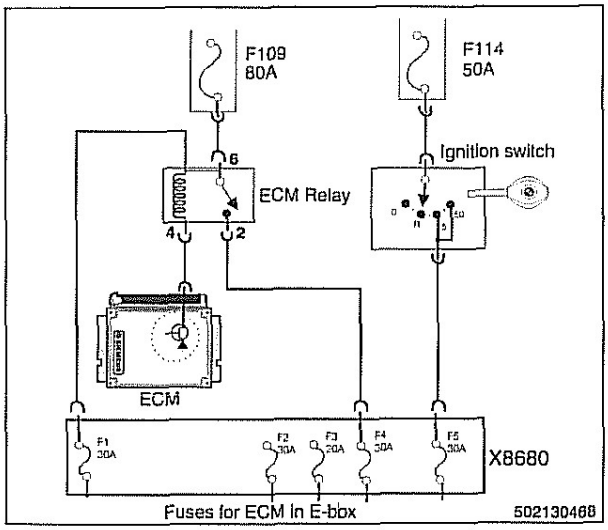
NOTE—

- *OBD II fault memory (including an illuminated MIL) can only be reset using an electronic scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment.*
- *The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.*

ECM relay, testing

The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

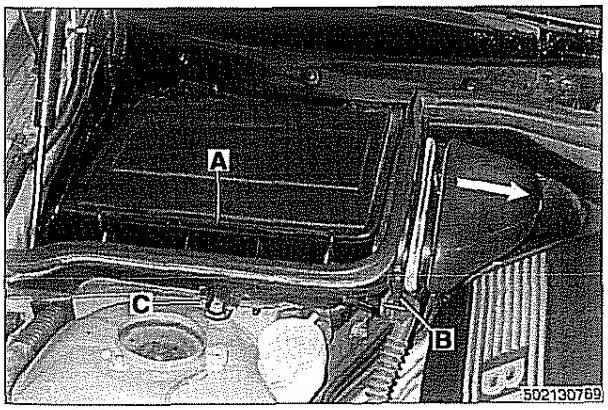
CAUTION—
Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in **ELE Electrical Wiring Diagrams**.



NOTE—
The ECM relay is also referred to as the DME main relay.

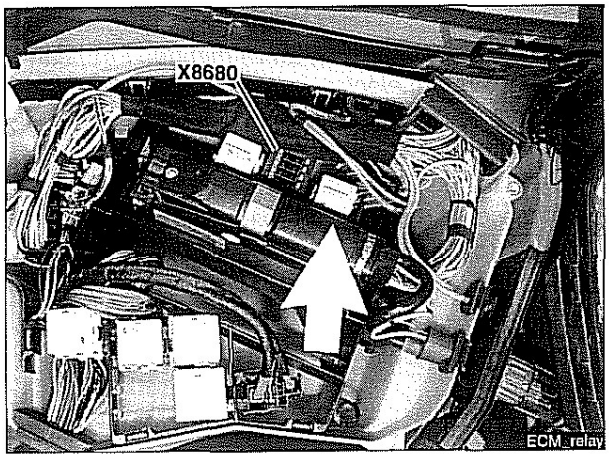
Working in right rear of engine compartment:

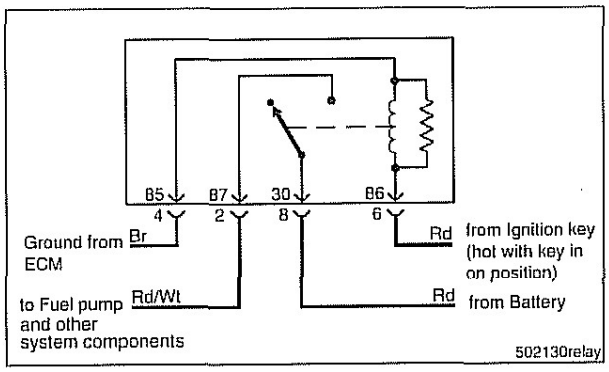
- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.



– Remove electrical box (E-box) cover fasteners and remove cover.

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➢ *With ignition off, remove main relay (K6300) (**arrow**) in E-box.*

➢ Check for voltage at terminal **8** (**30**) on relay socket.

- If battery voltage is present continue testing.
- If battery voltage is not present, check fuse 109 (80-amp fusible link) under passenger seat carpet. See **ELE Electrical Wiring Diagrams**.

– Reinstall relay and turn ignition on. Gain access to back side of relay socket and check for ground on terminal **4** (**85**).

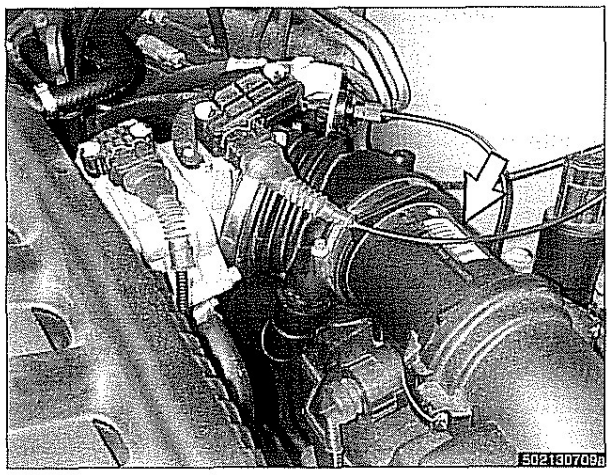
- If ground is present continue testing.
- If ground is not present, signal from ECM is missing. Check wire between ECM and relay.

– With ignition on and relay installed, check for battery voltage on terminal **2** (**87**).

- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

NOTE—
*If no faults are found during testing but power is not reaching the ECM or other components, check the fuses in the fuse carrier **X8680** in the E-box.*

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Mass air flow (MAF) sensor, checking and replacing

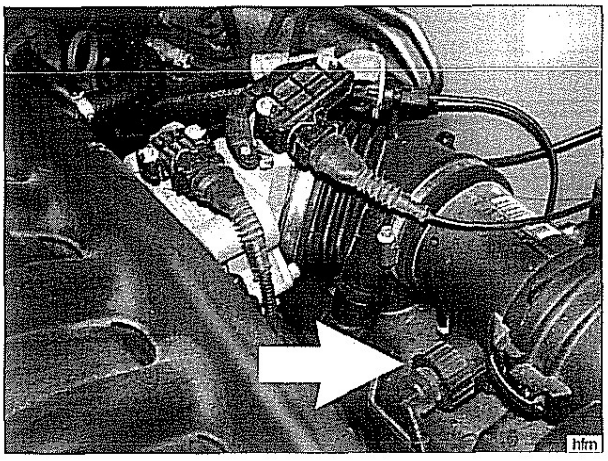
The hot film mass air flow (MAF) sensor (**arrow**) sends a varying voltage (approx. 0.5 - 4.5 vdc) to the ECM representing the measured intake air. The air mass input signal is produced electronically by the MAF sensor using a heated metal film in the air flow stream.

The ECM relay provides the operating voltage to the MAF sensor. As air flows through the MAF sensor, the film is cooled. To maintain the film at a constant temperature, additional heating current is necessary. It is this additional current that is the basis for the input signal.

If there is no output signal from the MAF sensor, the ECM operates the engine using throttle position and engine rpm inputs. A faulty MAF sensor illuminates the MIL.

A faulty MAF sensor can produce the following problems:

- Difficult to restart when engine is hot.
- Engine starts then stalls.
- Engine starts and runs only with accelerator pedal depressed.



Disconnect electrical harness connector from MAF sensor (**arrow**).

– Turn ignition on and check for voltage and ground at connector.
  - There should be ground at pin 1 and battery voltage at pin 3.
  - If any faults are found, check for wiring breaks between MAF sensor and ECM and between MAF sensor and ECM relay.

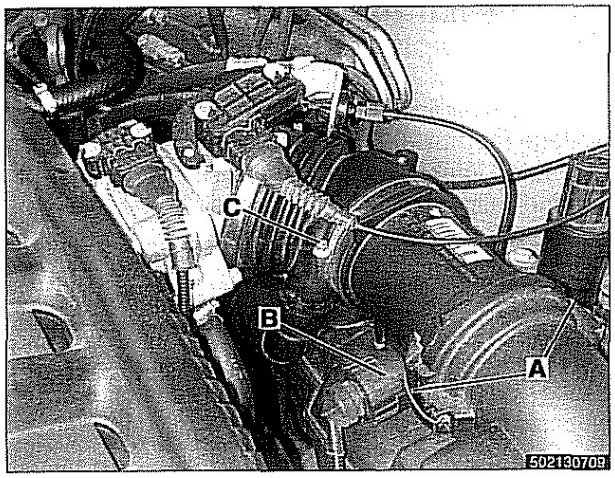
NOTE—
Visually inspect the sensor for damage, missing or blocked screens. The screens affect air flow calibration. Also inspect the sealing O-rings where the sensor inserts into the air filter housing and intake boot. Ensure the pin connections are clean and tight.



Connect a BMW-compatible scan tool or an OBD II generic scan tool. Check air mass signal (load signal) with the engine at idle. Raise idle speed and check that load signal changes with rpm.

> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

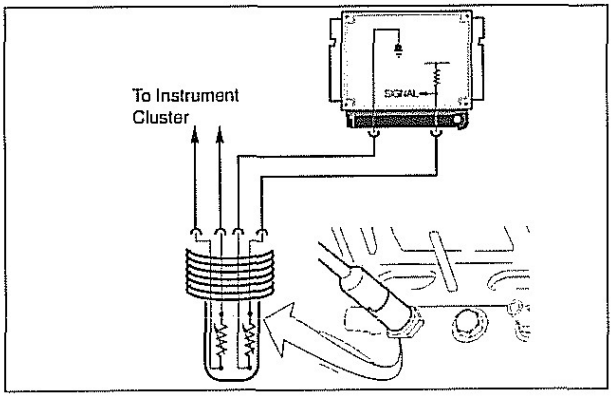
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➢ Remove MAF sensor:
- *Release clips from air filter housing* (**A**).
- Disconnect harness connector (**B**).
- Loosen intake boot clamp (**C**) and remove MAF sensor. Note large sealing O-rings.

– Installation is reverse of removal.
- No adjustment to MAF sensor is possible.
- Check intake hoses for cracks and vacuum leaks.

Engine coolant temperature (ECT) sensor, testing and replacing



➢ The ECT sensor is located below cylinder 1 intake port.

The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

NOTE—
The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

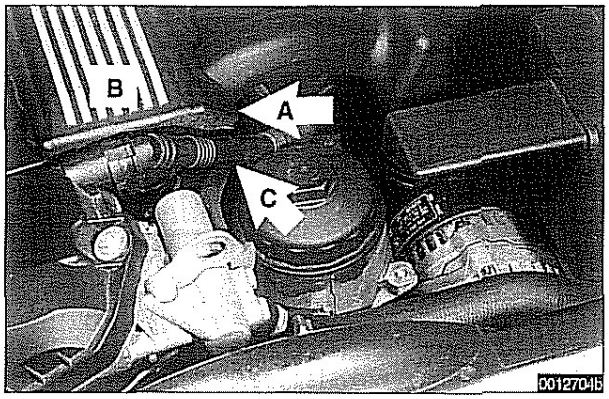
– Check ECT sensor resistance using a multimeter at sensor terminals.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ
Temperature gauge sensor resistance @ 20° C (68°F)	6.7 kΩ

WARNING—
Due to risk of personal injury, be sure the engine is cold before disconnecting or reconnecting ECT sensor.

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CAUTION—
Be sure ignition is OFF before disconnecting or reconnecting DME system components.

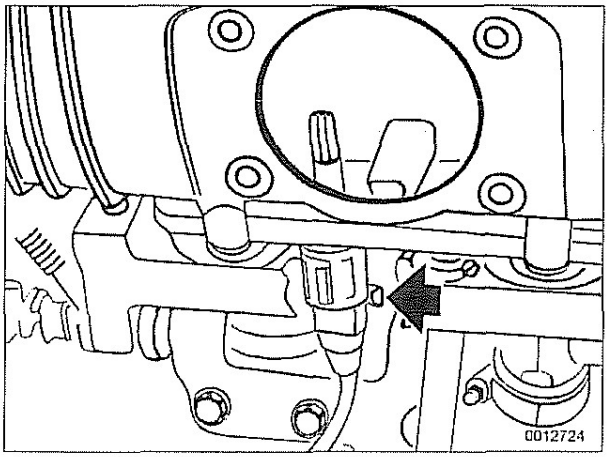


- Remove engine coolant temperature sensor:
  - Unclip crankcase vent hose (**C**) from cylinder head cover.
  - Remove plastic cover (**B**) from atop intake manifold runners.
  - Working under front of intake manifold, disconnect ECT harness.
  - Unscrew ECT sensor (**C**) from cylinder head.

– Installation is reverse of removal:
  - Use new copper sealing washers when installing sensor.
  - Replace any engine coolant lost.

Tightening torque	
Temperature sensor to cylinder head	13 Nm (10 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing



The intake air temperature (IAT) sensor (**arrow**) signal is used by the ECM to monitor intake air temperature for fuel and ignition adaptation. The sensor is located in the intake manifold behind the throttle housing.

The ECM monitors an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the intake air temperature (sensor resistance) changes.

NOTE—
The IATsensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the IAT sensor input is implausible, a fault code is set.The MIL is illuminated when OBD II fault criteria are exceeded. The ECM then operates the engine using only the engine coolant temperature (ECT) sensor input.

The intake air temperature sensor can be tested using a multimeter across its terminals:

IAT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ

CAUTION—
Be sure ignition is OFF before disconnecting or reconnecting DME system components.

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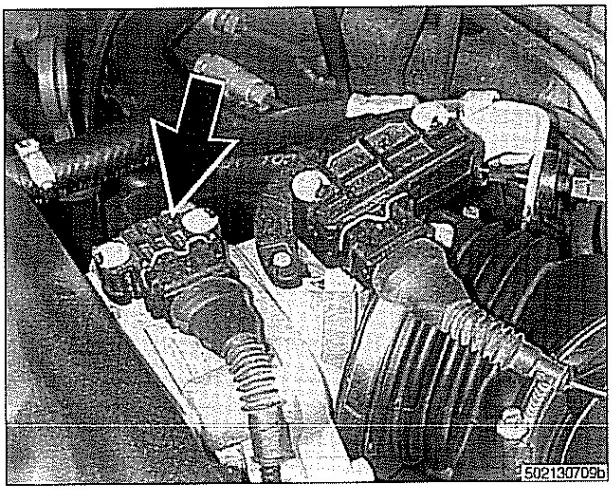
– Disconnect intake air boot from throttle housing. Unbolt throttle housing and lay aside. It is not necessary to disconnect throttle cable or electrical harness connectors from throttle housing.

– Remove electrical harness connector from IAT sensor.

– Unclip temperature sensor and remove from intake manifold.

– Installation is reverse of removal. Use a new gasket at throttle housing.

Throttle position sensor (TPS), testing and replacing



The throttle position sensor (**arrow**) is located on top of the throttle valve housing and provides the ECM with a voltage value that represents throttle position (angle) and rate of movement.

The TPS is non-adjustable. If the throttle position sensor is replaced, the previous 'learned' TPS settings must be cleared from the ECM using a BMW-compatible scan tool.

If the throttle position sensor signal is defective, a fault code is stored and the MIL is illuminated when OBD II fault criteria are exceeded. The ECM still operates the engine using the mass air flow (MAF) sensor and engine rpm inputs.

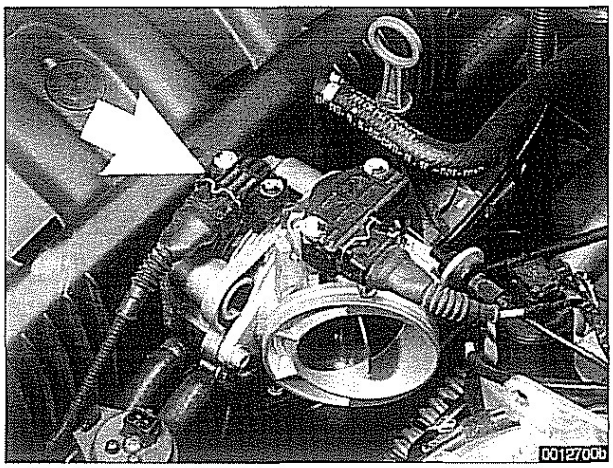
– Check throttle position sensor function by disconnecting harness connector and checking continuity across terminals. If test results are incorrect, replace throttle position sensor. The sensor is non-adjustable.

Throttle position sensor testing values

Terminals	Test values
1 and ground in harness connector, key on	5 vdc (approx.)
1 and 3 at sensor	4.0 kΩ (approx.)
1 and 2 at sensor	Throttle plate rotated from idle to full throttle, continuously variable from 1.0 - 4.0 kΩ

CAUTION—
Be sure ignition is OFF before disconnecting or reconnecting DME system components.

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Unplug harness connector (**arrow**) from sensor.

> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

NOTE—
Do not confuse the throttle position sensor on the main throttle body with the throttle position switch on the secondary throttle body, where applicable.

- Remove two mounting screws holding sensor to throttle housing.
- Installation is reverse of removal. Clear adaptation settings from ECM using BMW-compatible scan tool.

NOTE—
Poor idle quality may be noticeable for a period if the adaptation settings are not cleared after installing new TPS.

Idle speed control valve, checking and replacing

The idle speed control valve regulates idle speed by redirecting air around the throttle valve.The idle speed control valve is mounted on the underside of the intake manifold adjacent to the dipstick tube bracket. Accessing the valve is best accomplished by first removing the air filter housing and the throttle body assembly.

The valve is supplied with battery voltage from the ECM relay. The idle speed control valve incorporates a two-coil rotary actuator. The ground sides of each coil are pulsed simultaneously by the ECM. The duty cycle of each circuit is varied to achieve the required idle speed.

A faulty Idle speed control valve sets a fault code and the MIL is illuminated when OBD II fault criteria are exceeded.

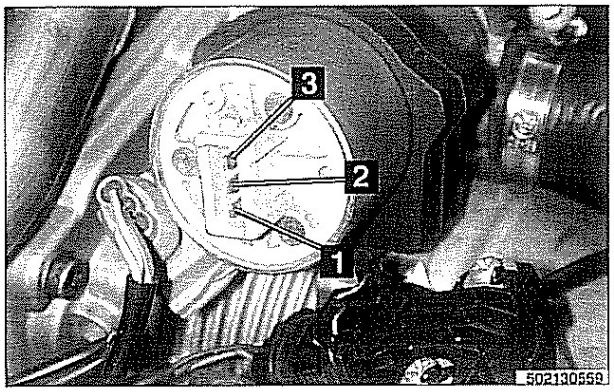
Before checking the idle speed control valve, confirm that the throttle position sensor is working correctly.

- With engine running, check that idle speed control valve is buzzing.
- Turn on A/C system or shift transmission into drive. Idle should remain steady or increase slightly.

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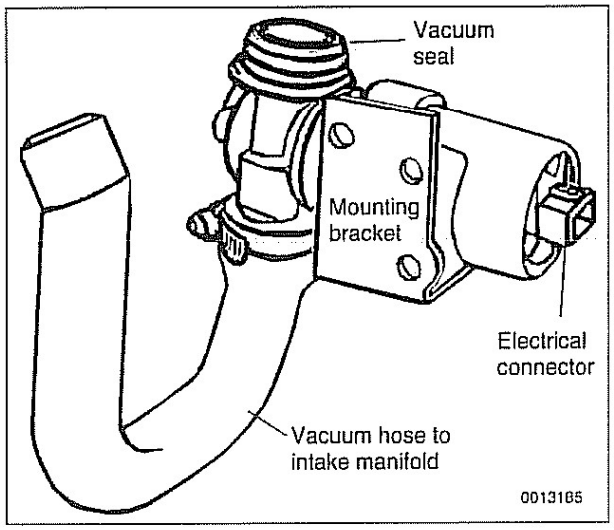
– If idle speed valve is not buzzing, or if idle decreases when A/C is turned on, stop engine and disconnect harness connector from idle speed valve.

> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*



➢ Check resistance of valve across valve terminals.

Idle speed control valve resistance	
Terminals **1** and **2**	20 ±2Ω
Terminals **2** and **3**	20 ±2Ω
Terminals **1** and **3**	40 ±4Ω

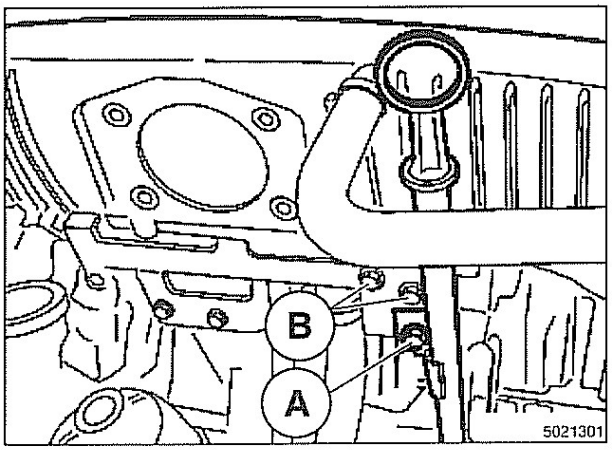


The idle speed control valve is mounted under the intake manifold. Accessing the valve is best accomplished by first removing the air filter housing and the throttle housing.

➢ Disconnect intake air boot from throttle housing. Unbolt throttle body and lay aside. Do not disconnect throttle cable or electrical harness connectors to throttle body.

NOTE—
For additional working room, unfasten and lift out the complete air filter housing.

– Working under intake manifold, disconnect electrical harness connector from idle speed control valve.



➢ Unbolt dipstick tube bracket (**A**) from intake manifold.

– Remove two bolts (**B**) retaining idle speed control valve to underside of intake manifold. Remove valve from intake manifold. Remove hose clamp and disconnect hose.

– Installation is reverse of removal. Use new gaskets when installing.

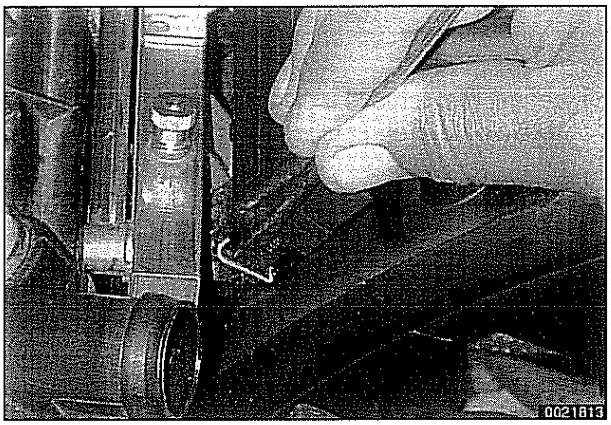
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Fuel injectors, checking and replacing

The fuel injectors are electronically controlled solenoid valves that provide precisely metered and atomized fuel into the engine intake ports.

The injectors receive voltage from the ECM relay. The ECM controls the opening by activating the ground circuit for the injector valve solenoids. The ECM varies the duration (in milliseconds) of "opening" time to regulate the air/fuel ratio.

For a quick check of the injectors, run the engine and touch each injector with a screwdriver or stethoscope. You should feel a vibration or hear a buzzing.



➢ Remove fuel injection harness from injectors by unclipping locking clip at each injector. Lift harness off injectors.

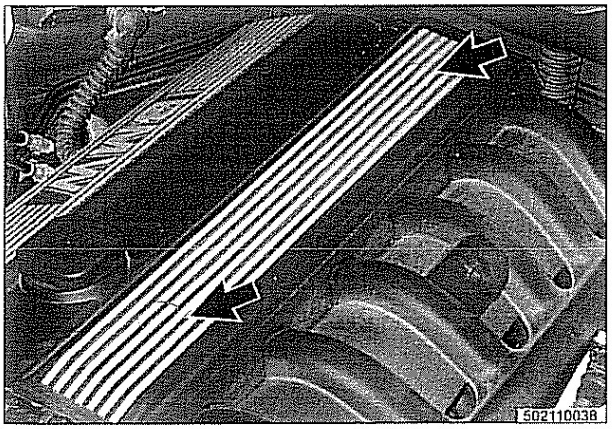
> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

– Use a multimeter to test injector coil resistance between injector terminals.

Fuel injector coil resistance	16Ω at 20° C (68° F)

– Disconnect negative (-) battery cable.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in* **001 General Warnings and Cautions.**

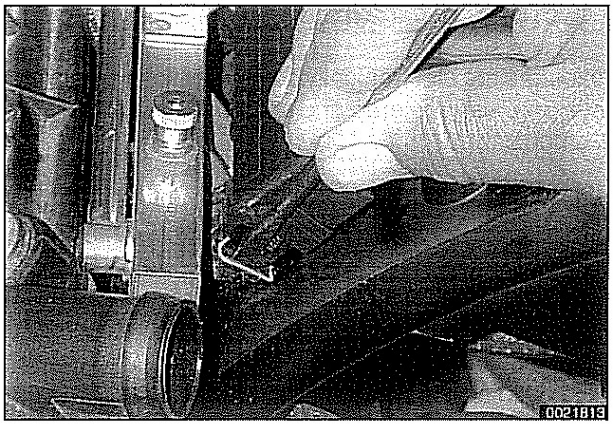


➢ Remove plastic trim plugs (**arrows**) and fasteners, then remove cover from above fuel injectors.

– Disconnect vacuum line from fuel pressure regulator.

– Remove wiring harness duct mounting fasteners.

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- Release injector locking clips at each injector and pry injector wiring duct up off injectors.
- Clamp off fuel supply line and fuel return line at end of fuel rail. Disconnect fuel supply fuel return lines from fuel rail.

> *WARNING —*
> - *Clamp off the fuel lines and then wrap a clean shop towel around the lines before removing them. Residual fuel pressure is present in the lines.*
> - *Fuel is discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

- Remove fuel rail mounting fasteners.
- Pull up on fuel rail and remove individual injectors by removing injector retaining clip and pulling injector from rail.
- Installation is reverse of removal. Fit new O-rings when installing injectors. For ease of installation, lightly lubricate injector O-ring with SAE90 gear lube.

Tightening torque

Fuel rail to intake manifold	10 Nm (89 in-lb)

Evaporative emissions, overview

On E39 MS 41.1 cars, the evaporative emissions system is combined with the tank ventilation system. The evaporative system is monitored by the ECM for correct purge operation and leak detection.

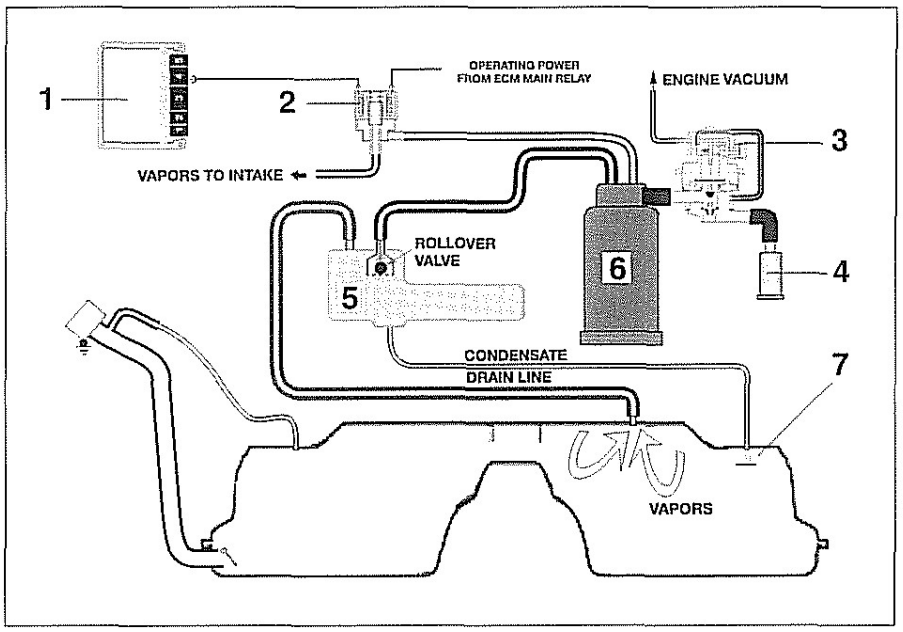
The carbon (purge) canister is purged using engine vacuum via the purge valve. The purge valve (located next to the mass air flow sensor) is ECM controlled and regulates the purge flow into the intake manifold. The valve is powered open and closed by an internal spring.

If the evaporative emission valve circuit is faulty, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. If the valve is mechanically faulty, poor driveability may result and a mixture adaptation fault is stored in the ECM.

The leak diagnosis pump (LDP) is activated by the ECM and pressurizes the fuel tank and evaporative system as apart of the OBD II leak detection monitor. If the LDP or the LDP circuit is defective, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. The LDP is mounted the left rear wheel well behind the fender liner.

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NOTE—
The 1998 528i with MS 41.1 requires a barometric pressure sensor input signal for activation of the LDP check. This sensor is located on the passenger side strut tower forward of ABS/ASC hydraulic unit.



Evaporative emissions

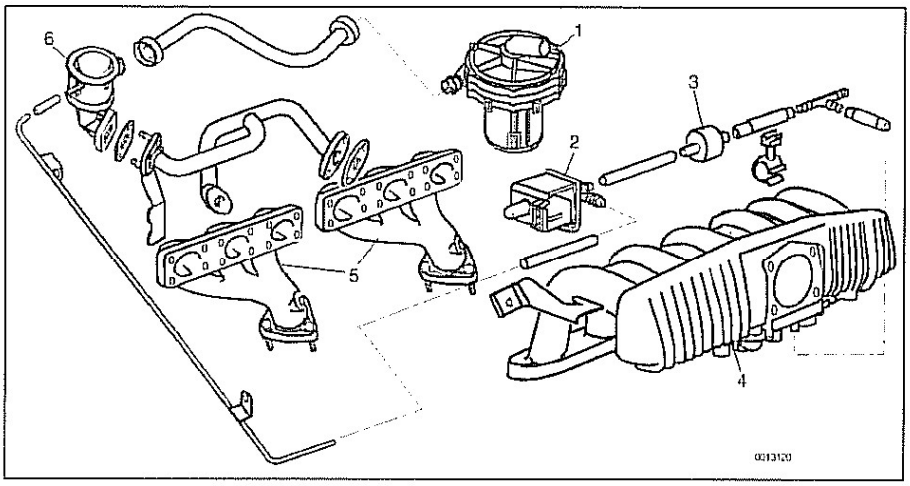
1. ECM
2. Purge valve
3. Leak detection pump (LDP) (in left rear wheel housing)
4. Filter
5. Liquid vapor separator
6. Purge canister
7. Fuel tank

Secondary air injection, overview

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce the warm up time of the catalytic converters and to reduces HC and CO emissions. The ECM controls and monitors the secondary air injection system. The secondary air pump operates at a start temperature of between 10°C (50°F) and 40°C (104°F) and continues to operate for a maximum of 2 minutes at idle speed.

The electric air pump draws in ambient air and supplies it to the diverter valve. The vacuum vent valve (solenoid) switches vacuum to open the diverter valve when activated by the ECM. Once opened, the diverter valve allows air to be pumped into the exhaust stream.

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Secondary air injection

1. **Secondary air pump (in right front wheel housing)**
2. **Secondary air vacuum vent valve solenoid (on intake manifold)**
3. **Secondary air check valve**
4. **Intake manifold**
5. **Exhaust manifolds**
6. **Diverter valve (at exhaust manifold)**

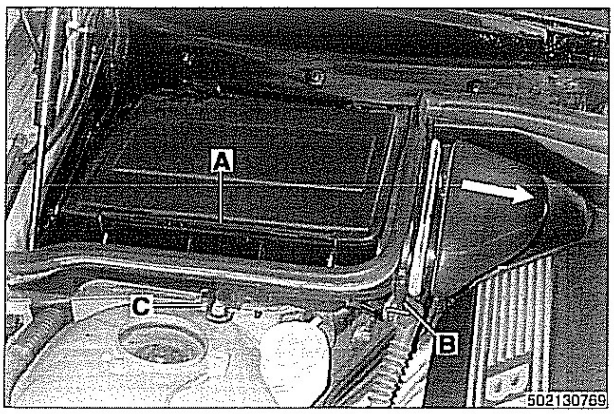
Engine control module (ECM), removing and installing

The ECM uses stored functions and processing programs to process the input signals from the sensors. These input signals are used to calculate the control (output) signals to the actuators (e.g., ignition coils, injectors).

NOTE—
Consult an authorized BMW dealer before replacing the ECM.

– Disconnect negative (-) battery cable. Wait approximately one minute.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions.**



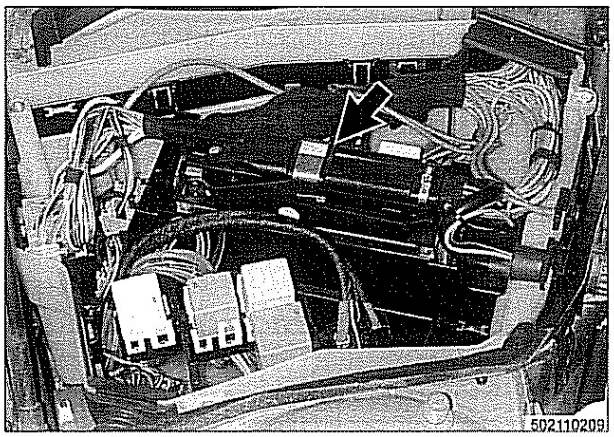
➢ Access engine control module (ECM):

- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate air duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.

– Remove electrical box (E-box) cover fasteners and remove cover.

– If testing ECM or connected components, use breakout box to allow tests to be made with connector attached to the ECM. This prevents damage to small terminals in connector.

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– As an alternative, harness connector housing can be separated so that electrical checks can be made from back of connector.

If replacing ECM, disconnect control module harness connector (**arrow**) by releasing fastener and pivoting connector up and off ECM.

> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

– Remove ECM from retaining brackets and lift off holder.

– Installation is reverse of removal.

– Before attempting to start engine, use BMW service tester DISplus, MoDiC, GT1 or equivalent:
  - Code replacement ECM with application information (i.e. engine code, transmission type, etc.).
  - Align ECM to EWS (electronic immobilizer).

Siemens MS 41.1 ECM pin assignments

ECM pin assignments are given in **Table b.** For engine management system schematics, see **ELE Electrical Wiring Diagrams.**

> ***CAUTION—***
> - *Always wait at least one minute after turning off the ignition before removing the connector from the ECM. If the connector is removed before this time, residual power in the system relay may damage the ECM.*
> - *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made from the back of the connector.

Table b. Siemens MS 41.1 ECM pin assignments

Pin	Signal	Component/function	Notes
1	output	Ignition coil control, cyl. 2	Primary signal, ignition coil 2
2	output	Ignition coil control, cyl. 4	Primary signal, ignition coil 4
3	output	Ignition coil control, cyl. 6	Primary signal, ignition coil 6
4	ground	Ground	Ground

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Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
5	output	Fuel injector control, cyl. 2	Pulsed ground (pulse width in ms), cyl. 2
6	output	Fuel injector control, cyl. 1	Pulsed ground (pulse width in ms), cyl. 1
7	ground	Mass air flow sensor	Mass air flow sensor signal
8	input	Mass air flow sensor	Mass air flow sensor signal
9	output	Instrument cluster	Fuel consumption signal
10	input	Engine coolant temp. (ECT) sensor	ECT signal
11	-	Not used	
12	input	Throttle position sensor (TPS)	Throttle position signal
13	-	Not used	
14	input	Intake air temp. sensor (IAT)	Intake air temperature signal
15	input	Traction control (rear engine speed signal)	ABS/ASC module
16	input	Automatic climate control	
17	-	Not used	
18	input	Electronic immobilizer control (EWS)	
19	input	Auto. climate control (A/C on input)	Automatic climate control
20	output	Instrument cluster	Instrument cluster (CARB signal)
21	output	Camshaft actuator control (VANOS)	Camshaft actuator (VANOS), switched ground
22	output	Fuel injector control, cyl. 3	Pulsed ground (pulse width in ms), cyl. 3
23	output	Fuel injector control, cyl. 6	Pulsed ground (pulse width in ms), cyl. 6
24	output	Fuel injector control, cyl. 4	Pulsed ground (pulse width in ms), cyl. 4
25	ground	Oxygen sensor heater (no. 1 in front of catalytic converter)	Oxygen sensor heater ground
26	input	Power supply (terminal 30)	Battery voltage (B+) at all times
27	output	Idle speed control valve	Pulsed ground-open signal (See pin 53)
28	ground	Ground	Ground
29	output	Ignition coil control, cyl. 1	Primary signal, ignition coil 1
30	output	Ignition coil control, cyl. 3	Primary signal, ignition coil 3
31	output	Ignition coil control, cyl. 5	Primary signal, ignition coil 5
32	ground	Ground	Ground
33	output	Fuel injector control, cyl. 5	Pulsed ground (pulse width in ms), cyl 5
34	ground	Ground	Ground
35	output	Secondary air injection	Secondary air inj. pump relay control
36	output	Engine speed output	Engine speed signal
37	-	Not used	
38	ground	Knock sensor	Shielding for knock sensor
39	output	Intake air temp (IAT) sensor and Engine coolant temp (ECT) sensor	Voltage supply to IAT sensor and ECT sensor

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Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
40	ground	Crankshaft position sensor	Crankshaft position sensor control
41	ground	Camshaft position sensor (CMP)	Shielding for CMP sensor
42	ground	Throttle position sensor (TPS)	TPS ground
43	ground	Camshaft position sensor (CMP)	Camshaft position/rpm sensor control
44	output	Throttle position sensor (TPS)	Voltage supply to TPS (5 vdc)
45	output	Throttle position sensor (traction control)	ABS/ASC module
46	output	Instrument cluster	Instrument cluster, fuel reserve signal
47	-	Not used	
48	output	Crankshaft position sensor (Hall effect)	Crankshaft position sensor control
49	input	Power supply (terminal 15)	Battery voltage with key on or engine running
50	-	Not used	
51	-	Not used	
52	-	Not used	
53	output	Idle speed control valve	Pulsed ground-close signal (see pin 26)
54	input	Power supply	Battery voltage from main relay (terminal 87)
55	ground	Oxygen sensor heater (no. 2 in front catalytic converter)	Oxygen sensor heater ground
56	ground	Ignition circuit	Ignition circuit monitoring signal
57	output	Knock sensor (cyl. 1-3)	Knock sensor
58	input	Knock sensor (cyl. 1-3)	Knock sensor signal
59	output	Knock sensor (cyl 4-6)	Knock sensor
60	input/output	Data link connector (TxD)	Diagnostic TxD (transmit) signal to pin 18 in data link connector
61	ground	Oxygen sensor heater (no. 2 behind catalytic converter)	Oxygen sensor heater ground
62	output	Secondary air injection	Secondary air injection control valve
63	input	Knock sensor (cyl. 4-6)	Knock sensor signal
64	input	Camshaft position/rpm sensor	Camshaft position/rpm sensor control
65	input	Camshaft position/rpm sensor	Camshaft position/rpm sensor control
66		Not used	
67	ground	Oxygen sensor (no. 1 in front of catalytic converter)	Oxygen sensor signal ground
68	output	Evaporative purge valve control	Pulse ground with engine at normal temperature with varying engine load
69	output	Fuel pump relay control	Fuel pump relay energizes with engine running
70	ground	Oxygen sensor signal (no. 2 in front of catalytic converter)	Oxygen sensor signal ground
71	ground	Oxygen sensor signal (no. 1 behind catalytic converter)	Oxygen sensor signal ground

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Table b. Siemens MS 41.1 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
72	ground	Oxygen sensor signal (no. 2 behind cat. conv.)	Oxygen sensor signal ground
73	input	ECM relay control	ECM relay activation (terminal 85)
74	output	A/C compressor control	A/C compressor relay control
75	input	Oxygen sensor signal (no. 1 in front of cat. conv.)	Oxygen sensor signal
76	input	Oxygen sensor signal (no. 2 in front of cat. conv.)	Oxygen sensor signal
77	input	Oxygen sensor signal (no. 1 behind cat. conv.)	Oxygen sensor signal
78	input	Oxygen sensor signal (no. 2 behind cat. conv.)	Oxygen sensor signal
79	ground	Oxygen sensor heater (no. 1 behind cat. conv.)	Oxygen sensor heater ground
80	input	Ignition delay (traction control)	ABS/ASC module
81	input	Ignition timing adjustment (traction control)	ABS/ASC module
82	input	Increase idle speed (traction control)	ABS/ASC module
83	input	Crankshaft position sensor (Hall effect)	Crankshaft position sensor control
84		Not used	
85	input/output	CAN-Bus low	Automatic transmission control module (AGS)
86	input/output	CAN-Bus high	Automatic transmission control module (AGS)
87	input	Power supply	Battery voltage from main relay terminal 87
88	input output	Diagnostic connector (TxD)	Diagnostic TxD signal to pin 17 in data link connector

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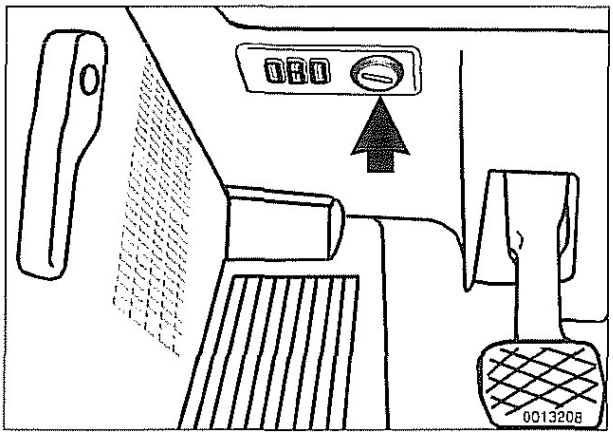
SIEMENS MS 42.0 AND MS 43.0

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

CAUTION—

- *The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See* **OBD On-Board Diagnostics.**
- *Only use a digital multimeter for electrical tests.*
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in* **ELE Electrical Wiring Diagrams.**



NOTE—

- *OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment. The 2o-pin DLC is discontinued on models after 6/2000.*
- *The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.*

The MS 42.0 and MS 43.0 systems manage the following functions.

– **Air:**
  - Idle speed valve
  - Electronic throttle
  - Hot film mass air flow (MAF) sensor
  - Resonance-turbulence intake control

– **Fuel:**
  - Fuel supply
  - Running losses/non return
  - Fuel injection

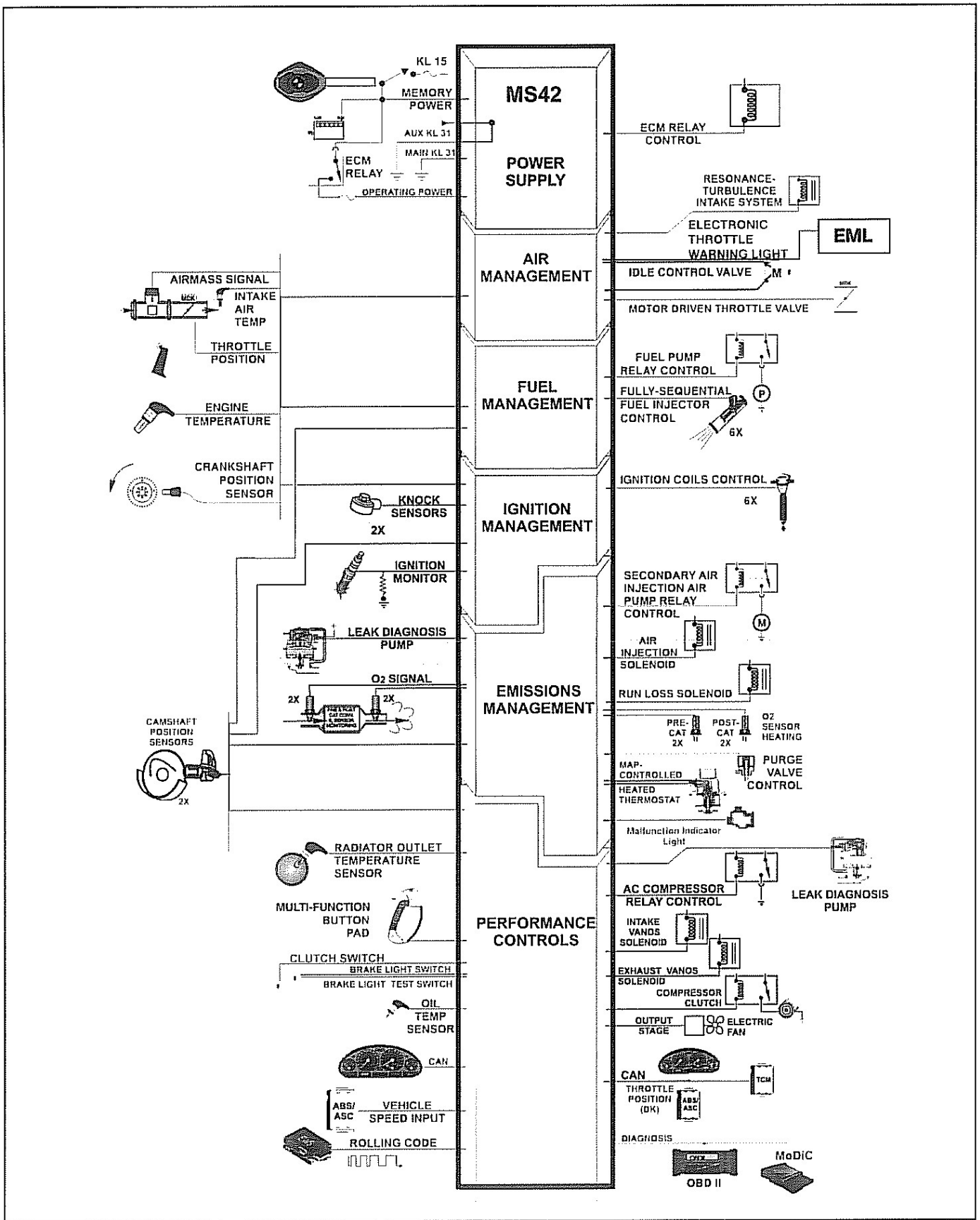
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- **Ignition:**
  - Direct ignition
  - Knock control
  - Primary/ secondary ignition monitoring
- **Emissions:**
  - OBD II compliance
  - Secondary air injection
  - Pre- and post-catalyst oxygen sensors
  - Electrically heated DME-mapped thermostat
  - Misfire detection
  - Evaporative emission control and leak detection
  - Malfunction indicator light (MIL)

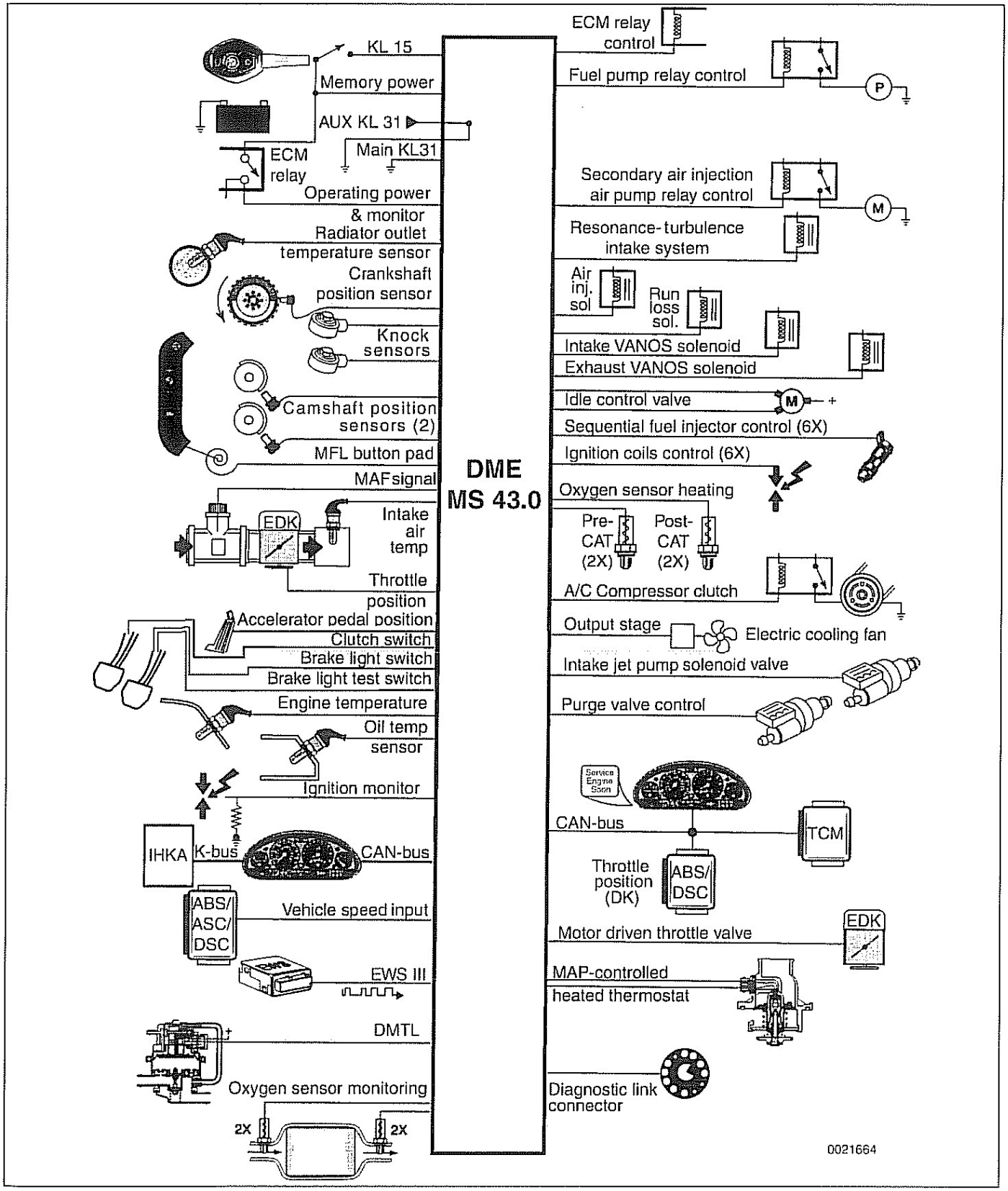
Performance controls:

- Dual VANOS control
- Output of injection signal (TI) for fuel economy gauge
- Output of engine rpm (TD) for tachometer
- A/C compressor control
- Electric radiator cooling fan
- CAN-Bus communication
- Stability and traction system (ABS/ASC/DSC) interface
- Electronic immobilizer (EWS)
- Cruise control
- ECM programming

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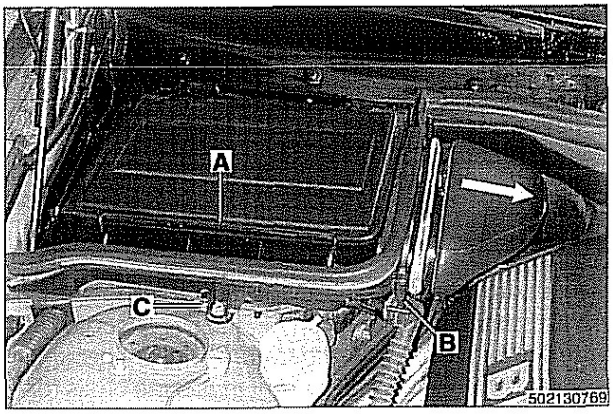
ECM relay, testing

The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

NOTE—
The ECM relay is also referred to as the DME main relay.

ECM relay powers:

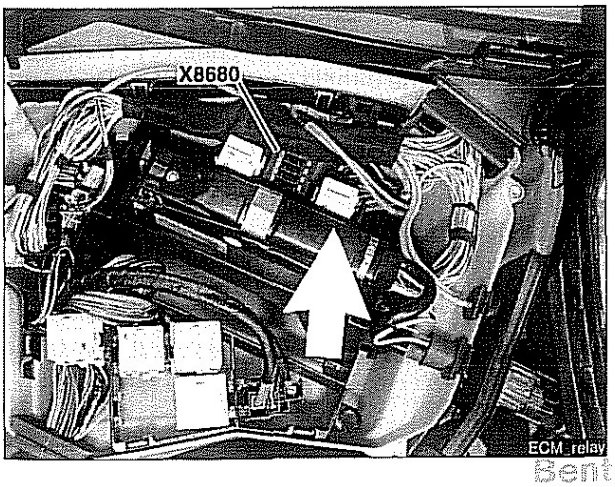
- ECM
- Ignition coils
- Fuel injection
- Evaporative leak detection pump
- Idle air actuator
- Camshaft sensors
- Evaporative emissions valve
- Hot film mass air flow sensor
- Fuel pump relay
- Oxygen sensor heaters



➢ Working in right rear of engine compartment:

- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.

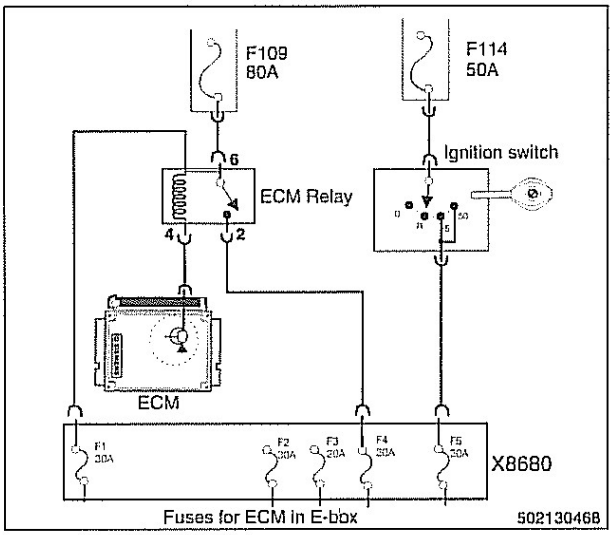
– Remove electrical box (E-box) cover fasteners and remove cover.



➢ With ignition off, remove ECM relay (**arrow**) in electronics box (E-box) at rear of engine compartment, right side.

NOTE—
Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.

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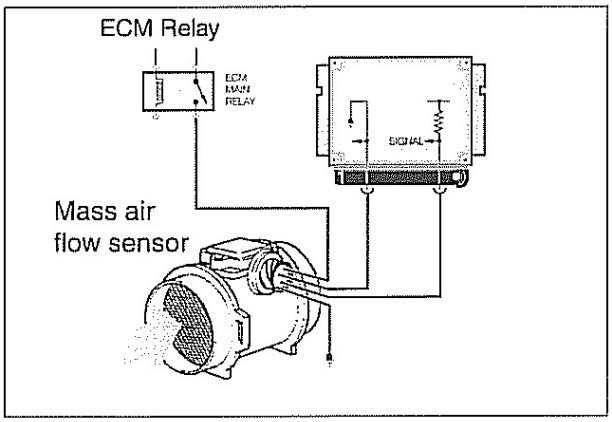
- Check for voltage at terminal **6** (30) at relay socket.
  - If battery voltage is present continue testing.
  - If battery voltage is not present, check fuse **109** (80-amp fusible link) under passenger seat carpet. See **610 Electrical Component Locations**.

– Reinstall relay and turn ignition on. Gain access to back side of relay socket and check for ground at terminal **4**.
  - If ground is present continue testing.
  - If ground is not present, signal from ECM is missing. Check wire between ECM and relay.

– With ignition on and relay installed, check for battery voltage at terminal **2**.
  - If battery voltage is present, relay has energized and is functioning correctly.
  - If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

NOTE—
*If no faults are found during testing but power is not reaching the ECM or other components, check the fuses in the fuse carrier **X8680** in the E-box.*

Mass air flow (MAF) sensor, checking and replacing



The hot film mass air flow (MAF) sensor sends a varying voltage (approx. 0.5 - 4.5 vdc) to the ECM representing the measured intake air. The air mass input signal is produced electronically using an electrically heated metal film in the air flow stream.

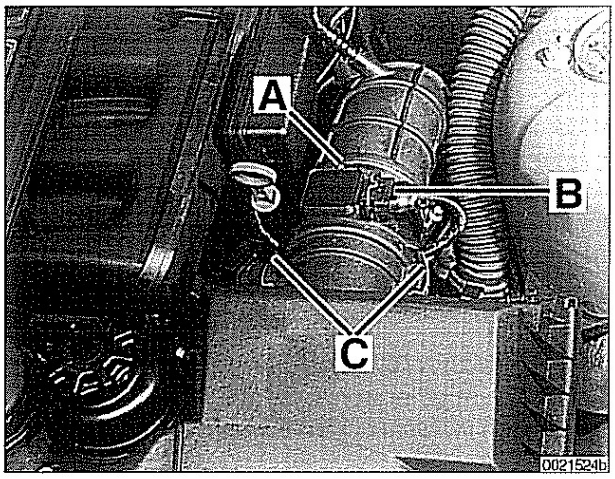
The ECM relay provides the operating voltage to the MAF sensor. As air flows through the sensor, the film is cooled. To maintain the film at a constant temperature, additional current is necessary. It is this additional current that is the basis for the input signal.

If there is no output signal from the MAF sensor, the ECM operates the engine using the throttle position and engine rpm inputs. A faulty MAF sensor illuminates the MIL.

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A faulty MAF sensor can produce the following problems:

- Difficult to restart when engine is hot
- Engine starts then stalls
- Engine starts and runs only with accelerator pedal depressed



➢ Disconnect electrical harness connector from MAF sensor (**B**).

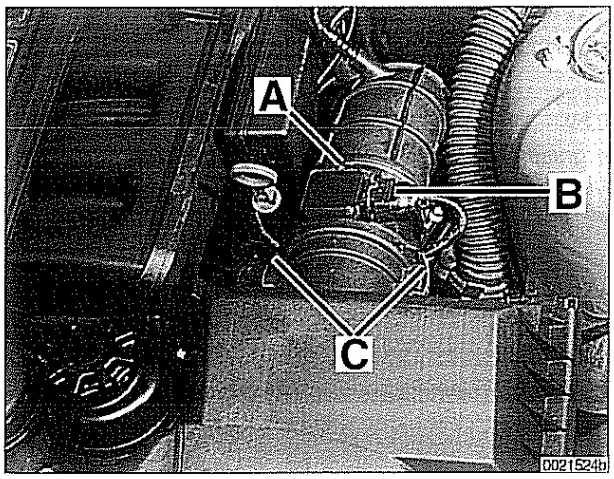
– Turn ignition on and check for voltage and ground at connector.
  - There should be ground at pin 1 and battery voltage at pin 3.
  - If any faults are found, check for wiring breaks between MAF sensor and ECM and between MAF sensor and main DME relay.

NOTE—
Visually inspect the sensor for damage, missing or blocked screens. The screens affect air flow calibration. Also inspect the sealing O-rings where the sensor inserts into the air filter housing and intake boot. Ensure the pin connections are clean and tight.



➢ Connect a BMW-compatible scan tool or an OBD II generic scan tool. Check air mass signal (load signal) with the engine at idle. Raise idle speed and check that load signal changes with rpm.

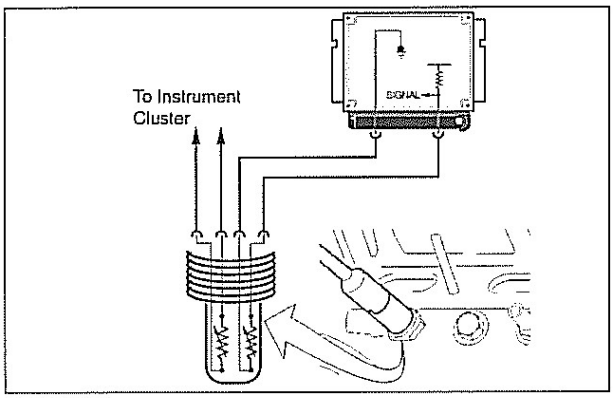
> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*



➢ Remove MAF sensor:
  - Loosen intake boot clamp (**A**).
  - Disconnect harness connector (**B**).
  - Release clip from air filter housing (**C**) and remove sensor.

– Installation is reverse of removal.
  - No adjustment to MAF sensor is possible.
  - Check intake hoses for cracks and vacuum leaks.

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Engine coolant temperature (ECT) sensor, testing and replacing

The ECT sensor is located below cylinder 6 intake port at the rear of the engine (**1**).

The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine temperature by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

NOTE—
The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

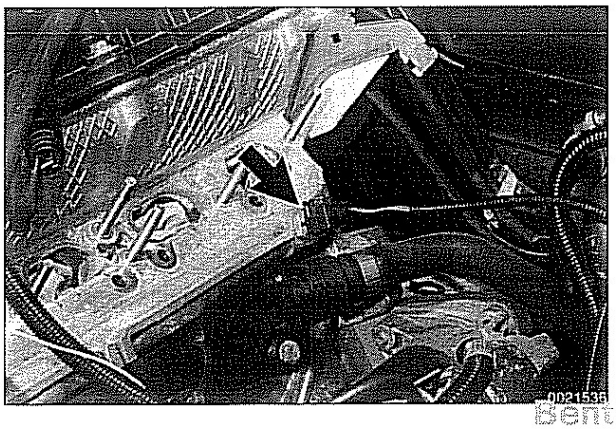
– Remove intake manifold to access ECT sensor on the M52 TU and the M54 engines. See **113 Cylinder Head Removal and Installation**.

– Check ECT sensor resistance using a multimeter at sensor terminals.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ

WARNING—
Due to risk of personal injury, be sure the engine is cold before removing ECT sensor connector.

CAUTION—
Be sure ignition is OFF before disconnecting or reconnecting DME system components.



Disconnect ECT sensor harness connector (**arrow**). Unscrew ECT sensor from cylinder head.

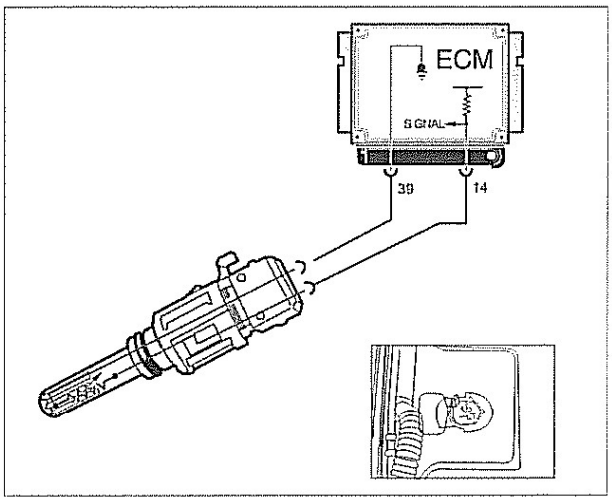
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– Installation is reverse of removal:
  - Use new copper sealing washers when installing sensor.
  - Replace any lost coolant.

Tightening torque

Temperature sensor to cylinder head	13 Nm (10 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing



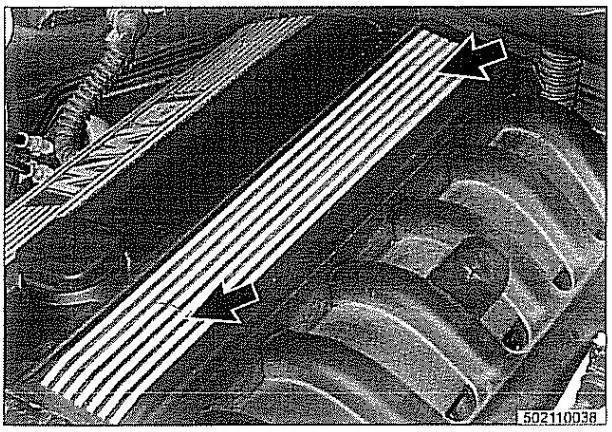
The intake air temperature (IAT) sensor, located at the top of the intake manifold, adapts (fine tunes) the fuel mixture and engine timing based on varying intake air temperatures.

If the intake air temperature signal is implausible, a fault code is set and the MIL is illuminated when OBD II fault criteria are exceeded. The ECM then operates the engine using the ECT sensor signal input as a back up.

NOTE —
The IAT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

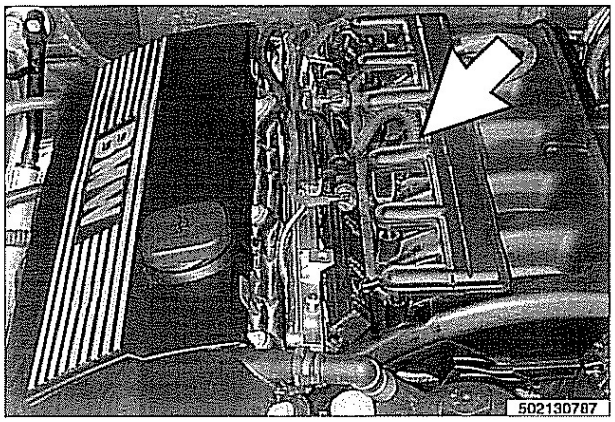
The IAT sensor can be tested using a multimeter:

IAT sensor resistance at 20° C (68°F)	2.2 - 2.7 kΩ



Remove engine cover by prying off plastic trim caps (**arrows**) and removing nuts below caps.

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➢ Remove electrical harness connector (**arrow**) from IAT sensor.

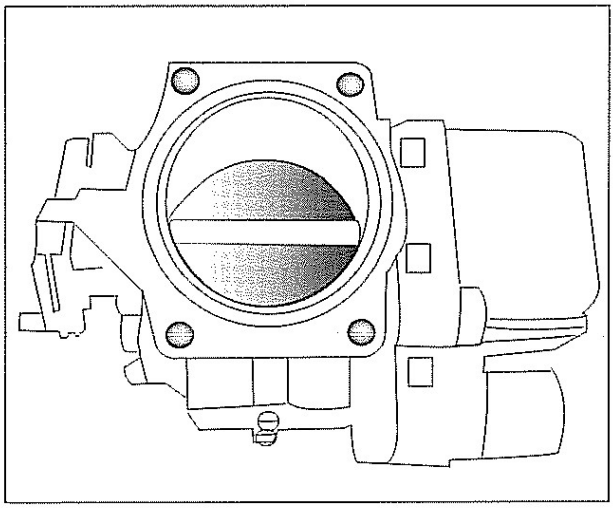
> ***CAUTION—***
> *Be sure the ignition switch is in the off position before replacing the intake temperature sensor.*

– Depress locking clip on side of temperature sensor and pull straight out of intake manifold.

– Installation is reverse of removal.

– Use a new sealing O-ring at base of sensor and lubricate with assembly lubricant for ease of installation.

MS 42.0 throttle valve assembly, replacing



➢ The motor driven throttle valve for the MS 42.0 system is referred to as MDK (motor driven throttle valve). The MDK unit is electronically operated to regulate intake air flow by the ECM.

The MS 42.0 system uses a throttle cable from the accelerator pedal to the MDK unit. The throttle cable is connected directly to the integral pedal position sensor (PWG) in the MDK unit. This sensor communicates pedal position to the ECM, which in turn electronically regulates throttle plate position. The MDK pulley is linked to the throttle shaft by springs to allow ASC intervention to override the driver's pedal position.

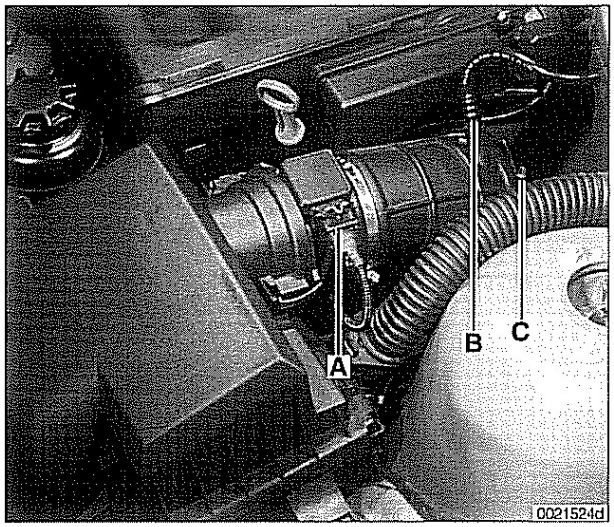
NOTE—
- *The MDK unit is non-adjustable and must be replaced as a complete unit if found to be faulty.*
- *If replacing the MDK unit, the adaptation values stored in the ECM must be cleared and the new unit initialized using BMW special service tools.*

> ***CAUTION—***
> *If the adaptation process is not completed correctly, the engine will not start.*

– Disconnect battery negative (-) cable in luggage compartment.

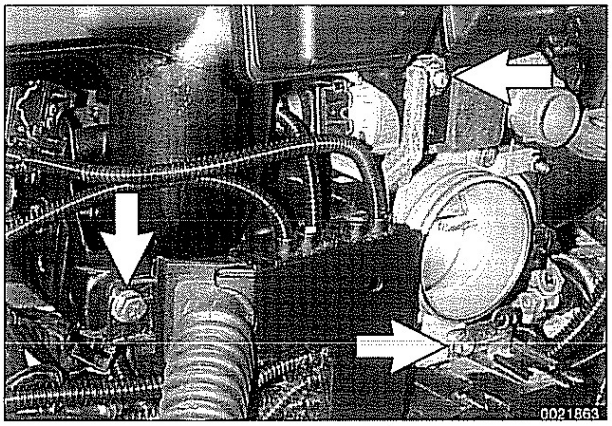
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions.**

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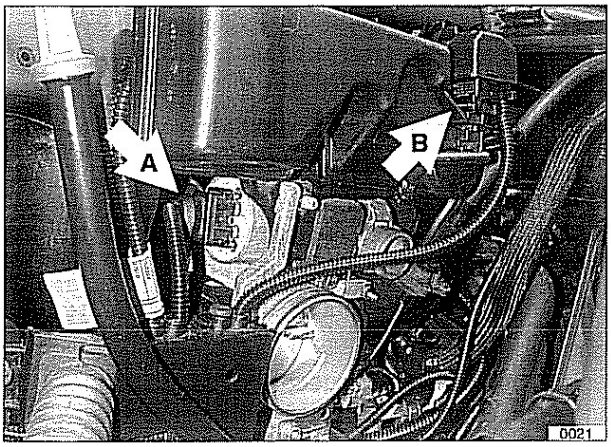
- Remove complete air filter housing:
  - Disconnect electrical harness connector on mass air flow sensor (**A**).
  - Disconnect vacuum line at intake boot (**B**).
  - Loosen intake air duct clamp (**C**).
  - Remove filter housing mounting screws.
  - Disconnect air duct and lift complete air filter housing and MAF sensor out of engine compartment, pulling it forward away from throttle housing.

– Pull throttle cable upwards out of rubber retainer and unhook ball end of cable from throttle actuator.



- Remove nuts and bolts (**arrows**) retaining wiring harness to throttle housing.

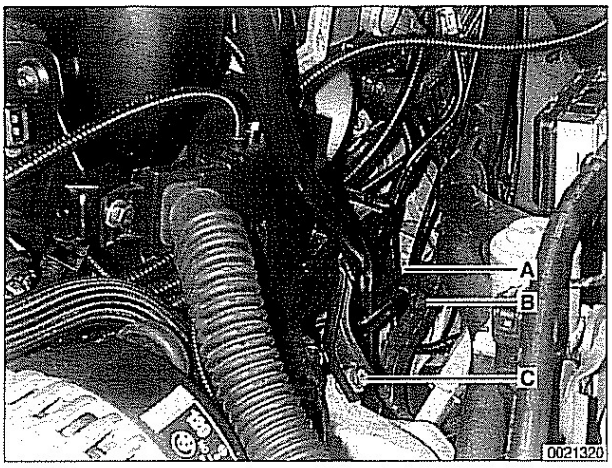
– Working at throttle housing, turn harness plug counterclockwise and remove plug.



- Working at side of intake manifold, disconnect electrical harness connectors:
  - Idle control valve (**A**)
  - Intake manifold resonance valve (**B**)

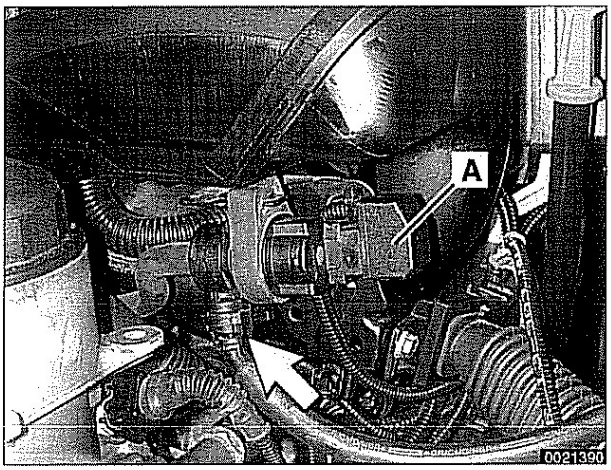
– Disconnect electrical harness connectors at oil pressure sender and oil temperature sender at base of oil filter housing.

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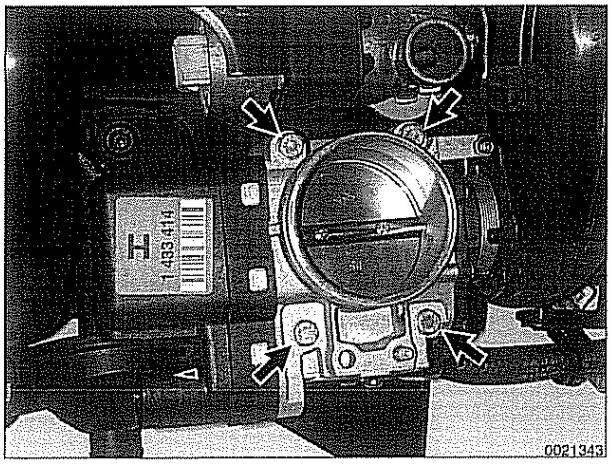


➢ Remove dipstick guide tube:

- Disconnect wiring harness brackets from tube (**A**).
- Unclip fuel lines from dipstick tube (**B**).
- Remove lower guide tube mounting bolt (**C**). Pull out dipstick guide tube.



➢ If necessary, disconnect electrical harness connector at fuel tank venting valve (**A**). Disconnect hose at quick disconnect fitting (**arrow**).



➢ Working at throttle housing, turn harness plug counterclockwise and disconnect. Remove throttle assembly mounting fasteners (**arrows**) and pull assembly off manifold.

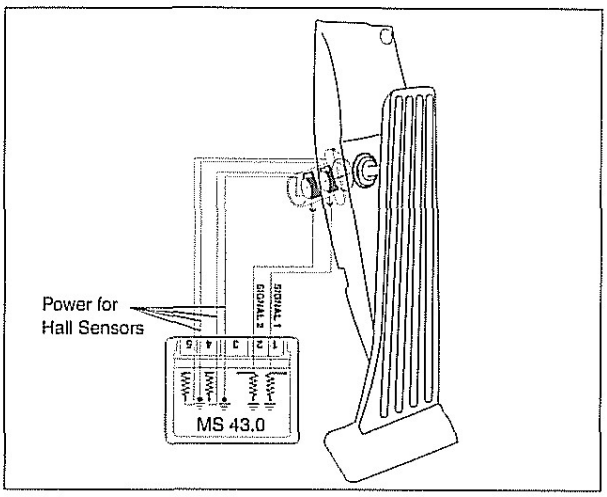
– Installation is reverse of removal.

- Replace sealing ring between throttle assembly and intake manifold.
- Reattach throttle assembly harness connector with care. Arrow on fully tightened connector must line up with corresponding arrow on throttle assembly housing.
- Connect BMW test equipment or equivalent and carry out throttle plate adaptation following the on-screen directions.
- Reattach throttle cable and check cable adjustment as described under **Throttle cable, adjusting (MS 42.0)**.

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MS 43.0 throttle valve assembly, replacing

The electronic throttle valve assembly for the MS43.0 system is referred to as EDK (electronic throttle valve). There is no mechanical (cable) link between the accelerator pedal and the throttle plate.



➢ The accelerator pedal module (PWG) at the pedal assembly communicates the pedal position directly to the ECM. The module provides two variable voltage signals (via two Hall sensors) to the ECM for pedal position and rate of movement.

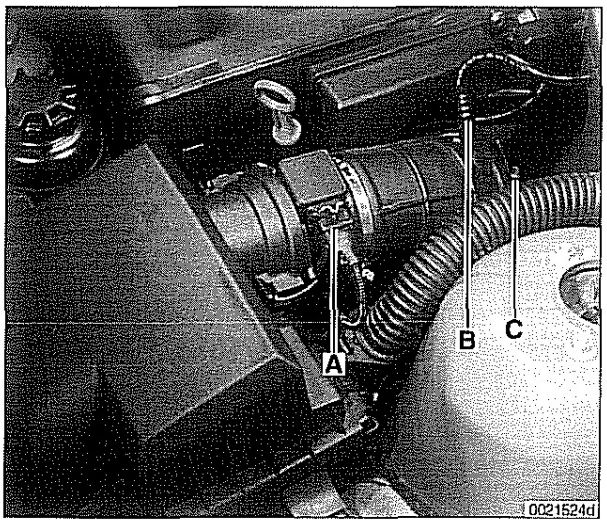
NOTE—

- *The EDK unit is non-adjustable and must be replaced as a complete unit if found to be faulty.*
- *If replacing the EDK unit, the adaptation values stored in the ECM must be cleared and the new unit initialized using BMW special service tools.*

CAUTION—
If the adaptation process is not completed correctly, the engine will not start.

– Disconnect battery negative (-) cable in luggage compartment.

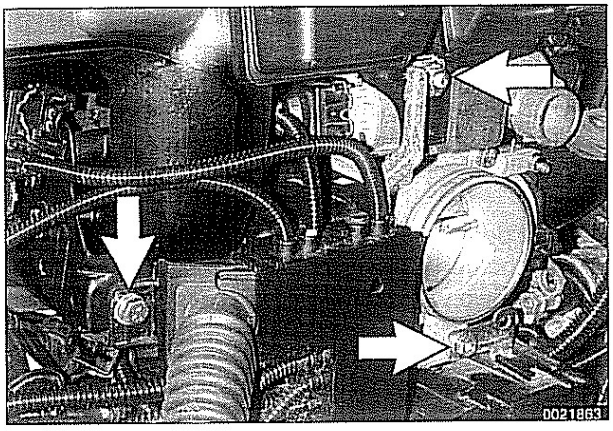
CAUTION—
Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions.**



➢ Remove complete air filter housing:

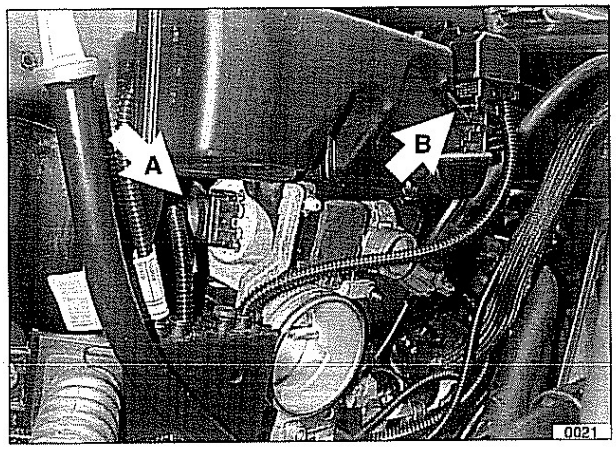
- Disconnect electrical harness connector on mass air flow sensor (**A**).
- Disconnect vacuum line at intake boot (**B**).
- Loosen intake air duct clamp (**C**).
- Remove filter housing mounting screws.
- Disconnect air duct and lift complete air filter housing and MAF sensor out of engine compartment, pulling it forward away from throttle housing.

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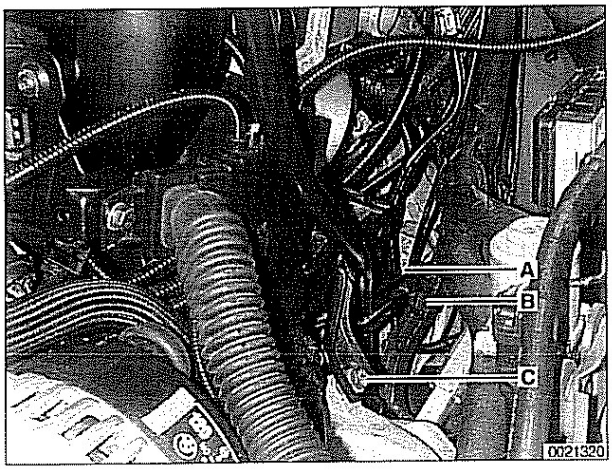
- Remove nuts and bolts (**arrows**) retaining wiring harness to throttle housing.

– Working at throttle housing, turn harness plug counterclockwise and remove.



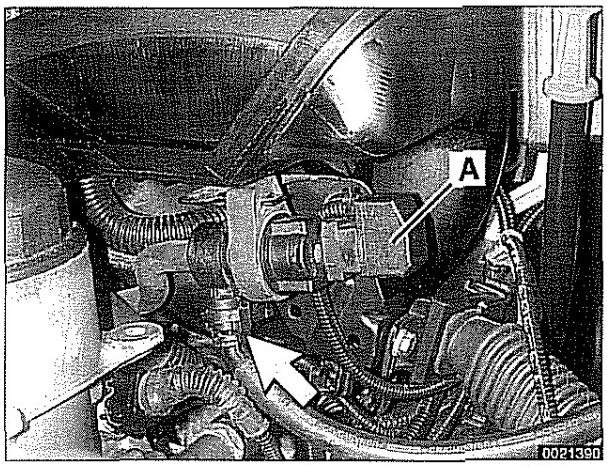
- Working at side of intake manifold, disconnect electrical harness connectors:
  - Idle control valve (**A**)
  - Intake manifold resonance valve (**B**)

– Disconnect electrical harness connectors at oil pressure sender and oil temperature sender at base of oil filter housing.

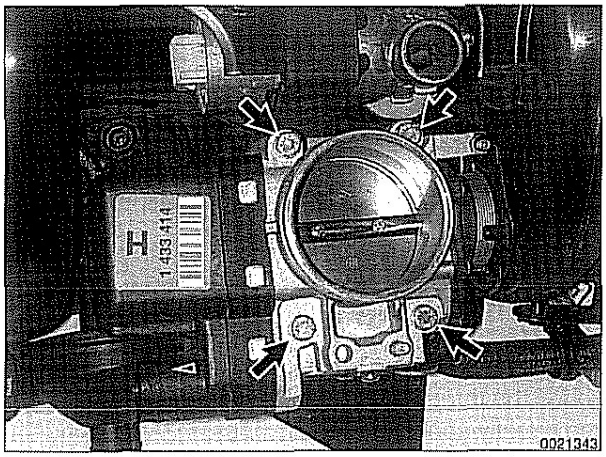


- Remove dipstick guide tube:
  - Disconnect wiring harness brackets from tube (**A**).
  - Unclip fuel lines from tube (**B**).
  - Remove lower guide tube mounting bolt (**C**).
  - Pull out dipstick guide tube.

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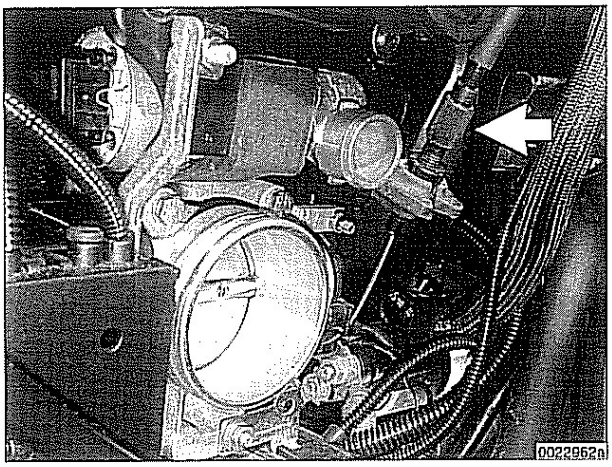
- If necessary, disconnect electrical harness connector at fuel tank venting valve (**A**). Disconnect hose at quick disconnect fitting (**arrow**).



- Working at throttle housing, turn harness plug counterclockwise and disconnect. Remove throttle assembly mounting fasteners (**arrows**) and pull assembly off manifold.

– Installation is reverse of removal.
  - Replace sealing ring between throttle assembly and intake manifold.
  - Reattach throttle assembly harness connector with care.
  - Arrow on fully tightened connector must line up with corresponding arrow on throttle assembly housing.
  - Use BMW scan tool to reset ECM adaptation values.

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Throttle cable, adjusting (MS 42.0)

The throttle assembly on MS 42.0 cars uses a throttle cable. The cable should be adjusted any time it is disconnected or replaced. This procedure requires the factory scan tool or an equivalent to read and adjust throttle angle. It is recommended the procedure be done by an authorized BMW dealer service department.

Basic adjustment:

- Ensure that at idle (accelerator pedal in rest position) throttle cable has detectable play at throttle lever attaching point. Play must not exceed maximum allowable.
- Adjust by turning knurled adjuster (**arrow**) on end of throttle cable sheath at throttle housing.

Max. play at throttle plate lever	3 mm (0.125 in)

NOTE —
Faulty throttle adjustment values must be reset using the BMW service tester DISplus, MoDiC, GT1 or equivalent.

Idle speed control valve, checking and replacing

The idle speed control valve regulates idle speed by redirecting air around the throttle valve. The idle speed control valve is mounted directly above the throttle housing. Accessing the valve is best accomplished by first removing the air filter housing and associated ducting.

The valve is supplied with battery voltage from the ECM relay. The idle speed control valve incorporates a two-coil rotary actuator. The ground sides of each coil are pulsed simultaneously by the ECM. The duty cycle of each circuit is varied to achieve the required idle speed.

A faulty idle speed control valve sets a fault code and the MIL is illuminated when OBD II fault criteria are exceeded.

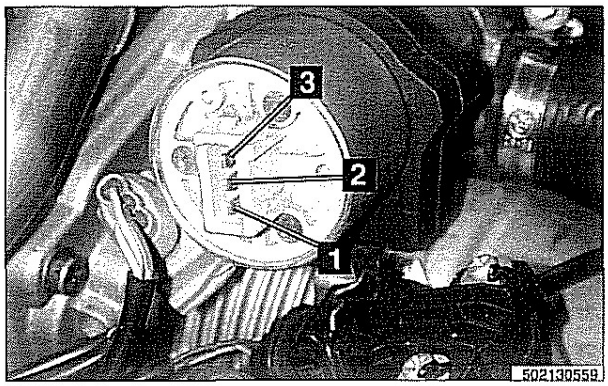
Before checking the idle speed control valve, confirm that the throttle position sensor is working correctly.

– With engine running, check that idle speed control valve is buzzing.

– Turn on A/C system or shift transmission into drive. Idle should remain steady or increase slightly.

– If idle speed valve is not buzzing, or if idle decreases when A/C is turned on, stop engine and disconnect harness connector from idle speed valve.

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➢ Check resistance of valve across valve terminals.

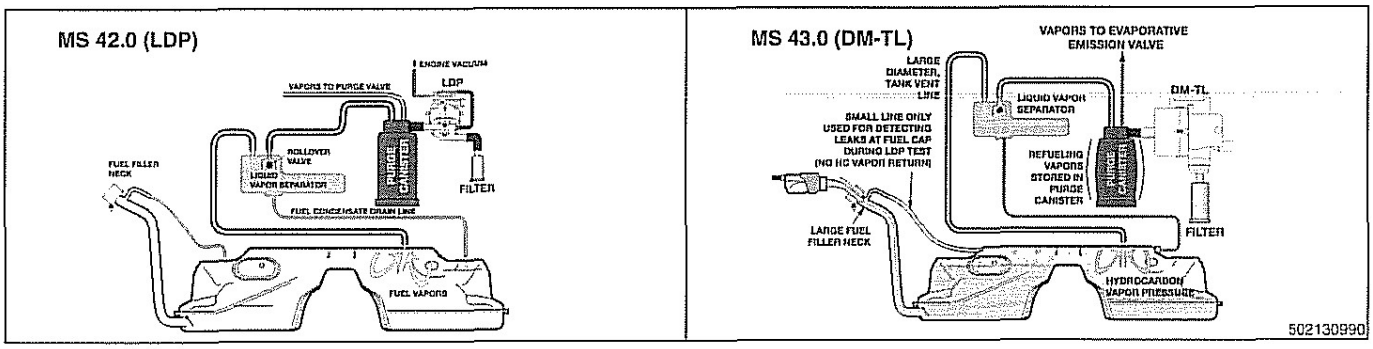
Idle speed control valve coil resistance	
Terminals 1 and 2	20 ±2Ω
Terminals 2 and 3	20 ±2Ω
Terminals 1 and 3	40 ±4Ω

CAUTION—
Be sure ignition is OFF before disconnecting or reconnecting DME system components.

– To remove valve, remove cable bracket mounting bolt and idle speed control valve mounting bracket bolts from front of throttle housing and remove idle speed control valve with attached bracket.

NOTE—
When installing idle speed control valve, remove intake boot sealing ring from valve and install into intake air boot. Then install valve into sealing ring.

Evaporative emissions control diagrams



Evaporative emissions control, (MS 42.0, MS 43.0)

E39 models with MS 42.0 or MS 43.0 engine are equipped with a fuel system evaporative pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP or DM-TL). The function of either system is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks.

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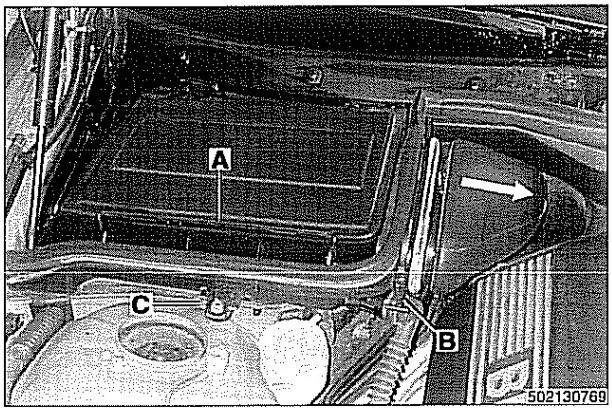
Engine control module (ECM), removing and installing

The ECM uses stored functions and processing programs to process the input signals from the sensors. These input signals are used to calculate the control (output) signals to the actuators (e.g., ignition coils, injectors).

NOTE—
Consult an authorized BMW dealer before replacing the ECM.

– Disconnect negative (-) battery cable. Wait approximately one minute.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions in* **001 General Warnings and Cautions.**



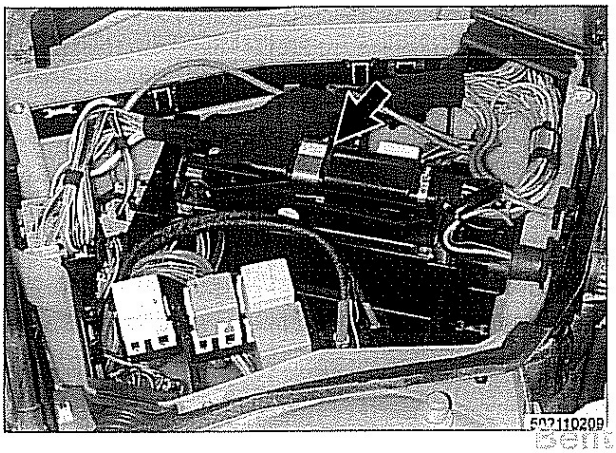
➢ Access engine control module (ECM):

- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate air duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.

– Remove electrical box (E-box) cover fasteners and remove cover.

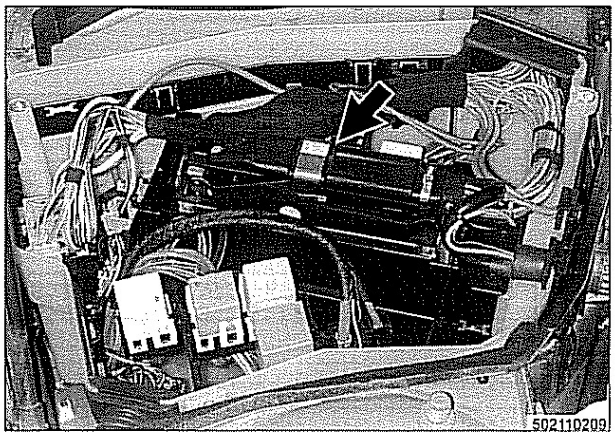
– If testing ECM or connected components, use breakout box to allow tests to be made with connector attached to ECM. This prevents damage to small terminals in connector.

– As an alternative, harness connector housing can be separated so that electrical checks can be made from back of connector.



➢ If replacing ECM, disconnect control module harness connector (**arrow**) by releasing fastener and pivoting connector up and off ECM.

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Working inside E-box, disconnect ECM harness connector (**arrow**) by releasing fastener and pivoting connector up and off ECM.

> ***CAUTION—***
> *Be sure ignition is OFF before disconnecting or reconnecting DME system components.*

- Remove ECM from retaining brackets and lift off holder.
- Installation is reverse of removal.
- Before attempting to start engine, use BMW service tester DISplus, MoDiC, GT1 or equivalent:
  - Code replacement ECM with application information (i.e. engine code, transmission type, etc.).
  - Align ECM to EWS (electronic immobilizer).

Siemens MS 42.0 and MS 43.0 ECM pin assignments

ECM pin assignments are given in **Table c**. For engine management system schematics, see **ELE Electrical Wiring Diagrams**.

> ***CAUTION—***
> - *Always wait at least one minute after turning off the ignition before removing the connector from the ECM. If the connector is removed before this time, residual power in the system relay may damage the ECM.*
> - *Always connect or disconnect the control module connector and meter probes with the ignition off.*

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made from the back of the connector.

Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments

Pin	Signal	Component/function	Notes
Connector X60001 9-pin black			
1	Output	Terminal 15	Unloader relay terminal 15
2		Not used	
3		Not used	
4	Ground	Ground	Ground point

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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
5	Ground	Ground	Ground connector
6	Ground	Ground	Ground connector
7	Input	Terminal 30	B+ terminal
8	Input	Voltage supply	Fuse carrier, engine electronics
9	Input	Voltage supply	Fuse carrier, engine electronics
Connector X60002 24-pin			
1	Input	Heater, precatalyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
2		Not used	
3	Input-output	CAN-Bus signal, low	Transmission control module
4	Input-output	Can-Bus signal, high	Transmission control module
5		Not used	
6	Input-output	Transmit diagnosis line (TXD) data link signal	Transmission control module
7	Input	Heater, post-catalyst oxygen sensor 1, ground	Heated oxygen sensor 1 behind cat. conv.
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12	Input	Signal, 3/2-way valve, running losses (MS 42.0)	3/2 way valve, running losses (MS 42.0)
13	Input	Heater, precatalyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
14	Input	Heater, precatalyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
15	Input	Heater, precatalyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
16	Input	Heater, post-catalyst oxygen sensor 1	Heated oxygen sensor 1 behind cat. conv.
17		Not used	
18	Input	Heater, post-catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.
19	Input	Heater, post-catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.
20	Ground	Ground, precatalyst oxygen sensor 1	Heated oxygen sensor 1 in front of cat. conv.
21	Ground	Ground, precatalyst oxygen sensor 2	Heated oxygen sensor 2 in front of cat. conv.
22	Ground	Ground, post catalyst oxygen sensor 1	Heated oxygen sensor 1 behind cat. conv.
23	Input	ECM (DME main) relay signal activation	ECM
24	Ground	Ground, post catalyst oxygen sensor 2	Heated oxygen sensor 2 behind cat. conv.
Connector X60003 52-pin			
1	Input	Signal, mass air flow sensor	Hot film mass air flow sensor
2	Input	Signal, exhaust camshaft sensor	Camshaft position sensor
3		Not used	
4	Output	Throttle valve supply (MS 42.0)	Throttle valve (MS 42)
5	Input	Signal, intake camshaft position sensor	Camshaft position sensor 1

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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
6		Not used	
7	Output	Throttle valve supply potentiometer 2	Throttle valve
8	Input	Signal, crankshaft position sensor	Crankshaft position sensor
9	Input	Signal, pedal position sensor 2 (MS 42.0)	Throttle valve (MS 42.0)
10	Input	Signal, throttle position sensor 1	Throttle valve
11		Not used	
12	Input	Feedback signal, engine start	Starter
13	Input	Signal, battery charge indicator lamp	Alternator (generator)
14	Ground	Ground, throttle position sensor (MS 42.0)	Throttle valve (MS 42.0)
15	Ground	Ground, exhaust camshaft sensor 1	Camshaft position sensor I
16	Input	Signal, pedal position sensor 1 (MS 42.0)	Throttle valve (MS 42.0)
17	Ground	Ground, mass air flow sensor	Hot film mass air flow sensor
18	Ground	Ground, intake camshaft sensor 1	Camshaft position sensor I
19	Input	Signal, throttle potentiometer 1	Throttle valve
20	Ground	Ground, throttle position sensor	Throttle valve
21	Ground	Ground, crankshaft position sensor	Crankshaft position sensor
22	Output	Signal, intake air temperature	Intake air temperature sensor
23	Ground	Ground, intake air temperature sensor	Intake air temperature sensor
24	Output	Signal, coolant temperature sensor	Coolant temperature sensor
25	Ground	Ground, coolant temperature sensor	Coolant temperature sensor
26	Input	Signal, oil pressure	Oil pressure switch
27	Output	Signal, engine oil temperature sensor	Oil temperature sensor
28	Ground	Ground, engine oil temperature sensor	Oil temperature sensor
29	Output	Signal, knock sensor	Knock sensor
30	Output	Signal, knock sensor	Knock sensor
31	Output	Signal, knock sensor	Knock sensor
32	Output	Signal, knock sensor	Knock sensor
33	Input	Signal, cylinder 1 fuel injector	Cylinder 1 fuel injector
34	Input	Signal, cylinder 2 fuel injector	Cylinder 2 fuel injector
35	Input	Signal, cylinder 3 fuel injector	Cylinder 3 fuel injector
36	Input	Signal, cylinder 4 fuel injector	Cylinder 4 fuel injector
37	Input	Signal, cylinder 5 fuel injector	Cylinder 5 fuel injector
38	Input	Signal, cylinder 6 fuel injector	Cylinder 6 fuel injector
39	Input	Signal, oil level sensor	Oil level sensor
40	Input	Signal, VANOS inlet valve	VANOS inlet valve
41	Input	Signal, VANOS outlet valve	VANOS outlet valve

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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
42	Input	Signal, evaporative emissions valve	Evaporative emissions valve
43	Input	Signal, throttle valve drive	Throttle valve
44	Input	Signal, throttle valve drive	Throttle valve
45	Input	Signal, engine coolant thermostat	Engine coolant thermostat (map controlled)
46	Input	Signal, close idle speed control valve	Idle speed control valve
47	Input	Signal, open idle speed control valve	Idle speed control valve
48	Ground	Signal, shield knock sensor	Shield, knock sensor
49	Input	Signal, resonance valve intake system	Resonance valve intake system
50		Not used	
51		Not used	
52	Input	Signal, secondary air injection pump valve	Secondary air injection valve

Connector X60004 40-pin

Pin	Signal	Component/function	Notes
1	Input	Signal, battery charge indicator lamp	Instrument cluster control unit
2	Input	Feedback signal, engine start	Instrument cluster control module
3	Input	Signal, secondary air injection pump	Secondary air injection pump relay
4	Input	Signal, electric cooling fan	Electric (auxiliary) fan motor
5		Not used	
6		Not used	
7		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
8		Signal, pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
9		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
10	Input	Signal, fuel pump relay 1	Fuel pump relay 1
11	Input	Signal, oil pressure switch	Instrument cluster control module
12		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
13		Signal, pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
14		Pedal position sensor (PWG) (MS 43.0)	Pedal position sensor (PWG) (MS 43.0)
15		Not used	
16		Not used	
17	Input	Speed signal (MS 42.0 up to 6/2000) (MS 42.0 from 6/2000 and all MS 43.0)	Data link connector OBD II 16 pin connector
18		Not used	
19		Not used	
20	Output	Diagnostic module tank leak (DM-TL) detection (MS 43.0)	Leak detection (DM-TL) (MS 43.0)
21	Input	Signal, oil level sensor	Instrument cluster control module
22	Input	Signal, processed wheel speed, right rear	ABS/ASC module, ABS/DSC module

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Table c. Siemens MS 42.0 and MS 43.0 ECM pin assignments (continued)

Pin	Signal	Component/function	Notes
23	Output	Signal, clutch pedal position switch	Clutch pedal position switch
24	Input	Signal, brake light switch	Light switching center control unit
25		Not used	
26	Input	Terminal 15	Fuse F29
27	Output	Voltage supply, multifunction steering wheel	Volute spring
28	Input	Signal, brake light switch	Brake light switch
29	Input	Signal, relay A/C compressor	A/C compressor relay
30		Signal, leakage diagnosis pump (MS 42.0) Signal, diagnostic module (MS 43.0)	Leakage diagnosis pump Leakage detection (MS 43.0)
31		Not used	
32	Input-output	Transmit diagnosis line (TXD) data link signal	Data link connector (MS 42.0) OBD II connector (MS 43.0)
33	Input	Electronic immobilization (EWS)	Electronic immobilizer (EWS) control module
34		Signal, leakage diagnosis pump (LDP) (MS 42.0)	Leakage diagnosis pump (LDP) (MS 42.0)
35		Not used	
36	Input-output	CAN-Bus signal, high	Connector, CAN bus
37	Input-output	CAN-Bus signal, low	Connector, CAN bus
38	Ground	Ground, coolant outlet temperature sensor	Temperature sensor
39	Output	Signal, coolant outlet temperature sensor	Temperature sensor
40		Not used	
Connector X60005 9-pin			
1	Input	Signal, ignition coil 3	Ignition coil 3
2	Input	Signal, ignition coil 2	Ignition coil 2
3	Input	Signal, ignition coil 1	Ignition coil 1
4		Not used	
5	Ground	Ground	Ground connector
6	Ground	Ground	Ground connector
7	Input	Signal, ignition coil 6	Ignition coil 6
8	Input	Signal, ignition coil 5	Ignition coil 5
9	Input	Signal, ignition coil 4	Ignition coil 4

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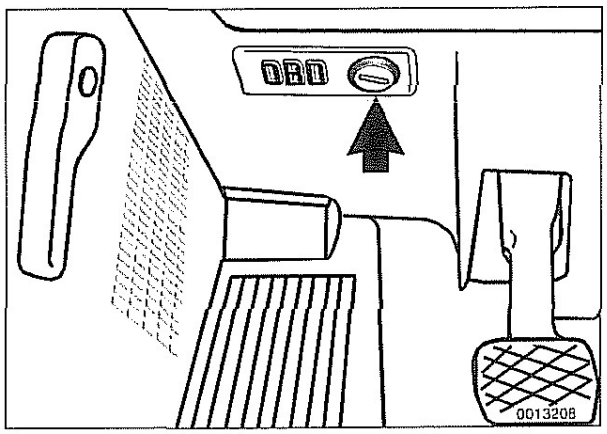
BOSCH M5.2 (M62 TO 9/1997) BOSCH M5.2.1 (M62 9/1997 TO 9/1998)

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

CAUTION—

- *The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See* **OBD On-Board Diagnostics.**
- *Only use a digital multimeter for electrical tests.*
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in* **ELE Electrical Wiring Diagrams.**



NOTE—

- *OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment.*
- *The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.*

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M5.2 system features

The Bosch M5.2 system used on 1997 540i models uses an 88-pin control unit. The M5.2 system has the following functions and capabilities:

- Fully sequential cylinder-individual fuel injection.
- Integrated adaptive knock control.
- Oxygen sensor fuel mixture control.
- Self-diagnosis and emergency operation characteristics.
- CAN-Bus link.
- OBD II functions (misfire detection, catalytic converter monitoring, oxygen sensor monitor, and fuel tank ventilation system).
- Electronic vehicle immobilization via EWS.
- One-touch starter function.
- Control of characteristic map thermostat.

M5.2.1 system features

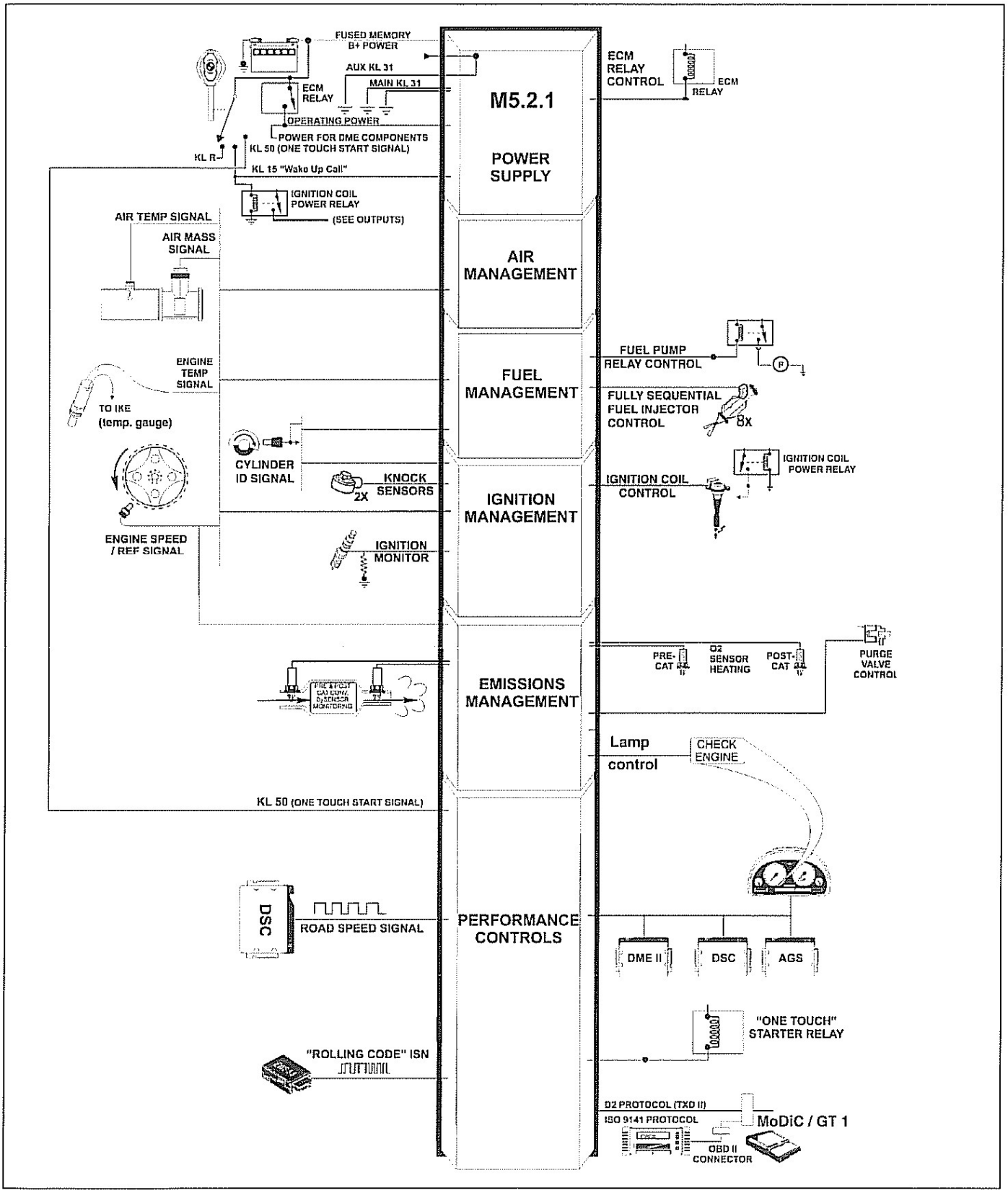
The Bosch M5.2.1 system is used on 1998 540i models. The M5.2.1 control module utilizes the SKE (standard shell construction housing) with 5 connectors and a combined total of 134 pins.

The M5.2.1 system has the following functions or capabilities:

- Separate power supply relay for ignition coils.
- Leak diagnosis pump (LDP) control and feedback monitoring for evaporative system leak testing.
- Fuel evaporative system providing ORVR (on-board refueling vapor recovery) compliancy.
- Battery/alternator charge logic (idle speed varied with the battery state of charge).
- CAN-Bus communications with the instrument cluster.
- EWS III "rolling code" ISN interface.
- More sensitive ignition knock sensors.
- Pulse width modulated (P-W-M) Heating and A/C (IHKA) status signal.
- Running loss (3/2-way) solenoid valve.

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Fuel Injection



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ECM relay, testing

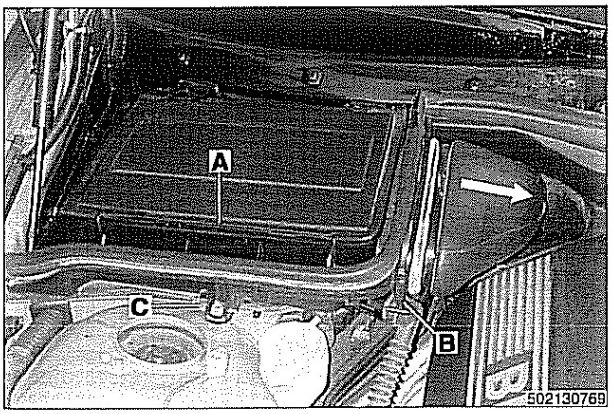
The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

> ***CAUTION—***
> *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in* **ELE Electrical Wiring Diagrams.**

NOTE—
The ECM relay is also referred to as the DME main relay.

ECM relay powers:

- ECM
- Ignition coils
- Fuel injection
- Evaporative leak detection pump (5.2.1 only)
- Idle air actuator
- Camshaft sensors
- Evaporative emissions valve
- Hot film mass air flow sensor
- Fuel pump relay
- Oxygen sensor heaters

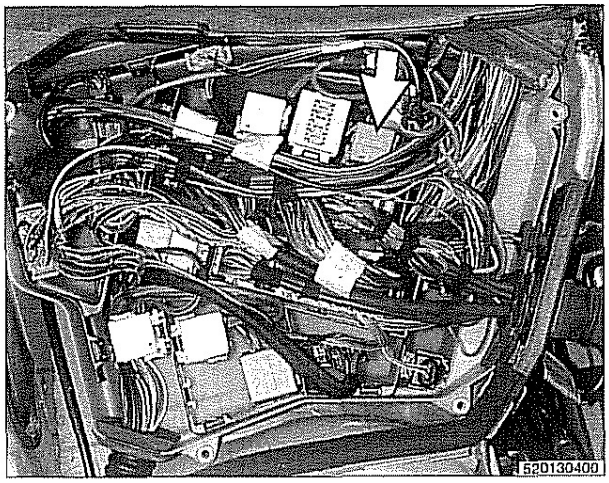


➢ Working in right rear of engine compartment:

- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.

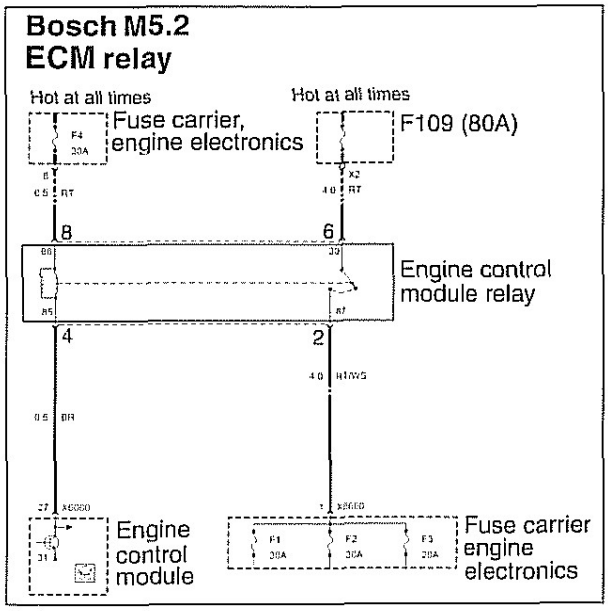
– Remove electrical box (E-box) cover fasteners and remove cover.

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With ignition off, remove ECM relay (**arrow**) in electronics box (E-box) at right rear of engine compartment.

NOTE—
Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.

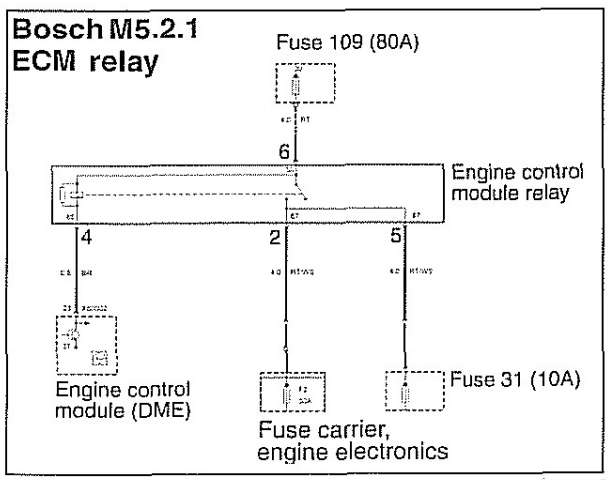


Check for voltage at terminal **6** of main relay socket (**30**-red wire). On M5.2 cars also check for battery voltage at terminal **8**.

- If battery voltage is present, continue testing.
- If battery voltage is not present, check large red wire(s) in relay socket. See **ELE Electrical Wiring Diagrams**.

– Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal **4** (**85**-brown wire).

- If ground is present, continue testing.
- If ground is not present, signal from ECM is missing. Check wire between ECM and relay.



With ignition on and relay installed, check for battery voltage at terminal **2** (**87**-red/white wire). On M5.2.1 cars also check for battery voltage at terminal **5**.

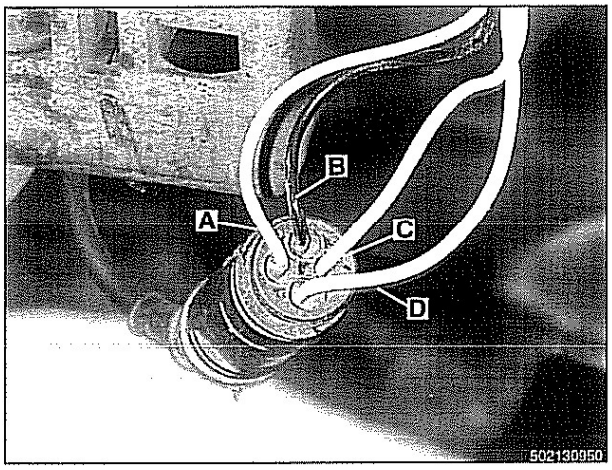
- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

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Oxygen sensors, checking

The oxygen sensor provides an input voltage signal [0.2 vdc (lean) to 0.8 vdc (rich)] to the ECM based on the oxygen content in the exhaust gas. To generate voltage, the sensor temperature must exceed 575° F (300° C). Therefore the sensor is electrically heated.

NOTE —
- *The test given below is not a conclusive test of oxygen sensor efficiency and does not test how the oxygen sensor reacts to changing conditions. Pin numbers and wire colors can vary. Always check the wiring diagrams to confirm wire color and pin assignment.*
- *The oxygen sensor connector plugs are located next to the catalytic converters.*



➢ With connector attached to sensor, connect digital voltmeter between **A** and **B** wires in connector.

> ***WARNING —***
> *Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.*

NOTE —
Connector style may vary depending on system application. Consult wiring diagram for system-specific wiring. See **ELE Electrical Wiring Diagrams**.

– Start engine. A fluctuating voltage signal should show on the meter. If voltage is incorrect, turn engine off and check preheater circuit as described below.

Oxygen sensor voltage at idle	0.2 to 0.8 vdc fluctuating

NOTE —
To check sensor response to lean and rich mixtures, create an air leak.

– Connect digital voltmeter between sensor heater wires (white wires, **C** and **D**). Start engine and check for battery voltage. If voltage is not present, check oxygen sensor heater fuses.

NOTE —
The oxygen sensor heater is powered via fused positive (+) battery voltage and a switched ground from the ECM. See **ELE Electrical Wiring Diagrams** *for specific circuit information.*

– The ground side of the oxygen sensor heater circuit is pulsed on and off by the DME control module.

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NOTE—
With engine off, disconnect harness connector and check heating element resistance between white wires on the sensor side of harness. If the element is electrically open (no continuity), replace sensor.

– If oxygen sensor does not produce a fluctuating voltage and preheater circuit is OK, replace sensor.

NOTE—
If not already applied, coat oxygen sensor threads with anti-seize compound before installation. Do not get the compound on the sensor tip.

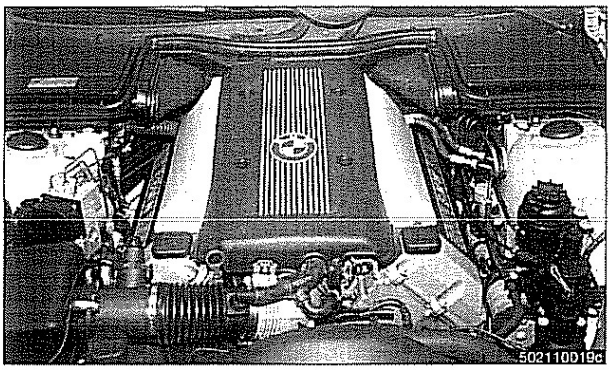
Tightening torque

Oxygen sensor to exhaust system	55 Nm (41 ft-lb)

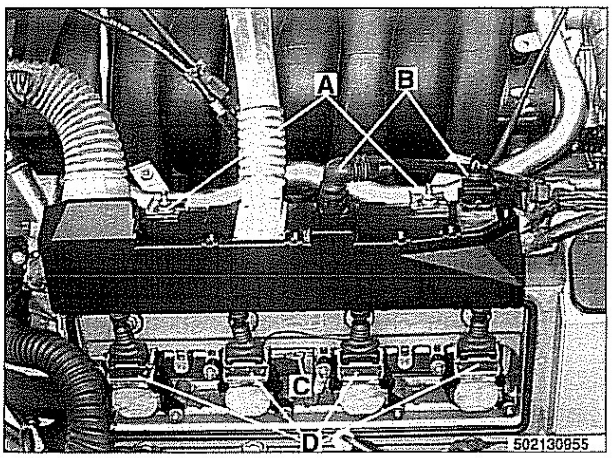
Fuel injectors, checking and replacing

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common power source. A ground signal from the ECM is used to open and close the injectors.

CAUTION—
Use only a digital multimeter or an LED injector tester when testing injectors or wiring. Use of an analog VOM or incandescent test light may damage the engine control module.



➢ Remove fuel rail cover. See **110 Engine Removal and installation**.

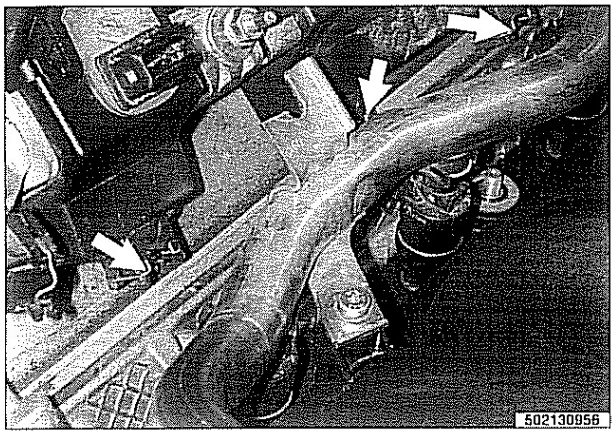


– With the engine running, place the point of a long screwdriver on each injector and check for a clicking vibration. If no vibration is found do the voltage check shown below.

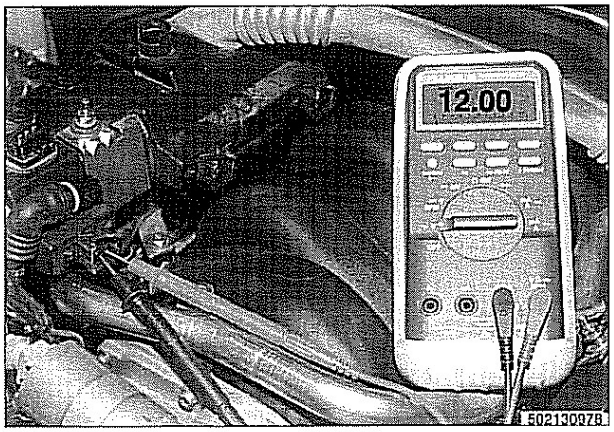
➢ Injector electrical loom removal:

- Loosen mounting nuts **A**.
- Remove ground wire **C**.
- Disconnect ignition coil harness **D**.

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➢ Release spring clips (**arrows**) from fuel injectors and pull injector electrical loom straight up to remove.



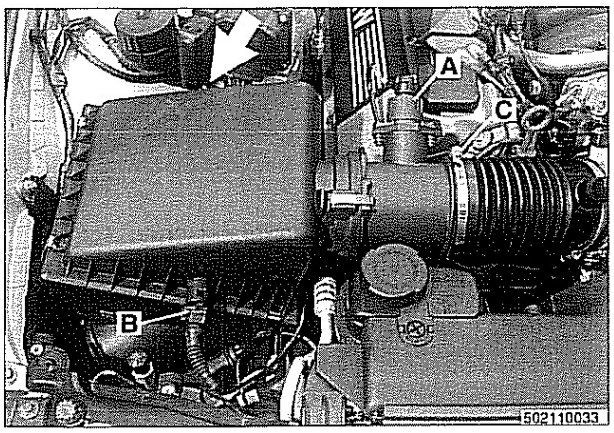
➢ Check that ECM signal is present at injector connectors.
- Connect digital voltmeter to fuel injector harness plug.
- Operate starter and check for voltage pulse.
- Repeat for each injector.

– Remove fuel injectors by removing retaining clips.

– Installation is reverse of removal:
- Fit new O-rings when installing injectors. For ease of installation, lightly lubricate all fuel system O-rings with assembly lubricant.
- Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.

Mass air flow sensor (MAF), replacing

The MAF sensor is provided with operating power from the ECM relay. Based on calculated intake air mass, the MAF generates a varying voltage (approx. 0.5 - 4.5 vdc) as an input signal to the ECM.



➢ Remove MAF sensor:
- Remove upper air filter housing locking clips.
- Unscrew and remove MAF sensor harness (**A**).
- Disconnect intake air temperature sensor harness (**B**).
- Loosen hose clamp (**C**).
- Remove upper filter housing with sensor.

– Installation is reverse of removal.

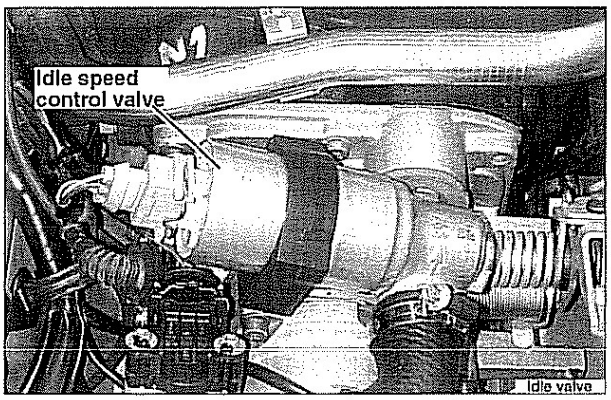
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Idle speed control valve, testing and replacing

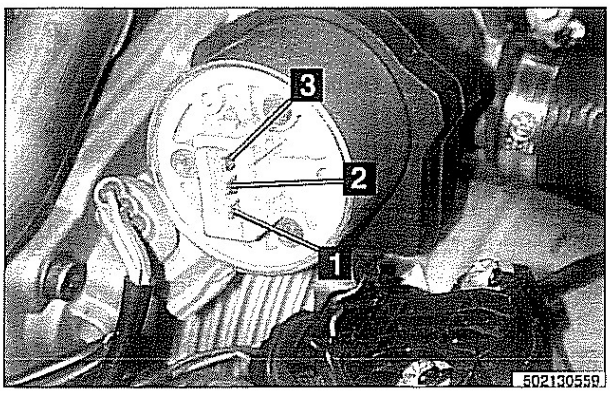
Idle speed is maintained by the ECM through the idle speed control valve. The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no adjustments can be made.

Before checking valve, confirm that throttle position sensor is working correctly.

NOTE—
The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.



- With engine running, check that idle speed control valve is buzzing.
- Turn on A/C or shift car into drive. Idle should remain steady or increase slightly.
- If valve is not buzzing, or if idle decreases in step above, stop engine and disconnect harness connector from valve.



- Check resistance of valve across its terminals. Test values are listed below.

Idle speed control valve coil resistance

Terminals **1** and **2**	20 ±2Ω
Terminals **2** and **3**	20 ±2Ω
Terminals **1** and **3**	40 ±4Ω

NOTE—
If you suspect an intermittent fault, lightly tap the valve while testing resistance.

With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition on. If there is no voltage, check wiring between connector and ECM relay. See **ELE Electrical Wiring Diagrams**.

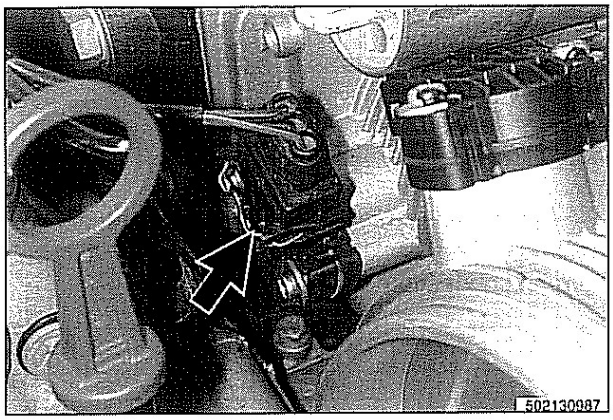
NOTE—
The idle speed control valve receives positive (+) battery voltage from the ECM (DME main) relay.

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– If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM signal to valve.

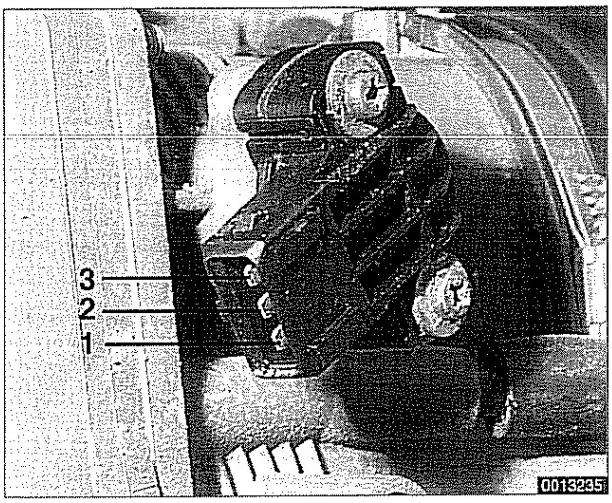
– When replacing idle speed control valve, clean and inspect all sealing areas.
  • Inspect sealing ring in throttle body and replace if necessary.

Throttle position sensor (TPS), testing and replacing



The throttle position sensor (**arrow**) is mounted on the side of the primary throttle housing and is directly connected to the throttle valve shaft. The ECM sends a voltage signal to the potentiometer-type sensor and monitors the voltage that comes back. Resistance decreases (voltage increases) as the throttle opens.

NOTE—
Do not confuse the TPS on the primary throttle housing with the throttle switch on the ASC secondary throttle housing.



Check throttle position sensor function by disconnecting harness connector and checking across terminals. If any faults are found, replace throttle position sensor.

Throttle position sensor (M62 engine)

Test conditions	Test Terminal	Test value
Harness connector disconnected, ignition on	Term. 1 at harness connector and ground	5 vdc (approx.)
Harness connector disconnected, ignition on	Term. 1 and term. 3 at sensor	4.0 kΩ (approx.)
Throttle plate rotated from idle to full throttle position	Term. 1 and term. 2 at sensor	Continuously variable from 1.0 to 4.0 kΩ without interruption

Engine coolant temperature (ECT) sensor, testing and replacing

The ECT sensor is located on the front of the engine in the coolant/thermostat flange.The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

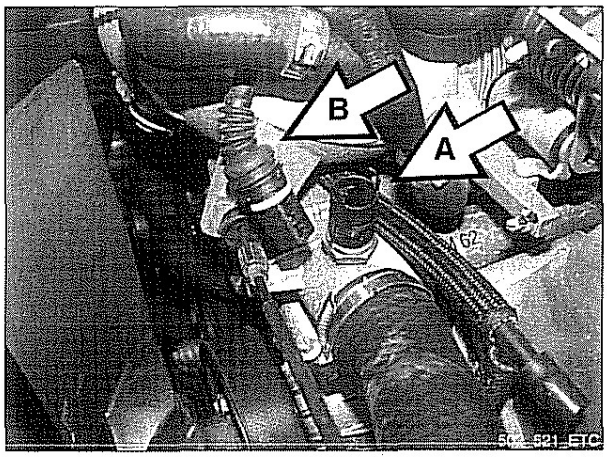
The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor

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varies as the coolant temperature (sensor resistance) changes.

NOTE—
The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.

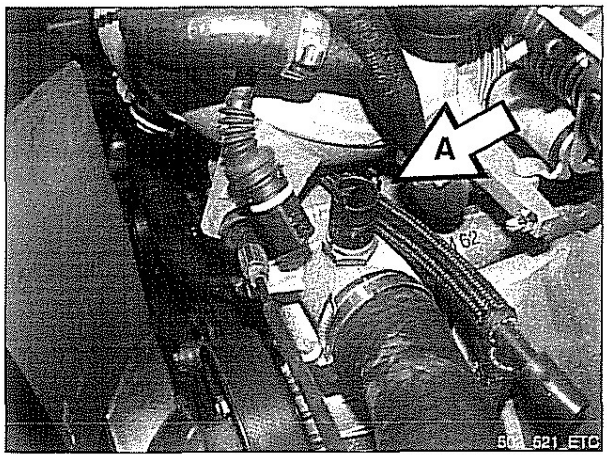


➢ Disconnect ECT sensor harness (**A**).

– Check ECT sensor resistance using a multimeter at sensor terminals 3 and 4. Peel back protective boot (**B**) to ID terminal numbers on connector housing.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ

WARNING—
Due to risk of personal injury, be sure the engine is cold before disconnecting ECT harness connector.



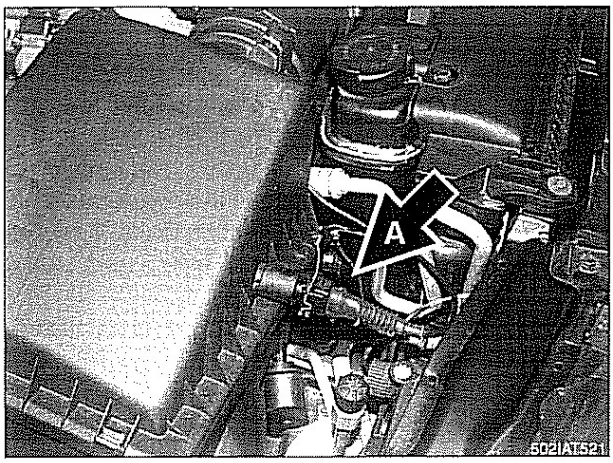
➢ Sensor replacement: Disconnect ECT sensor harness (**A**).

– Unscrew ECT sensor from cylinder head and install new sensor.
  - Use new copper sealing washers when installing sensor.
  - Replace any lost coolant.

Tightening torque

ECT sensor to coolant flange	13 Nm (10 ft-lb)

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Intake air temperature (IAT) sensor, testing and replacing

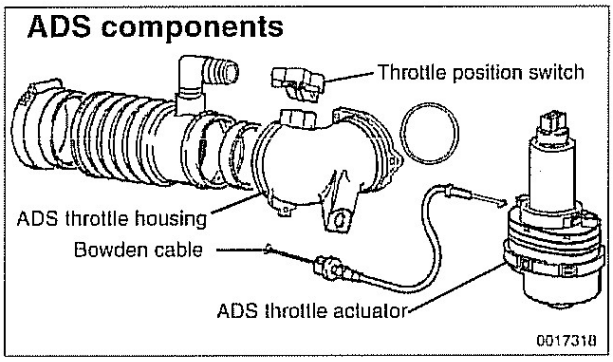
Disconnect harness connector from intake air temperature sensor (**A**) at air filter housing.

– Turn ignition on. Using a digital voltmeter, check for 5 volts between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

– With harness connector disconnected, test resistance across sensor terminals. If any faults are found, replace IAT sensor.

IAT test resistance

@ 10° ±1°C (50° ±2°F)	7-11.6 kΩ
@20° ±1°C (68° ±2°F)	2.1–2.9 kΩ
@80° ±1°C (176° ±2°F)	0.27–0.40 kΩ



Auxiliary throttle valve (ADS) (M62 and M62 TU engine), replacing

540i models with ASC and DSC are fitted with a motor-driven auxiliary throttle valve and housing ahead of the standard throttle housing. The ADS throttle valve controls engine throttle intervention based on signals from the DME control module if road conditions, such as slipping driven wheel, warrant reduced engine power.

NOTE—
Before replacing the ADS throttle housing, read DME fault codes.

– ADS throttle housing replacement:

- Switch off ignition and disconnect electrical connector on ADS throttle body.
- Remove hose from idle control valve.
- Loosen hose clamps and remove throttle housing air intake boot.
- Disconnect cable from ADS throttle body.
- Unscrew 3 bolts and remove ADS throttle body.
- Installation is reverse of removal.
- Adjust cable so that no free play is present.

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Evaporative fuel system pressure leak diagnosis, overview (M5.2.1 only)

1998 540i models are equipped with an evaporative fuel system pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP). The function of the LDP is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks. This system is capable of detecting a leak as small as 0.5 mm.

The LDP, located in the left rear wheel housing, is a unitized component that contains the following:

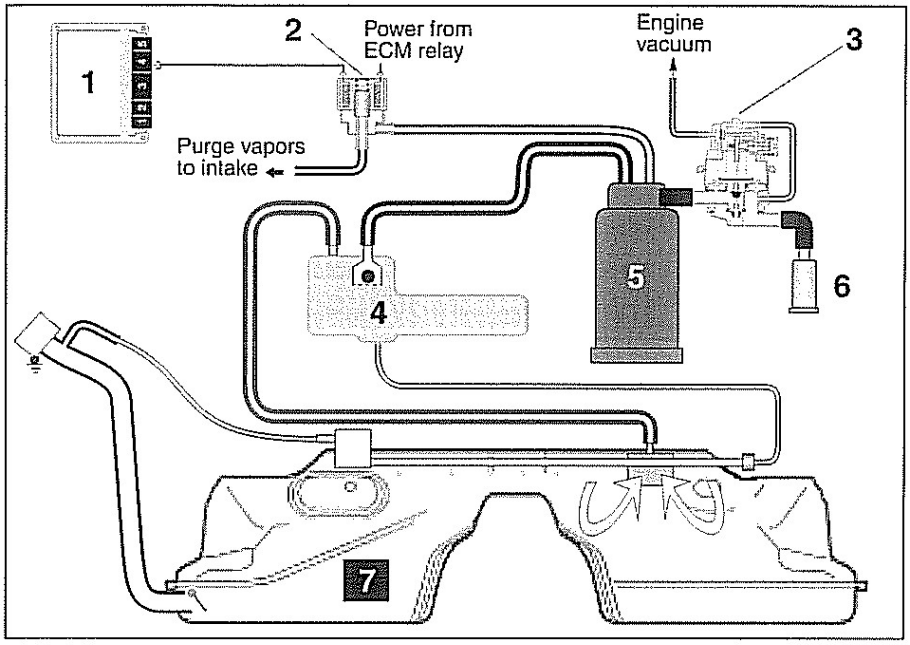
- Vacuum chamber.
- Pneumatic pump chamber.
- DME activated vacuum solenoid.
- Reed switch (provides switched voltage feedback signal to ECM).

The vacuum supply line is in the wiring harness from the engine compartment and runs down the driver's side of the vehicle.

The canister vent valve is integrated into the LDP, which is electrically controlled by the ECM. The canister vent valve is opened to provide fresh air entry into the fuel system only during purge operation.

– Purge operation characteristics:
  - Off idle through full throttle: purge valve opened by pulse width modulated (PWM) control of the ECM. PWM duty cycle varies by engine operating conditions (e.g. warm idle, purge valve opened slightly; cold idle/decel with engine temp < 67° C, purge valve always closed).

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Evaporative emissions control diagram (M5.2.1)

1. ECM
2. Purge valve
3. Leak detection pump (LDP)
4. Liquid vapor separator
5. Purge canister
6. Filter
7. Fuel tank

Bosch M5.2 ECM pin assignments (M62 up to 9/1997)

Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
1	output	Oxygen sensor heater signal	DME heated oxygen sensor 1 splice
2	output	Idle speed control - closing winding	Idle speed control valve (cycled ground)
3	output	Cyl. 1 fuel injection valve	Cyl. 1 fuel injection valve (cycled ground)
4	output	Cyl. 4 fuel injection valve	Cyl. 4 fuel injection valve (cycled ground)
5	output	Cyl. 5 fuel injection valve	Cyl. 5 fuel injection valve (cycled ground)
6	ground	Fuel injection valve ground	Ground
7	output	Cyl. 6 fuel injection valve	Cyl. 6 fuel injection valve (cycled ground)
8	output	Malfunction indicator light (MIL) (USA only)	Illuminated for exhaust gas related diagnostic trouble code
9	input	Start signal	Starter relay
10	input	Electronic immobilizer (EWS)	Electronic immobilizer (EWS) control unit
11	output	A/C compressor signal	Heating and A/C control module
12	input	Terminal 50 signal	Ignition switch
13	input	Knock sensor signal	Knock sensor
14		Not used	
15		Not used	
16	output	Intake air temperature	Intake air temperature sensor (voltage value)
17	ground	Hot film mass air flow (MAF) sensor ground	Hot film mass air flow (MAF) sensor ground
18	input	Heated oxygen sensor signal	Heated oxygen sensor II in front of catalytic converter (0.1-1.0 V with engine running at operating temperature)
19	input	Heated oxygen sensor signal	Heated oxygen sensor I in front of catalytic converter (0.1-1.0 V with engine running at operating temperature)

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Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
20	output	Crankshaft position sensor (speed and position)	Crankshaft position/rpm sensor
21	output	Camshaft position sensor (cylinder reference)	Hall effect camshaft position sensor
22	output	Cyl. 6 ignition signal (primary signal)	Cyl. 6 ignition coil (RZV adapter)
23	output	Cyl. 3 ignition signal (primary signal)	Cyl. 3 ignition coil (RZV adapter)
24	output	Cyl. 7 ignition signal (primary signal)	Cyl. 7 ignition coil (RZV adapter)
25	output	Cyl. 2 ignition signal (primary signal)	Cyl. 2 ignition coil (RZV adapter)
26	input	Terminal 30	Fuse carrier, engine electronics
27	output	Engine control module relay	Engine control module relay
28	ground	Ground for electronics and sensor shield	Ground splice
29	output	Idle speed control - opening winding	Idle speed control valve (cycled ground)
30	output	Oxygen sensor heater signal	Heated oxygen sensor I in front of catalytic converter, Heated oxygen sensor II in front of catalytic converter
31	output	Cyl. 5 fuel injection valve	Cyl. 5 fuel injection valve (cycled ground)
32	output	Cyl. 8 fuel injection valve	Cyl. 8 fuel injection valve (cycled ground)
33	output	Cyl. 3 fuel injection valve	Cyl. 3 fuel injection valve (cycled ground)
34	ground	Remaining output stages ground (not ignition and fuel injection valves)	Ground point
35	output	Cyl. 2 fuel injection valve	Cyl. 2 fuel injection valve (cycled ground)
36	output	A/C compressor relay signal	Heating and A/C control module (ground - compressor OFF)
37		Not used	
38		Not used	
39		Not used	
40	input	Knock sensor signal	Knock sensor
41	input	Knock sensor signal	Knock sensor
42	input	Fuel reserve signal	Instrument cluster
43		Not used	
44	input	Throttle position sensor signal (0.4-4.2 V)	Throttle position sensor
45	output	Hot film mass air flow sensor signal (0-5 V)	Hot film mass air flow sensor
46	ground	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Oxygen sensors
47		Not used	
48		Not used	
49	output	Cyl. 1 ignition signal (primary signal)	Cyl. 1 ignition coil (RZV adapter)
50	output	Cyl. 5 ignition signal (primary signal)	Cyl. 5 ignition coil (RZV adapter)
51	output	Cyl. 4 ignition signal (primary signal)	Cyl. 4ignition coil (RZV adapter)
52	output	Cyl. 8 ignition signal (primary signal)	Cyl. 8 ignition coil (RZV adapter)
53	output	Throttle position sensor (+ 5 V voltage supply)	Throttle position sensor
54	input	Terminal 87 (> 10 V)	Fuse F1
55	ground	Ignition ground	Ground point
56	input	Terminal 15 (> 10 V)	Ignition switch

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Table d. Bosch M5.2 ECM pin assignments

Pin	Type	Component/function	Note
57		Not used	
58		Not used	
59	input	Heated thermostat (characteristic map, cooling)	Characteristic map, cooling
60	input	Programming voltage input (voltage value)	Data link connector
61	input	Signal input Evaporative emission valve	Evaporative emission valve
62		Not used	
63	input	Fuel pump relay (ground)	Fuel pump relay
64		Not used	
65		Not used	
66		Not used	
67		Not used	
68		Not used	
69	input	A/C system standby signal (> 10 V)	Heating and A/C control module
70	input	Knock sensor signal	Knock sensor
71	ground	Control module ground	Ground splice
72		Not used	
73		Not used	
74	input	Coolant temperature	Dual temperature switch
75		Not used	
76	input	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Heated oxygen sensor II behind catalytic converter
77	input	Heated oxygen sensor signal (voltage 0.1-1.0 V)	Heated oxygen sensor I behind catalytic converter
78	input	Crankshaft position sensor signal (speed and position, AC voltage)	Crankshaft position/rpm sensor
79	input	Right rear wheel speed signal	ABS/ASC control module
80	output	TD signal (engine speed)	TD signal splice
81		Not used	
82		Not used	
83	output	Injection signal	Integrated instrument cluster control module (IKE)
84		Not used	
85	input-output	CAN-Bus low	Transmission control module (AGS)
86	input-output	CAN-Bus high	Transmission control module (AGS)
87		Not used	
88	input-output	Data link TxD	Data link connector

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Bosch M5.2.1 ECM pin assignments (M62 from 9/1997 to 9/1998)

Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
Connector X60001			
1		Not used	
2		Not used	
3		Not used	
4	Ground	Ground	Ground point right-hand drive Ground connector X6460
5		Not used	
6	Ground	Ground	Ground point right-hand drive Ground connector X6460
7	Input	Terminal 30 voltage supply	Fuse F4
8	Input	Terminal 87	Fuse F1
9		Not used	
Connector X60002			
1	Output	Oxygen sensor heater signal	Heater oxygen sensor II behind catalytic converter
2	Input	Not used	Back up light switch
3	Input Output	CAN-Bus low	Transmission control module (AGS)
4	Input Output	CAN-Bus high	Transmission control module (AGS)
5	Ground	Ground	Ground connector X6480
6		Not used	
7	Output	Oxygen sensor heater signal	Heater oxygen sensor I behind catalytic converter
8	Ground	Oxygen sensor heater ground	Heater oxygen sensor II behind catalytic converter
9	Ground	Oxygen sensor heater ground	Heater oxygen sensor 1 in front of catalytic converter
10	Ground	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
11	Ground	Oxygen sensor heater ground	Heater oxygen sensor I behind catalytic converter
12		Not used	
13	Output	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
14	Input	Oxygen sensor heater ground	Heater oxygen sensor II behind catalytic converter
15	Input	Oxygen sensor heater ground	Heater oxygen sensor 1 in front of catalytic converter
16	Input	Oxygen sensor heater ground	Heater oxygen sensor II in front of catalytic converter
17	Input	Oxygen sensor heater ground	Heater oxygen sensor I behind catalytic converter
18	Output	Signal, running losses	Fuel changeover (3/2 way valve) circuit
19	Output	Oxygen sensor heater ground	Heater oxygen sensor 1 in front of catalytic converter
20		Not used	
21		Not used	
22		Not used	
23	Output	Terminal 85 control	Engine control module relay
24		Not used	

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Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
Connector X60003			
1	Output	Injection signal	
2	Output	Injection signal	
3	Output	Signal, evaporative emission valve	Evaporative emission valve
4		Not used	
5		Not used	
6	Ground	Ground for electronic components	Ground point right-hand drive Ground connector X6460
7		Not used	
8		Not used	
9	Ground	Hot film mass air flow sensor ground	Hot film mass air flow sensor
10	Output	Throttle position sensor voltage supply	Throttle position sensor
11	Output	Signal, secondary air injection pump valve	Secondary air injection pump valve
12	Input	Terminal 30 voltage supply	Starter
13	Input	Alternator D+ (terminal 61) signal	Alternator (generator)
14		Injection signal	Cylinder 7 fuel injection valve
15		Injection signal	Cylinder 6 fuel injection valve
16		Not used	
17		Not used	
18		Not used	
19		Not used	
20	Input	Camshaft position sensor signal	Camshaft position sensor (Hall effect)
21	Ground	Ground	Dual temperature switch
22	Input	Signal, engine coolant temperature sensor	Dual temperature switch
23	Input	Hot film mass air flow sensor signal	Hot film mass air flow sensor
24	Input	Throttle position sensor slider voltage	Throttle position sensor
25	Ground	Shield, throttle potentiometer (DK)	Throttle position sensor
26		Not used	
27	Output	Injection signal	Cylinder 8 fuel injection valve
28	Output	Injection signal	Cylinder 5 fuel injection valve
29		Not used	
30		Not used	
31	Output	Signal, cooling characteristic map	Characteristic map, cooling
32	Input	Crankshaft position sensor signal	Crankshaft position/rpm sensor
33		Not used	
34	Input	Intake air temperature	Intake air temperature sensor
35	Ground	Shield, knock sensor	Knock sensor
36	Input	Signal, sensor 2	Knock sensor
37	Input	Signal, sensor 4	Knock sensor

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Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
38	Ground	Shield, knock sensor	Knock sensor
39	Input	Oil level - thermal	Oil level sensor
40	Output	Injection signal	Cylinder 4 fuel injector valve
41	Output	Injection signal	Cylinder 1 fuel injector valve
42	Output	Idle speed control - opening winding	Idle speed control valve
43	Output	Idle speed control - closing winding	Idle speed control valve
44		Not used	
45	Ground	Ground	Shield, crankshaft sensor
46	Input	Crankshaft position sensor	Crankshaft position/rpm sensor
47	Ground	Ground	Intake air temperature sensor
48	Ground	Shield, knock sensor	Knock sensor
49	Input	Shield, sensor I	Knock sensor
50	Ground	Shield, sensor 3	Knock sensor
51	Ground	Shield, knock sensor	Knock sensor
52		Not used	
Connector X60004			
1	Output	Alt. charge indicator signal, terminal 61	Instrument cluster
2	Input	Terminal 30 voltage supply	Integrated instrument cluster control module (IKE)
3		Not used	
4		Not used	
5		Not used	
6	Input	Start signal terminal 50	Ignition switch
7		Not used	
8		Not used	
9		Not used	
10	Output	Activation of relay for fuel pump	Fuel pump relay
11		Not used	
12		Not used	
13		Not used	
14		Not used	
15		Not used	
16		Not used	
17	Output	Engine speed signal output (TD)	Cruise control module (Tempomat)
18		Not used	
19		Not used	
20	Output	CARB signal	Data link connector
21	Output	Washer fluid level, brake fluid level	Light module
22	Input	Right rear wheel speed signal	ABS/ASC or ABS/DSC control module
23		Not used	

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Table e. Bosch 5.2.1 ECM pin assignments

Pin	Signal	Description	Note
24		Not used	
25		Not used	
26	Input	Voltage supply, terminal 15	Fuse F14
27		Not used	
28		Not used	
29	Input	Compressor ON signal from engine control module (DME)	Heating and A/C control module
30	Ground	Ground	Leakage diagnosis pump
31		Not used	
32	Output	Diagnosis signal TXD	Data link connector
33	Input- output	Communication link (EWS)	Electronic immobilizer (EWS)
34	Output	Signal, leak diagnosis pump	Leakage diagnosis pump (LDP)
35		Not used	
36	Input- output	CAN-Bus high	CAN link
37	Input- output	CAN-Bus low	CAN link
38		Not used	
39		Not used	
40	Output	Start signal	Starter relay
Connector X60005			
1	Output	Terminal 1 signal	Cylinder 7 ignition coil
2	Output	Terminal 1 signal	Cylinder 8 ignition coil
3	Output	Terminal 1 signal	Cylinder 2 ignition coil
4	Output	Terminal 1 signal	Cylinder 3 ignition coil
5	Ground	Ground	Ground point
6	Output	Terminal 1 signal	Cylinder 1 ignition coil
7	Output	Terminal 1 signal	Cylinder 4 ignition coil
8	Output	Terminal 1 signal	Cylinder 5 ignition coil
9	Output	Terminal 1 signal	Cylinder 6 ignition coil

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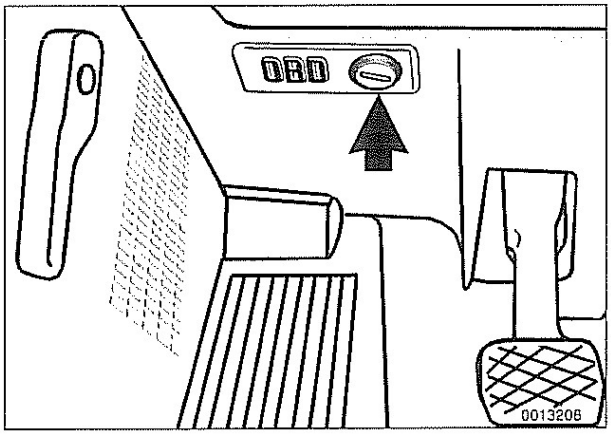
BOSCH ME 7.2

When system faults are detected, a diagnostic trouble code (DTC) is stored in the engine control module (ECM). The MIL also illuminates if an emissions-related fault is detected.

When faults arise, or if the malfunction indicator lamp (MIL) is illuminated, begin troubleshooting by connecting BMW service tester DISplus, MoDiC, GT1 or equivalent scan tool. The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components.

CAUTION—

- *The tests in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After all testing is completed, access and clear DTC fault memory using an OBD II or BMW compatible scan tool. See* **OBD On-Board Diagnostics.**
- *Only use a digital multimeter for electrical tests.*
- *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found in* **ELE Electrical Wiring Diagrams.**



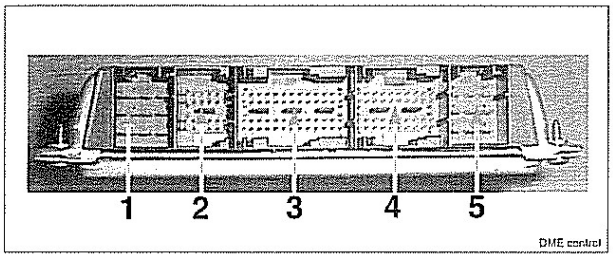
NOTE—

- *OBD II fault memory (including an illuminated MIL) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The BMW-dedicated 20-pin diagnostic link connector (DLC) is in the right rear of the engine compartment. The 20-pin DLC was eliminated on models after 6/2000.*
- *The 16-pin OBD II diagnostic connector (**arrow**) is located inside the car on the lower left dash panel.*

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ME 7.2 system overview

The Bosch ME 7.2 system is used on 1999 - 2002 540i models.

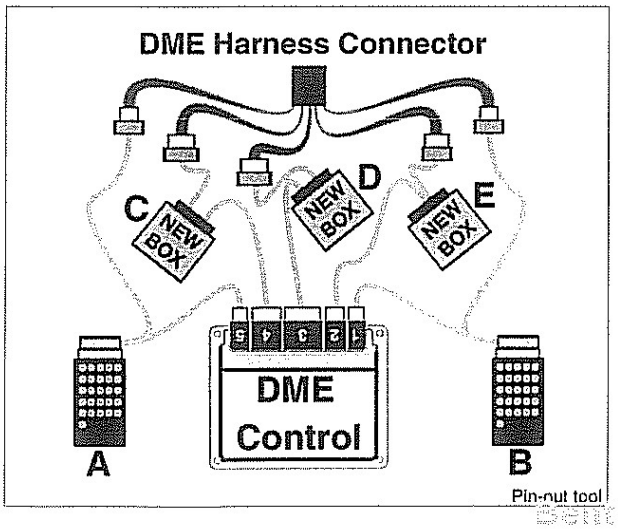


The ME 7.2 engine control module (ECM), located on the right side of the engine compartment in the E-box, utilizes the SKE (standard shell housing) construction with 5 connectors and a combined total of 134 pins.

1. 9 pin connector
2. 24 pin connector
3. 52 pin connector
4. 40 pin connector
5. 9 pin connector

The ME 7.2 system has the following functions or capabilities:

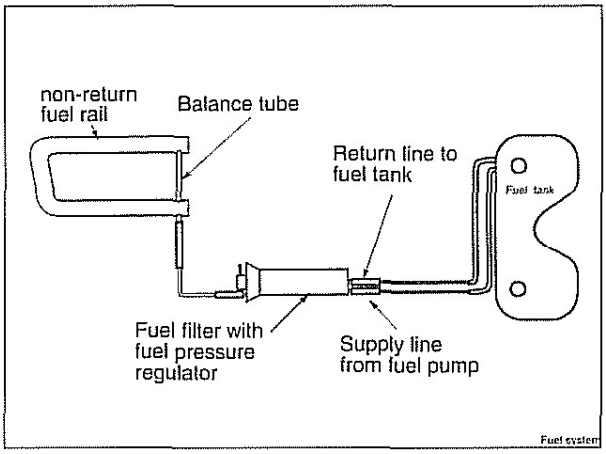
- Electronic throttle control (EDK) integrates idle and cruise control functions. ECM carries out all throttle and idle control functions directly via EDK system.
- Leak diagnosis pump (LDP) control and feedback monitoring for evaporative system leak testing.
- Battery/alternator charge logic (idle speed varies with battery state of charge).
- CAN-Bus communications with instrument cluster.
- EWS III (3.3) "rolling code" ISN interface.
- Ignition knock sensors.
- DSC (dynamic stability control) torque reduction.
- Monitoring and control of VANOS (camshaft timing) with active Hall sensor for camshaft position monitoring.
- Integrated altitude sensor.
- One touch engine start control.
- Single speed secondary air injection system.
- Electrically heated (characteristic map) cooling system thermostat.
- Long life spark plugs.
- IHKA auxiliary (electric) cooling fan control.



All emissions-related ME 7.2 electrical components are monitored for faults. If driveability complaints are encountered or the malfunction indicator light (MIL) is illuminated, interrogate fault memory using a compatible scan tool.

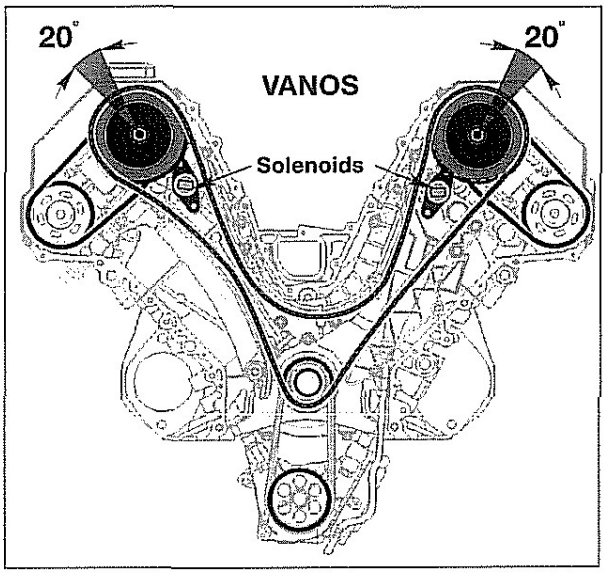
Use a break-out box for ME 7.2 system testing and diagnosis at the control module (break out box set: BMW special tool 90 88 6 121 300).

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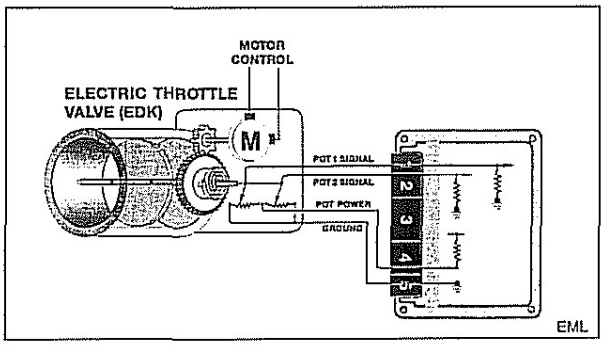


The ME 7.2 uses a non-return fuel rail. The fuel pressure regulator is integrated into the fuel filter.

NOTE —
The fuel filter is available as a replacement part without the fuel pressure regulator. When replacing the fuel filter, transfer the fuel pressure regulator from the old filter to the new filter.



The M62 TU engine uses a continuously variable VANOS system at each intake camshaft. This system enhances engine performance and reduces tailpipe emissions. Both camshafts are adjusted simultaneously within 20° (maximum) of the camshafts rotational axis. This equates to a maximum span of 40° crankshaft rotation.

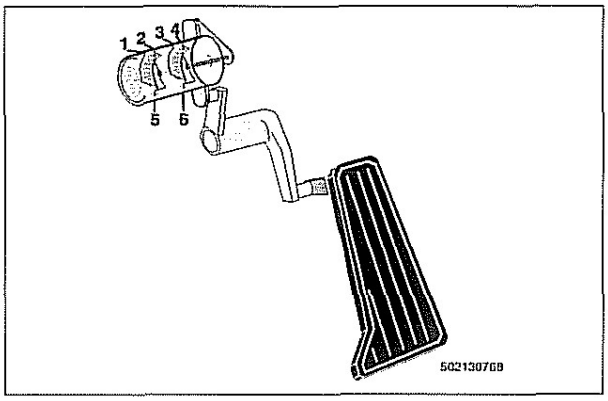


The M62 TU engine uses an electrically controlled throttle valve called EDK. The throttle plate is positioned by a DC gear reduction motor based on inputs signals to the ECM from the pedal position sensor (PWG).

When the accelerator pedal is moved, the PWG provides a change in the monitored signals. The ME 7.2 control module compares the input signal to a programmed map and appropriately activates the EDK motor via proportional pulse width modulated control signals. The control module self-checks its activation of the EDK motor via the EDK feedback potentiometers.

Engine idle speed control is a function of the EDK. The M62 TU engine does not use a separate idle control valve.

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The PWG potentiometers provide DC voltage signals as input to the ME 7.2 control module for throttle and idle control functions. Potentiometer signal 1 is the primary signal, potentiometer 2 is used for a plausibility cross-check.

1. Potentiometer 1 ground
2. Potentiometer 1 power
3. Potentiometer 2 ground
4. Potentiometer 2 power
5. Potentiometer 1 signal to ECM
6. Potentiometer 2 signal to ECM

If errors are detected between potentiometer 1 and 2, the ECM calculates the engine intake air mass (from MAF sensor signal) and only utilizes the potentiometer signal that closely matches the detected intake air mass. The ECM control module uses the air mass signal for a comparative source to provide fail-safe operation. If the ECM cannot calculate a plausible conclusion from the monitored potentiometer the EDK motor is switched off and fuel injection cut-out is activated (no fail-safe operation possible).

EDK is continuously monitored during all phases of engine operation. If faults are detected, the EDK motor is switched off and fuel injection cut off is activated. The engine continues to run extremely roughly at idle speed.

EDK adaptation

When the EDK throttle assembly is replaced, the adaptation values of the previous EDK must be cleared from the ME 7.2 ECM using the BMW service tester or an equivalent scan tool. Once the old adaptation values have been cleared, the new EDK assembly should be installed and adapted as follows:

- Switch ignition OFF for 10 seconds.
- Switch ignition ON. After approximately 30 seconds, the EDK is briefly activated indicating that the replacement unit is now adapted to the ME 7.2 system.

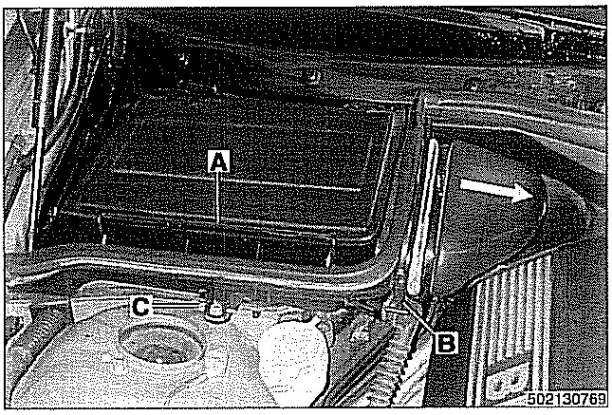
NOTE—
This EDK adaptation procedure is also necessary after replacing the ME 7.2 engine control module. However, the adaptation values do not require clearing since they have not yet been established.

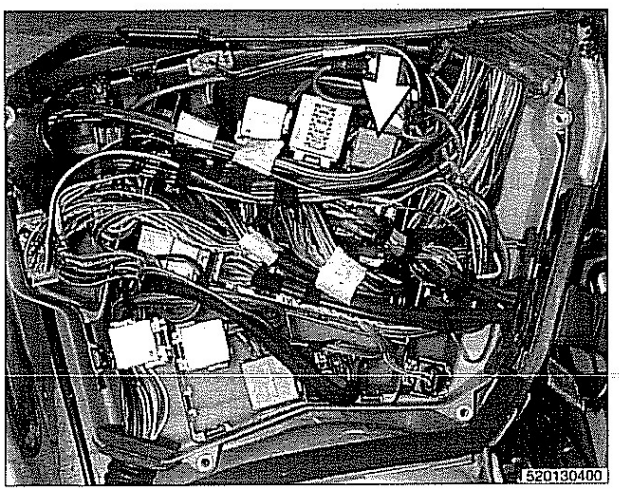
ECM relay, testing

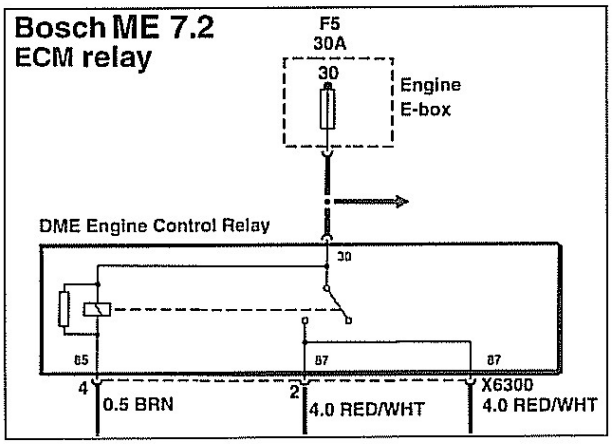
The engine control module (ECM) relay is energized via the ECM and supplies battery positive (B+) power to many of the engine management components and subsystems. If this relay is faulty, the engine will not start.

NOTE—
The ECM relay is also referred to as the DME main relay.

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CAUTION—
Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams in **ELE Electrical Wiring Diagrams.**

➢ Working in right rear of engine compartment:

- Release interior ventilation filter cover latch (**A**) and remove cover.
- Release plastic locking tab (**B**).
- Rotate duct inward (**arrow**) to unlock from bulk head and remove duct.
- Release spring lock (**C**) to remove lower filter housing.
- Slide filter housing away from inner fender to remove.

– Remove electrical box (E-box) cover fasteners and remove cover.

➢ With ignition off, remove main relay (**arrow**) in electronics box (E-box) at right rear of engine compartment.

NOTE—
Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers.

➢ Check for voltage at terminal 6 of main relay socket (30-red wire).

- If battery voltage is present, continue testing.
- If battery voltage is not present, check large red wire in relay socket. See **ELE Electrical Wiring Diagrams.**

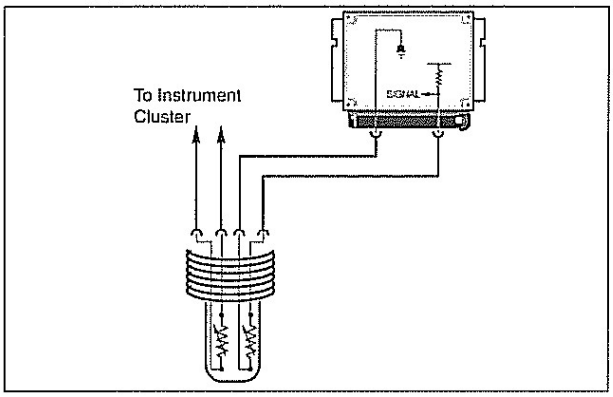
– Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal **4** (**85**-brown wire).

- If ground is present, continue testing.
- If ground is not present, switched ground signal from ECM is missing. Check wire between ECM and relay.

– With ignition on and relay installed, check for battery voltage at terminal **2** (**87**-red/white wire).

- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

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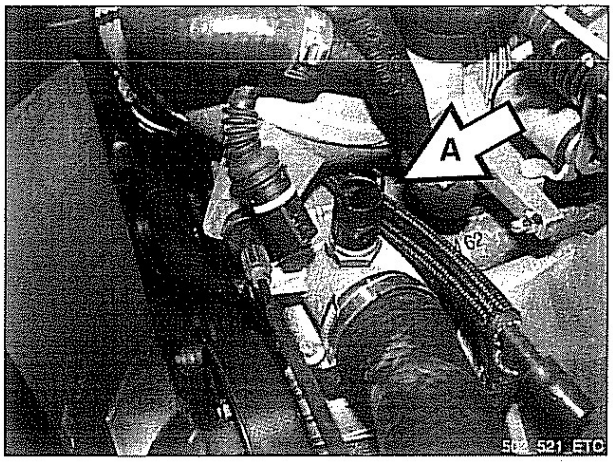
Engine coolant temperature (ECT) sensor, testing

The ECT sensor is located on the front of the engine in the coolant/thermostat flange. The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

The ECM determines the correct ignition timing and air/fuel mixture required for the engine by monitoring an applied voltage (5 vdc) to the sensor. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.

NOTE—
The ECT sensor is an NTC (negative temperature coefficient) type sensor. In other words, as the temperature rises, resistance through the sensor decreases.

If the ETC sensor input is faulty or non-plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a conservative/safe basic setting.



Disconnect harness from ECT sensor (**A**) at coolant flange at front of engine.

– Check ECT sensor resistance using a multimeter at sensor terminals 3 and 4. Peel back protective boot (**B**) to ID terminal numbers on connector housing.

ECT sensor resistance @ 20° C (68°F)	2.2 - 2.7 kΩ

Engine coolant temperature (ECT) sensor, replacing

WARNING—
Due to risk of personal injury, be sure the engine is cold before replacing ECT sensor.

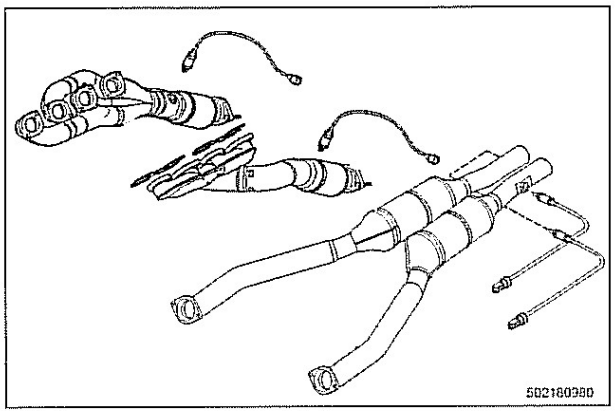
– Disconnect ECT sensor harness.

– Unscrew ECT sensor from cylinder head and install new sensor.
- Use new copper sealing washers when installing sensor.
- Replace any lost coolant.

Tightening torque

ECT sensor to coolant flange	13 Nm (10 ft-lb)

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Oxygen sensors, replacing

Four Bosch oxygen sensors (2 precatalytic converter sensors and 2 post-catalytic converter sensors) provide a varying voltage signal [0.2 vdc (max. lean) to 0.8 vdc (max. rich)] to the ME 7.2 ECM representing oxygen content in the exhaust gas.

> ***WARNING—***
> *Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.*

– Using a special oxygen sensor socket, remove the threaded sensors from the exhaust system.

– If not already applied, coat the new oxygen sensor threads with an anti-seize compound before installation. Do not get compound on the sensor tip.

Tightening torque

Oxygen sensor to exhaust system	50 Nm (37 ft-lb)

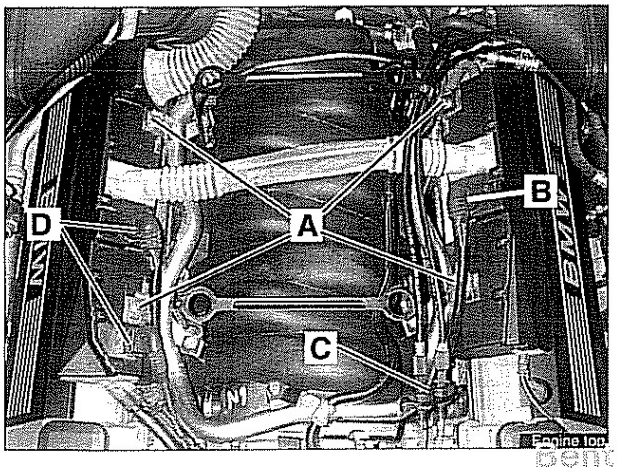
Fuel injectors, removing and installing

The ME 7.2 system uses ball seat type fuel injectors. This design provides precise sealing when the injector is closed thereby eliminating raw HC (unburned fuel) formation in the intake. The fuel injectors are switched on and off by the ECM at the ground side.

– Remove plastic cover from above fuel rail. See **100 Engine Removal and Installation**.

– Disconnected battery negative (-) cable.

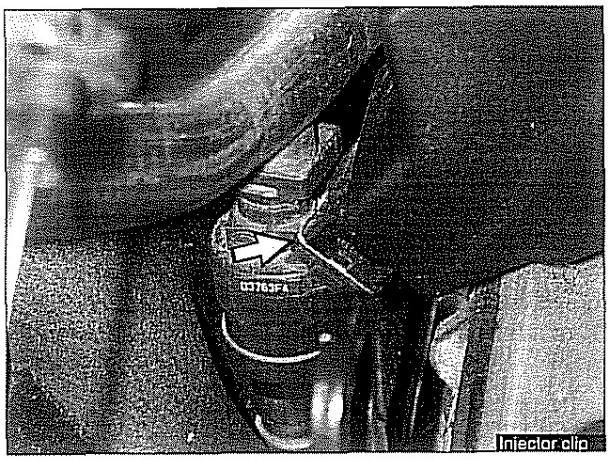
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual. See* **001 General Warnings and Cautions**.



– Remove both ignition coil covers.
  - Disconnect ignition coil connectors.
  - Remove left and right ignition coil ground wires.

Remove fuel injector loom boxes.
  - Loosen mounting fasteners (**A**).
  - Disconnect electrical plugs (**B** and **D**).

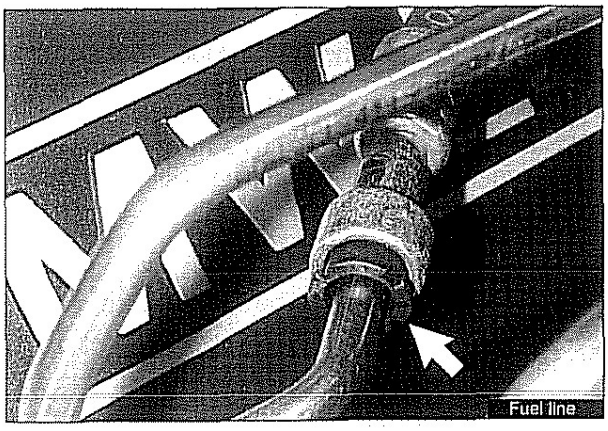
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➢ Release fuel injector locking clips (**arrow**).

– Remove fuel injector loom boxes and lay to one side.

– Remove 4 fuel rail mounting fasteners.



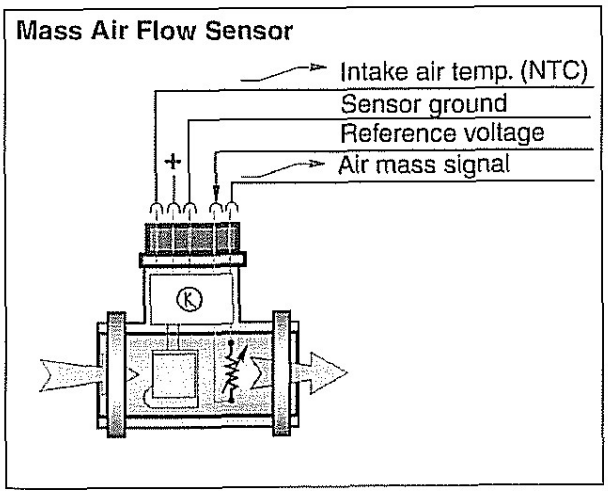
➢ Disconnect fuel line at quick-disconnect. To disconnect, press in plastic collar (**arrow**) and separate fuel line.

> ***WARNING —***
> *Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hose to absorb any leaking fuel. Plug all open fuel lines.*

– Lift fuel rail and injectors straight up to remove.

– Installation is reverse of removal. Use new injector seals and clamps during installation.

Mass air flow (MAF) sensor, removing and installing



➢ The MAF sensor is provided with operating power from the ECM relay. Based on intake air mass, the MAF sensor generates a varying voltage (approx. 0.5 - 4.5 vdc) as an input signal back to the ECM. A separate intake air temperature sensor is not used.

– Removing MAF sensor:
- Remove upper air filter housing locking clips.
- Unscrew and remove sensor harness.
- Disconnect air temperature sensor harness.
- Loosen hose clamp.
- Remove upper filter housing with sensor.

– Installation is reverse of removal.

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Evaporative system pressure leak diagnosis, overview

The M62 TU engine is equipped with an evaporative fuel system pressure leak diagnosis system. The main component of this system is the leak diagnosis pump (LDP). The function of the LDP is to pressurize the fuel tank and the evaporative emission system for the purpose of detecting leaks.

This system is capable of detecting a leak as small as 0.5 mm. The LDP, located in the left rear wheel housing, contains the following:

- Vacuum chamber.
- Pneumatic pump chamber.
- DME activated vacuum solenoid.
- Reed switch (provides switched voltage feedback signal to DME).

The vacuum supply line is in the wiring harness from the engine compartment and runs down the driver's side of the vehicle.

The canister vent valve is integrated into the LDP, which is electrically controlled by the ECM. The canister vent valve is opened to provide fresh air entry into the fuel system only during purge operation.

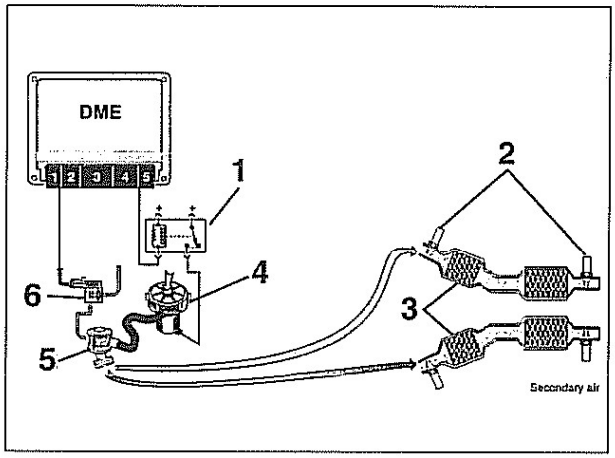
- Purge operation characteristics:
  - Off idle through full throttle: purge valve opened by pulse width modulated (PWM) control of the ECM. PWM duty cycle varies by engine operating conditions (e.g. warm idle, purge valve opened slightly; cold idle/decel with engine temp < 67° C, purge valve always closed).

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Secondary air injection, overview

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce the warm-up time of the catalytic converters and to reduces HC and CO emissions. The ME 7.2 ECM controls and monitors the secondary air injection system. The secondary air pump operates at a start temperature of between 10°C (50°F) and 40°C (104°F). and continues to operate for a maximum of 2 minutes at idle speed.

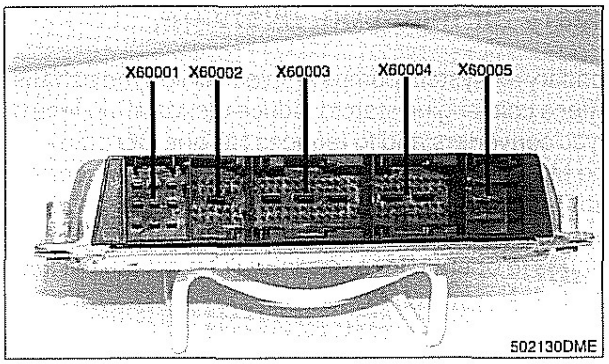
The electric air pump draws in ambient air and supplies it to the check valve. The vacuum vent valve (solenoid) switches vacuum to open the check valve when activated by the ECM. Once opened, the check valve allows air to be pumped into the exhaust stream.



The secondary air injection system consists of the following components:

1. Secondary air pump relay
2. Oxygen sensors
3. Catalytic converters
4. Electric air pump
5. Non-return valve
6. Vacuum vent valve

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Bosch ME 7.2 ECM pin assignments

Bosch ME 7.2 ECM connectors

X60001	9-pin, Black
X60002	24-pin, Black
X60003	52-pin, Black
X60004	40-pin, Black
X60005	9-pin, Black

Table e. Bosch ME 7.2 ECM pin assignments

Connector X60001

Pin	Type	Description/function	Notes
1		Not used	
2		Not used	
3		Not used	
4	Ground	Ground	Ground connector X6460
5	Ground	Ground	Ground connector X6460
6	Ground	Ground	Ground connector X6460
7	Input	Terminal 30 voltage supply	Fuse F4
8	Input	Terminal 87 voltage supply	Fuse F1
9		Not used	

Connector X60002

Pin	Type	Description/function	Notes
1	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor II behind catalytic converter
2	Input	Back-up light signal	Back-up light switch
3	Input/ Output	CAN-Bus Low	Automatic transmission control module (AGS)
4	Input/ Output	CAN-Bus High	Automatic transmission control module (AGS)
5		Not used	
6		Not used	
7	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor I behind catalytic converter
8	Ground	Heated oxygen sensor ground	Heated oxygen sensor II behind catalytic converter
9	Ground	Heated oxygen sensor ground	Heated oxygen sensor I in front of catalytic converter
10	Ground	Heated oxygen sensor ground	Heated oxygen sensor II in front of catalytic converter
11	Ground	Heated oxygen sensor ground	Heated oxygen sensor I behind catalytic converter
12		Not used	
13	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor II in front of catalytic converter

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Connector X60002 (continued)

14	Input	Heated oxygen sensor signal	Heated oxygen sensor II behind catalytic converter
15	Input	Heated oxygen sensor signal	Heated oxygen sensor I in front of catalytic converter
16	Input	Heated oxygen sensor signal	Heated oxygen sensor II in front of catalytic converter
17	Input	Heated oxygen sensor signal	Heated oxygen sensor I behind catalytic converter
18		Not used	
19	Ground	Heated oxygen sensor, heater ground	Heated oxygen sensor I in front of catalytic converter
20		Not used	
21		Not used	
22		Not used	
23	Output	Terminal 85 control	Engine control module relay
24		Not used	

Connector X60003

Pin	Type	Description/function	Notes
1	Output	Injection signal	Cylinder 2 fuel injector valve
2	Output	Injection signal	Cylinder 3 fuel injector valve
3	Output	Signal evaporative emission valve	Evaporative emission valve
4	Output	Temperature signal, E-box fan	E-box fan
5		Not used	
6	Ground	Ground for electronic components	Ground connector X6460
7	Output	Voltage supply for hot film mass air flow sensor	Hot film mass air flow sensor
8	Input	Signal EDK (electric throttle actuator)	Electric throttle actuator
9	Ground	Hot film mass air flow sensor, ground	Hot film mass air flow sensor
10	Output	Electric throttle actuator	Electric throttle actuator, voltage supply
11		Not used	
12	Input	Voltage signal, terminal 30h	Starter
13	Input	Alternator D+ (terminal 61) signal	Alternator (generator)
14	Output	Injection signal	Cylinder 7 fuel injection valve
15	Output	Injection signal	Cylinder 6 fuel injection valve
16	Input	VANOS valve, signal	VANOS valve, cylinder 5-8
17		Not used	
18		Not used	
19		Not used	
20	Input	Camshaft position sensor signal	Hall effect sensor, camshaft 2
21	Ground	Ground	Dual temperature sensor
22	Input	Signal, coolant temperature	Dual temperature sensor
23	Input	Hot film mass air flow sensor, signal	Hot film mass air flow sensor
24	Input	Electric throttle actuator, signal	Electric throttle actuator

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Connector X60003 (continued)

25	Input	Ground, electric throttle actuator	Electric throttle actuator
26		Not used	
27	Output	Injection signal	Cylinder 8 fuel injection valve
28	Output	Injection signal	Cylinder 5 fuel injection valve
29	Input	VANOS valve, signal	VANOS valve, cylinders 1-4
30		Not used	
31	Output	Thermostat characteristic map, signal	Characteristic map
32	Input	Crankshaft position sensor, signal	Crankshaft position/rpm sensor
33		Not used	
34	Input	Hot film mass air flow sensor, signal	Hot film mass air flow sensor
35	Ground	Knock sensor, shield	Knock sensor
36	Input	Knock sensor 2, signal	Knock sensor
37	Input	Knock sensor 4, signal	Knock sensor
38	Ground	Knock sensor, shield	Knock sensor
39	Input	Oil level (thermal)	Oil level sensor
40	Output	Injection, signal	Cylinder 4 fuel injection valve
41	Output	Injection, signal	Cylinder 1 fuel injection valve
42	Input	Electric throttle actuator, signal	Electric throttle actuator
43	Input	Electric throttle actuator, signal	Electric throttle actuator
44		Not used	
45	Ground	Ground	Crankshaft sensor shield
46	Input	Crankshaft position sensor, signal	Crankshaft position/rpm sensor
47		Not used	
48	Ground	Knock sensor, shield	Knock sensor
49	Input	Knock sensor 1, signal	Knock sensor
50	Input	Knock sensor 3, signal	Knock sensor
51	Ground	Knock sensor, shield	Knock sensor
52	Input	Secondary air injection pump valve, signal	Secondary air injection pump valve

Connector X60004

Pin	Type	Description/signal type	Notes
1	Output	Charge indicator signal (terminal 61)	Instrument cluster
2	Output	Voltage signal, terminal 30h	Integrated instrument cluster control
3	Output	Secondary air pump relay, activation	Secondary air injection pump relay
4	Input	Signal, electric (auxiliary) cooling fan, signal	Electric (auxiliary) cooling fan
5		Not used	
6	Input	Start signal (terminal 50, start detection)	Ignition switch
7	Ground	Pedal position sensor (PWG), ground	Pedal position sensor

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Connector X60004 (continued)

8	Input	Pedal position sensor (PWG), signal	Pedal position sensor
9	Output	Pedal position sensor (PWG), power supply	Pedal position sensor
10	Output	Fuel pump relay, activation	Fuel pump relay
11	Output	Oil pressure indicator	Instrument cluster
12	Ground	Pedal position sensor (PWG), ground	Pedal position sensor
13	Input	Pedal position sensor (PWG), signal	Pedal position sensor
14	Output	Pedal position sensor (PWG), power supply	Pedal position sensor
15		Not used	
16		Not used	
17	Output	Engine speed signal output (TD)	OBD II plug
18		Not used	
19		Signal back-up light	Integrated instrument cluster control module (IKE)
20	Input	DM-TL (diagnostic module, tank leakage)	
21	Output	Signal oil level sensor	Light module
22	Input	Right rear wheel speed, signal	ABS/DSC control module
23	Input	Clutch pedal position switch, signal	Clutch pedal position switch
24	Input	Brake light switch, signal	Brake light switch
25		Not used	
26	Input	Voltage supply, terminal 15	Fuse F14
27	Input	Data link, MFL (multi-function steering wheel)	Airbag contact coil spring
28	Input	Brake light test signal	Brake light switch
29	Input	A/C compressor signal	Heating and A/C control module
30	Input	DM-TL (diagnostic module, tank leakage)	
31		Not used	
32	Output	Diagnosis signal TxD	OBD II plug
33	Input/-output	Communication link (EWS)	Electronic immobilizer (EWS)
34		Not used	
35		Not used	
36	Input/-output	CAN-Bus high	CAN-Bus link
37	Input/-output	CAN-Bus low	CAN-Bus link
38	Ground	Ground	Coolant outlet temperature sensor
39	Input	Signal	Coolant outlet temperature sensor
40	Output	Start signal	Starter relay

Connector X60003

Pin	Type	Description/signal type	Notes
1	Output	Terminal 1 signal	Cylinder 7 ignition coil
2	Output	Terminal 1 signal	Cylinder 8 ignition coil

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Connector X60005 (continued)			
3	Output	Terminal 1 signal	Cylinder 2 ignition coil
4	Output	Terminal 1 signal	Cylinder 3 ignition coil
5	Ground	Ground	Ground point
6	Output	Terminal 1 signal	Cylinder 1 ignition coil
7	Output	Terminal 1 signal	Cylinder 4 ignition coil
8	Output	Terminal 1 signal	Cylinder 5 ignition coil
9	Output	Terminal 1 signal	Cylinder 6 ignition coil



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160 Fuel Tank and Fuel Pump

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GENERAL

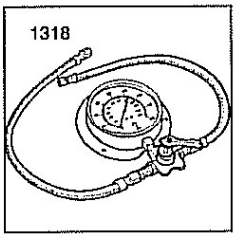
This repair group covers service information specifically for the fuel supply system. Information on the fuel injection system is covered in **130 Fuel Injection**.

In the descriptions and procedures given below, engine and engine management (DME) systems are referred to by manufacturer code. If necessary, see **100 Engine-General** for model year, engine code, and DME applications.

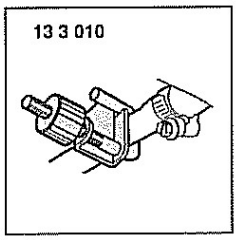
NOTE—
*Fuel filter replacement is covered in **020 Maintenance**.*

Special tools

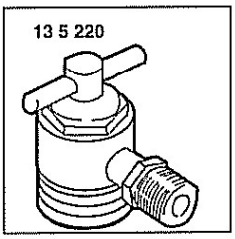
Some of the procedures in this group require the use of special tools.



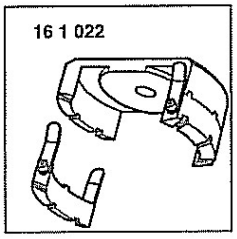
- Fuel pressure gauge
(Tool No. 1318 [Source: Baum Tools Unlimited])



- Fuel line clamp
(Tool No. BMW 13 3 010)



- Fuel pressure gauge T-fitting with shut-off valve
(Tool No. BMW 13 5 220)



- Fuel tank threaded collar spanner
(Tool No. BMW 16 1 022)

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Fuel pump

The electric fuel pump is mounted in the fuel tank in tandem with the right side fuel level sender. The fuel pump delivers pressurized fuel to the fuel injection system. A pressure regulator maintains system pressure. The quantity of fuel supplied exceeds demand, so excess fuel returns to the fuel tank via a return line. See **130 Fuel Injection** for more information.

NOTE—
*Fuel pump removal procedures are given under **Fuel level sender (right side) and fuel pump, removing and installing.***

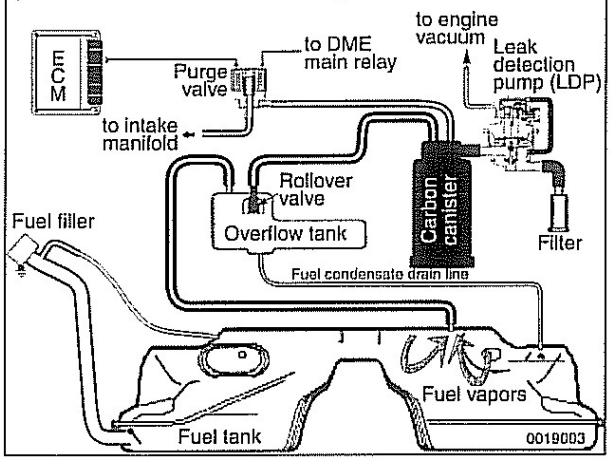
Fuel tank evaporative control system

Evaporative control, also referred to as running losses control, is designed to prevent fuel system evaporative losses from venting into the atmosphere.

The components of this system allow control and monitoring of evaporative losses by the on-board diagnostic (OBD II) software incorporated into the engine control module (ECM).

NOTE—
1997 V-8 models (540i) with Bosch DME M5.2 are not equipped with an OBD II running losses monitoring system.

Fuel tank evaporative control system (models with DME MS42.0)



The main components of the evaporative control system and their functions:

- Fuel overflow tank acts as a liquid/vapor separator.
- Carbon canister stores evaporated fuel.
- Plumbing ducts vapors from fuel tank to canister and from canister to intake manifold.
- Carbon canister purge valve is controlled by engine control module (ECM).
- Running losses or 3/2-way valve (not shown) shunts excess fuel volume directly back to fuel tank before it circulates through injector fuel rail (models with Siemens MS42 or Bosch M5.2.1 engine management only).
- Leak detection unit (LDP or DMTL) pressurizes fuel tank and evaporative system to monitor system leaks (models with Siemens MS42 or Bosch M5.2.1 and later).

Leak detection systems vary among models and years, and are further described in **130 Fuel Injection**.

NOTE—
"3/2-way valve", "running losses valve" and "fuel changeover valve" are used interchangeably in BMW technical literature.

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Evaporative system troubleshooting

- Start by accessing diagnostic trouble codes (DTCs) using a BMW or BMW compatible aftermarket scan tool.
  - For purposes of OBD II emissions compliance, the DME system sets a diagnostic trouble code (DTC) when it detects a leak that is equal or larger than minimum leak sensed by system.
  - Malfunction Indicator Light (MIL) is illuminated upon second recurrence of fault. See **OBD On-Board Diagnostics**.
- When leak testing, observe following conditions to obtain plausible results:
  - Fuel tank $^{1}/_{4}$ to $^{3}/_{4}$ full.
  - Vehicle parked for at least 2 hours to allow fuel to reach room temperature. Ideal fuel temperature is 10° - 20° C (50° - 68° F).
  - Do not refuel immediately before leak test.
- If a leak is detected, check the following areas:
  - Fuel filter cap (leaking or off).
  - Fuel tank ventilation lines leaking at fuel tank or activated carbon canister.
  - Tank ventilation valve leaking (in engine compartment).
  - Fuel level sensor/fuel pump cap leaking.

  Evaporative system component replacement is covered later in this group in **Fuel Tank and Fuel Lines**.

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Warnings and cautions

Observe the following warnings and cautions when servicing the fuel system.

WARNING—

- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop rags to capture leaking fuel.*
- *Before beginning any work on the fuel system, place a fire extinguisher in the vicinity of the work area.*
- *Fuel is highly flammable. When working around fuel, do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*
- *When disconnecting a fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.*
- *Do not use a work light with an incandescent bulb near any fuel. Fuel may spray on the hot bulb causing a fire.*
- *Make sure the work area is properly ventilated.*

CAUTION—

- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*
- *Before making any electrical tests with the ignition turned on, disable the ignition system as described in **120 Ignition System**. Be sure the battery is disconnected when replacing components.*
- *To prevent damage to the ignition system or other DME components, including the engine control module (ECM), always connect and disconnect wires and test equipment with the ignition off.*
- *Cleanliness is essential when working with the fuel system. Thoroughly clean the fuel line unions before disconnecting any of the lines.*
- *Use only clean tools. Keep removed parts clean and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.*
- *Do not move the car while the fuel system is open.*
- *Avoid using high pressure compressed air to blow out lines and components. High pressure can rupture internal seals and gaskets.*
- *Always replace seals, O-rings and hose clamps.*

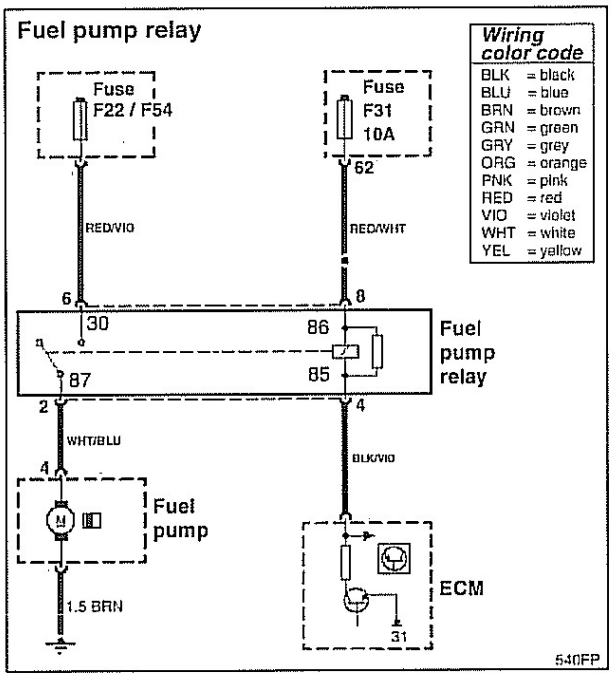
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Fuel System Troubleshooting

Fuel pump fuse and relay

Troubleshooting of any fuel pump fault should begin with checking the fuel pump fuse and the fuel pump relay. The DME main relay should also be checked. The fuel pump relay is located behind right side luggage compartment interior panel.

NOTE—
Special tools are required for some of the tests described here.



Fuel pump circuit is fuse-protected.

- 6–cylinder models with Siemens DME MS41.1, MS42, V-8 models with Bosch DME M5.2, M5.2.1 engine management: Fuse F54, 15A (luggage compartment fuse panel)
- 6–cylinder models with Siemens DME MS43 engine management: Fuse F22, 25A (glove compartment fuse panel)
- V-8 models with Bosch DME M7.2: Fuse F54, 25A (luggage compartment fuse panel)

– Fuse 31 in glove compartment fuse panel supplies power to coil side of fuel pump relay. Engine control module (ECM) supplies switched ground to relay. During starting, fuel pump runs as long as ignition switch is in START position and continues to run once engine starts. If electrical system fault interrupts power to fuel pump, engine will not run.

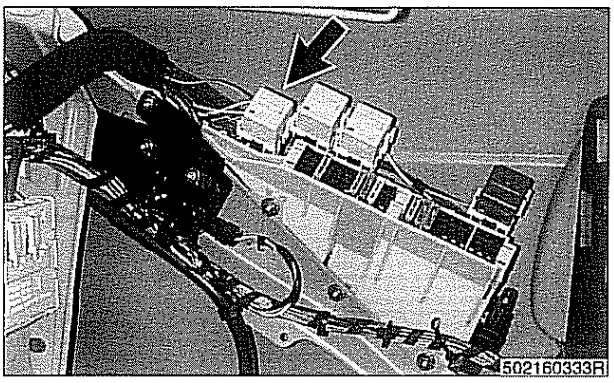
Operating fuel pump for tests

– To operate fuel pump for testing purposes without having to run engine, bypass fuel pump relay to power pump directly.

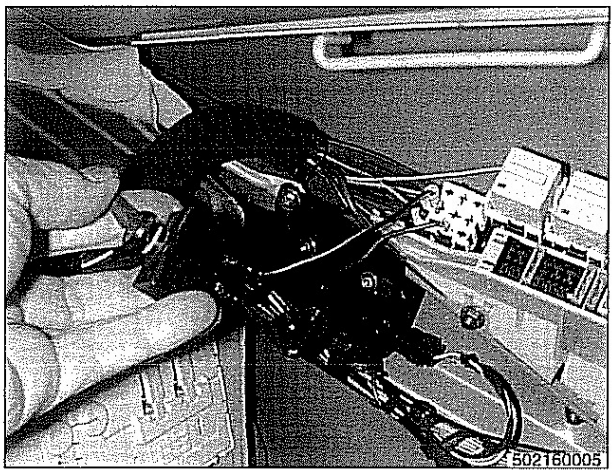
To run fuel pump, open luggage compartment and release right side trim panel.



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➢ Remove fuel pump relay (**arrow**).



➢ Connect relay socket terminal 6 (red/violet wire) to relay socket terminal 2 (white/blue wire) with a fused jumper wire. After completing tests, remove jumper harness.

CAUTION—
- *Relay locations may vary. Use care when identifying relays and making electrical checks at the fuse/relay panel. See **610 Electrical Component Locations** for additional relay information.*
- *The fuel pump relay has a 1.5 mm^2 red/violet wire at terminal 6 in the relay socket. Terminal 2 has a 2.5 mm^2 white/blue wire. See **ELE Electrical Wiring Diagrams** for additional wiring information.*

NOTE—
- *The fuel pump will run as soon as the jumper wire is attached.*
- *The jumper wire should be 1.5 mm^2 (14 ga.) and include an in-line fuse holder with a 15A fuse. To avoid fuse/relay panel damage from repeated connecting and disconnecting, also include a toggle switch in the jumper harness.*

– If pump does not run with jumper installed, fault could be in fuel pump, fuses F31 or F22 / F54, or wiring to pump. Check pump, fuses and its wiring as described below.

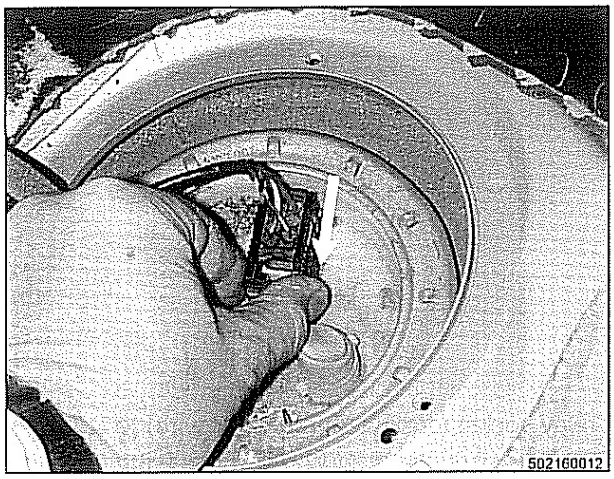
Fuel pump electrical circuit, testing

– The test given below assumes that the fuel pump relay circuit is functioning correctly as described earlier. Access to the pump is from below the rear seat bottom cushion.

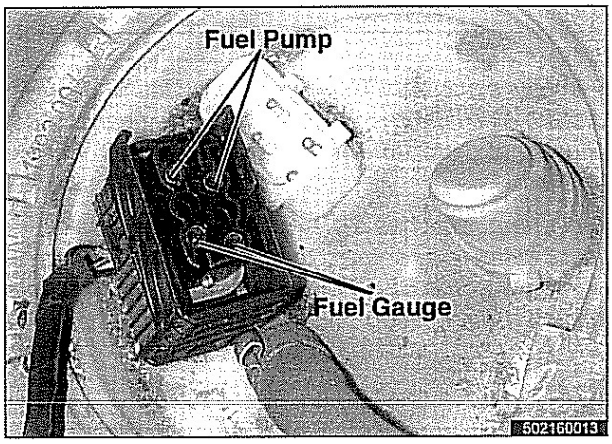
– Remove rear seat lower cushion by lifting front edge off left and right catches.

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Fuel Tank and Fuel Pump

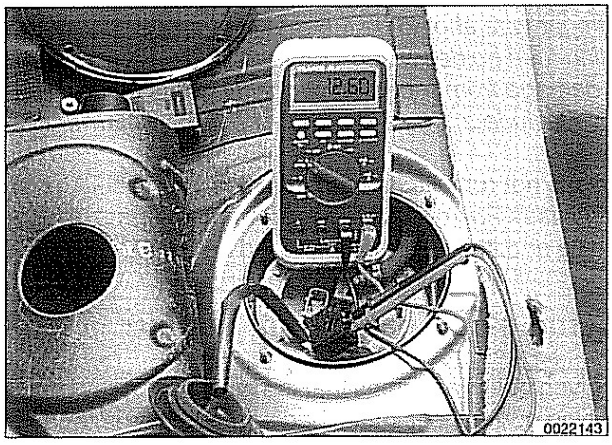


- Disconnect harness connector from tank sending unit by sliding connection lock to release connector.



- Connect voltmeter between fuel pump terminals on connector.

NOTE —
Fuel pump power (+) is supplied through the white/blue wire. Ground (-) is supplied by the brown wire.



- With jumper wire connected in place of fuel pump relay as described above, check for battery voltage at fuel pump harness connector terminals.

– If voltage and ground are present, fuel pump is probably faulty. If there is no voltage, check wiring between fuel pump and relay.

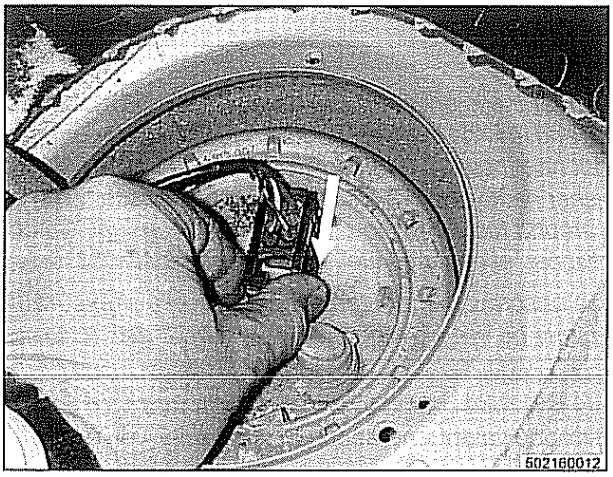
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Fuel pump power consumption, testing

To achieve accurate test results, the battery voltage at the fuel pump connector should be 12.6 volts. Charge the battery as necessary.

A higher than normal power consumption may indicate a worn fuel pump, which may cause intermittent fuel starvation due to pump overheating and seizure. The only remedy is pump replacement. A lower than normal power consumption may indicate a blockage. Be sure to check that the return line and the pump pickup are not obstructed before replacing the pump.

– Expose right side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove right side cover to expose electrical harness connector.



➢ Disconnect harness connector from tank sending unit by sliding lock back. Lift off connector.



➢ Test fuel pump for current draw by attaching digital ammeter between pump and harness (terminal 2, white/blue wire) and connect a jumper wire between pump and harness (terminal 1, brown wire) as shown.

> ***CAUTION—***
> *Do not allow the test leads to short to ground.*

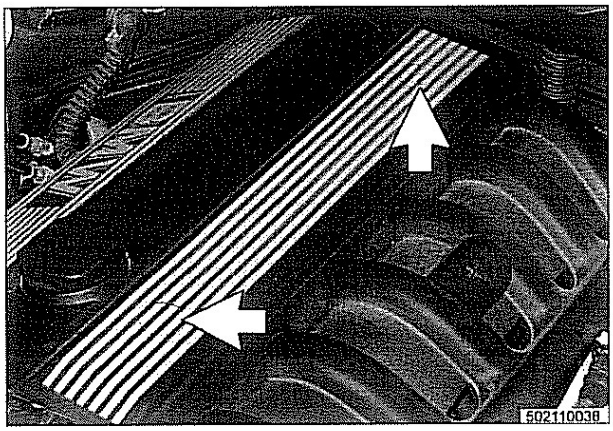
NOTE—
*See **600 Electrical System-General** for information on electrical tests using a digital multimeter.*

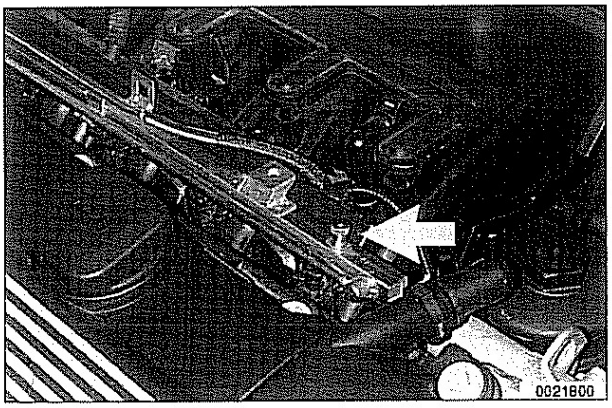
– Run pump as described in **Operating fuel pump for tests.**

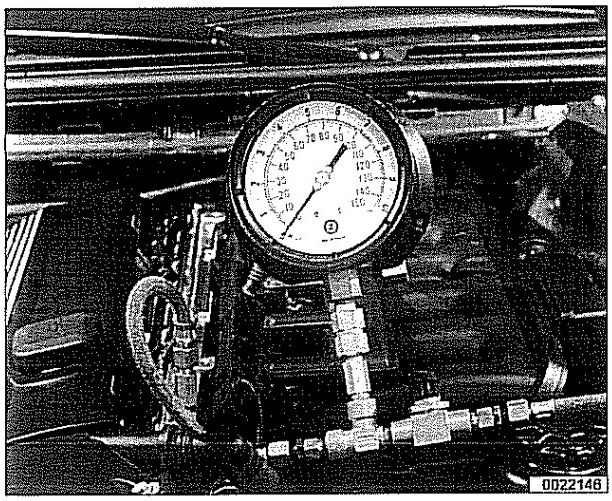
– Compare ammeter reading with specification listed in accompanying table.

Fuel pump current	
Current consumption (average)	9.5 amps

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Fuel pressure gauge, installing (6–cylinder models)

- Remove fuel rail cover by prying off trim covers (**arrows**) and removing nuts.

- If equipped, remove schraeder valve cap (**arrow**). Blow fuel back through feed line using a brief burst of compressed air (maximum 3 bar or 43.5 psi).

WARNING —
- *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

- Attach fuel pressure gauge to BMW special tool 13 5 220 (T-fitting) or equivalent and attach to schraeder valve.

WARNING —
The fuel pressure gauge must be securely connected to prevent it from coming loose under pressure.

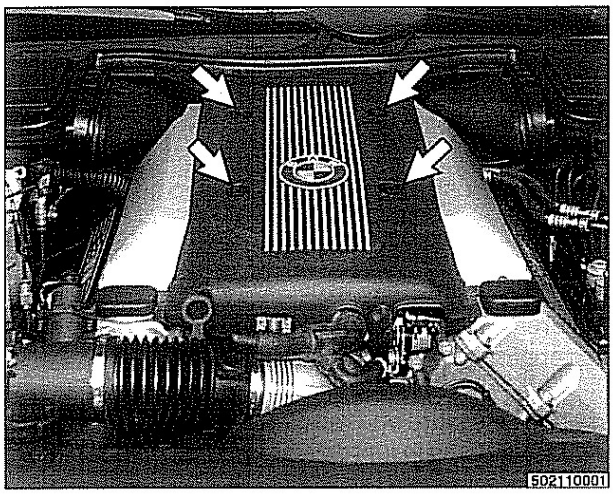
CAUTION—
When using the BMW special tool, use care when turning the T-handle in to open the schraeder valve. Screw the handle in just until the schraeder valve opens. Turning the handle in too far will damage the schraeder valve.

NOTE —
- *The schraeder valve must be opened to the fuel pressure gauge connection. Either remove the valve using a standard tire valve removal tool or use the BMW special tool 15 5 220.*
- *The fuel pressure gauge should have a minimum range of 0 to 5 bar (0 to 75 psi).*

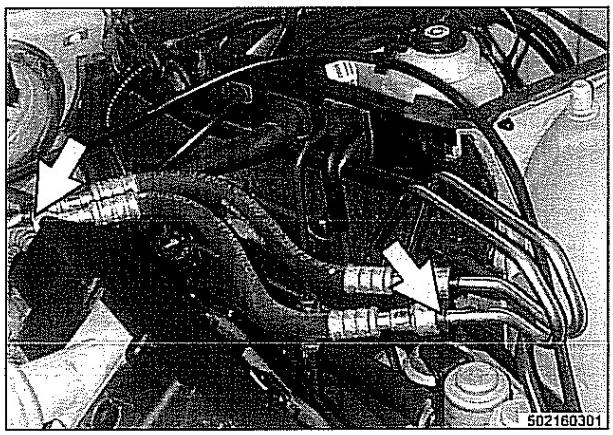
– For vehicles without the schraeder valve on the fuel rail, attach the fuel pressure gauge in line with the fuel supply line to the fuel rail.

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Fuel pressure gauge, installing (V-8 models)



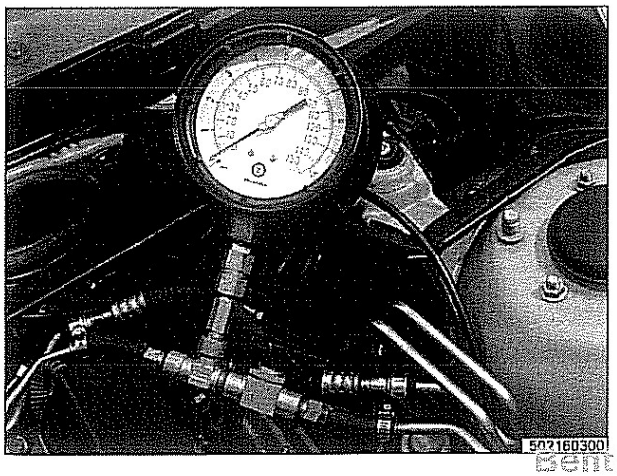
- Remove engine cover by pressing down on pins (**arrows**) to release cover locks.



- Disconnect and remove fuel supply line from left side of fuel rail by sliding locking collar in (**arrows**) and pulling lines apart.

NOTE—
- *M62 TU and MS43 vehicles (1999 and later models) use a non-return fuel line with only one line to the fuel rail.*
- *BMW uses three styles of fuel line connections; a one-use clamp, a locking fitting that uses BMW special tool 16 1 050 to release, and a quick release sleeve (above) that disconnects the line when depressed.*

WARNING—
- *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
- *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*



- Install inline fuel pressure gauge.

WARNING—
The fuel pressure gauge must be securely connected to prevent it from coming loose under pressure.

NOTE—
The fuel pressure gauge should have a minimum range of 0 to 5 bar (0 to 75 psi).

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Fuel delivery, testing

Checking fuel delivery is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. An accurate fuel pressure gauge will be needed to make the tests.

There are two significant fuel delivery values to be measured:

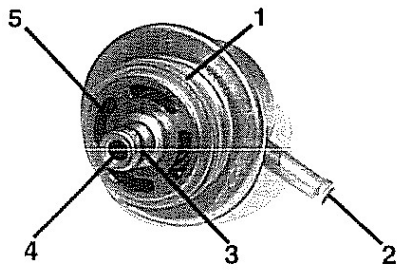
- System pressure — created by fuel pump and maintained by pressure regulator
- Residual pressure — pressure maintained in closed system after engine and fuel pump are shut off

If proper system pressure and residual pressure are present, also check for problems in fuel delivery volume, which can be affected by restrictions such as clogged fuel filter or fuel pick-up port in the fuel tank.

System pressure, testing

System pressure is created by the fuel pump and maintained by the pressure regulator. System pressure is not adjustable.

Fuel pressure regulator



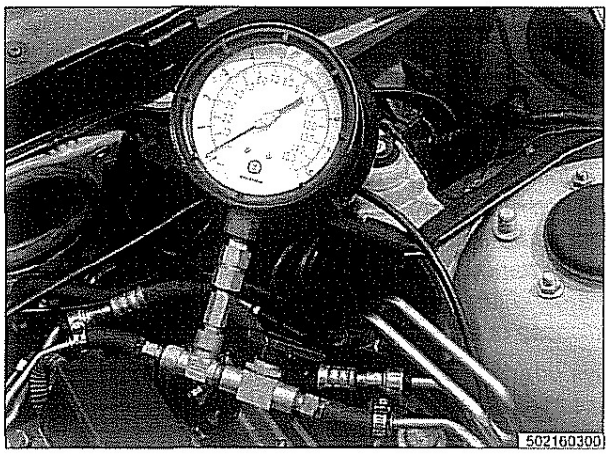
502160684

1. Fuel pressure regulator outer seal.
2. Vacuum line connection.
3. Fuel pressure regulator inner seal.
4. Fuel flow back to fuel tank.
5. Fuel flow from fuel pump.

Fuel pressure regulator locations

M52	In fuel injector rail, in engine compartment
M52 TU	In 3/2 way valve, below vehicle under driver seat
M54	In fuel filter
M62 to 9/97	In fuel injector rail, in engine compartment
M62 from 9/97 to 9/98	In 3/2 way valve, below vehicle under driver seat
M62 TU from 9/98	In fuel filter, below vehicle under driver seat

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Relieve system pressure and attach a fuel pressure gauge as described in **Fuel pressure gauge, installing (6–cylinder models)** or **Fuel pressure gauge, installing (V-8 models)**.

> ***WARNING—***
> - *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
> - *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines.*

– Operate fuel pump as described in **Operating fuel pump for tests**. Compare fuel pressure to specifications in accompanying table.

Fuel pressure specification

All E39 vehicles	3.5 ±0.2 bar (50.76 ±2.9 psi)

– If pressure is low, repeat test while gradually pinching off return hose to fuel tank. Pressure should rise rapidly. If not, fuel pump is most likely faulty. If pressure rises, the fuel pressure regulator is most likely faulty.

– If pressure is too high, check return line from pressure regulator to tank. Check for kinks in hose. If no faults can be found, pressure regulator is most likely faulty.

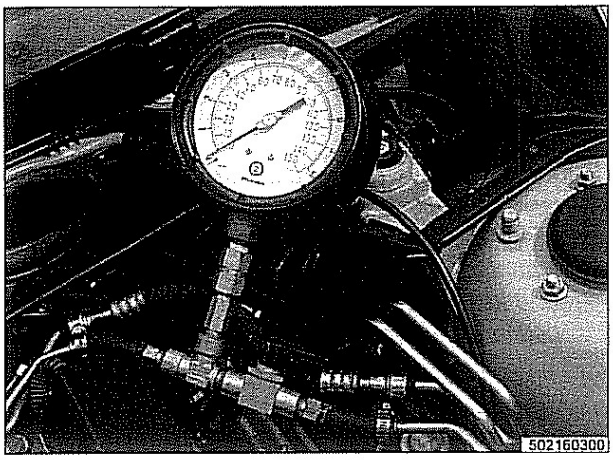
> ***CAUTION—***
> *The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. In the event the fuel pump check valve is faulty (stuck closed), make sure the fuel pressure does not rise above 6.0 bar (87 psi). Damage to the fuel lines or fuel system components could result.*

– Reassemble engine, noting the following:
  - Remove fuel pressure gauge and fittings.
  - Replace schraeder valve, if removed.
  - Replace fuel pump relay.
  - Replace fuel filler cap.

Residual pressure, testing

For quick restarts and to avoid vapor lock when the engine is hot, the fuel injection system retains fuel pressure after the engine is shut off. This residual pressure is primarily maintained by the fuel pressure regulator and a check valve at the fuel pump outlet.

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Relieve system pressure and attach a fuel pressure gauge as described in **Fuel pressure gauge, installing (6–cylinder models)** or **Fuel pressure gauge, installing (V-8 models).**

> ***WARNING —***
> - *Fuel in fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Catch and dispose of escaped fuel. Plug all open fuel lines.*
> - *Always unscrew the fuel tank cap to release pressure in the tank before working on the tank or lines*

– Start engine allow it to run for approximately one minute. Note fuel pressure reading.

– Observe fuel pressure reading after approximately 20 minutes. The pressure should not drop more than 0.5 bar from system pressure listed in fuel pressure specifications in accompanying table.

Fuel pressure specification	
All E39 vehicles	3.5 ±0.2 bar (50.76 ±2.9 psi)

– When finished, disconnect pressure gauge and fitting, and replace schraeder valve, if removed.

– If fuel system does not maintain pressure:
  - Visually check for leaks in fuel lines and unions.
  - Check for leaking injector(s).
  - Check for faulty fuel pump check valve.

– To test fuel pump check valve:
  - Repeat residual pressure test.
  - Immediately after shutting off engine, pinch off fuel delivery line using a fuel hose pinch clamp (BMW 13 3 010 or equivalent).
  - If pressure is now maintained, fault is most likely at fuel pump check valve.
  - If pressure again drops below specifications, fault is most likely in fuel pressure regulator.

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FUEL PUMP AND FUEL LEVEL SENDER

E39 models use a two-lobed fuel tank. Each lobe of the tank has its own fuel level sending unit. Each sender has a float connected to a variable resistance wiper contact. To equalize fuel level between the two tank lobes, a siphon pump is installed in the left lobe.

When replacing a sender or fuel pump, always replace hose clamps, gaskets and O-rings.

> ***WARNING —***
> *When removing the fuel level sender or the fuel pump, the fuel tank should be drained to 1/4 capacity or below as described later in this repair group.*

NOTE —
The compensating siphon pump maintains the fuel level between the right and left tank lobes. If fuel level sender resistances are not approximately the same on left and right, remove the senders and visually inspect the level in each lobe. If the levels are different, check the siphon pump.

Fuel level sender resistances

Float position	Test results (Ω)
Down (empty)	50 — 70
Up (full)	401 — 415

Fuel level sender (right side) and fuel pump, removing and installing

– Drain fuel from tank as described later.

– Disconnect negative cable from battery.

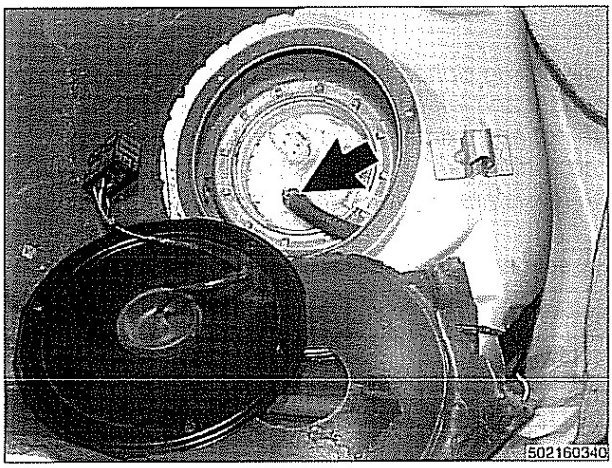
> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings.***

– To access top of fuel tank, remove rear seat lower cushion by lifting front edge off catches.

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- Expose right side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove right side cover to expose electrical harness connector.

> ***WARNING—***
> - *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*
> - *When disconnecting fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.*

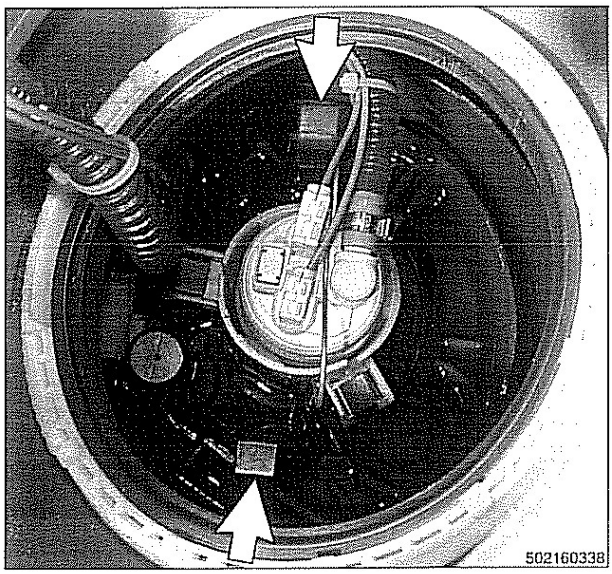


- Remove tank sending unit:
  - Release electrical harness by sliding lock back, then lifting off connector.
  - Disconnect hose (**arrow**).
  - Unscrew threaded collar from fuel pump/fuel level sender.

NOTE—
BMW special spanner 16 1 020 should be used to remove and install the threaded collar. Damage to the collar may result if the special tool is not used.

  - Slowly withdraw assembly from tank, allowing fuel to drain off. If necessary, push level sender arm toward sending unit to facilitate removal.

> ***CAUTION—***
> *Do not bend fuel level sender arm.*



- To remove fuel pump, press locking tabs (**arrows**) towards pump body. Lift out pump, using care not to damage hoses.

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– To reinstall:
  - Use new sealing ring at tank collar.
  - Align tab of sending unit with matching recess in opening of tank.
  - Be sure that fuel line connections point in same direction as they came out.
  - Reconnect harness connector and hose.
  - Fill tank and check for leaks by running engine.
  - Install access cover and its mounting fasteners.

> ***CAUTION—***
> *After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump will be damaged if run without fuel.*

NOTE—
*It is common practice to replace the fuel filter when the fuel pump unit is replaced. See **020 Maintenance**.*

Tightening torque	
Tank collar locking ring to tank	35 Nm (26 lb-ft)

Fuel level sender (left side), removing and installing

The procedure for removing and replacing the left side fuel level sender is similar to that used for the right side. There is no fuel pump on the left side.

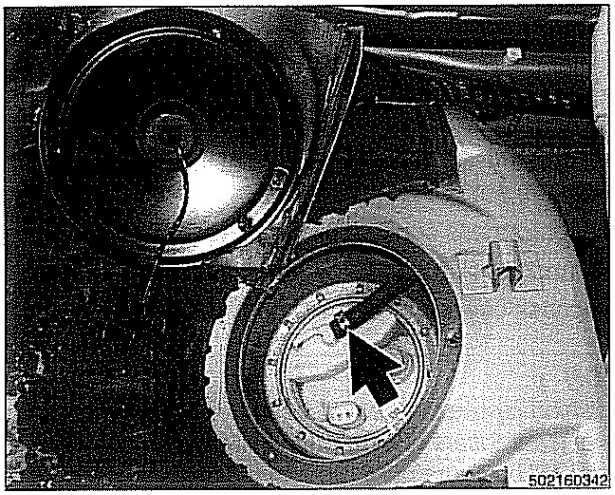
– Remove rear seat lower cushion by lifting off catches at front.

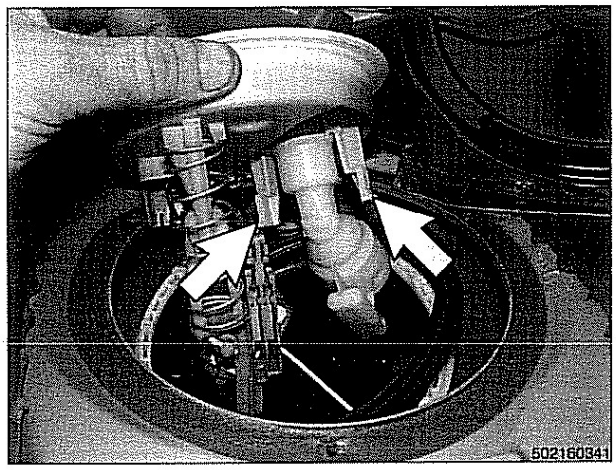
– Expose left side access cover:
  - Peel forward lip of carpet.
  - Release rubber grommet from center of access cover insulation.
  - Peel back insulation at perforations to expose fuel tank access cover.
  - Remove cover to expose electrical harness connector.

> ***WARNING—***
> - *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*
> - *When disconnecting fuel hose, wrap shop rag around end of hose to prevent spray of fuel under pressure.*

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Fuel Tank and Fuel Pump





Remove tank sending unit:

- Disconnect electrical harness connector.
- Disconnect hose (**arrow**).
- Unscrew threaded collar from fuel level sender.

NOTE —
BMW special spanner 16 1 020 should be used to remove and install the threaded collar. Damage to the collar may result if the special tool is not used.

- Slowly withdraw assembly from tank, allowing fuel to drain off. If necessary, push level sender arm toward sending unit to facilitate removal.

CAUTION—
Do not bend fuel level sender arm.

Once level sensor unit has been lifted partially out of tank, disconnect tank siphon hose by pressing tabs (**arrows**).

– Installation is reverse of removal.

- Attach tank siphon hose to sender unit firmly.
- Use new sealing ring at tank collar.
- Be sure that fuel sender float points in same direction as during removal.
- Reconnect harness connector.
- Fill tank and check for leaks by running engine.

CAUTION—
After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.

Tightening torque

Tank collar locking ring to tank	35 Nm (26 lb-ft)

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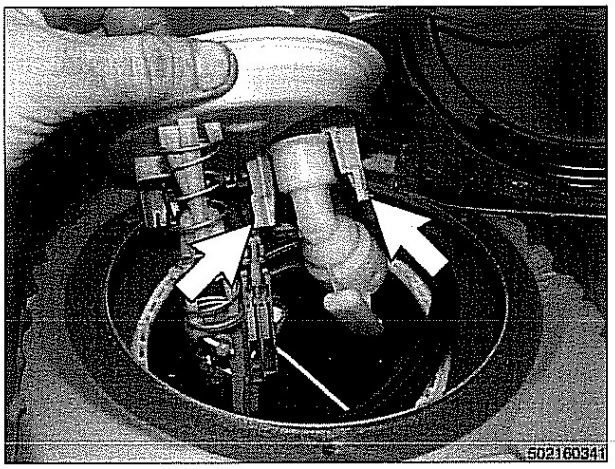
Siphon pump, removing and installing

The fuel compensating siphon pump equalizes fuel level between the two fuel tank lobes.

– Drain fuel tank as described later.

> ***WARNING—***
> *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

– Remove left and right fuel level sensors and fuel pump as described earlier.



➢ Once left side level sensor unit has been lifted partially out of tank, disconnect tank siphon hose by pressing tabs (**arrows**).

– The tank lobe siphon pump is held to baffle in bottom of right tank lobe. Release retainer and lift out pump.

– Installation is reverse of removal.

- Attach siphon pump to right side baffle.
- Attach tank siphon hose to left sender unit firmly.
- Use new sealing ring at tank collars.
- Be sure that fuel sender floats point in same direction as during removal.
- Reconnect harness connectors.
- Before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.
- Check for leaks by running engine.

> ***CAUTION—***
> *After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.*

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FUEL TANK AND FUEL LINES

The plastic fuel tank is mounted underneath the center of the car (underneath the rear seat). Mounted in the fuel tank are the fuel pump and fuel level sending units. Connecting lines for the evaporative emission control system and expansion tank are also attached to the tank.

Fuel tank capacity for E39 models	
Tank capacity	70 liters (18.5 gal)
Reserve capacity	8 liters (2.1 gal)

Fuel tank, draining

Drain fuel tank into a safe storage unit using an approved fuel pumping device.

WARNING—
- *Before removing tank, be sure that all hot components, such as the exhaust system, are completely cooled down.*
- *Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.*

– Start engine and allow to run 10 - 15 seconds to fill fuel compensating siphon assembly. This will allow both lobes of fuel tank to be drawn off through fuel filler pipe.

– Disconnect negative cable from battery.

CAUTION—
*Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.*

– Remove fuel tank filler cap.

– Slide suction hose into filler neck about 130 cm (51 in.), twisting as necessary. Withdraw fuel into storage unit.

– Monitor fuel level reduction in both lobes:
- Remove rear seat cushion and access both fuel tank sender harness connectors.
- Use multimeter to measure resistance at both senders. Resistance should drop as fuel level drops.

– If siphoning mechanism is faulty, drain left tank lobe separately by removing sender cover and pumping fuel directly out of left lobe.

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– Remove suction hose from tank filler neck carefully to avoid damaging filler neck baffle plate.

> ***CAUTION—***
> *After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump will be damaged if run without fuel.*

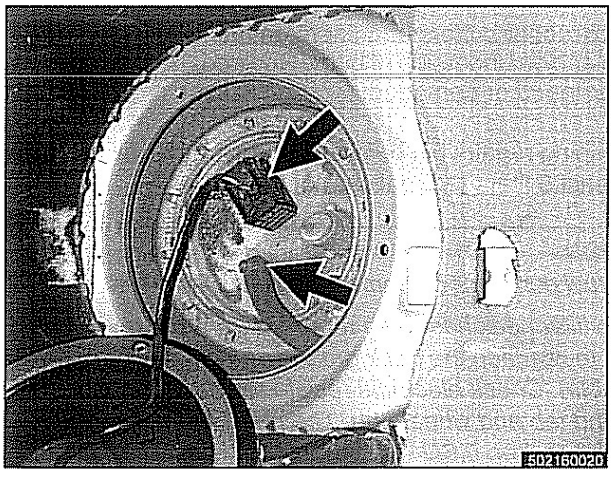
Fuel tank, removing and installing

– Remove fuel tank filler cap and drain tank as described earlier.

– Disconnect negative cable from battery.

> ***CAUTION—***
> *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Cautions and Warnings**.*

– Remove rear seat bottom cushion. Peel forward lip of carpet from beneath seat cushion and carefully peel back insulation to expose fuel tank access cover on left and right sides. Remove covers.



– Disconnect right side supply hose and electrical harness connector (**arrows**).

– Disconnect left side return hose and electrical harness connector.

– Working inside car, disconnect parking brake cable ends from parking brake lever. See **340 Brakes**.

– Lift car and support safely.

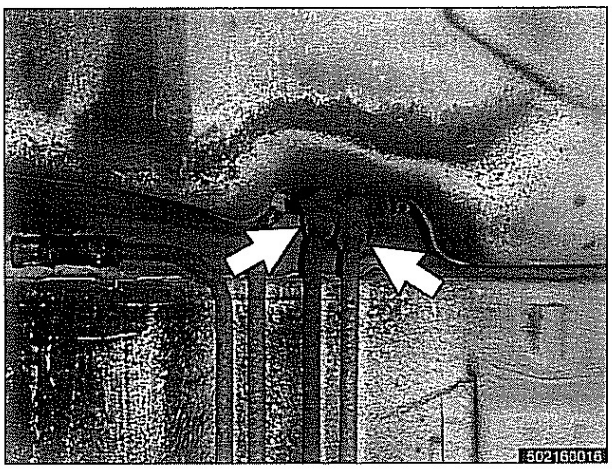
> ***CAUTION—***
> *Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.*

– Remove complete exhaust system and heat shield. See **180 Exhaust System**.

– Remove drive shaft. See **260 Driveshaft**.

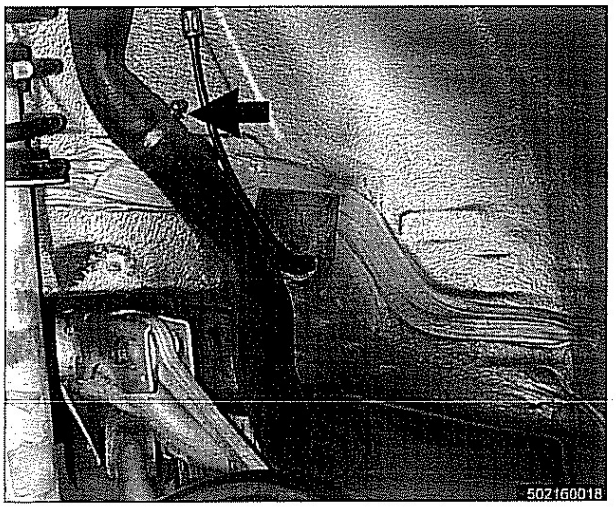
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Fuel Tank and Fuel Pump



➢ Working underneath car, pinch off supply and return fuel hoses (**arrows**), then disconnect hoses from rigid metal lines.

– Remove right rear wheel and wheel housing splash shield.



➢ Working at right rear wheel housing, loosen hose clamp (**arrow**) and disconnect filler pipe from tank.

– Support tank from below. Remove tank strap mounting bolts. Lower and remove tank, disconnecting right side vent and other hoses/electrical connectors as necessary.

- Always use new seals, gaskets, O-rings, and hose clamps.
- Inspect hoses and replace any that are chafed, dried out or cracked.
- Inspect heat shield and replace if corroded.
- Inspect rubber buffers and liners on fuel tank, support straps and on underside of body. Replace rubber parts that are hardened or damaged.

– After finishing repairs but before starting engine, fill fuel tank with at least 5 liters (1.5 gallons) of fuel.

CAUTION—

- *The fuel pump will be damaged if run without fuel.*
- *If the filler neck has been removed from the body, be sure to reattach the neck grounding screw (where applicable). Check electrical resistance between the ground tab and wheel hub. The resistance should be no higher than 0.6Ω*

Tightening torques

Fuel tank to body	23 Nm (17 ft-lb)
Hose clamp 8 -13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)
Hose clamp 42 - 48 mm dia.	4 Nm (36 in-lb)

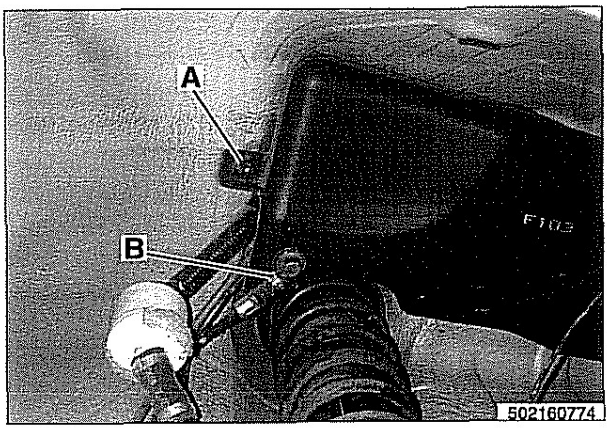
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Fuel expansion tank, removing and installing

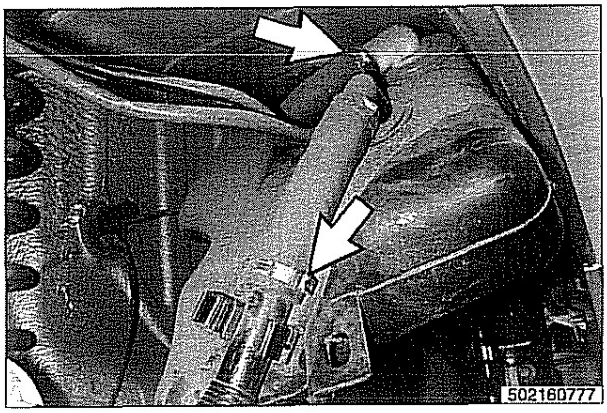
– Raise rear end of car and support safely.

> ***CAUTION—***
> *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 left rear wheel and wheel housing inner shield.



➢ Remove plastic nut (**A**) and disconnect hose (**B**).



➢ Tilt vent tank down and loosen or cut off hose clamps (**arrows**). Pull hoses off fittings.

– Release vacuum line locking clips and remove tank.

– Installation is reverse of removal. Use new hose clamps.

Tightening torques	
Hose clamp 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)
Hose clamp 42 - 48 mm dia.	4 Nm (36 in-lb)

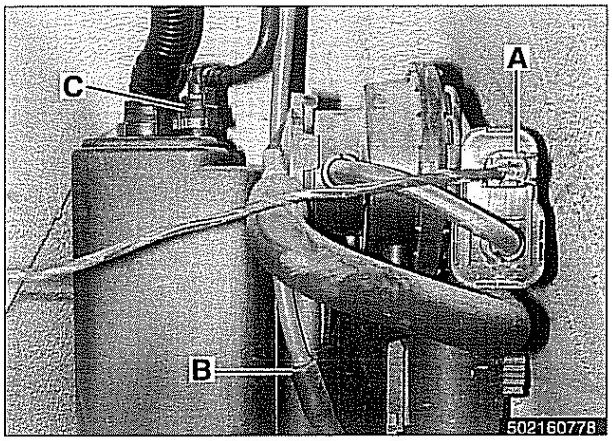
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Activated carbon canister / fuel tank leak detection unit (LDP or DMTL), removing and installing

– Raise rear end of car and support safely.

> ***CAUTION—***
> *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 left rear wheel and inner fender panel.



◀ Remove carbon canister/fuel tank leak detection unit (V-8 model shown):

- Disconnect electrical harness connector (**A**) from fuel tank leak detection unit.
- Pinch and remove quick-disconnect fittings at intake line to air filter housing (**B**) and hose to expansion tank (**C**).
- Remove mounting clamp and lower canister with fuel tank leak detection unit.

– Installation is reverse of removal.

Tightening torques

Hose clamp 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamp 13 - 16 mm dia.	3 Nm (27 in-lb)

Running losses (3/2–way) valve, removing and installing

The running losses (3/2–way) valve is located under the car beneath the driver's seat, just ahead of the fuel filter. A protective cover shields fuel system components from road hazards and dirt.

The engine control module (ECM) controls the operation of the 3/2–way valve (pulse-width modulated). On engine start up, the valve solenoid is energized for 20 seconds in order to supply full fuel volume to the fuel rail. After 20 seconds, the solenoid is deactivated and sprung closed (the bypass is opened). This reduces the amount of fuel circulating through the fuel rail and diverts the excess to return to the fuel tank through the fuel pressure regulator.

The fuel injectors are supplied with pressurized fuel, but excess fuel is diverted to the fuel tank without first passing through the fuel rail. This prevents the excess fuel from absorbing heat in the engine compartment, thus lowering the temperature and amount of vaporization in the fuel tank.

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The 3/2–way valve is also activated briefly if an engine misfire is detected. This provides full fuel flow through the fuel rail to determine if the misfire was caused by a lean fuel condition. The valve is monitored by the ECM for faults.

– Using BMW or compatible scan tool, read out fault memory. See **OBD On-Board Diagnostics**.

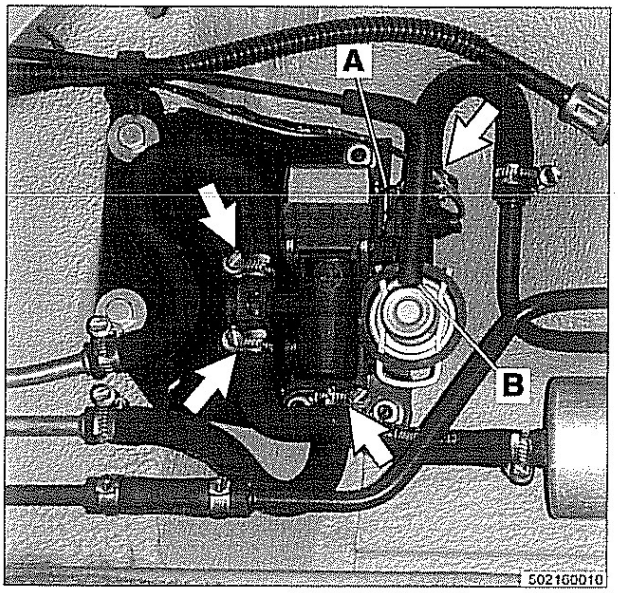
– Turn off ignition.

– Raise car and support safely.

> ***CAUTION—***
> *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.*

– Working under car beneath driver's seat, remove protective panel from fuel filter and 3/2–way valve.

– Clamp off fuel lines at 3/2–way valve.



➢ To remove 3/2-way valve (V-8 model shown):

- Disconnect electrical harness connector (**A**) from valve.
- Remove vacuum hose (**B**) from fuel pressure regulator.
- Remove hose clamps (**arrows**) and disconnect fuel lines.
- Remove M6 mounting nuts and lower 3/2–way valve.

> ***WARNING—***
> *Fuel will be spilled. Use shop rags to capture fuel as fuel lines are disconnected. Do not smoke or work near heaters or other fire hazards.*

– Installation is reverse of removal. Use new hose clamps.

> ***NOTE—***
> *Install protective cover and seals correctly to keep moisture and road dirt out of underbody fuel system components.*

Tightening torques

Hose clamps 8 - 13 mm dia.	2 Nm (18 in-lb)
Hose clamps 10 - 16 mm dia.	2 Nm (18 in-lb)
Hose clamps 18 mm dia.	3 Nm (27 in-lb)
Hose clamps 42 - 48 mm dia.	4 Nm (36 in-lb)



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170 Radiator and Cooling System

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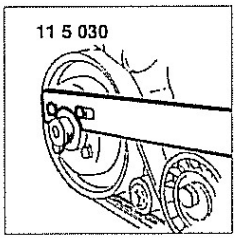
GENERAL

This section covers component repair information for the engine cooling system.

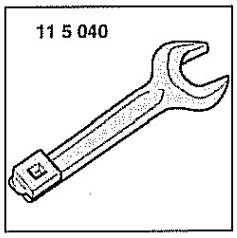
Heater core replacement is covered in **640 Heating and Air Conditioning**.

Special tools

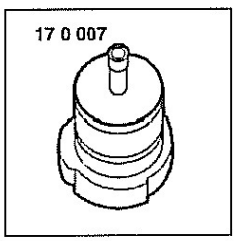
Special tools are necessary for belt-driven fan clutch removal and also for pressure testing the cooling system.



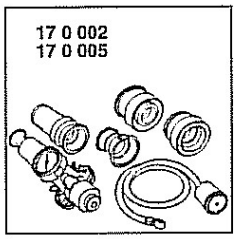
- Cooling fan counterhold wrench
(Tool No. BMW 11 5 030)



- Cooling fan wrench
(Tool No. BMW 11 5 040)



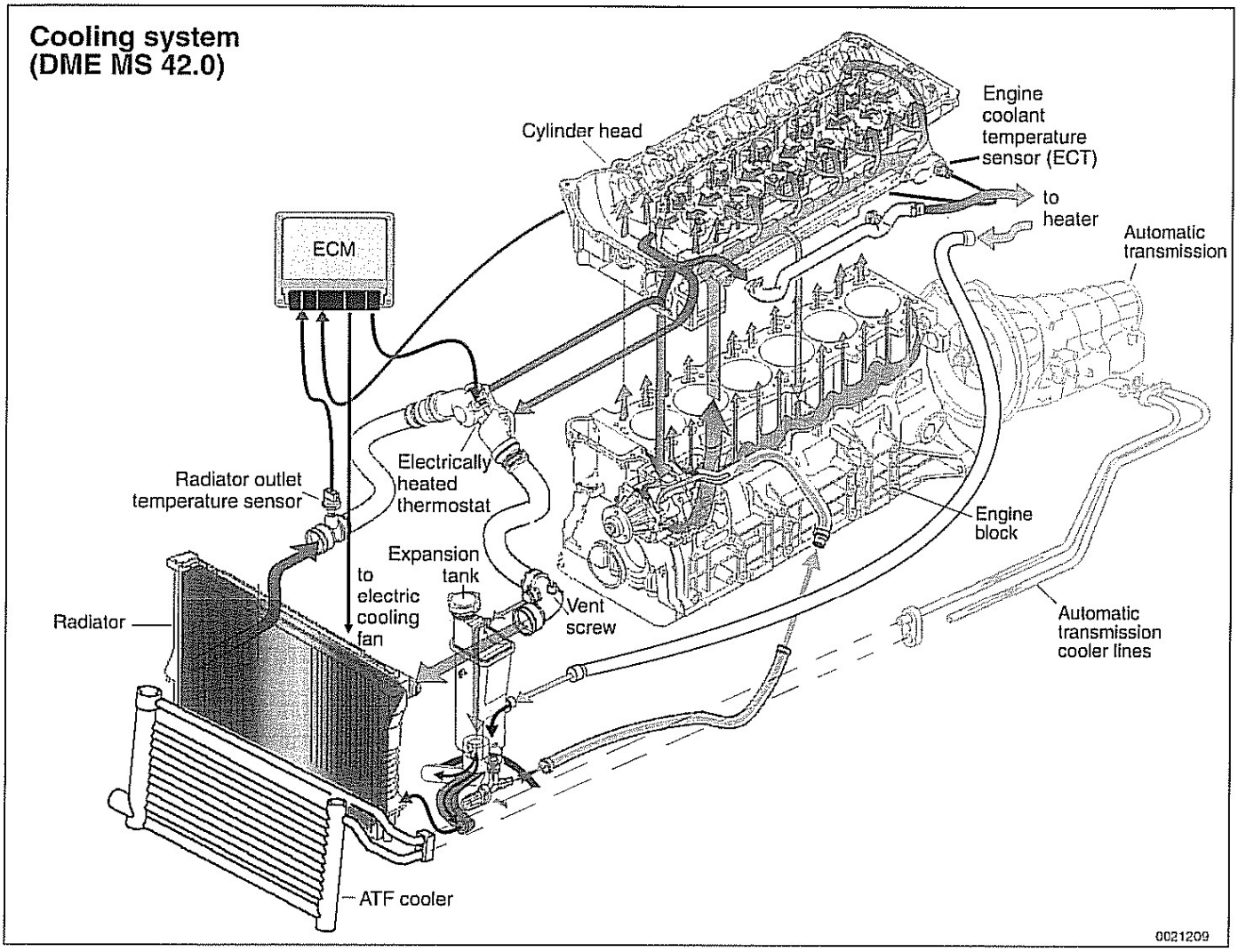
- Expansion tank cap test adaptor
(Tool No. BMW 17 0 007)



- Cooling system pressure tester set
(Tool No. BMW 17 0 002/17 0 005)

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Cooling system overview (M52 TU shown, others similar)



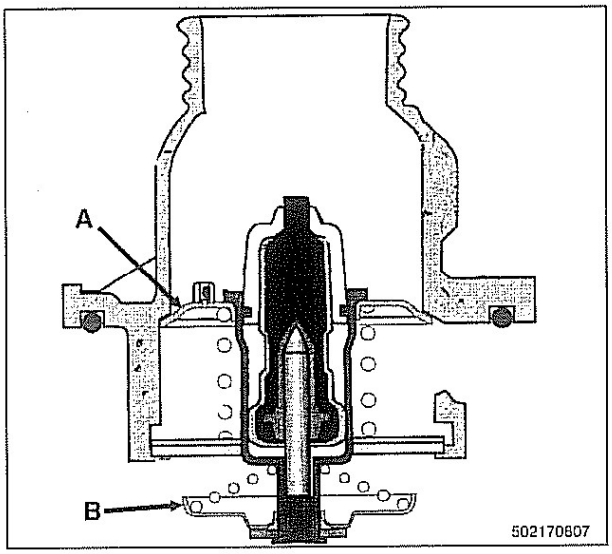
Coolant pump

A centrifugal coolant pump is mounted to the front of the engine. The belt-driven pump circulates coolant through the system whenever the engine is running.

Thermostat

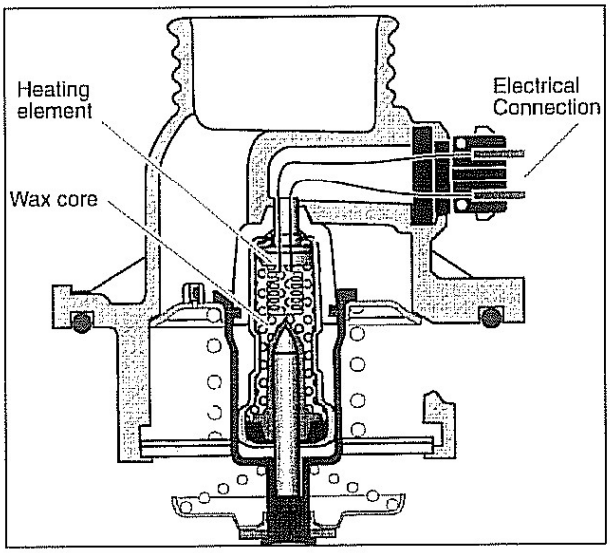
Two types of thermostats are used in the cars covered by this manual. 6–cylinder models built up to 9/1998 (M52 engine) use a conventional mechanical thermostat. All V-8 models and 6–cylinder models from 9/1998 use an electrically heated thermostat.

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Mechanical thermostat (M52 engine)

The mechanical thermostat relies on coolant temperature to operate. While coolant is cold, it remains closed, and circulating coolant bypasses the radiator for rapid engine warm up. At higher coolant temperature, the thermostat progressively opens to allow coolant flow through the radiator, thus controlling engine temperature. Port **A** restricts coolant flow from radiator, and port **B** restricts coolant flow to radiator.



Electrically heated thermostat

The electrically heated thermostat is DME map-controlled. The engine control module (ECM) activates the thermostat to maintain engine coolant temperature within a narrow range.

In case of failure of the electronics, the mechanical function of the thermostat acts as a fail-safe.

Radiator and expansion tank

The radiator is a crossflow design. An expansion tank provides for coolant expansion at higher temperatures and easy monitoring of the coolant level.

On cars with automatic transmission, ATF is circulated through an additional heat exchanger (ATF cooler).

Mechanical cooling fan with viscous clutch

The mechanical cooling fan is belt-driven via a viscous fluid coupling (clutch) attached to the front of the coolant pump. The fan clutch controls the speed of the fan based on the temperature of the air flowing through the radiator core.

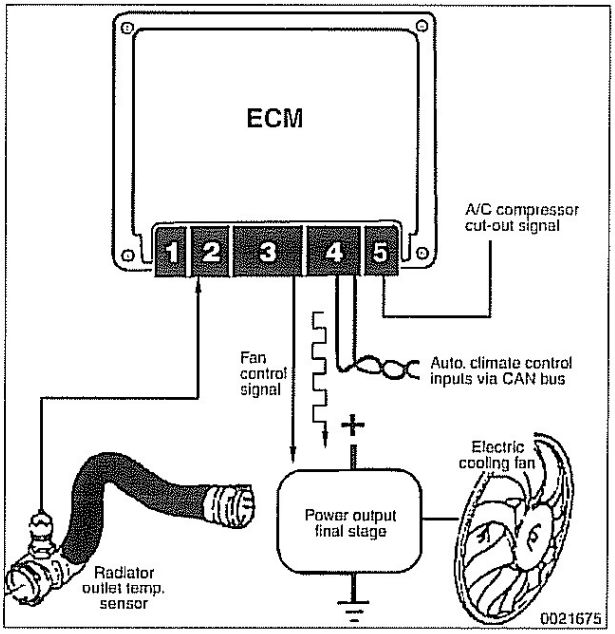
Electric (auxiliary) cooling fan

The electric cooling fan is mounted on the bumper side of the radiator.

In models manufactured up to 9/1998 (M52 or 1997 M62 engine), the electric cooling fan is controlled by a dual temperature fan switch mounted in the side of the radiator.

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Fan switch calibration (M52, M62 engine)	
Electric fan activation:	
• Low speed	91° C (196° F)
• High speed	104° C (219° F)



In models manufactured after 9/1998 (M52 TU engine, M54 engine, M62 TU engine), the electric cooling fan is controlled by the engine control module (ECM) via the output final stage.

The output final stage is mounted on the fan housing, next to the fan motor. The fan is operated using a pulse width modulated signal. Fan circuit wiring is protected by a 50-amp fuse. Electric fan activation is based on the following inputs to the ECM:

- Radiator outlet temperature
- Calculated catalytic converter temperature
- Vehicle speed
- Battery voltage
- Calculated A/C pressure

When the vehicle is first started, the ECM activates the electric fan briefly at 20% of its maximum speed, then switches off. This is for diagnostic monitoring. The voltage generated by the fan when it slows down (acting as a generator) must match the stored rpm values in the fan output stage to confirm that the fan is operating correctly.

NOTE —
- *If the ECM fault memory indicates a cooling fan fault, check that the fan is not seized and that it spins freely.*
- *When A/C is switched ON, the electric fan is not immediately turned on.*
- *After the engine is switched OFF, the fan may continue to run at varying speeds for up to 10 minutes, based on calculated catalyst temperature.*

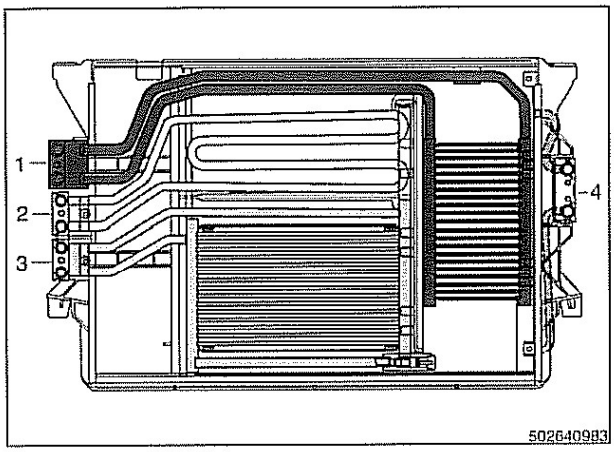
Transmission fluid heat exchanger

Automatic transmission fluid lines circulate transmission fluid (ATF) to and from a heat exchanger at the radiator.

All 6–cylinder models and V-8 models produced to 9/1998 are equipped with a transmission cooler located in a cooling cassette in front of the radiator.

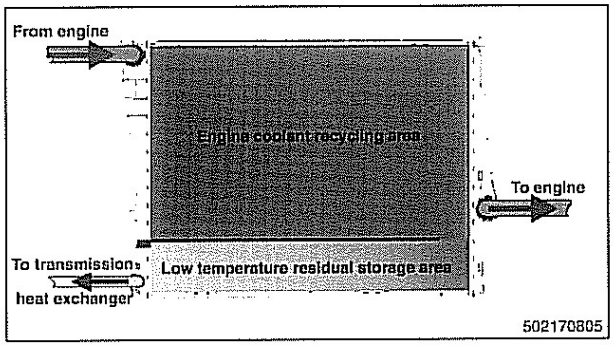
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Radiator and Cooling System



- The cooling cassette incorporates cooling coils for various vehicle systems:

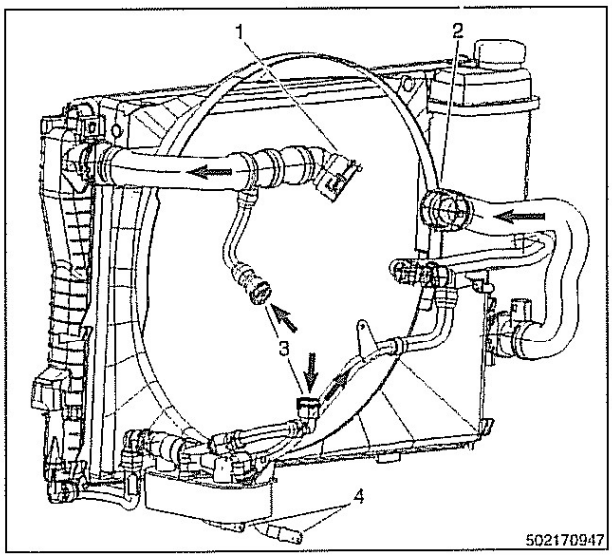
1. Steering fluid cooler
2. Transmission oil cooler
3. A/C condenser



- In V-8 cars produced after 9/1998 (M62 TU engine), the engine radiator is divided into an upper chamber (about 80%) and a lower chamber (about 20%). The ATF heat exchanger is coupled to the lower chamber.

On cold engine start-up, the engine coolant is heated more quickly than the transmission fluid. Heat from engine coolant is used to warm up the ATF faster, reducing drag in the transmission and improving fuel mileage.

Once the ATF has reached normal operating temperature, the ATF heat exchanger acts as cooling device. The lower 20% of the radiator stays cooler than the upper chamber, so the ATF is cooled more effectively.



- M62 TU cooling system ducting at radiator:

1. Coolant distribution housing connection
2. Thermostat connection
3. Water cooled alternator connections
4. Transmission fluid heat exchanger connections

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Warnings and cautions

Observe the following warnings and cautions when working on the cooling system.

WARNING—

- *At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening (a minimum of one hour), then release the cap slowly to allow safe release of pressure.*
- *Releasing the coolant system pressure lowers the coolant boiling point and the coolant may boil suddenly. Use heavy gloves and wear eye and face protection to guard against scalding.*
- *Use extreme care 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.*

CAUTION—

- *Avoid adding cold water to the coolant while the engine is hot or overheated. If it is necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.*
- *To avoid excess silicate gel precipitation in the cooling system and loss of cooling capacity, use BMW coolant or equivalent low silicate antifreeze.*
- *If oil enters the cooling system, the radiator, expansion tank and heating circuit must be flushed with cleaning agent. BMW recommends removal of the radiator and expansion tank to flush.*
- *When working on the cooling system, cover the alternator to protect it against coolant drips.*
- *Prior to disconnecting the battery, read the battery disconnection cautions given in **001 General Warnings and Cautions**.*

TROUBLESHOOTING

Begin the diagnosis of cooling system problems with a thorough visual inspection. If no visual faults are found, it is recommend that the engine control module (ECM) fault memory be checked for stored diagnostic trouble codes (DTCs) using BMW scan tool DISplus or equivalent.

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Common cooling system faults can be grouped into one of 4 categories:

- Cooling system leaks
- Poor coolant circulation
- Radiator cooling fan faults
- Electrical/electronic faults

Cooling system inspection

– Check that coolant pump drive belt tensioner is functioning properly and that belt tension is correct. Belt tensioner systems for the different models are shown in **020 Maintenance**.

– Check condition of coolant pump drive belt.

– Check coolant hoses for cracks or softness. Check clamps for looseness. Check coolant level and check for evidence of coolant leaks from engine.

– Check that radiator fins are not blocked with dirt or debris. Clean radiator using low-pressure water or compressed air. Blow outward, from engine side out.

– To check coolant pump:
  - Remove mechanical cooling fan. See **Mechanical (viscous clutch) cooling fan, removing and installing**.
  - Remove drive belt from coolant pump pulley. See **020 Maintenance**.
  - Firmly grasp opposite sides of pulley and check for play in all directions.
  - Spin pulley and check that shaft runs smoothly without play.

  NOTE —
  The coolant provides lubrication for the pump shaft, so an occasional drop of coolant leaking from the pump is acceptable. If coolant drips steadily from the vent hole, replace the pump.

– At normal engine operating temperature, cooling system is pressurized. This raises boiling point of coolant. Leaks may prevent system from becoming pressurized. If visual evidence is inconclusive, pressure test cooling system as described later to help pinpoint hard-to-find leaks.

– If cooling system is full of coolant and holds pressure:
  - Use an appropriate scan tool to interrogate engine control module (ECM) for radiator fan or DME control circuit faults.
  - Check for loose or worn drive belt.
  - Test for failed thermostat or coolant pump impeller. Some pumps may be fitted with plastic impellers.

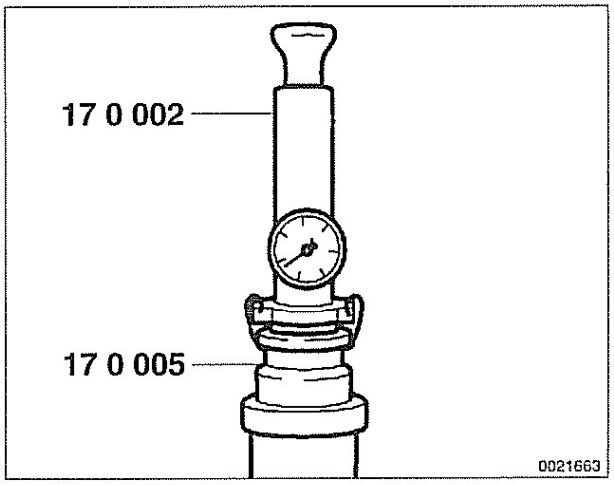
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- Check for clogged/plugged radiator or coolant passages.

Cooling system pressure test

A cooling system pressure tester is used to test for coolant leaks, including internal ones. Common sources of internal coolant leaks are a faulty cylinder head gasket, a cracked cylinder head, or a cracked engine block.

WARNING—
At normal operating temperature the cooling system is pressurized. Allow the system to cool before opening. Release the cap slowly to allow safe release of pressure.



With engine cold, install pressure tester (BMW special tools 17 0 002/17 0 005 or equivalent) to expansion tank. Pressurize system to specification listed in **Table a. Cooling system test pressures**.

- Pressure should not drop more than 0.1 bar (1.45 psi) for at least two minutes.
- If pressure drops rapidly and there is no sign of external leakage, cylinder head gasket may be faulty. Perform compression and leak-down tests.
- Test expansion tank cap using pressure tester with correct adapter (BMW special tool 17 0 007 or equivalent). Replace faulty cap or cap gasket.

Table a. Cooling system test pressures

Component	Test pressure
Radiator	1.5 bar (21.75 psi)
Radiator cap	2 bar (29 psi)

CAUTION—
Exceeding the specified test pressure could damage the radiator or other system components.

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Combustion chamber leak test

– If you suspect that combustion chamber pressure is leaking into the cooling system past the cylinder head gasket, use an exhaust gas analyzer to test the vapors rising from the coolant at the expansion tank.

> ***CAUTION—***
> - *Use an extension tube above the reservoir neck to maintain distance between the top of the coolant and the gas analyzer nozzle. The gas analyzer is easily damaged if it is allowed to inhale liquid coolant.*
> - *While running engine to check for causes of overheating, observe coolant temperature carefully in order to avoid engine damage.*

Thermostat

If the engine overheats or runs too cool and no other cooling system tests indicate trouble, the thermostat may be faulty.

In V-8 models and 6–cylinder models produced after 9/1998 (M52 TU or M54 engine), the electrically heated thermostat is monitored by the OBD II diagnostic software. The fault may lie in the DME software or hardware, or it may lie in the wiring to the thermostat. See **OBD On-Board Diagnostics**.

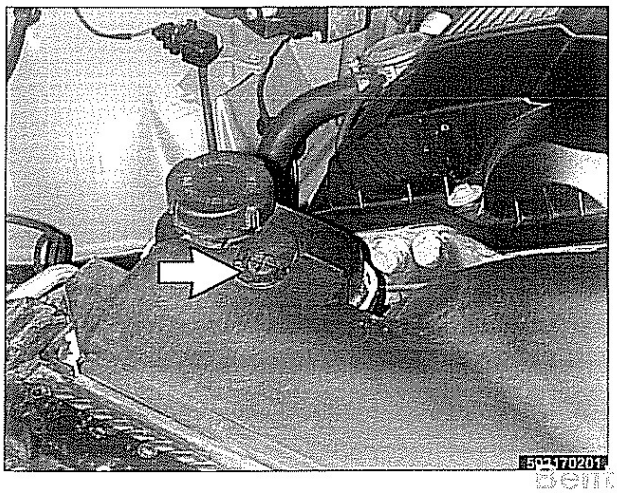
Cooling System Service

Coolant, draining and filling (6-cylinder models)

> ***WARNING—***
> *Allow the cooling system to cool before opening or draining the cooling system.*

– Raise front of 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.*



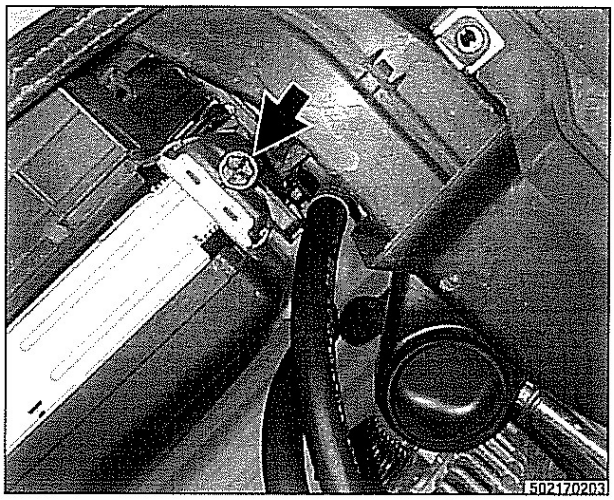
– Remove splash shield from under engine.

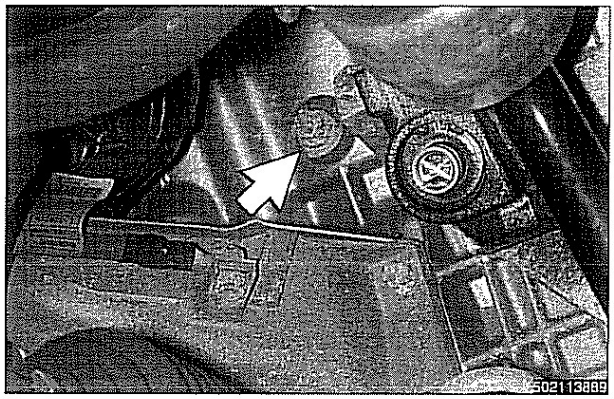
➢ Loosen radiator bleed screw at top radiator fitting (**arrow**).

– Remove cap from radiator expansion tank. Set temperature controls to full warm.

– Place 3-gallon pail underneath radiator.

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Remove drain plug (**arrow**) at bottom of radiator.

> ***WARNING —***
> *Coolant is poisonous. It is especially lethal to pets. Clean up spills immediately and rinse the area with water. If coolant is ingested, immediately seek medical attention.*

– Place a 3–gallon pail beneath the engine block. Remove engine block coolant drain plug and drain coolant.

M52 TU / M54 engine: Block drain plug is located on exhaust side of engine block at cylinder 2 (**arrow**).

- M52 engine: Block drain plug is located on exhaust side of engine block between cylinders 3 and 4.

– Reinstall radiator and engine block drain plugs using new sealing washers.

– Before refilling radiator:
  - Switch ignition to ON. (Do not start engine).
  - Set temperature controls to full warm.
  - Set blower control to low.

– Using a coolant mixture of 50% antifreeze and 50% distilled water, fill expansion tank slowly. Continue until coolant emerges from bleed screw. Cooling system capacity is listed in **Table c. Cooling system capacity (6–cylinder models).**

NOTE —
- *Be sure radiator bleed screw is loose when filling cooling system.*
- *Tap water may cause corrosion of radiator, engine and coolant hoses.*
- *Coolant can be reused provided it is clean and less than two years old. Do not reuse coolant when replacing damaged engine parts.*

– Bleed cooling system. See **Cooling system, bleeding.**

Table c. Cooling system capacity (6–cylinder models)

Engine	Capacity
M52, M52TU, M54	10.5 liters (11.1 US qts)

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Tightening torques	
Block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2-3 Nm (18-27 in-lb)

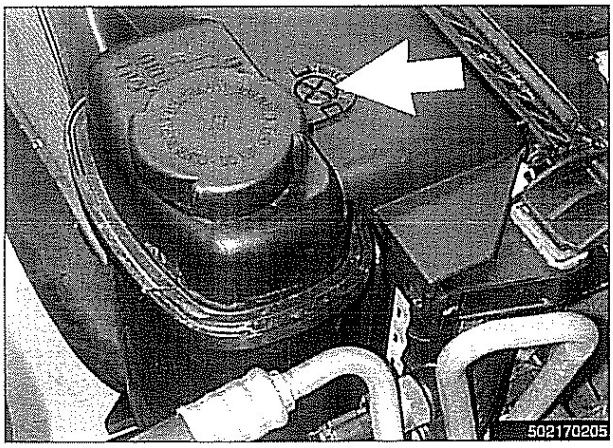
Coolant, draining and filling (V-8 models)

WARNING—
Allow the cooling system to cool before opening or draining the cooling system.

– Raise front of 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.

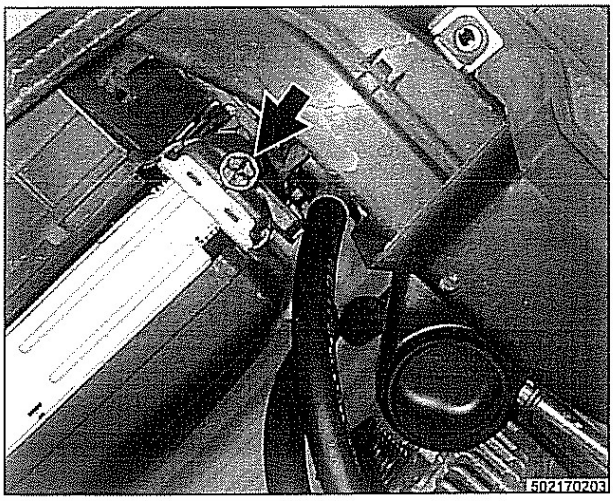
– Remove splash shield from under engine.



◁ Loosen radiator bleed screw at top radiator fitting (**arrow**).

– Remove cap from radiator expansion tank. With ignition switch in ON position, set temperature controls to full warm.

– Place 5-gallon pail underneath radiator.

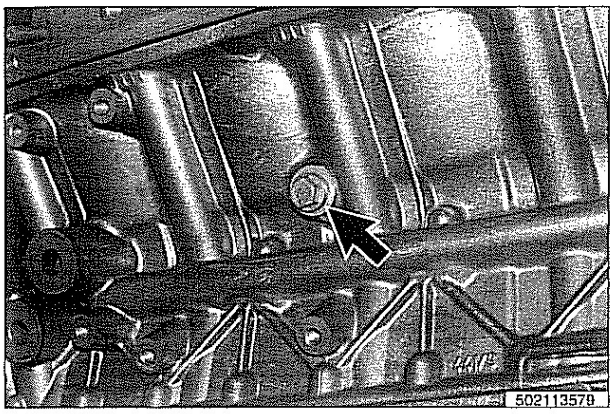


◁ Remove drain plug (**arrow**) on bottom of radiator and allow coolant to drain.

NOTE—
For radiators without drain plug, remove lower hose to drain radiator.

WARNING—
Coolant is poisonous. It is especially lethal to pets. Clean up spills immediately and rinse the area with water. If coolant is ingested, immediately seek medical attention.

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V-8 engine block drain plugs (one shown at **arrow**) are located on each side of engine block (exhaust manifold removed for photo).

– Place 5–gallon pail underneath engine block coolant drain plugs.

– Remove engine block coolant drain plugs and drain coolant.

– Reinstall radiator and engine block drain plugs using new sealing washers.

– Before refilling radiator:
  - Switch ignition to **ON**. (Do not start engine).
  - Set temperature controls to full warm.
  - Set blower control to low.

– Using a coolant mixture of 50% antifreeze and 50% distilled water, fill expansion tank slowly. Continue until coolant emerges from bleed screw. Cooling system capacity is listed in **Table d. Cooling system capacity (V-8 models)**.

NOTE—
- *Be sure radiator bleed screw is loose when filling cooling system.*
- *Tap water may cause corrosion of radiator, engine and coolant hoses.*
- *Coolant can often be reused provided it is clean and less than two years old. Do not reuse coolant when replacing damaged engine parts.*

– Bleed cooling system. See **Cooling system, bleeding**.

Table d. Cooling system capacity (V-8 models)

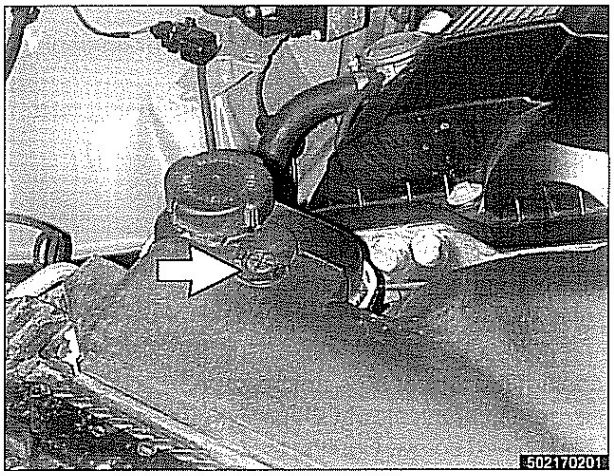
Engine	Capacity
M62, M62 TU	12.0 liters (12.7 US qts)

Tightening torques	
Block drain plug	25 Nm (18 ft-lb)
Radiator drain plug	2 - 3 Nm (18 - 27 in-lb)

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Cooling system, bleeding

Trapped air in the cooling system can prevent proper coolant circulation and overheating. Whenever the coolant is drained and filled, bleed the cooling system to remove trapped air.



- Loosen bleed screw (**arrow**) on radiator expansion tank.
- Set temperature controls in passenger compartment to full warm, set blower to low setting and turn ignition to ON position (do not start engine).

> ***CAUTION—***
> *On late model cars with latent heat pump, do not turn ignition to ON position.*

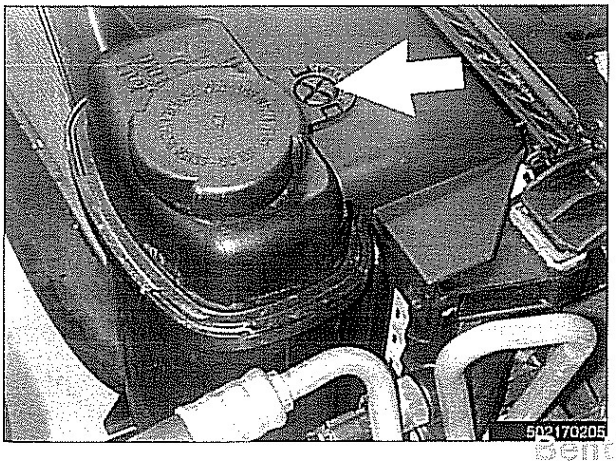
- Slowly add coolant/distilled water mixture to expansion tank until it spills from bleed screw. When coolant spilling from bleed screws is free of air bubbles, tighten screw and replace cap on expansion tank.
  - Run engine until it reaches operating temperature.
  - After engine has cooled, recheck coolant level.
  - Top up so that coolant level indicator is at MAX.
- If trapped air cannot be bled manually, pressure-bleed system using cooling system pressure tester.

> ***CAUTION—***
> *Always use genuine BMW coolant or its equivalent to avoid the formation of harmful, clogging deposits in the cooling system.*

Tightening torque

Radiator bleed screw to radiator	2.5 Nm (22 in-lb)

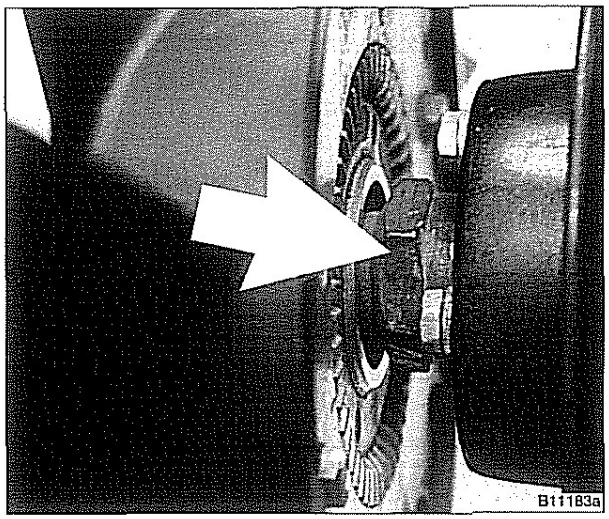
Mechanical (viscous clutch) cooling fan, removing and installing

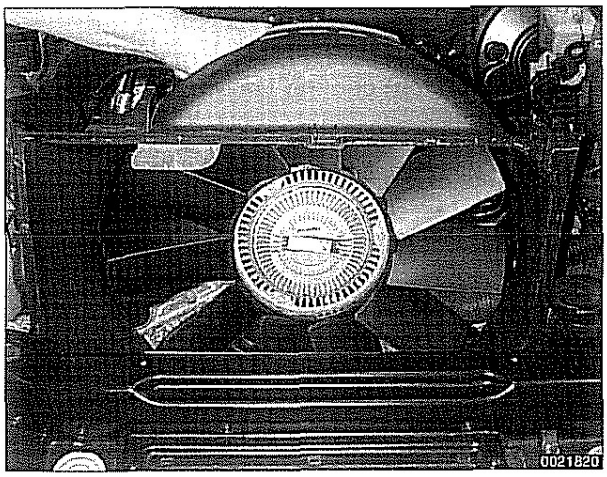


The procedure given here describes the removal of the mechanical fan and fan shroud. It is possible to remove the fan without the shroud.

- Working at top of fan shroud:
  - Remove expansion tank bleed screw (**arrow**) and expansion tank locking tabs.
  - Push top of expansion tank toward engine and lift to free from lower mounts.
- Remove two expansion rivets in upper corners of fan shroud. Unclip expansion tank bleed hose located under shroud.

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– Remove rubber trim strip between top of shroud and radiator.

◀ Using 32 mm wrench (BMW special tool 11 5 040) on fan clutch nut (**arrow**), turn wrench in a clockwise direction (working from front of car) while counterholding pulley with BMW special tool 11 5 030. Spin fan off coolant pump.

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

– Unclip AUC (air quality) sensor from shroud.

– M54 engine: Disconnect auxiliary coolant pump from base of fan shroud.

◀ Lift fan and shroud together out of engine compartment.

– To replace fan clutch, remove fan mounting bolts and separate viscous clutch from fan.

– Installation is reverse of removal.

Tightening torques	
Clutch nut to pump	
• Without BMW tool 11 5 040	40 Nm (29 ft-lb)
• With BMW tool 11 5 040	30 Nm (22 ft-lb)
Fan to viscous clutch	10 Nm (89 in-lb)

Electric cooling fan, removing and installing

The electric cooling fan is mounted behind the front bumper, in front of the A/C condenser.

– Remove front bumper. See **510 Exterior Trim, Bumpers**.

– Remove left and right headlights. See **630 Lights**.

– Where applicable, detach horizontal air ducts behind front bumper and fold to side.

– Disconnect fan electrical connector on right side of radiator shroud and lay aside.

– Detach wire loom from air duct in front of cooling fan.

– Pry out expansion rivets holding air duct. Slide air duct downward to remove.

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– Remove fan and fan shroud mounting fasteners. Slide fan and fan shroud downward to remove.

– Reinstallation is reverse of removal.

Thermostat, removing and installing (M52 engine)

The coolant thermostat is installed in a housing at the front of the engine.

– Drain coolant from radiator and engine block. See **Coolant, draining and filling (6–cylinder models)**.

> ***WARNING—***
> *Allow the cooling system to cool before opening or draining the system.*

– Remove mechanical cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

– Disconnect coolant hoses from thermostat housing.

– Remove thermostat housing from front of engine.

– Remove thermostat. Note thermostat direction and orientation before removing.

– Installation is reverse of removal, noting the following:

- Use new O-ring and gasket(s) when installing thermostat and housing.

NOTE—
Some thermostats have a direction arrow or vent hole near the edge. Install the thermostat so that either the arrow or hole are at the top.

- Fill system with coolant as described in **Coolant, draining and filling (6–cylinder models)**.

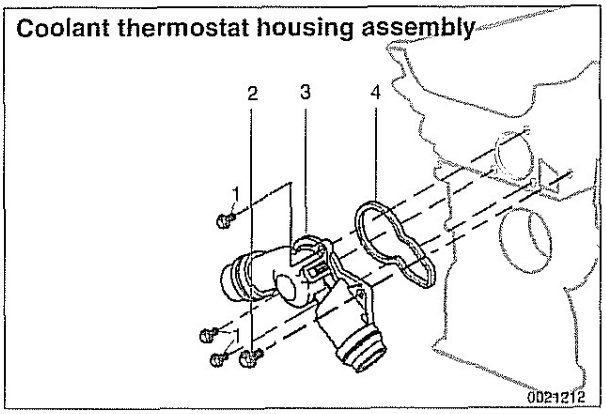
> ***CAUTION—***
> *Be sure to reconnect ground wire(s) at thermostat housing mounting bolt, where applicable.*

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Tightening torques	
Block drain plug to block	25 Nm (18 ft-lb)
Coolant hose clamp (32 — 48 mm hose diameter)	2. 5 Nm (22 in-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat housing to cylinder head	10 Nm (89 in-lb)

Thermostat, removing and installing (M52 TU or M54 engine)

Coolant thermostat housing assembly



The electric map-controlled thermostat is part of the thermostat housing at the front of the cylinder head.

1. Bolts (M6)
2. Bolt (M8)
3. Housing with thermostat
4. Gasket

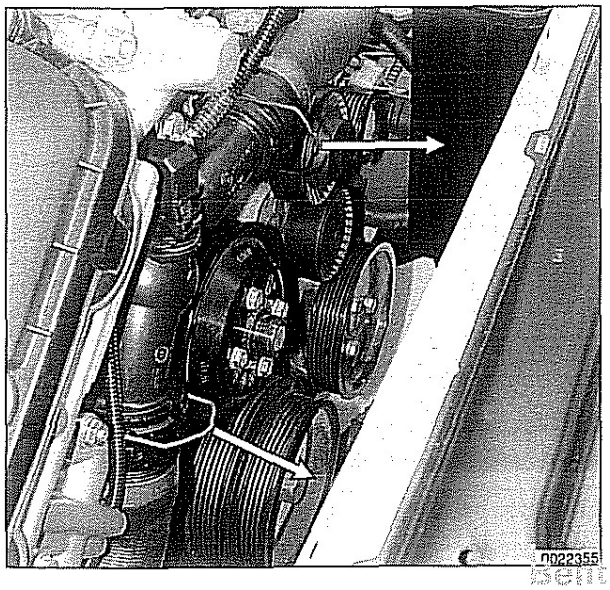
– If a faulty thermostat is suspected, use appropriate scan tool to interrogate ECM for stored fault codes.

– Drain radiator and engine block. See **Coolant, draining and filling (6–cylinder models)**.

> ***CAUTION—***
> *Allow cooling system to cool before opening or draining the system.*

– Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

– Disconnect electrical harness connector from thermostat housing.



Lever out retaining clips (**arrows**) and pull hose fittings off thermostat housing.

– Unbolt and remove thermostat housing from front of engine. Loosen nut at top of engine lifting eye to facilitate removal.

– Installation is reverse of removal, noting the following:

- Keep sealing faces free of oil.
- Use new sealing gasket.
- When reinstalling hose to thermostat housing, install clip on hose end fitting, then push hose onto housing until it clicks into place.
- Fill system with coolant. See **Coolant, draining and filling (6–cylinder models)**.

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Tightening torques	
Block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat housing to cylinder head	10 Nm (89 in-lb)

Thermostat, removing and installing (V-8 models)

The electrically-heated thermostat is an integral part of the thermostat housing. The operation of the thermostat is monitored by the engine control module (ECM).

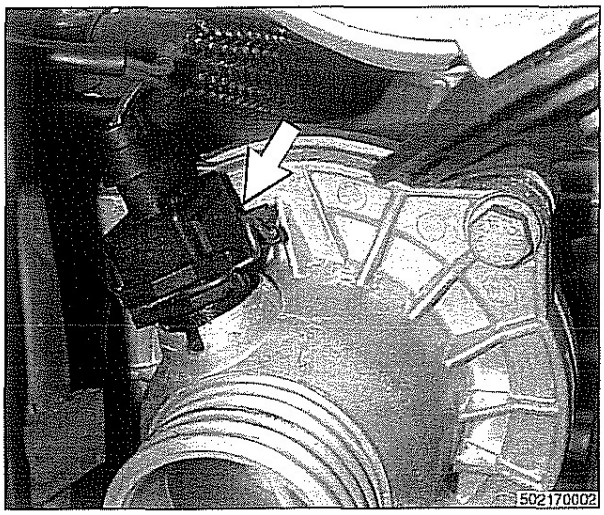
– If a faulty thermostat is suspected, use appropriate scan tool to interrogate ECM for stored fault codes.

– Drain radiator and engine block. See **Coolant, draining and filling (V-8 models)**.

> ***WARNING —***
> *Allow cooling system to cool before opening or draining the system.*

– Disconnect mass air flow (MAF) sensor electrical harness connector. Remove air intake duct together with MAF sensor.

– Remove mechanical cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

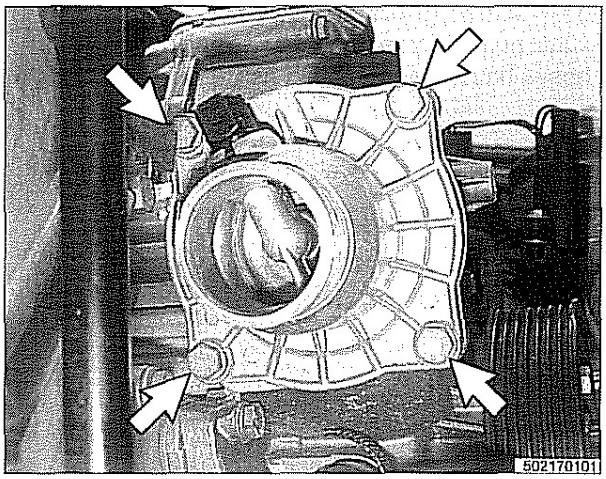


Disconnect electrical harness connector (**arrow**) from thermostat housing.

– Remove coolant hose from thermostat housing.

NOTE —
- *M62 engine: Hose is clamped on.*
- *M62 TU engine: Hose is attached with quick-disconnect fitting. Remove clip to disconnect hose.*

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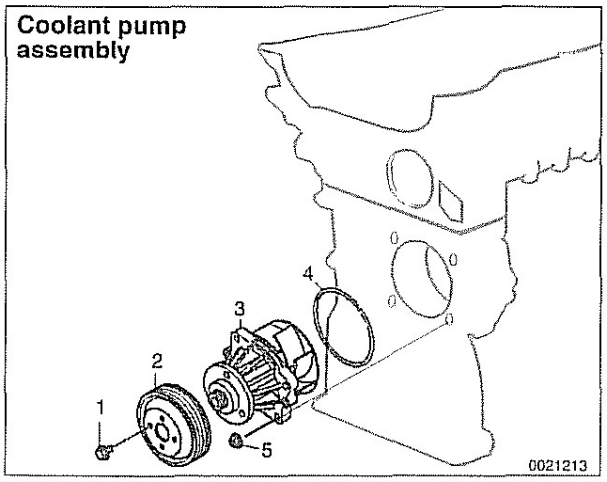
➢ Remove thermostat housing fasteners (**arrows**) and remove thermostat housing.

– Installation is reverse of removal, noting the following:
  - Keep sealing faces clean and free of oil.
  - Use new sealing gasket.
  - Fill system with coolant. See **Coolant, draining and filling (V-8 models)**.

Tightening torques

Block drain plug to block	25 Nm (18 ft-lb)
Coolant hose clamp (32 — 48 mm hose diameter)	2. 5 Nm (22 in-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat cover to coolant pump	10 Nm (89 in-lb)

Coolant pump, replacing (6–cylinder models)



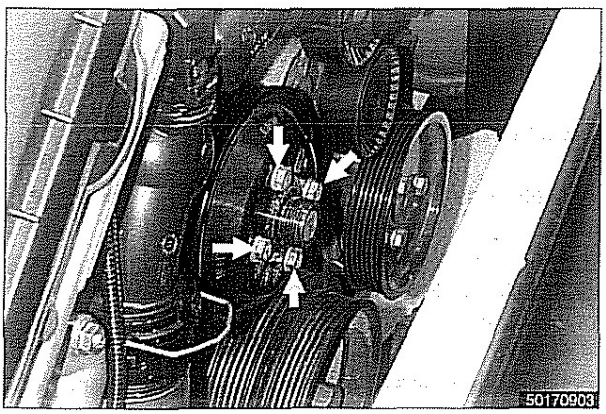
➢ The engine coolant pump is mounted in the front of the engine in the timing chain cover.

– Drain cooling system as described earlier. See **Coolant, draining and filling (6–cylinder models)**.

> ***WARNING —***
> *Allow cooling system to cool before opening or draining system.*

– Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

– Remove coolant pump drive belt. See **020 Maintenance**.

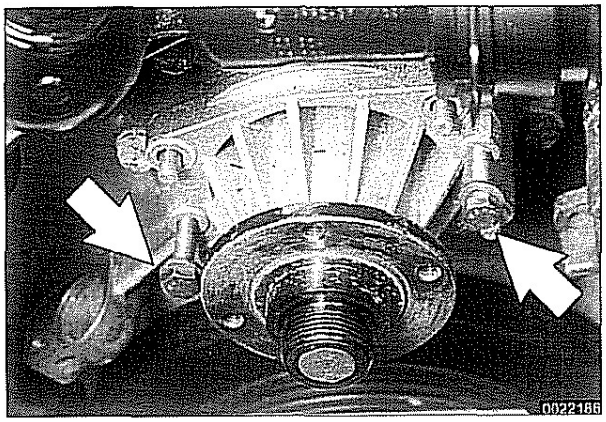


➢ Remove coolant pump pulley bolts (**arrows**) and remove pulley from pump.

– Remove nuts retaining pump to engine block.

NOTE —
The coolant pump is mounted on studs and retained by nuts.

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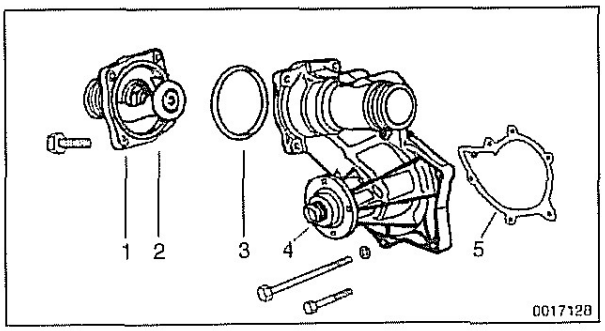


- Insert two M6 screws (**arrows**) in tapped bores and tighten uniformly until pump is free from timing chain cover (thermostat and hoses have been removed for purposes of visual clarity).

- Installation is reverse of removal, noting the following:
  - Be sure to replace sealing O-ring and gaskets.
  - Coat O-ring with water-based lubricant during installation.
  - Refill with coolant. See **Coolant, draining and filling (6–cylinder models)**.

Tightening torques	
Coolant pump to timing chain cover	10 Nm (89 in-lb)
Coolant pump pulley to coolant pump	10 Nm (89 in-lb
Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)

Coolant pump, replacing (V–8 models)



- *The engine coolant pump is mounted in the front of the engine in the timing chain cover.*

1. Thermostat housing
2. Thermostat
3. Thermostat sealing O-ring
4. Water pump
5. Water pump gasket

- Drain cooling system. See **Coolant, draining and filling (V-8 models)**.

- Remove cooling fan and fan shroud. See **Mechanical (viscous clutch) cooling fan, removing and installing**.

- *Remove engine drive belts: See* **020 Maintenance**.

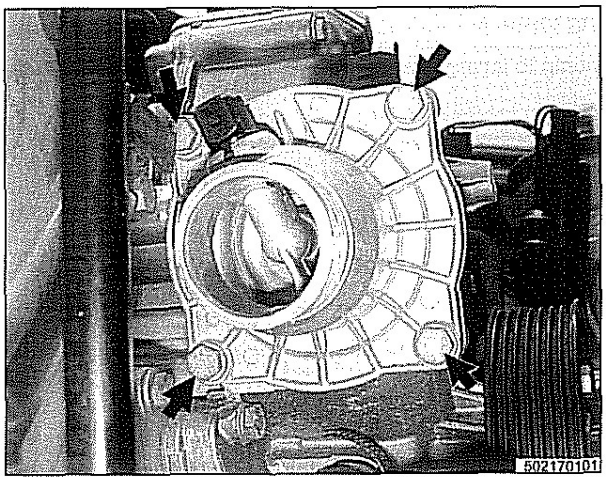
NOTE—
Mark direction of drive belt rotation if reusing belt.

- Remove vibration dampener. See **117 Camshaft and Timing Chain**.

- Disconnect mass air flow (MAF) sensor electrical harness connector. Remove air intake duct together with MAF sensor.

- *Disconnect coolant hoses from thermostat housing and coolant pump housing.*

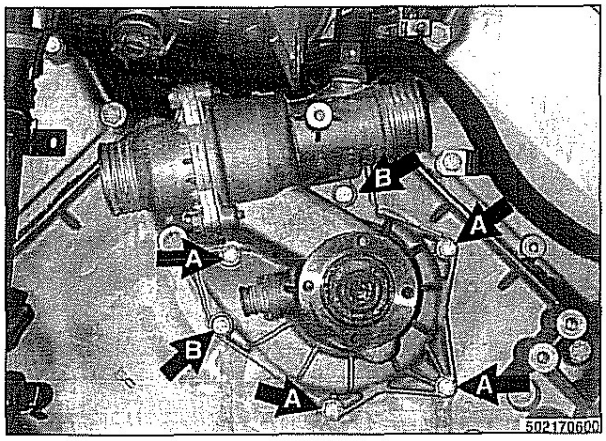
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– Disconnect thermostat and cooling system temperature sensor plug connectors.

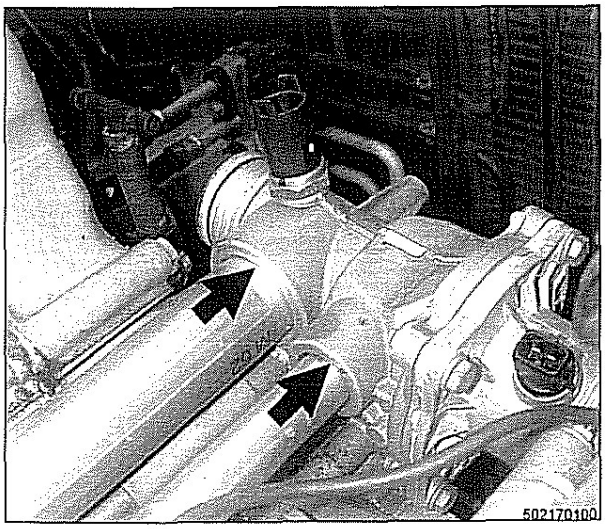
➢ Remove thermostat housing fasteners and remove housing.

– Remove coolant pump pulley bolts and remove pulley from pump.



➢ Remove fasteners A and B (**arrows**).

NOTE—
- *The coolant pump is retained to the block using different length bolts.*
- *Bolts A: M6 X 105 mm*
- *Bolts B: M6 X 35 mm*



➢ Slide coolant pump away from coolant pipes (**arrows**) while being careful not to dislodge pipes from fittings at rear of engine.

– Installation is reverse of removal, noting the following:
- Replace all sealing O-rings and washers.
- Coat O-rings with water-based lubricant during installation.
- Fill system with coolant. See **Coolant, draining and filling (6-cylinder models)** or **Coolant, draining and filling (V-8 models)**.

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Tightening torques	
Coolant pump to timing chain cover	10 Nm (89 in-lb)
Coolant pump pulley to coolant pump	10 Nm (89 in-lb
Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)
Thermostat cover to coolant pump assembly	10 Nm (89 in-lb)

Radiator, removing and installing

Removal of the radiator is similar for V-8 and 6–cylinder models.

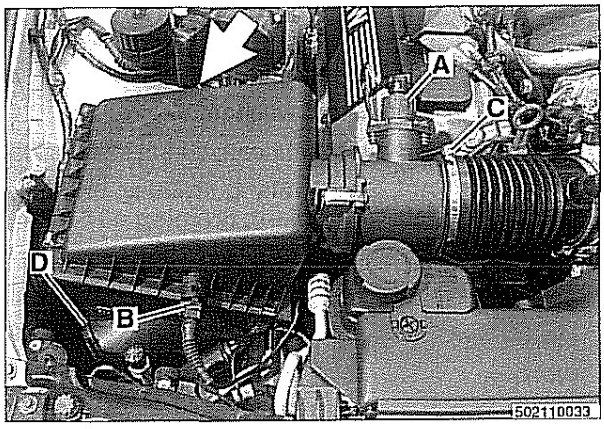
– Raise front of car and support safely.

> ***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.*

– Remove splash shield from under engine.

– Drain radiator and engine block. See **Coolant, draining and filling (V-8 models)**.

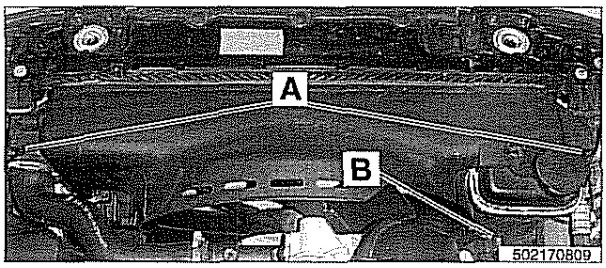
> ***WARNING —***
> *Allow cooling system to cool before opening or draining system.*



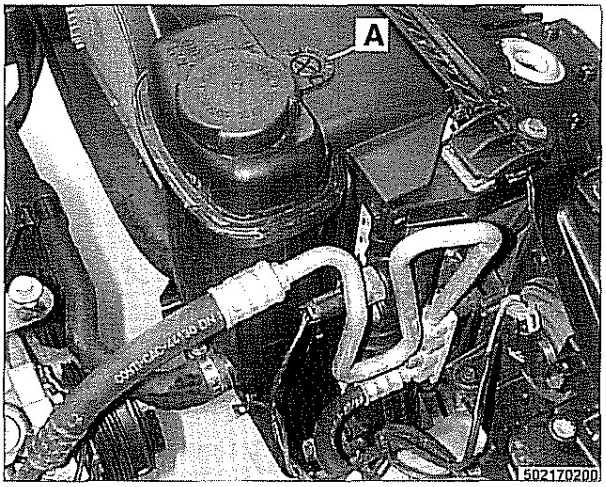
Remove air filter housing:

- Disconnect electrical harness connectors (**A** and **B**).
- Loosen clamps (**C** and **D**).
- Remove mounting fastener (**arrow**) and remove air filter housing together with mass air flow (MAF) sensor.

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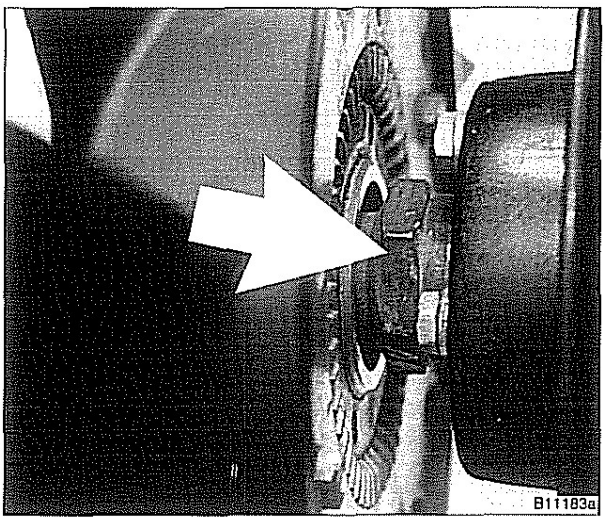


➢ Pry out expansion rivets (**A**) on left and right side of fan shroud. Loosen hose clamp (**B**) and remove hose from expansion tank.



➢ Remove expansion tank:

- Remove expansion tank cap, vent plug (**A**) and tank retaining clips (**arrows**).
- Lift expansion tank upward and off lower retaining lugs.
- Push shroud back to expose expansion tank vent line. Remove line.

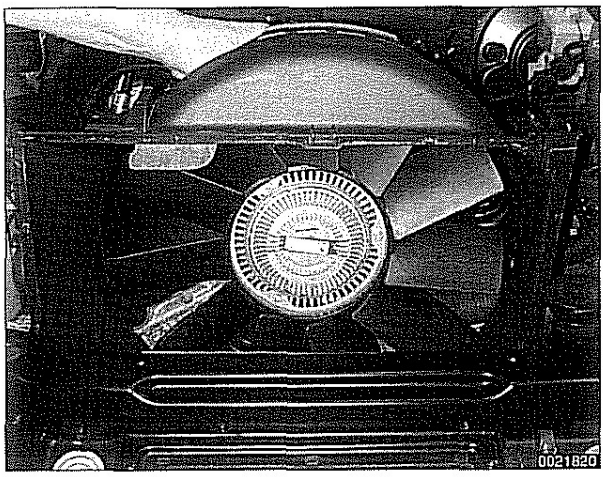


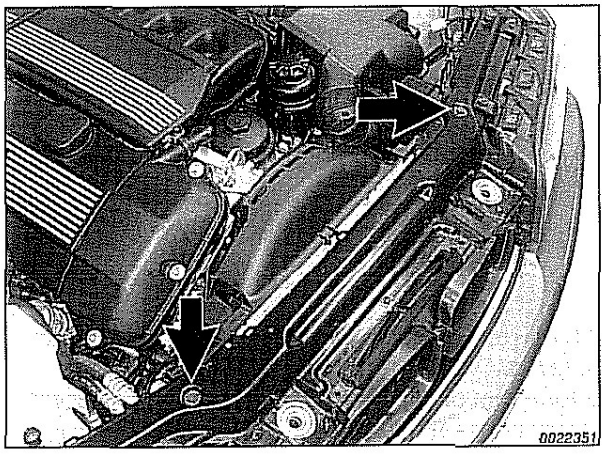
➢ Using 32 mm wrench (BMW special tool 11 5 040) on fan clutch nut (**arrow**), turn wrench in a clockwise direction (working from front of car) while counterholding pulley with BMW special tool 11 5 030. Spin fan off coolant pump.

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

– Disconnect electrical harnesses from AUC (air quality) sensor and coolant level sensor.

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➢ Lift fan and shroud together out of engine compartment.

– Detach upper and lower radiator hoses.

NOTE—
Later models use retaining clips to fasten coolant hoses to expansion tank and radiator.

– Disconnect temperature sensor harness connector.

➢ Remove radiator support bolts and supports (**arrows**). 6–cylinder shown.

– Slide right side of radiator back toward engine and pull radiator up to remove.

– Installation is reverse of removal, noting the following:

- Fill radiator and cooling system. See **Coolant, draining and filling (6–cylinder models)** or **Coolant, draining and filling (V-8 models).**

Tightening torques

Engine block drain plug to block	25 Nm (18 ft-lb)
Radiator drain plug to radiator	2 - 3 Nm (18 - 27 in-lb)

Expansion tank, removing and installing

– Raise front of car and support safely.

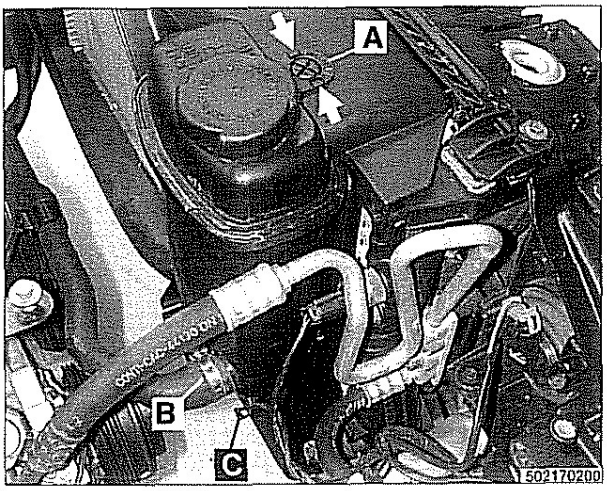
WARNING—
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

– Remove splash shield from under engine.

– Drain radiator as described earlier. See **Coolant, draining and filling (6–cylinder models)** or **Coolant, draining and filling (V-8 models).**

WARNING—
Allow cooling system to cool before opening or draining system.

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➢ Disconnect expansion tank:

- Remove expansion tank bleed screw and support clip (**A**).
- Loosen hose clamp (**B**) and disconnect coolant hose from expansion tank.
- Disconnect harness connector from coolant level sensor (**C**).
- Push top of expansion tank toward engine and disconnect bleed hose.
- Lift expansion tank to free it from lower mounts, then lift straight up to remove.

– Installation is reverse of removal, noting the following:

- *Fill radiator and cooling system as described earlier. See **Coolant, draining and filling (6–cylinder models)** or **Coolant, draining and filling (V-8 models)**.*



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180 Exhaust System

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GENERAL

The exhaust system is designed to be maintenance free, although regular inspection is warranted due to the harsh operating conditions. Under normal conditions, the catalytic converter does not require replacement unless it is damaged.

EXHAUST SYSTEM

New fasteners, clamps, rubber mounts and gaskets should be used when replacing exhaust components. A liberal application of penetrating oil to the exhaust system nuts and bolts in advance may make removal easier.

WARNING —

- *The exhaust system and catalytic converter operate at very high temperatures. Allow components to cool before servicing. Wear protective clothing to prevent burns. Do not use flammable chemicals near a hot catalytic converter.*
- *Corroded exhaust system components crumble easily and often have exposed sharp edges. To avoid injury, wear eye protection and heavy gloves when working with old exhaust parts.*

Exhaust system, removing and installing

The removal and installation procedures given here are general procedures for all models. The removal of the exhaust system as a complete unit is recommended. Once the complete system is removed from the car, individual pipes and mufflers can be more easily replaced.

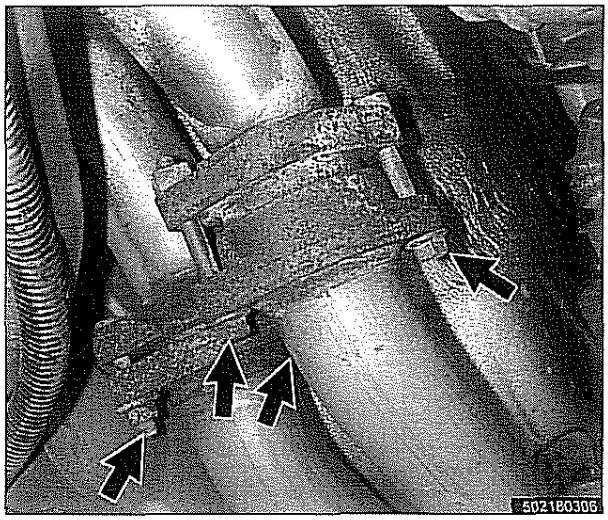
WARNING —

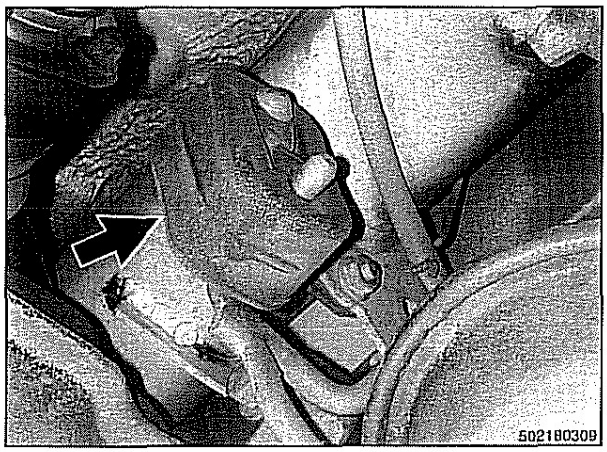
Exhaust gases are colorless, odorless, and very toxic. Run the engine only in a well-ventilated area. Immediately repair any leaks in the exhaust system or structural damage to the car body that might allow exhaust gases to enter the passenger compartment.

CAUTION—

Use care not to drag or bang oxygen sensors. Oxygen sensors can be easily ruined.

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– With exhaust system fully cold, raise and support car for access to exhaust system.

> ***WARNING —***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

– Disconnect oxygen sensor connector(s).

◀ Loosen and remove bolts holding front exhaust pipes to exhaust manifolds (**arrows**). Right side of V8 model shown.

– Support exhaust system.

– Where applicable, disconnect exhaust support bracket assembly from transmission.

◀ Remove hangers by prying off bracket (**arrows**).

– Lower exhaust system as a single unit to ground.

NOTE —
If the catalytic converter/front exhaust pipe assembly is to be replaced, transfer the oxygen sensors to the new pipe(s).

Tightening torque	
Oxygen sensor	55 Nm (41 ft-lb)

– Installation is reverse of removal.
- Make sure there is at least 20 mm (3/4 in.) clearance between exhaust system and car body at every point.
- Loosely install all exhaust system mounting hardware and hangers before tightening fasteners to their final torque.
- Coat manifold studs with copper paste before installing nuts.

NOTE —
Where applicable, tighten front pipe with semi-flexible compensator last when installing front pipe to manifolds.

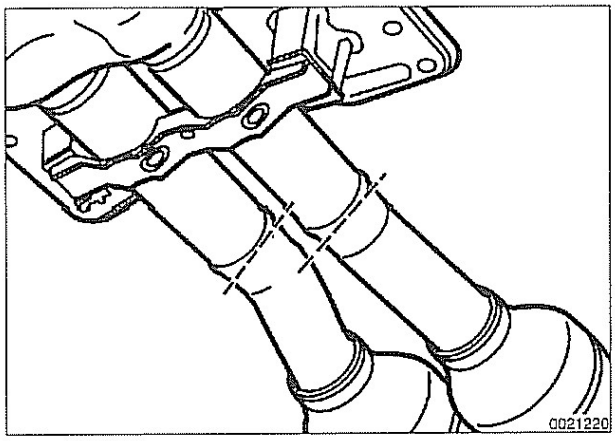
Tightening torques	
Exhaust manifolds to cylinder head	22 Nm (17 ft-lb)
Front exhaust pipe to manifolds	30 Nm (22 ft-lb)

To prevent exhaust system rattles and vibration, the system should be slightly preloaded by pushing the rear clamping brackets forward about 7 mm (1/4 in).

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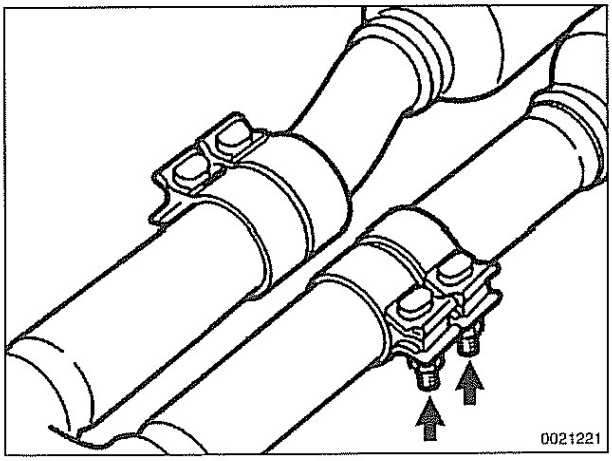
Muffler, replacing

BMW offers individual mufflers as replacement parts for the original one-piece assembly. Replacement of a rear muffler may be possible with the system installed on the car. Replacement of the front or middle muffler should only be done with the exhaust removed from the car.



➢ Mark length of new muffler pipe(s) on old system.

– Use exhaust pipe cutter to cut pipe(s). Deburr cut pipe end(s).



➢ Use clamping sleeves to join new pipe(s) to old.

- Make sure pipe ends are centered inside sleeve.
- Point clamping sleeve bolt threads (**arrows**) down.

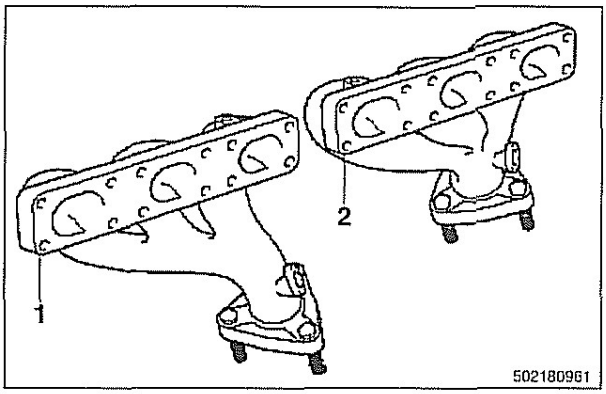
– Reinstall exhaust system.

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EXHAUST MANIFOLDS

Exhaust manifold removal procedures are organized according to engine code. If necessary, see **100 Engine-General** for engine code and application information.

Exhaust manifolds, removing and installing (M52 engine)



Exhaust manifolds for the M52 engine.

Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.

– With exhaust system cold, raise and support car for access to exhaust system.

> ***WARNING —***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

– Disconnect secondary air check valve and pipe from exhaust manifold.

– Unbolt front exhaust pipe(s) from exhaust manifold(s).

– Remove exhaust support bracket from transmission.

– Loosen and remove nuts from exhaust manifolds and remove manifolds. Discard nuts and gaskets.

NOTE —
On cars with oxygen sensors mounted in the exhaust manifolds, use care when removing manifolds. To be safe, remove the sensors from the manifolds before removing manifolds.

– Installation is reverse of removal.

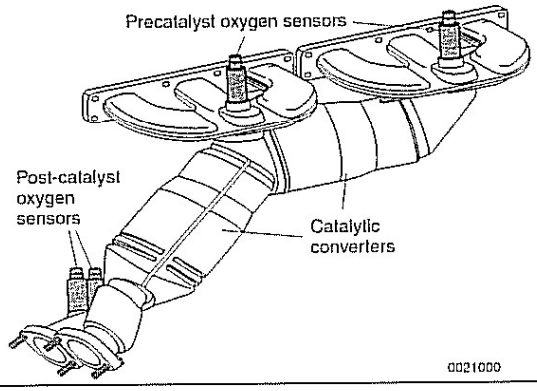
- Coat exhaust manifold mounting studs with copper paste before installing new nuts.
- Install manifold gaskets with arched side facing manifolds.

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

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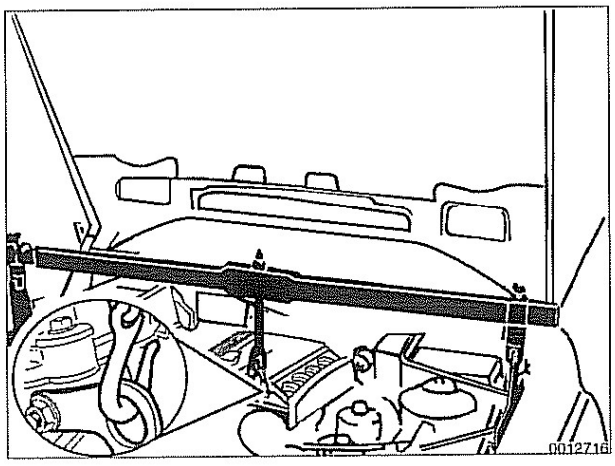
Exhaust manifolds, removing and installing (M52 TU and M54 engines)

Exhaust manifolds with converters



➢ The exhaust manifolds incorporate the catalytic converters. Two precatalyst and two post-catalyst oxygen sensors are mounted in the exhaust manifold assembly.

Under normal conditions, the catalytic converters do not require replacement unless damaged. Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.



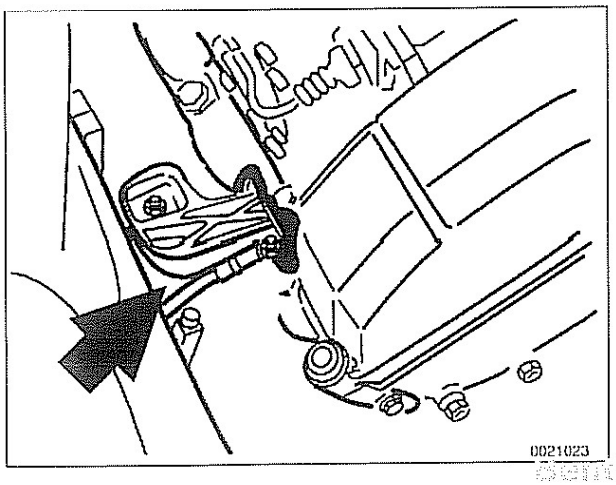
➢ Using engine support equipment (BMW special tools 00 0 200, 00 0 201, 00 0 202, 00 0 204, 00 0 208 or equivalent), connect to lifting eye on front of engine. Raise engine approx. 5 mm (1/4 in).

– With exhaust system cold, raise and support car for access to exhaust system.

> ***WARNING—***
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

– In order to avoid damaging oxygen sensors:
- Detach oxygen sensor harness connectors.
- Remove oxygen sensors from exhaust manifolds as described later in this group.

> ***CAUTION—***
> *Take care that the front and rear oxygen sensor connectors are not mixed up.*



– Unbolt and remove secondary air check valve and pipe from right front of cylinder head/exhaust manifold.

– Working underneath car, unbolt front exhaust pipes from exhaust manifolds.

➢ With engine supported from above, remove right engine mount bracket and right engine mount (**arrow**).

– Loosen and remove nuts from exhaust manifolds and remove manifolds. Discard nuts and gaskets.

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NOTE—
The front exhaust manifold must be removed before the rear manifold.

– Installation is reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new gaskets and self-locking nuts.

Tightening torques	
Exhaust manifold to cylinder head	20 Nm (15 ft-lb)
Front exhaust pipe to manifold	30 Nm (22 ft-lb)
Oxygen sensor to manifold	50 Nm (37 ft-lb)

Exhaust manifolds, removing and installing (M62 engine)

Always use new retaining nuts and gaskets when removing and installing the exhaust manifolds.

NOTE—
Access to manifolds is extremely limited. If removing exhaust manifolds as part of additional engine work (such as cylinder head removal), it may be easier to first remove engine.

– With exhaust system cold, raise and support car for access to exhaust system.

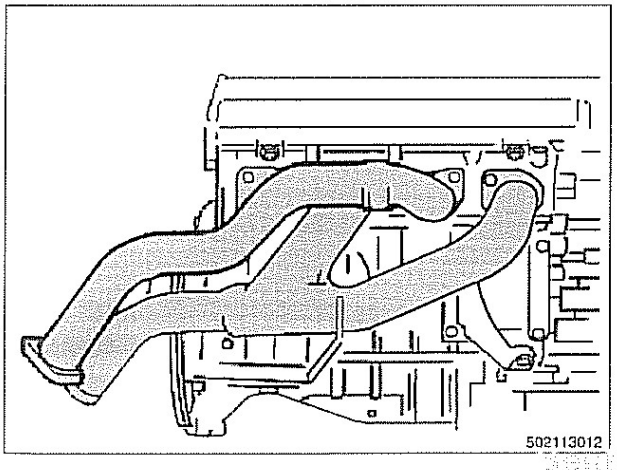
> *WARNING—*
> *Do not work under a lifted car unless it is solidly supported on jack stands designed for the purpose. Never work under a car that is supported solely by a jack.*

– Remove exhaust system. See **Exhaust system, removing and installing.**

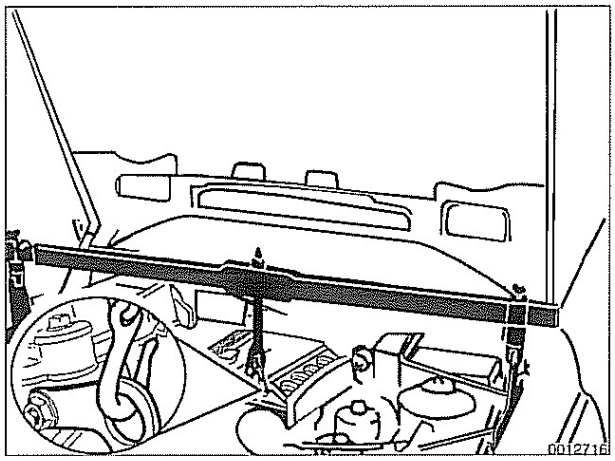
– Removing right side exhaust manifolds (cylinder bank 1–4):
  - Remove heat baffle plate.
  - Disconnect plug connection to oxygen sensor.

➢ Remove nuts securing exhaust manifolds to head.
  - Remove manifolds towards bottom.

– Installation is the reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new gaskets and self-locking nuts.



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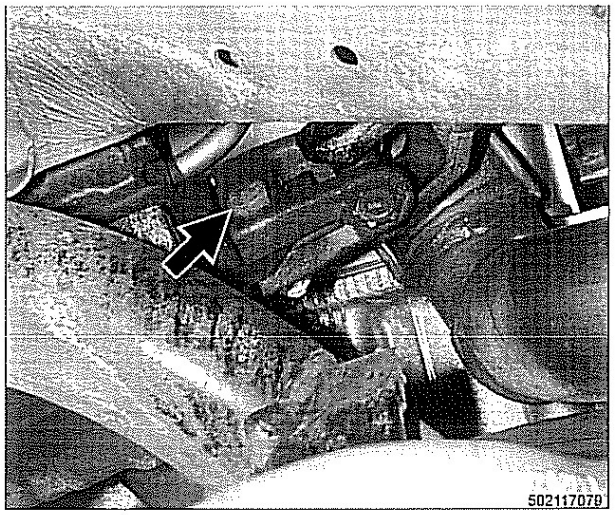
– Removing left side exhaust manifolds (cylinder bank 5–8):
  - Remove heat baffle plate on left side.
  - Remove oxygen sensor using BMW special tool 11 7 030 or similar oxygen sensor socket.

Install BMW special tools 00 0 200, 00 0 201, 00 0 202, 00 0 204, and 00 0 208 or other suitable engine lifting support above engine and attach to lifting eye on left head.

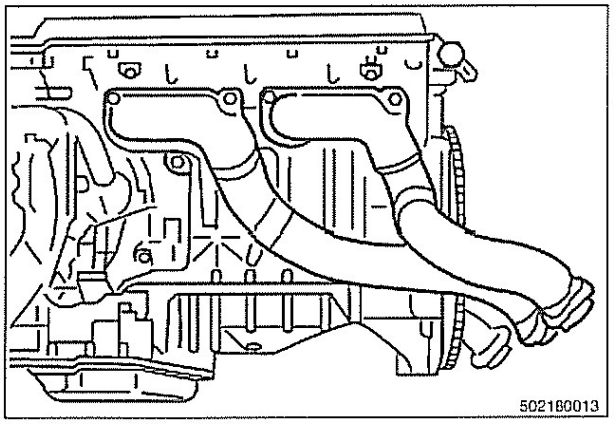
NOTE—
The supports on special tool 00 0 208 must rest on the screws on the fenders.

– Remove nut at top of engine support on left side.

– Raise engine at front suspension lug a maximum of 25 mm (1.0 in).



Release clamping bolt and nut (**arrow**) and slide universal joint off steering gear.



Remove nuts securing left exhaust manifold to head.
  - Raise front of manifold as high as possible past end position of steering gear and feed out towards bottom.

– Installation is reverse of removal.
  - Coat exhaust mounting studs with CRC or equivalent copper paste.
  - Use new exhaust gaskets and self-locking nuts.
  - Install new self-locking nuts on engine mount and steering shaft bolt.

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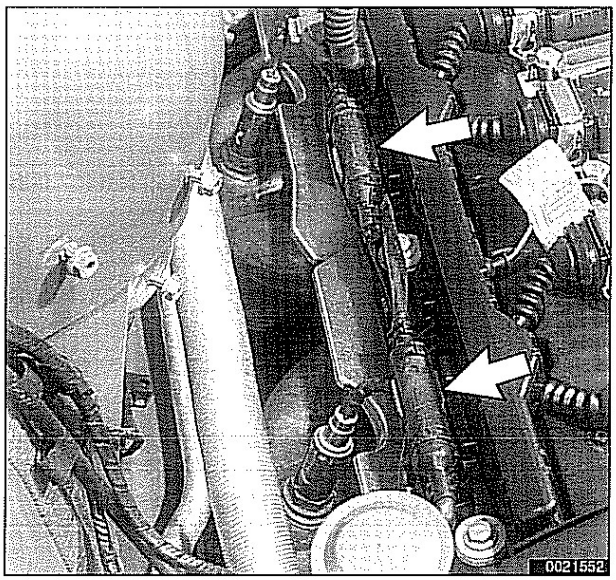
OXYGEN SENSORS

Oxygen sensors (precatalyst), replacing (M52 TU and M54)

The precatalyst oxygen sensors are installed at the top of the exhaust manifolds.

WARNING—
Allow components to cool before servicing.

– Using BMW scan tool DISplus (Diagnostic Information System) or equivalent, read out and clear ECM fault codes.



➢ Working at right side of engine above exhaust manifolds, remove front or rear oxygen sensor harness connector (**arrows**) from bracket, then separate plug.

NOTE—
In photo, secondary air pump has been removed for clarity.

– Remove oxygen sensor using special oxygen sensor removal socket.

– Installation is reverse of removal.

- New sensor threads come coated with anti-seize paste.
- If reusing a sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
- Install harness and connector in original location.

Tightening torque	
Oxygen sensor to manifold	50 Nm (37 ft-lb)

Oxygen sensors (post-catalyst), replacing (M52 TU and M54)

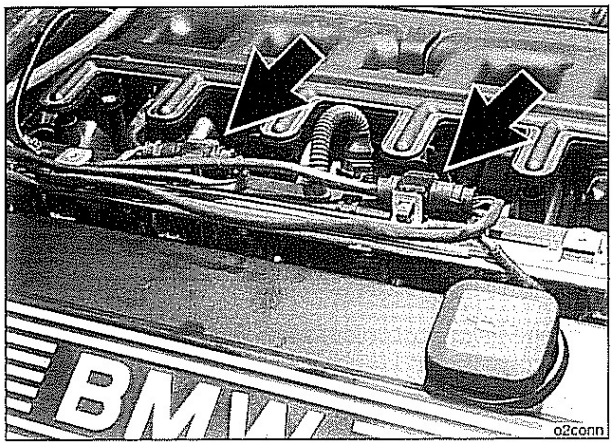
The post-catalyst oxygen sensors are installed at the rear of the catalytic converters.

WARNING—
Allow components to cool before servicing.

– Using BMW scan tool DISplus or equivalent, read out and clear ECM fault codes.

– Remove large cover from above fuel rail/intake manifold.

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Label and disconnect sensor harness connectors (arrows).

> ***CAUTION—***
> *Label connectors so that front and rear connectors are not mixed up.*

– Detach harness from guides and brackets.

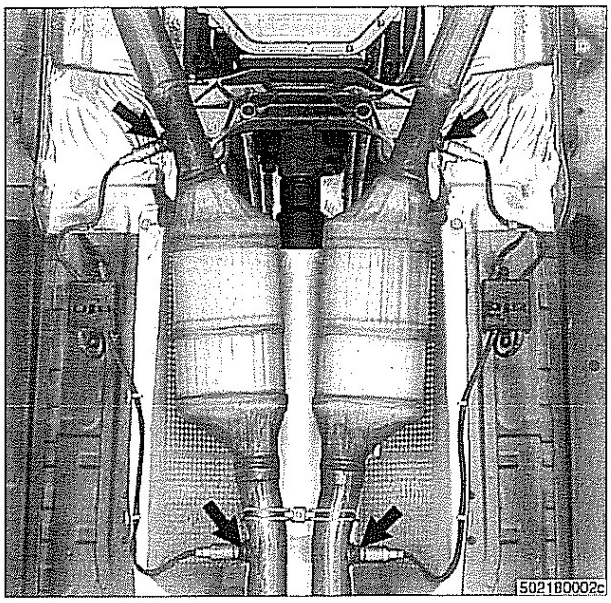
– Remove oxygen sensor from exhaust manifold using special tool 11 7 030 or equivalent.

– Installation is reverse of removal.
  - New sensor threads come coated with anti-seize paste.
  - If reusing old sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
  - Install harness and connector in original location.

Tightening torque	
Oxygen sensor to manifold	50 Nm (37 ft-lb)

Oxygen sensor, replacing (M52 and M62 engine)

The sensors are installed at the front and rear of the catalytic converters.



> ***WARNING—***
> *Allow components to cool before servicing.*

– Using BMW scan tool DISplus or equivalent, read out and clear ECM fault codes.

– Detach harness from guides and brackets.

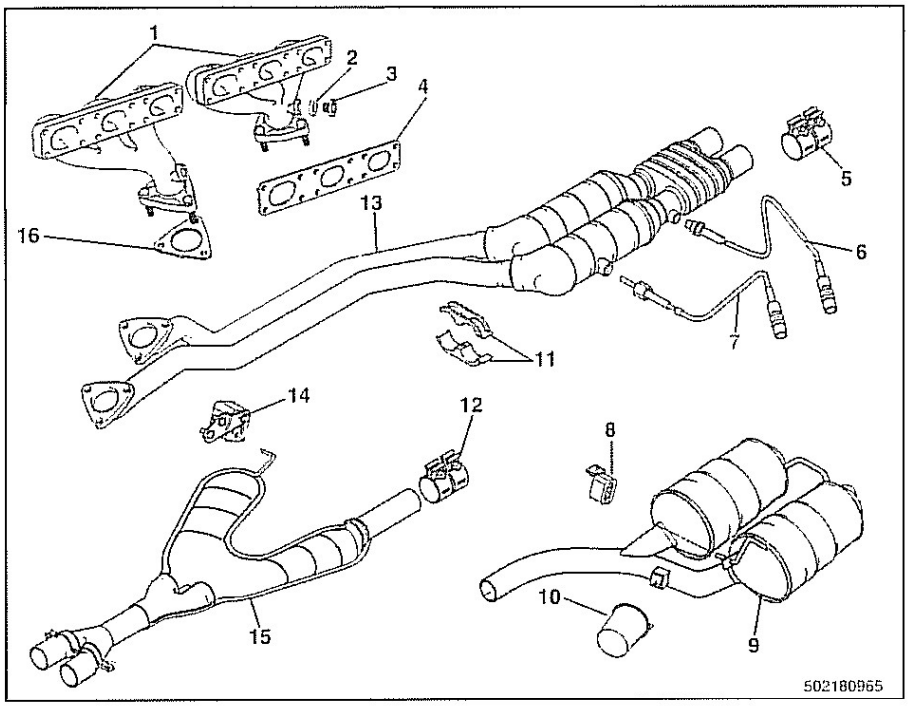
Remove oxygen sensors (**arrows**) from exhaust using special tool 11 7 030 or equivalent.

– Installation is reverse of removal.
  - New sensor threads come coated with anti-seize paste.
  - If reusing a sensor, apply thin coat of anti-seize paste to threads only. Do not contaminate tip of sensor with paste or lubricants of any sort.
  - Install harness and connector in original location.

Tightening torque	
Oxygen sensor to manifold	50 Nm (37 ft-lb)

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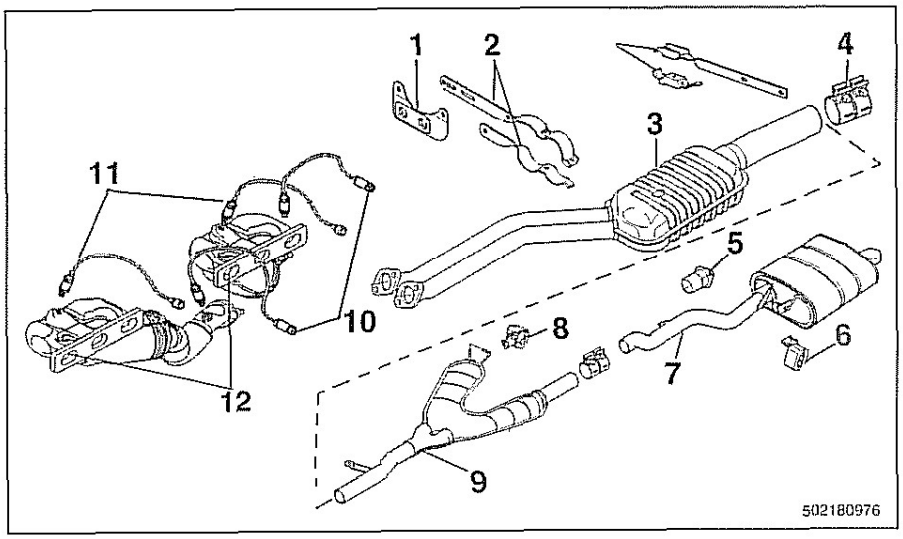
EXHAUST SYSTEM DIAGRAMS



M52 engine (528i 1997–1998)

1. Exhaust manifolds
2. Sealing washer
3. Plug
4. Gasket (manifold to cylinder head)
5. Clamping sleeve
6. Post-catalytic converter oxygen sensor
7. Pre-catalytic converter oxygen sensor
8. Hanger
9. Rear muffler
10. Vibration dampener
11. Center support bracket
12. Clamping sleeve
13. Front pipe with catalytic converters
14. Hanger
15. Center muffler
16. Gasket (front pipe to manifold)

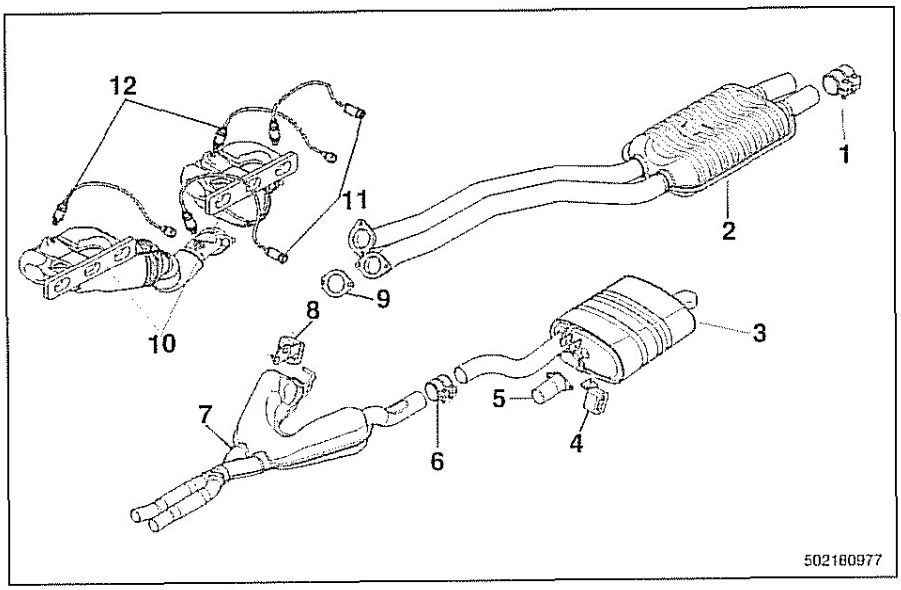
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M52 TU and M54 engines (528i 1999–2000 and 525i 2001–2003)

1. Transmission bracket
2. Center support bracket
3. Front muffler
4. Clamping sleeve
5. Vibration dampener
6. Hanger
7. Rear muffler
8. Hanger
9. Center muffler
10. Oxygen sensors, post-catalytic converter
11. Oxygen sensors, pre-catalytic converter
12. Exhaust manifold/catalytic converter assemblies

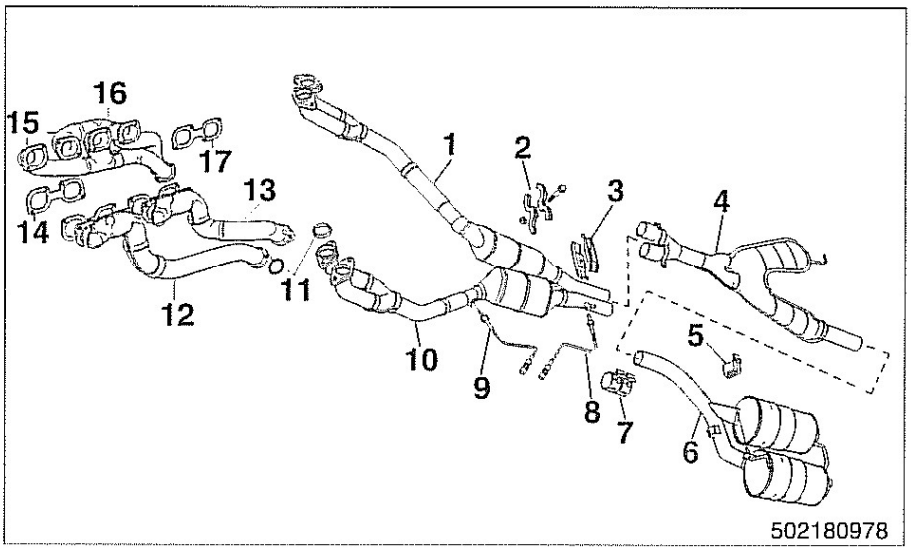
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M54 engine (530i 2001–2003)

1. Clamping sleeve
2. Front muffler
3. Rear muffler
4. Hanger
5. Vibration dampener
6. Clamping sleeve
7. Center muffler
8. Hanger
9. Gasket (front pipe to manifold)
10. Exhaust manifold/catalytic converter assemblies
11. Oxygen sensors, post-catalytic converter
12. Oxygen sensors, pre-catalytic converter

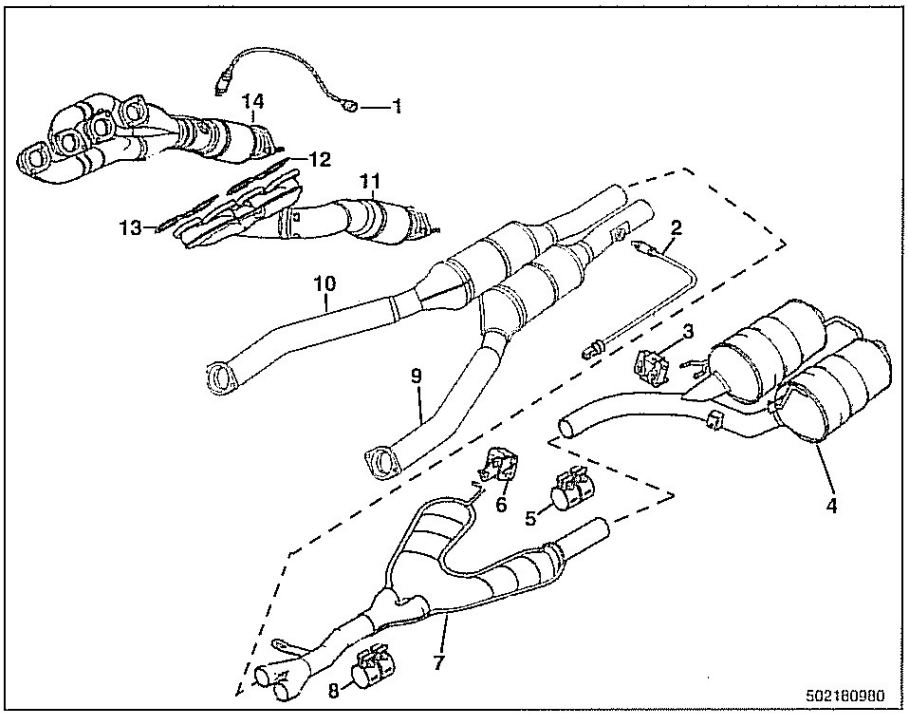
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M62 engine (540i 1997–1998)

1. Right side catalytic converters
2. Support bracket
3. Support bracket
4. Center muffler
5. Hanger
6. Rear muffler
7. Clamping sleeve
8. Oxygen sensors, post-catalytic converter
9. Oxygen sensors, pre-catalytic converter
10. Left side catalytic converter
11. Sealing rings
12. Left front exhaust manifold
13. Left rear exhaust manifold
14. Gasket
15. Exhaust manifold, right front
16. Exhaust manifold, right rear

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M62 TU engine (540i 1999–2003)

1. Oxygen sensors, pre-catalytic converter (2)
2. Oxygen sensors, post-catalytic converter (2)
3. Hanger
4. Rear muffler
5. Clamping sleeve
6. Hanger
7. Center muffler
8. Clamping sleeve
9. Catalytic converter, left side
10. Catalytic converter, right side
11. Exhaust manifold/catalytic converter, left side
12. Gasket (2)
13. Gasket (2)
14. Exhaust manifold/catalytic converter, right side



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