

113 Cylinder Head Removal and Installation

GENERAL 113-1

M30 CYLINDER HEAD 113-1

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GENERAL

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

The procedures are organized according to engine code. If necessary, see **100 Engine-General** for engine code and application information.

NOTE—

If a head gasket problem is suspected, a compression test will usually detect a faulty gasket. See 100 Engine-General for compression testing information.

M30 CYLINDER HEAD

Cylinder head cover gasket, replacing (M30 engine)

WARNING—

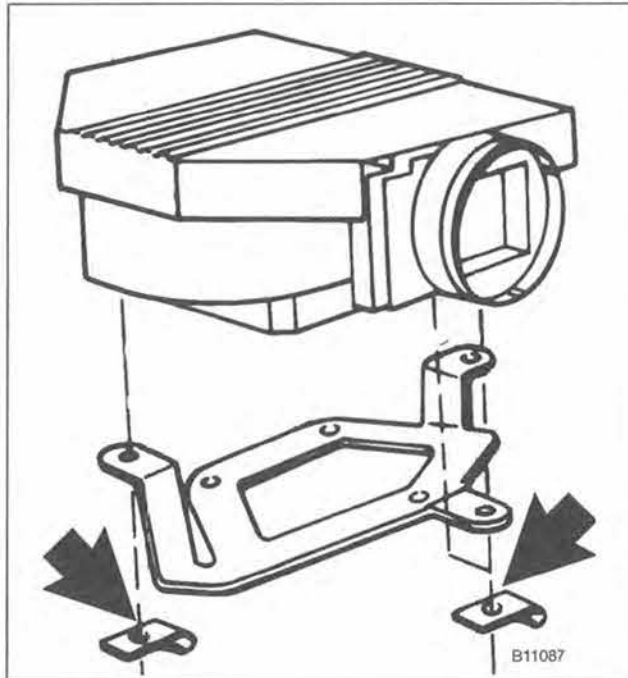
Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.

- Loosen hose clamps for intake air ducts (A), disconnect harness connector from air flow sensor (B) and remove idle air stabilizer bracket mounting nut (C). Pull idle air valve out of intake boot.



M30 CYLINDER HEAD

113-2 CYLINDER HEAD REMOVAL AND INSTALLATION



- Remove retaining clips (**arrows**) from underside of air flow sensor. Remove sensor and air ducts.
- Disconnect center wire from ignition coil. Disconnect ignition wires from spark plugs. Remove ignition wiring harness mounting nuts and place harness aside.



- Remove cylinder head cover nuts and bolts (**arrows**).
- Disconnect crankcase (PCV) breather hose from cylinder head cover.
- Lift off cylinder head cover and its gasket.
- Clean old gasket and sealant from sealing surfaces. Install a new gasket, then reinstall cylinder head cover.
- Installation is reverse of removal.
 - Starting with inner fasteners, tighten cylinder head cover mounting nuts and bolts using a crisscross pattern.
 - Be sure to reconnect all hoses.

Tightening Torque

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

M30 CYLINDER HEAD

Cylinder head, removing (M30 engine)

Cover all painted surfaces before beginning the cylinder head 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 (–) battery cable. See **020 Maintenance**.

CAUTION—

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

- Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—

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

- Disconnect coolant hoses from thermostat housing.
- ◀ Disconnect harness connector and hoses (**arrows**) from coolant reservoir. Remove mounting bolts (**A**) and set reservoir aside.



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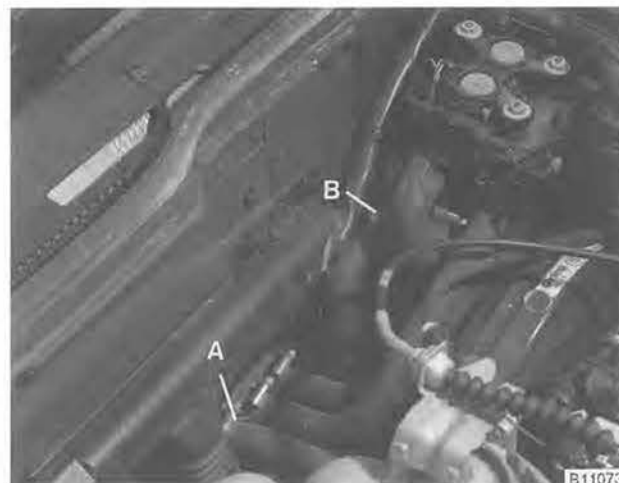
- ◀ Disconnect heater hoses (**A and B**).

- Remove front exhaust pipes from manifolds.

- Loosen air cleaner housing mounting nuts. Loosen intake air boot hose clamps. Disconnect intake air hose and lift air cleaner housing out of car.

NOTE—

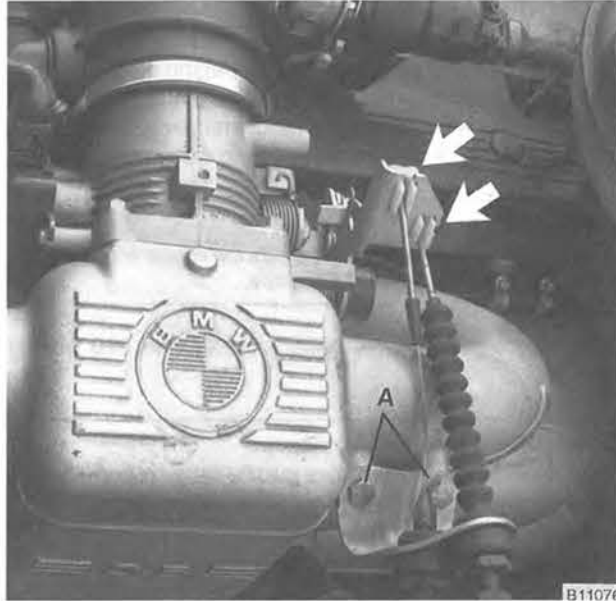
Some hoses may be secured with one-time crimp-type hose clamps. The clamps may be pried loose with a small screwdriver. During reinstallation, replace with standard screw-type clamps.



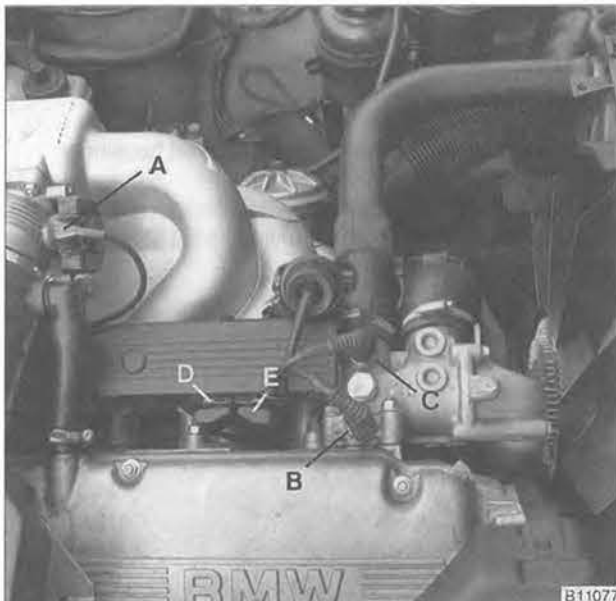
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M30 CYLINDER HEAD

113-4 CYLINDER HEAD REMOVAL AND INSTALLATION



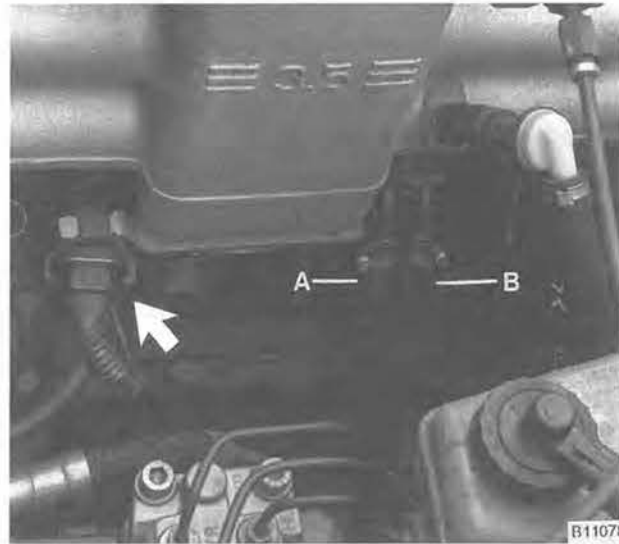
- Detach cables at throttle lever (**arrows**).
- Remove cable bracket bolts (**A**) from intake manifold and move bracket with cables aside.



- Disconnect engine harness connectors **A** through **E**.

A. Throttle switch
B. Coolant temperature sensor
C. Temperature gauge sender
D. Crankshaft position sensor
E. Cylinder identification sender

CYLINDER HEAD REMOVAL AND INSTALLATION 113-5



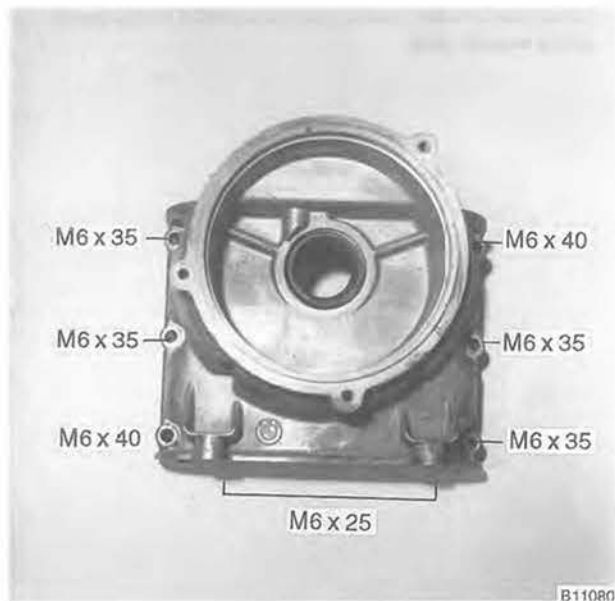
✦ Disconnect harness connector from evaporative control purge valve (**arrow**)

- Disconnect fuel supply (**B**) and return (**A**) lines beneath intake manifold. Label fuel lines.

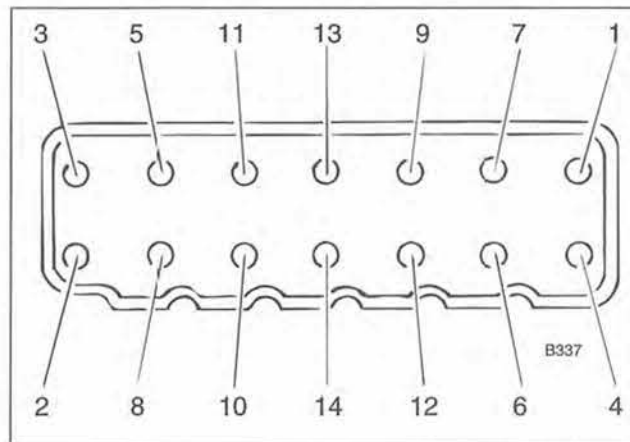
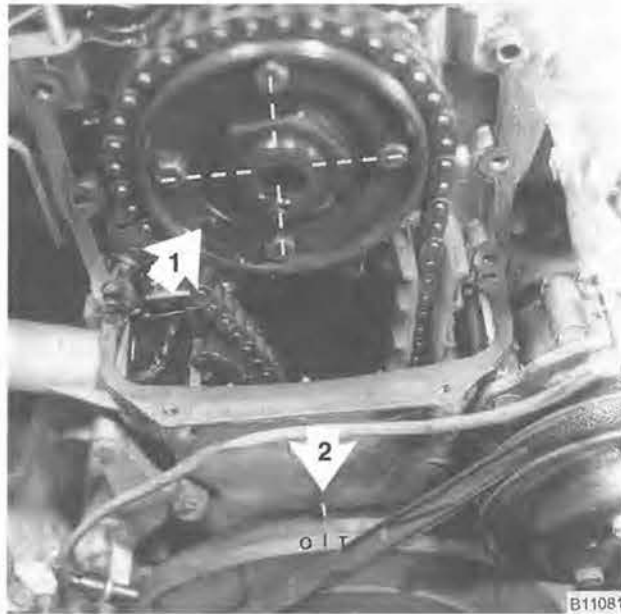
WARNING—

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.

- Disconnect large vacuum hose from brake vacuum booster. Plug opening in vacuum booster.
- Disconnect harness connector from oil pressure switch at left rear corner of cylinder head. Remove main harness from its mounting studs, disconnecting any remaining connectors. Set harness aside.
- Remove distributor cap, spark plug wires and distributor rotor. Remove rotor adaptor and black dust shield from front of camshaft. See **120 Ignition System**.
- Working beneath intake manifold, remove intake manifold support bracket.
- Remove cylinder head cover as described earlier.
- ✦ Remove upper camshaft timing chain cover.



113-6 CYLINDER HEAD REMOVAL AND INSTALLATION



- Set crankshaft and camshaft to TDC position.
 - Position sprocket bolts straight up and down with locating dowel (1) in lower left corner.
 - Check O/T mark on vibration damper alignment with mark on timing chain cover (2).
- Remove timing chain tensioner from side of lower timing chain cover.

CAUTION—

Remove the tensioner slowly. There is a long compressed spring beneath the tensioner plug.

- Remove camshaft sprocket mounting bolts and remove sprocket. Tie chain up using stiff wire.

CAUTION—

The crankshaft should not be allowed to rotate once the camshaft timing chain is removed.

- Check carefully for any remaining connectors, wiring, hoses, brackets, wire ties, clamps or components that will interfere with removal of cylinder head.

- Gradually and evenly loosen and remove cylinder head bolts in sequence shown.
 - Remove cylinder head.

NOTE—

If the head is stuck, use a soft-faced mallet or pry gently with a wooden stick.

Cylinder head, installing (M30 engine)

- Prior to installation, clean cylinder head and gasket surface of cylinder block.
 - Clean threads of head bolts and bolt holes with a thread chaser and remove all foreign matter and any liquid from bolt holes.
 - Avoid letting debris fall into cylinders or oil passages in cylinder block.

CAUTION—

Do not use a metal scraper or wire brush to clean the aluminum engine parts. 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.

- Using a straight edge, check gasket surface of cylinder head and cylinder block for warpage.

NOTE—

If 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.

- Place a new cylinder head gasket on surface of cylinder block. Gasket will fit correctly in only one orientation. Check that two locating dowels are correctly positioned in block and are not damaged.

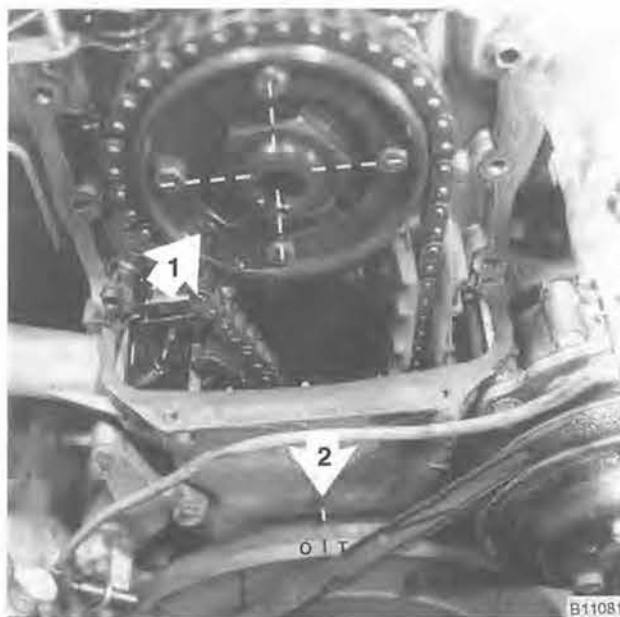
NOTE—

The word "OBEN", printed on the gasket, should face up.



- Set crankshaft and camshaft to TDC position.

- Position sprocket bolts straight up and down with locating dowel (1) in lower left corner.
- Check O/T mark on vibration damper alignment with mark on timing chain cover (2).



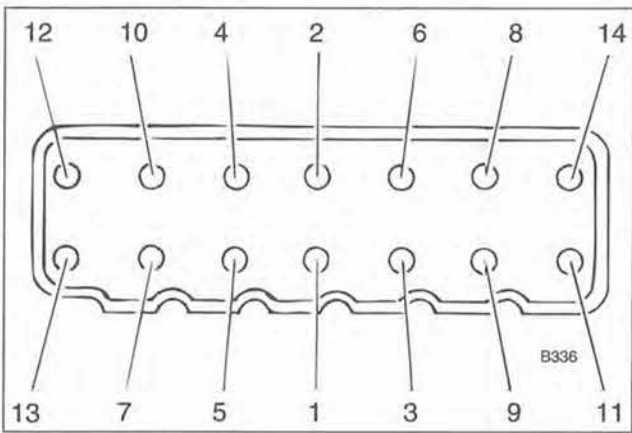
113-8 CYLINDER HEAD REMOVAL AND INSTALLATION

- Place cylinder head on cylinder block. Lubricate head bolts lightly. Loosely install head bolts and their washers.

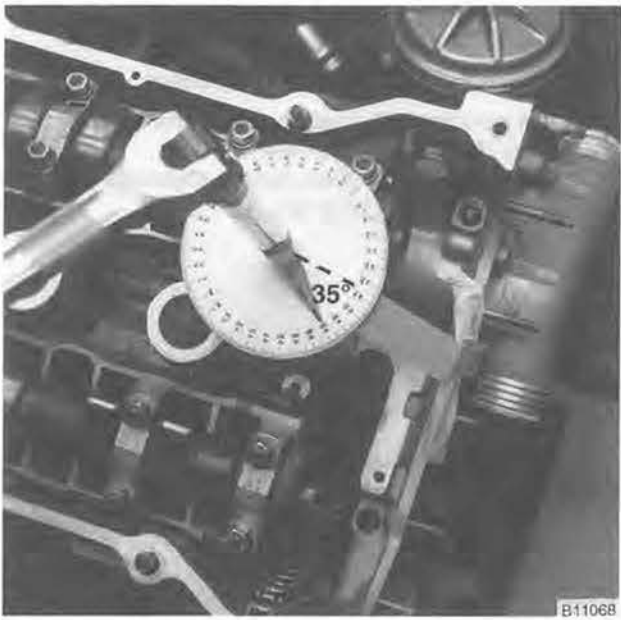
CAUTION—

- Always use new head bolts.
- Head bolts should be tightened in three stages. The final stage requires using a special tool (BMW Tool no. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle.
- The engine must be fully assembled and run for twenty-five minutes before tightening the head bolts to their final torque.

- Tighten new cylinder head bolts in sequence shown.



- Protractor and pointer are used to tighten bolts to specified torque angle.



Tightening Torques (M30 Engine)

- Cylinder head to cylinder block

Stage 1	60 ± 2 Nm (43 ± 1 ft-lb)
Wait 20 minutes	
Stage 2	80 ± 2 Nm (58 ± 1 ft-lb)
Run engine for 25 minutes	
Stage 3	35°

- Mount camshaft sprocket and timing chain so that all chain slack is on tensioner side of chain. Tighten sprocket mounting bolts.
- Install camshaft chain tensioner piston, spring, a new seal and chain tensioner end plug. Leave end plug a little loose.

NOTE—

The tapered end of the spring should face the plug. The cutout in the tensioner piston should engage the tensioner rail.

CYLINDER HEAD REMOVAL AND INSTALLATION 113-9

- Pour a small amount of oil down side of camshaft timing chain cover. Move tensioner rail back and forth slowly until oil runs out past end plug and resistance can be felt at rail, then tighten plug.

Tightening Torque

- Camshaft timing chain tensioner
to lower timing chain cover 40 Nm (30 ft-lb)
-

- Turn engine over by hand at least two full crankshaft rotations. Recheck that camshaft and crankshaft TDC timing marks are correctly aligned.
- Installation of remaining parts is reverse of removal.
 - Adjust valve clearances as described in **116 Cylinder Head and Valvetrain**.
 - Install exhaust front pipe to exhaust manifold using new nuts. Coat exhaust pipe flanges with copper paste prior to installing pipes to manifold, tightening pipe with corrugated section last.
 - Refill cooling system and bleed any trapped air as described in **170 Radiator and Cooling System**.
 - Change engine oil and filter as described in **020 Maintenance**.
 - Adjust accelerator cable as described in **130 Fuel Injection**.
 - When reinstalling upper timing chain cover, use new gaskets and seal lower corners of cover (where cover meets head gasket) using 3-Bond®1207 or equivalent silicon sealer.

Tightening Torques (M30 Engine)

- Camshaft sprocket to
camshaft flange 10 Nm (89 in-lb)
 - Coolant drain plug
to cylinder block 35Nm (25 ft-lb)
 - Cylinder head cover
to cylinder head 10 Nm (89 in-lb)
 - Exhaust pipe to exhaust manifold
(coat flanges with copper paste)
Stage 1 tighten nuts evenly to 10 Nm (89 in-lb)
Stage 2 loosen nuts 1½ turns
 - Ignition rotor adaptor to camshaft (install with
thread locking compound) 23 Nm (17 ft-lb)
 - Radiator cooling fan
to coolant pump 40 Nm (30 ft-lb)
 - Radiator drain screw to radiator 2.5 Nm (22 in-lb)
 - Upper timing chain cover
to cylinder head 10 Nm (89 in-lb)
-

113-10 CYLINDER HEAD REMOVAL AND INSTALLATION

M60 CYLINDER HEADS

Cylinder head cover gaskets, replacing (M60 engine)

This procedure covers replacement of both left and right cylinder head cover gaskets.

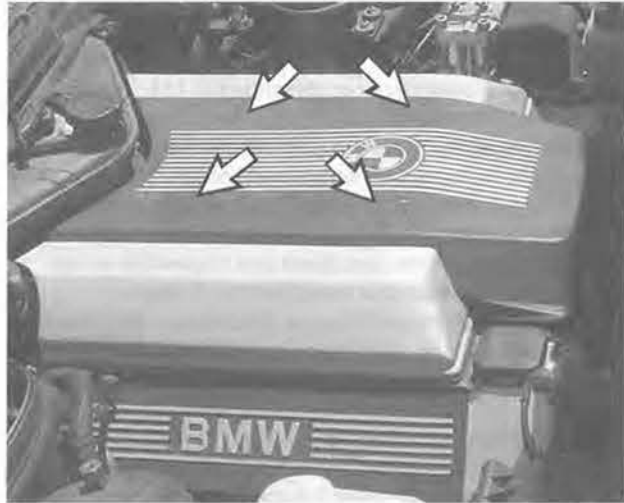
WARNING—

Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.

- Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

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



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- Remove plastic covers from top of engine.
 - Pry out plugs (**arrows**) from covers.
 - Remove nuts and bolts from beneath plugs.
 - Lift off covers, removing center cover first.
- Remove upper section of air filter housing.
 - Loosen hose clamps for intake air ducts.
 - Disconnect harness connector from mass air flow sensor.
 - Remove air flow sensor and ducting.



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- Disconnect harness connectors from ignition coils. Remove ignition coil mounting nuts (**arrows**) and pull coils straight up.

NOTE—

*Ground straps are at cylinders no. 3 and no. 7. See **120 Ignition System**.*

- Detach left and right wiring harness ducts and fold inward.
- Disconnect positive (+) jumper junction from top of cylinder head cover, if applicable.
- Remove cylinder head cover cap nuts and remove covers. Remove inner and outer gaskets.
- Clean gasket residue off sealing surfaces. Apply a thin coating of glycerine or suitable rubber lubricant to new inner and outer gaskets.

CYLINDER HEAD REMOVAL AND INSTALLATION 113-11

- Install inner gasket evenly into inner gasket groove in cylinder head cover, pressing four corners into position first and working evenly into groove.
- Apply thin bead of sealer (Hylomar® SQ 23 or equivalent) to gasket surface at joint where upper timing chain cover meets cylinder head, at corners of half-moon sections.
- Install outer gasket evenly into outer gasket groove in cylinder head, pressing rear corners into position first and working evenly into groove.
- The remainder of installation is reverse of removal.
 - Install all cylinder head cover cap nuts by hand, then tighten evenly and in stages, working diagonally from inside to outside.

CAUTION—

Be sure harness connectors are correctly installed, especially at knock sensors. Incorrect installation of connectors at knock sensors may result in serious engine damage.

Tightening Torques

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

Intake manifold, removing and installing (M60 engine)

WARNING—

Due to risk of personal injury, be sure the engine is cold before beginning work on the intake manifold.

- Disconnect negative (–) battery cable. See 020 Maintenance.

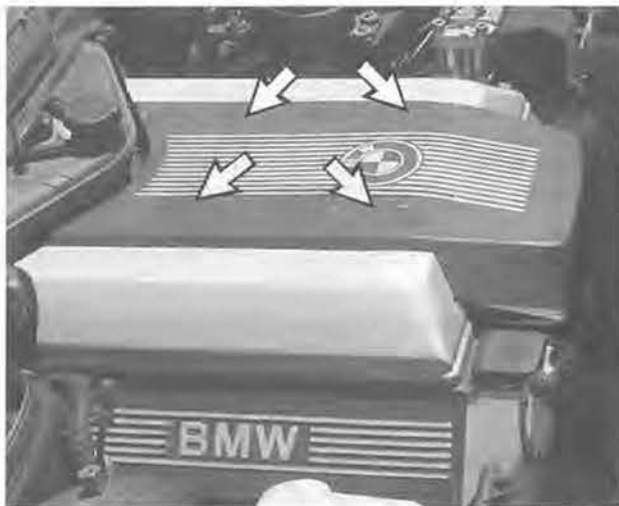
CAUTION—

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

- 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.

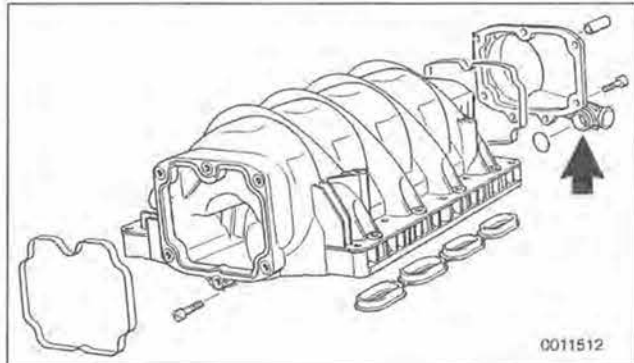
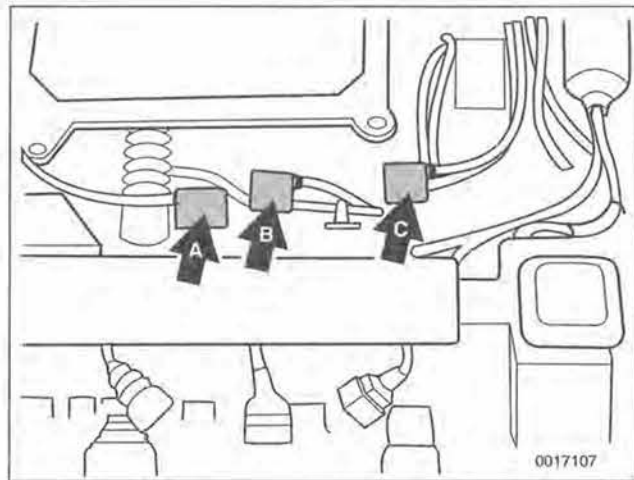


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- Remove plastic covers from top of engine.
 - Pry out plugs (arrows) from covers.
 - Remove nuts and bolts from beneath plugs.
 - Lift off covers, removing center cover first.

M60 CYLINDER HEADS

113-12 CYLINDER HEAD REMOVAL AND INSTALLATION



- Remove upper section of air filter housing.
 - Loosen hose clamps for intake air ducts.
 - Disconnect harness connector from mass air flow sensor.
 - Remove air flow sensor and ducts.
- Disconnect harness connectors from ignition coils.
- ✦ Disconnect engine electrical harness connectors.
 - Knock sensor connectors for cylinders 3 and 4 (A) and cylinders 1 and 2 (B). **Connectors must not be interchanged.**
 - Crankshaft position sensor (C).
 - Throttle position sensor and throttle position switch (ASC+T cars).
 - Crankshaft position sensor.
 - Automatic transmission control connector.
 - Cooling system harness connectors.
- Disconnect hoses and electric harness connectors from coolant expansion tank, then remove tank from engine compartment rear bulkhead.
- Remove mounting nuts from left and right wiring harness ducting. Lift wire duct off cylinder head covers and set aside.
- Detach bowden cables from throttle housing, if applicable. Disconnect electrical harness connectors and vacuum hoses from throttle housing, as applicable.
- ✦ Disconnect crankcase ventilation valve ducting (arrow) from rear intake manifold cover.
- Disconnect brake booster vacuum hose from booster and plug openings.
- Disconnect fuel tank purge valve hoses.
- Disconnect fuel rail electrical harness connectors and lay harness aside.
- Label and then disconnect fuel supply and return lines.

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.

NOTE—

On some later production engines, a special fitting is used to retain the fuel lines to the fuel rail. Use BMW special tool no. 16 1 050 to expand the locking clip inside the end of the fuel line fittings.

- Remove intake manifold nuts from left and right cylinder heads, noting arrangement of rubber grommets beneath nuts.

CYLINDER HEAD REMOVAL AND INSTALLATION 113-13

- Lift intake manifold together with throttle housing from cylinder heads.
- Installation is reverse of removal.
 - Use new gaskets when mounting manifold.
 - Tighten nuts finger tight first, then torque to specification in stages working diagonally from inside to outside.

Tightening Torque

- Intake manifold to cylinder heads . . . , 15 Nm (11 ft-lb)

Left cylinder head, removing (M60 engine)

This procedure covers removal of the left (driver side) cylinder head only.

NOTE—

- When removing the cylinder heads on the M60 engine, it may be simpler to remove the engine due to an extremely crowded engine compartment.
- Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in **117 Camshaft Timing Chain** before removing the cylinder head.

Cover all painted surfaces before beginning the cylinder head 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 (–) battery cable. See **020 Maintenance**.

CAUTION—

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

- 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.

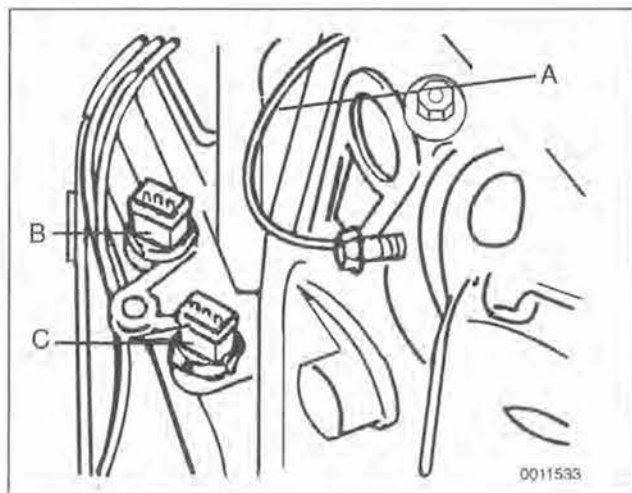
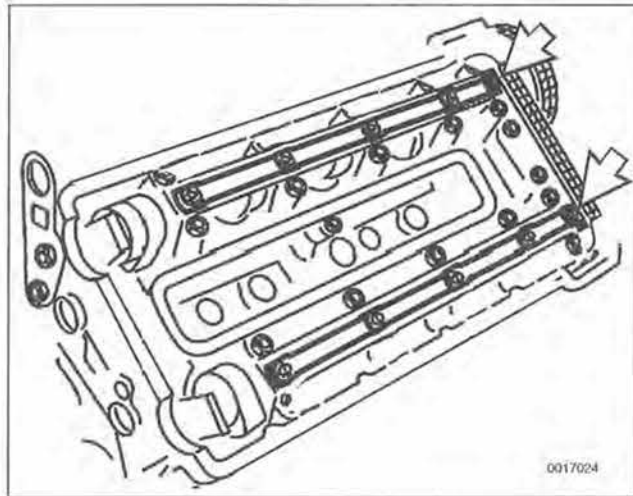
- Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

113-14 CYLINDER HEAD REMOVAL AND INSTALLATION

NOTE—

- The radiator cooling fan nut (32 mm wrench) has left-hand threads.
- There are two block drains, one on either side of the engine. It is not necessary to remove both plugs if only one head is being removed.

- Remove left exhaust manifolds. See **180 Exhaust System**. Discard mounting nuts.
- Remove intake manifold as described earlier.
- Remove cylinder head covers as described earlier.
- Remove spark plugs. See **120 Ignition System**.
- Remove oil filter housing.
 - Remove filter housing cap to allow oil to drain back.
 - Disconnect oil pressure lines.
- Remove oil supply lines (arrows) and oil deflector baffles above camshafts.
- Remove coolant crosspipe (accumulator) from rear of engine.
 - Unbolt coolant expansion tank and set aside.
 - Disconnect and label harness connectors at crosspipe.
 - Disconnect all coolant hoses from crosspipe.
 - Remove crosspipe mounting bolts and carefully remove pipe.



- Disconnect ground wire for ignition coils (A), coolant temperature gauge (B, black connector) and DME coolant temperature sensor (C, white connector) near rear engine lifting bracket.
- Remove upper timing chain cover from front of left cylinder head.
 - Remove secondary air injection ducting, if applicable.
 - Remove timing chain cover mounting bolts (qty. 9) and carefully separate cover from cylinder head.
- Remove timing chain tensioner from side of right cylinder head.
- Turn engine over in direction of normal rotation until cylinder no. 1 is at TDC overlap position (i.e. intake and exhaust valves open, 360° away from TDC ignition).

CYLINDER HEAD REMOVAL AND INSTALLATION 113-15

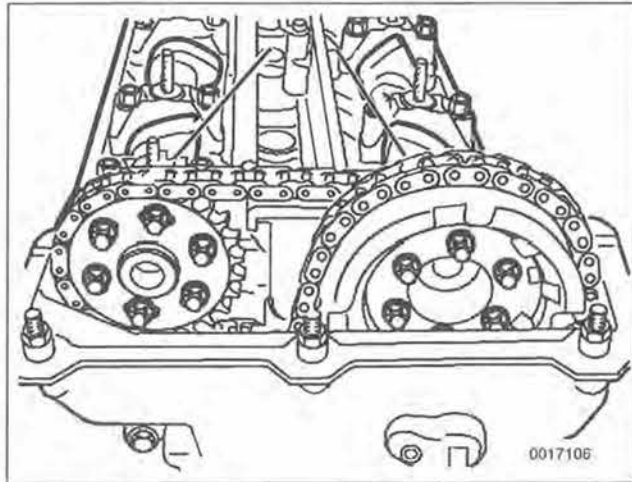
NOTE—

- Cylinder no. 1 is on the front right (passenger) side.
- TDC position is marked on the crankshaft vibration damper as 0/T.

- Loosen by ½ turn top camshaft sprocket mounting bolts on each cylinder head.

CAUTION—

- Hold camshaft stationary (at hex on camshaft) when loosening or tightening camshaft sprocket mounting bolts.
- Do not damage cylinder head casting when using open end wrench at camshaft hex. If necessary, grind or machine wrench to fit into opening in cylinder head.

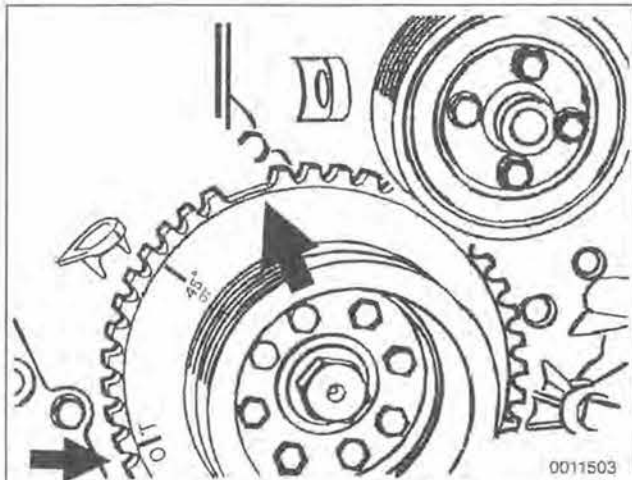


- Turn engine in direction of normal rotation until cylinder no. 1 is at TDC. Cylinder no. 1 camshaft lobes pointing up and toward each other indicates TDC.

- Loosen remaining camshaft sprocket bolts on camshafts.
- Remove all left intake camshaft sprocket bolts. Remove large sprocket and suspend main timing chain with wire.

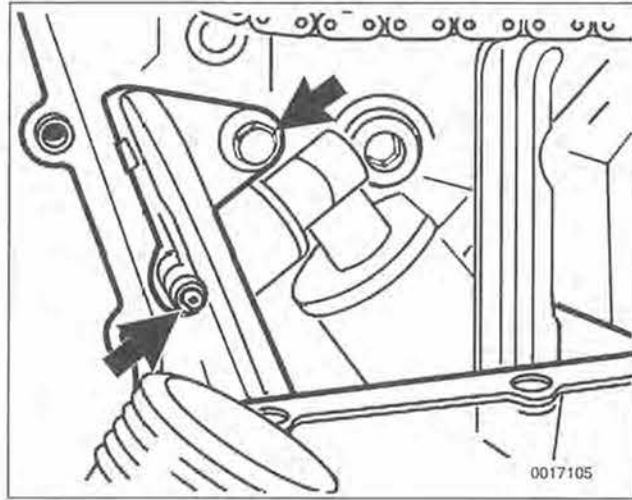
NOTE—

Replace two sprocket bolts and secure them finger tight to prevent remaining chain and sprocket from falling off intake camshaft.

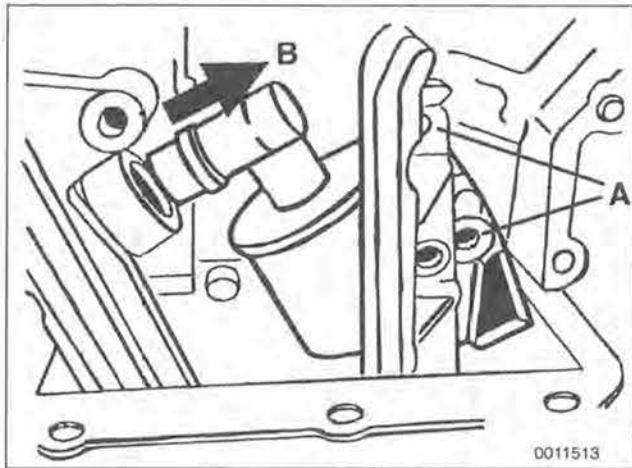


- Keeping chain under manual tension, slowly turn engine away from direction of normal rotation until cylinder no. 1 is at 45° before TDC (BTDC). Note position of 0/T mark and gap in toothed wheel (arrows).

113-16 CYLINDER HEAD REMOVAL AND INSTALLATION



- Remove bolt and grub screw (arrows) from main timing chain guide rails.



- Pull crankcase ventilation oil separator (B) away from cylinder head. Timing chain guide rail mounting bolt hole is at A
- Using BMW special tool no. 11 2 250 or equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head. Remove cylinder head.

CAUTION—

Be sure to lift crankcase ventilation oil separator away as head is lifted off.

Left cylinder head, installing (M60 engine)

- Prior to installation, clean cylinder head and gasket surfaces.
 - Remove all foreign matter and liquid from head bolt holes in cylinder block.

CAUTION—

Do not use a metal scraper or wire brush to clean the aluminum engine parts. 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.

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.

CYLINDER HEAD REMOVAL AND INSTALLATION 113-17

- Apply thin bead of sealer (Hylomar® SQ 32 M or equivalent) to corner-joint where lower timing chain cover mates with cylinder block.
- Place new cylinder head gasket into position. Make sure dowel sleeves are correctly positioned in block and not damaged.
- With crankshaft at 45° BTDC for cylinder no. 1, set cylinder head in position.

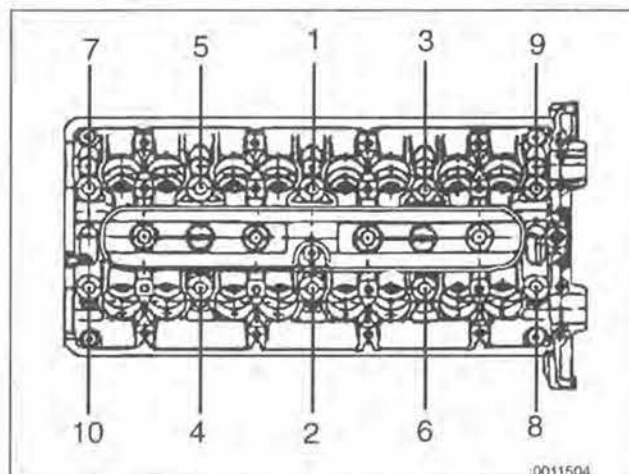
NOTE—

Be sure to lift crankcase ventilation oil separator away from head as the head is lowered into position.

- Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.

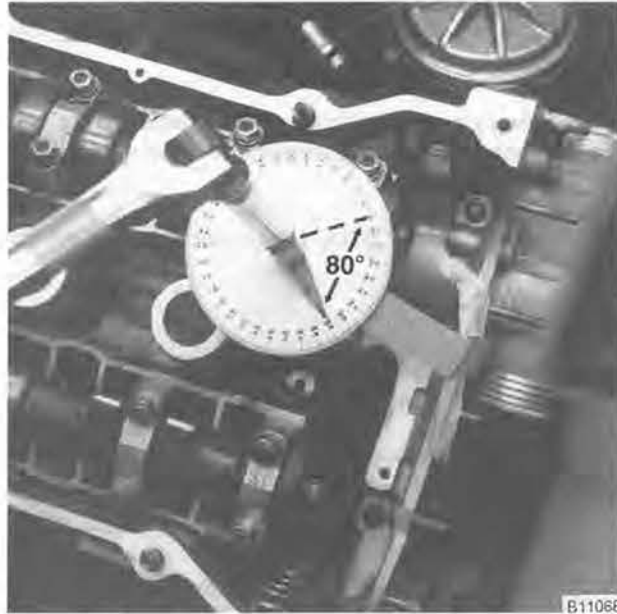
CAUTION—

- Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.
- Do not wash protective coating from new bolts.
- Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.
- The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle.



- ◀ Tighten cylinder head bolts in stages, alternately and diagonally, as shown.

113-18 CYLINDER HEAD REMOVAL AND INSTALLATION



- ◀ Use protractor and pointer to tighten bolts to specified torque angle

Tightening Torques (M60 Engine)

- Cylinder head to cylinder block

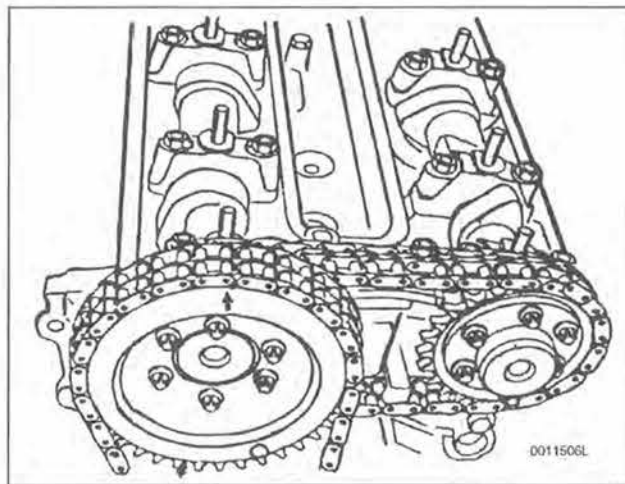
Stage 1	 30 Nm (22 ft-lb)
Stage 2	 +80°
Stage 3	 +80°

- Make sure crankcase breather oil separator is correctly attached to return pipe at bottom. Fit oil separator to guide rail and fit guide rail assembly to cylinder head.

NOTE—

Use the original grub (shoulderless) screw when mounting the guide rail to the cylinder head. Tighten the screw to 2 - 3 Nm (15 - 22 in-lb).

- Position camshafts and crankshaft at cylinder no. 1 TDC and lock all shafts in position using BMW special tools. See **117 Camshaft Timing Chain**.



- ◀ Install intake sprocket (left cylinder head) to timing chain and camshaft with **arrow** on sprocket pointing up.

- Bolt holes in sprocket should be centered to threaded bores in camshaft.
- Tighten sprocket bolts finger tight.

- Adjust camshaft timing, tighten sprocket mounting bolts, and install timing chain tensioner as described in **117 Camshaft Timing Chain**.

- Remainder of installation is reverse of removal.

- When installing front timing chain cover, use new gaskets. Remove protective film from gaskets.
- Seal lower corners of chain cover to cylinder head before installing cover.
- Tighten bolts in two stages, tightening cover-to-cylinder block bolts first.
- 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 electronic systems, be sure to install all ground wires removed earlier.

CYLINDER HEAD REMOVAL AND INSTALLATION 113-19

Tightening Torque (M60 engine)

- Coolant drain plug to cylinder block . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft (M6) 15 Nm (11 ft-lb)
- Camshaft timing chain tensioner to cylinder head 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block 10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover M6 10 Nm (89 in-lb) M7 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head . . . 22 Nm (17 ft-lb)
- Oil pressure lines to oil filter housing or oil pan (Banjo bolts) 30 Nm (22 ft-lb)
- Radiator cooling fan to coolant pump 40 Nm (30 ft-lb)
- Spark plugs to cylinder head . . 23 ± 3 Nm (17 ± 2 ft-lb)

Right cylinder head, removing (M60 engine)

This procedure covers removal of the right (passenger side) cylinder head only.

NOTE—

- When removing the cylinder heads on the M60, it may be simpler to remove the engine due to an extremely crowded engine compartment.
- Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in **117 Camshaft Timing Chain** before removing the cylinder head.

Cover all painted surfaces before beginning the cylinder head 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 (–) battery cable. See **020 Maintenance**.

CAUTION—

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

- 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.

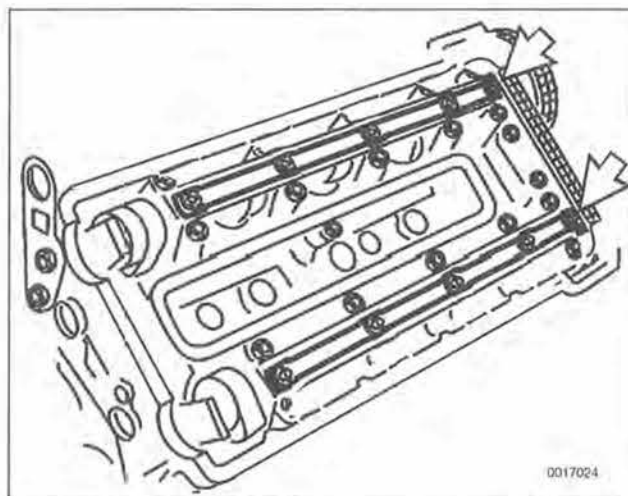
113-20 CYLINDER HEAD REMOVAL AND INSTALLATION

- Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

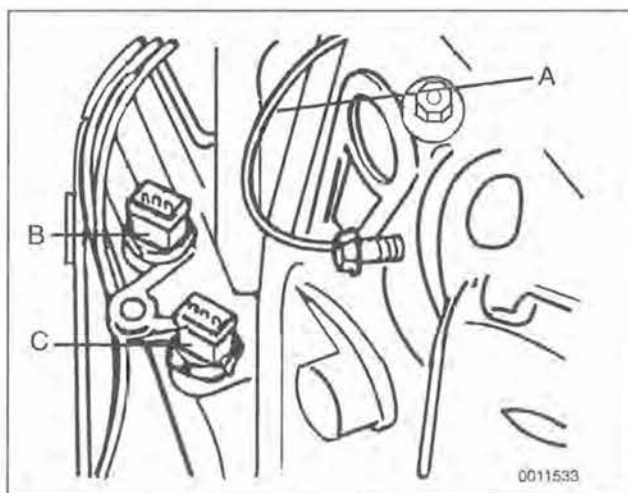
NOTE—

- The radiator cooling fan nut (32 mm wrench) has left-hand threads.
- There are two block drains, one on either side of the engine. It is not necessary to remove both plugs if only one head is being removed.

- Remove right exhaust manifolds. See **180 Exhaust System**. Discard mounting nuts.
- Remove intake manifold as described earlier.
- Remove cylinder head cover as described earlier.
- Remove spark plugs. See **120 Ignition System**.



- Remove oil supply lines (**arrows**) and oil deflector baffles above camshafts.
- Remove coolant crosspipe (accumulator) from rear of engine.
 - Unbolt coolant expansion tank and set aside.
 - Disconnect and label harness connectors at crosspipe.
 - Disconnect all coolant hoses from crosspipe.
 - Remove crosspipe mounting bolts and carefully remove pipe.



- Disconnect ground wire for ignition coils (**A**), coolant temperature gauge (**B**, black connector) and DME coolant temperature sensor (**C**, white connector) near rear engine lifting bracket.
- Remove upper timing chain cover from front of right cylinder head.
 - Remove secondary air injection ducting, if applicable.
 - Remove timing chain cover mounting bolts (qty. 9) and carefully separate cover from cylinder head.
- Remove timing chain tensioner from side of right cylinder head.
- Turn engine over in direction of normal rotation until cylinder no. 1 is at TDC overlap position (i.e. intake and exhaust valves open, 360° away from TDC ignition)

CYLINDER HEAD REMOVAL AND INSTALLATION 113-21

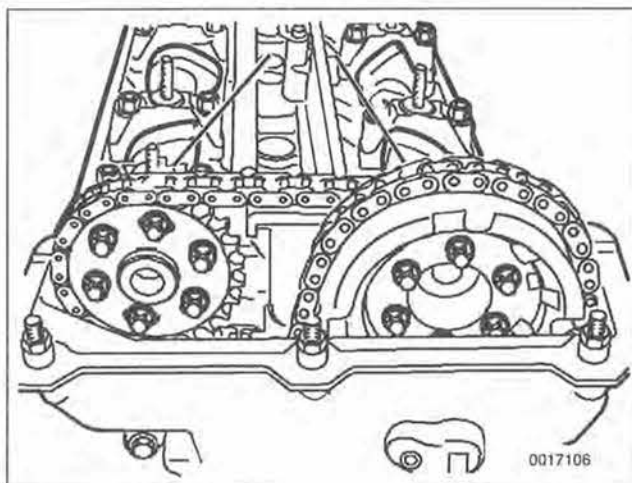
NOTE—

- Cylinder no. 1 is on the front right (passenger) side.
- TDC position is marked on the crankshaft vibration damper as 0/T.

- Loosen by ½ turn top camshaft sprockets mounting bolts on each cylinder head.

CAUTION—

- Hold camshaft stationary (at hex on camshaft) when loosening or tightening camshaft sprocket mounting bolts.
- Do not damage cylinder head casting when using open end wrench at camshaft hex. If necessary, grind or machine wrench to fit into opening in cylinder head.

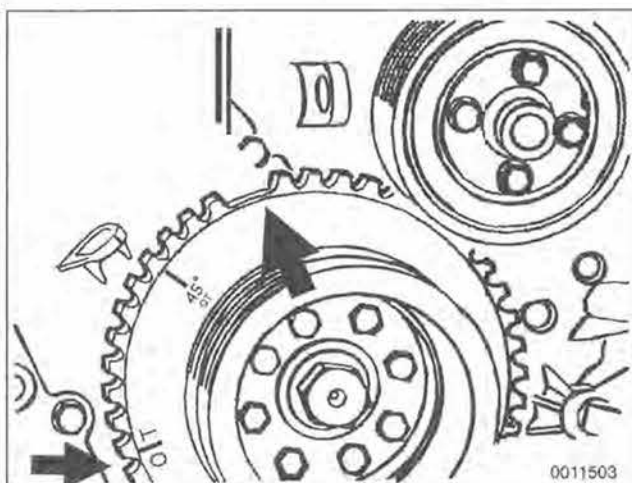


- Turn engine in direction of normal rotation until cylinder no. 1 is at TDC. Cylinder no. 1 camshaft lobes pointing up and toward each other indicates TDC.

- Loosen remaining camshaft sprocket bolts.
- Remove all right intake camshaft sprocket bolts. Remove large sprocket and suspend main timing chain with wire.

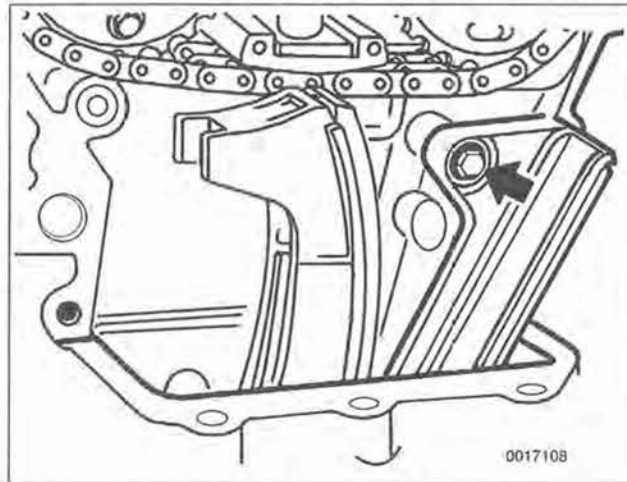
NOTE—

Replace two sprocket bolts and secure them finger tight to prevent remaining chain and sprocket from falling off intake camshaft.



- Slowly turn engine away from direction of normal rotation until cylinder no. 1 is at 45° before TDC (BTDC). Note position of 0/T mark and gap in toothed wheel (arrows).

113-22 CYLINDER HEAD REMOVAL AND INSTALLATION



- Remove camshaft timing chain guide rail mounting bolt (arrow) on right cylinder head. Disconnect timing chain guide rail from cylinder head.
- Using BMW special tool no. 11 2 250 or equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head. Remove cylinder head.

Right cylinder head, installing (M60 engine)

- Prior to installation, clean cylinder head and gasket surfaces.
 - Remove all foreign matter and liquid from head bolt holes in cylinder block.

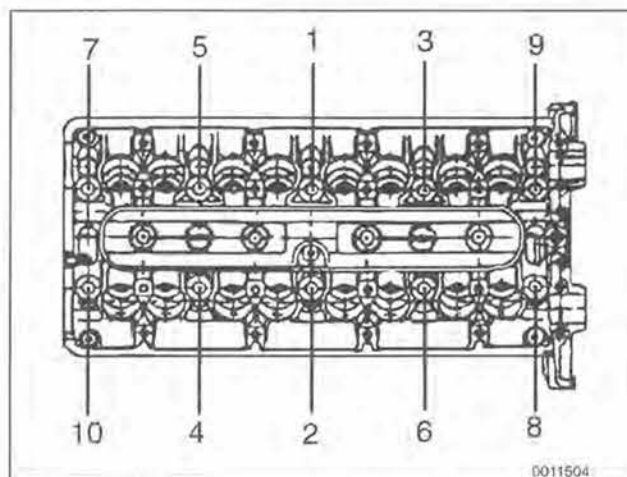
CAUTION—

Do not use a metal scraper or wire brush to clean the aluminum engine parts. 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.

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.

- Apply thin bead of sealer (Hylomar® SQ 32 M or equivalent) to corner-joint where lower timing chain cover mates with cylinder block.
- Place a new cylinder head gasket into position. Make sure dowel sleeves are correctly positioned in block and not damaged.
- With crankshaft at 45° BTDC for cylinder no. 1, set cylinder head in position.
- Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.
- Tighten cylinder head bolts in stages, alternately and diagonally, in sequence shown.



M60 CYLINDER HEADS

CYLINDER HEAD REMOVAL AND INSTALLATION 113-23

CAUTION—

- Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.
- Do not wash protective coating from new bolts.
- Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.
- The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle.

Tightening Torques (M60 Engine)

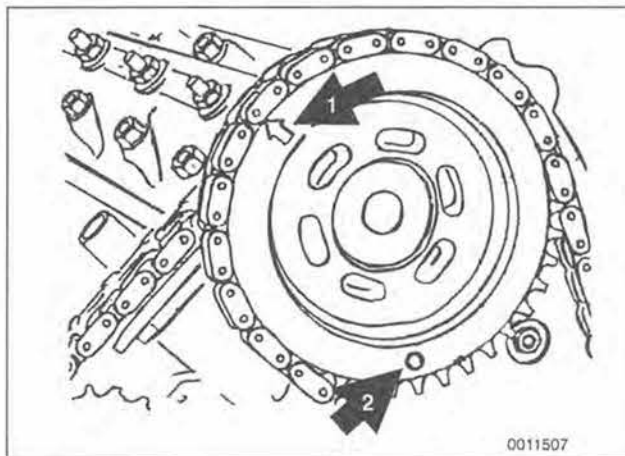
- Cylinder head to cylinder block
 - Stage 1 30 Nm (22 ft-lb)
 - Stage 2 +80°
 - Stage 3 +80°



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- Use protractor and pointer to tighten bolts to specified torque angle

- Fit timing chain guide rail to cylinder head and install bolt.
- Position camshafts and crankshaft at TDC and lock all shafts in position using BMW special tools. See **117 Camshaft Timing Chain**.



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- Install intake sprocket (right cylinder head) to timing chain and camshaft with arrow on sprocket (1) pointing up and dowel pin for camshaft position sensor in lower left (2).

- Bolt holes in sprocket should be centered to threaded bores in camshaft.
- Tighten sprocket bolts finger tight.

- Adjust camshaft timing, tighten sprocket mounting bolts, and install timing chain tensioner, as described in **117 Camshaft Timing Chain**.

M60 CYLINDER HEADS

113-24 CYLINDER HEAD REMOVAL AND INSTALLATION

- Remainder of installation is reverse of removal.
- When installing front timing chain cover, use new gaskets. Remove protective film from gaskets.
- Seal lower corners of chain cover to cylinder head before installing cover.
- Tighten bolts in two stages, tightening cover-to-cylinder block bolts first.
- 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 electronic systems, be sure to install all ground wires removed earlier.

Tightening Torques (M60 engine)

- Coolant drain plug to cylinder block . . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft (M6) 15 Nm (11 ft-lb)
- Camshaft timing chain tensioner to cylinder head 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block 10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover M6 10 Nm (89 in-lb)
M7 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head . . . 22 Nm (17 ft-lb)
- Radiator cooling fan to coolant pump 40 Nm (30 ft-lb)
- Spark plugs to cylinder head . . . 23±3 Nm (17±2 ft-lb)

M70 CYLINDER HEADS

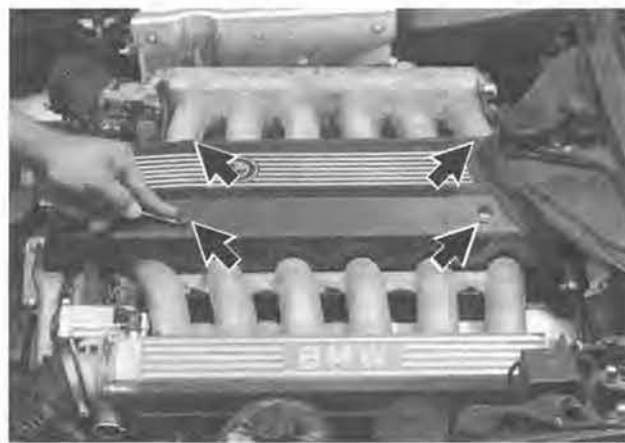
Intake manifolds, removing and installing (M70 engine)

This procedure covers replacement of the intake manifold assembly.

WARNING—

Due to risk of personal injury, be sure engine is cold before beginning work on cylinder head.

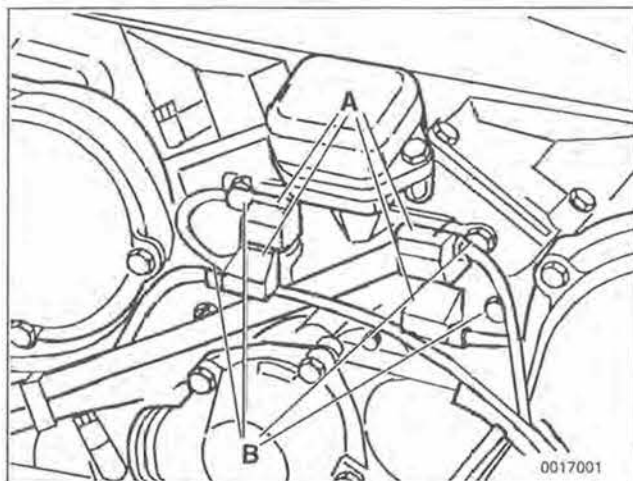
- Drain coolant expansion tank and disconnect coolant hoses at tank. Remove expansion tank from engine compartment rear bulkhead.
- Remove cover from top of engine.
 - Pry out 4 plugs from cover. Turn screws 1/4 turn to release. Lift off cover.
- Drain windshield washer tank. Disconnect washer fluid hose and electrical harness connector from washer pump.



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M70 CYLINDER HEADS

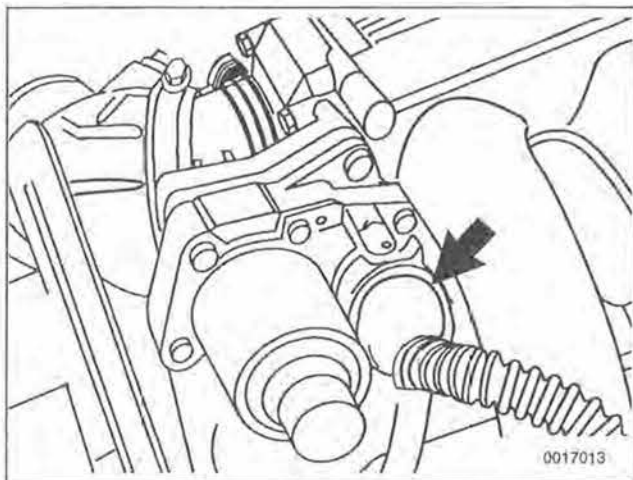
CYLINDER HEAD REMOVAL AND INSTALLATION 113-25



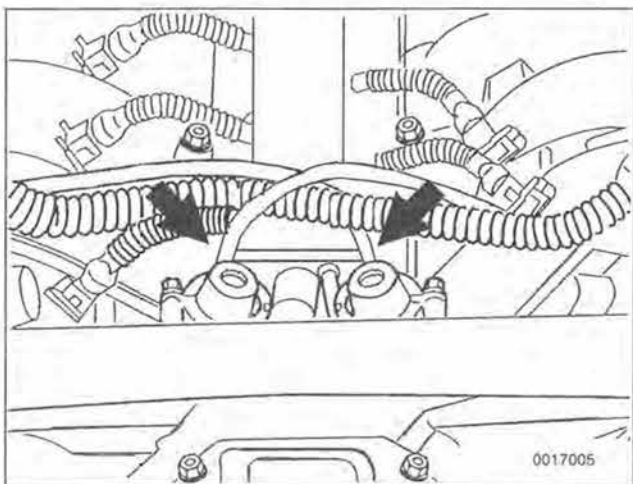
- Working at front of engine in front of oil filler cap, pull off oil drip shield. Disconnect engine sensor connectors (A). Remove pulse sender bracket bolts (B), lift of bracket and disconnect harness plugs from it.

NOTE—

Label harness connections before disconnecting.



- Disconnect harness connectors at left and right EML throttle actuators.



- Disconnect vacuum hoses (arrows) at fuel pressure regulator.

- Disconnect fuel return hose at right rear of engine.
- Disconnect fuel supply hoses at top rear of engine.

WARNING—

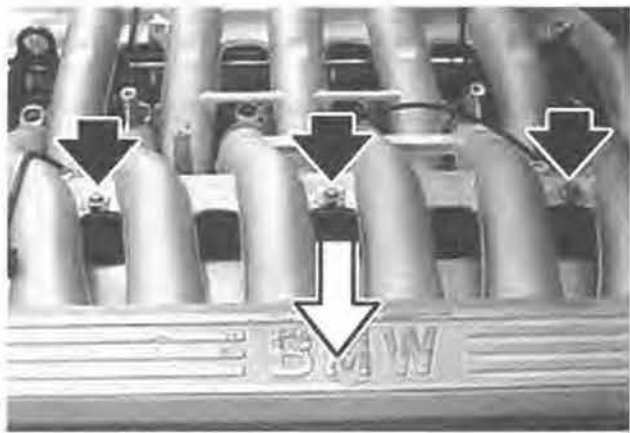
Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy. Before disconnecting fuel hoses, wrap a cloth around fuel hoses to absorb any leaking fuel. Plug all open fuel lines.

NOTE—

On some late production engines, a special fitting is used to retain the fuel lines to the fuel rail. Use BMW special tool no. 16 1 050 to expand the locking clip inside the end of the fuel line fittings.

- Disconnect harness connectors at intake manifold.

113-26 CYLINDER HEAD REMOVAL AND INSTALLATION



- Pull off fuel injector harness connectors.
- Working at engine compartment rear bulkhead, cut off wire ties and remove retaining screws for wiring harness bracket. Lift off harness and set aside.
- Disconnect air filter housing clamps and remove mass air flow sensors and intake air ducting.
- Remove throttle housings from intake manifolds.
- Detach and remove ignition wire loom.
- Disconnect crankcase breather hoses from cylinder head covers.
- Loosen intake manifold support brackets, then unbolt intake manifolds and lift off.

NOTE—

Where necessary, remove crankcase ventilation valve from end of manifold.

- Installation is reverse of removal.
 - Use new gaskets and O-rings.
 - Place manifold noise insulation strip on cylinder head cover first.
 - Oil dipstick guide tube is mounted with same fasteners as ignition wire loom.
 - Fuel rail is mounted with front two fasteners of right (passenger side) manifold.

Tightening Torque

- Intake manifold to cylinder head 22 Nm (17 ft-lb)

Cylinder head cover gaskets, replacing (M70 engine)

WARNING—

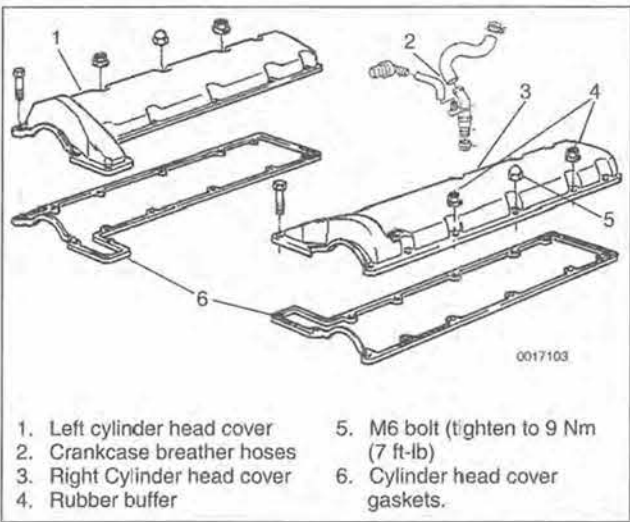
Due to risk of personal injury, be sure the engine is cold before beginning work on the cylinder head cover.

- Disconnect negative (–) battery cable. See 020 Maintenance.

CAUTION—

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

- Remove intake manifolds as described earlier.
- Remove cylinder head covers.
- Clean old gasket and sealer material from sealing surfaces.
- Install gasket on cylinder head.



CYLINDER HEAD REMOVAL AND INSTALLATION 113-27

- Apply thin bead of sealer (Hylomar® SQ 23 or equivalent) to gasket surface at joint where upper timing chain cover meets cylinder head.
- The remainder of installation is reverse of removal.
 - Install all cylinder head cover cap nuts by hand, then tighten evenly and in stages, working in a crisscross pattern.

Tightening Torque

- Cylinder head cover to cylinder head and timing chain cover
M6 10 Nm (89 in-lb)

Cylinder heads, removing (M70 engine)

NOTE—

- When removing the cylinder heads on the M70 engine, it may be simpler to remove the engine due to an extremely crowded engine compartment.
- Special service tools are required to adjust camshaft timing as part of cylinder head installation. Be sure to review the adjustment procedure outlined in **117 Camshaft Timing Chain** before removing the cylinder head.

Cover all painted surfaces before beginning the cylinder head 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.

- Disconnect negative (–) battery cable. See **020 Maintenance**.
- 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.

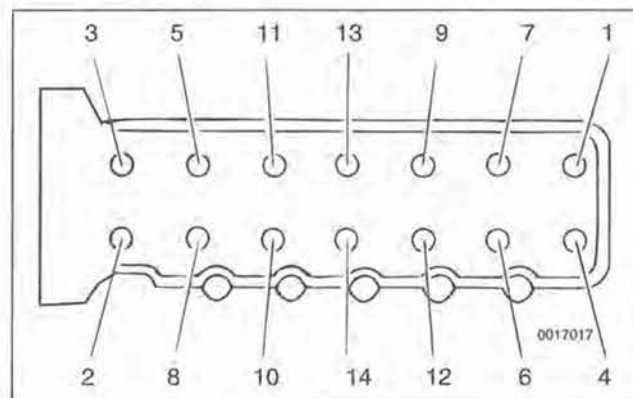
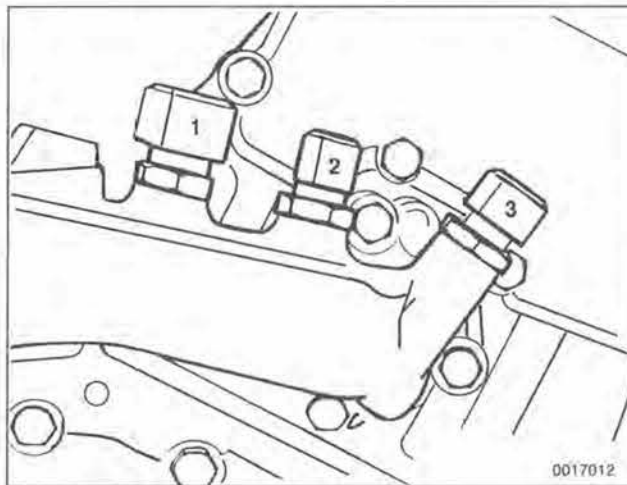
- Remove exhaust manifold heat shields, then unbolt front exhaust pipes from exhaust manifolds.
- Drain engine coolant from radiator and from cylinder block. Remove radiator cooling fan and radiator fan shroud. See **170 Radiator and Cooling System**.

NOTE—

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

- Remove intake manifolds as described earlier.
- Remove cylinder head covers as described earlier.

113-28 CYLINDER HEAD REMOVAL AND INSTALLATION



⚠ Disconnect harness connectors from temperature sensor connectors at coolant crosspipe:

- 1. DME
- 2. EML
- 3. Temperature gauge

— Remove crosspipe.

— Left cylinder head: Disconnect electrical harness connectors and coolant hoses from heater valve, then remove valve.

— Remove upper timing case and timing chain sprockets as described in **117 Camshaft Timing Chain**.

— Use wire to tie chain to camshaft chain sprockets. Remove sprockets with chain attached and support.

⚠ Using BMW special tool no. 11 2 250 or an equivalent, loosen cylinder head bolts in stages, working diagonally from outermost bolts toward center of head, as shown. Remove cylinder head.

Cylinder heads, installing (M70 engine)

— Prior to installation, clean cylinder head and cylinder block gasket surfaces.

- Remove all foreign matter and liquid from head bolt holes in cylinder block.

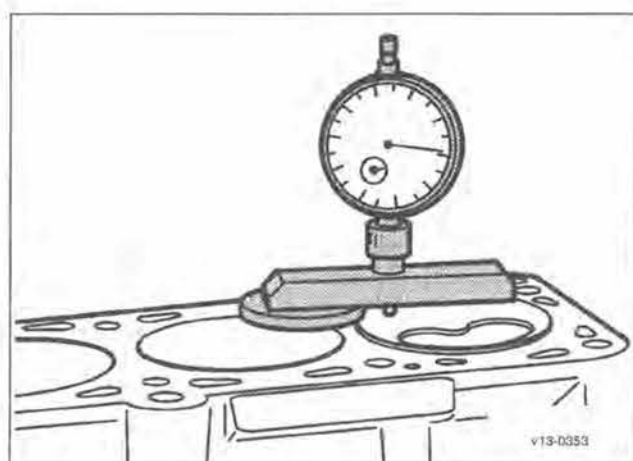
CAUTION—

Do not use a metal scraper or wire brush to clean the aluminum engine parts. 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.

- Check cylinder head and cylinder block sealing surfaces for warpage using a straight edge

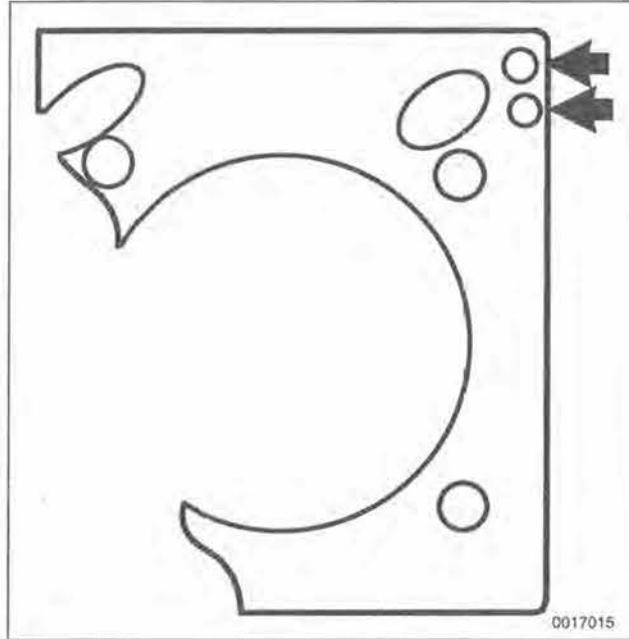
⚠ Check piston protrusion above gasket surface.

- Lay dial indicator flush across top of shim of known thickness. Measure piston height at two different spots, then average.
- Turn engine over, bringing each piston to top of its travel. Clean each piston surface, then measure piston height above cylinder block surface.



M70 CYLINDER HEADS

CYLINDER HEAD REMOVAL AND INSTALLATION 113-29



➤ Cylinder head gasket thickness identification holes (arrows).

- Use **Table a** to select each cylinder head gasket based on maximum piston height for each bank of cylinders.

Table a. V-12 Piston Height Specifications

Maximum piston height	No. head gasket holes
0.388 - 0.610 mm (0.015 - 0.024 in)	1
0.610 - 0.832 mm (0.024 - 0.033 in)	2

- Place new cylinder head gasket on each cylinder block surface with "top/oben" up and "front/vorn" toward timing chain.

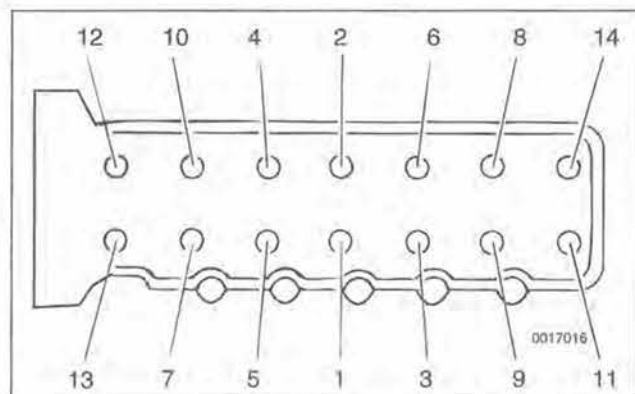
NOTE—

- Make sure head gasket alignment dowels are in place.
- Left and right head gaskets are different.

- Align cylinder heads with guide dowels and set in position.
- Lightly lubricate new cylinder head bolts. Loosely install bolts with washers. Thread all bolts in finger tight.

CAUTION—

- Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.
- Do not wash protective coating from new bolts.
- Check that all washers for the head bolts are in place before installing bolts. Some washers may be staked to the cylinder head.
- The use of a special tool (BMW Tool No. 11 2 110) or a suitable protractor is required to tighten head bolts to a specified torque angle (Stage 2).



➤ Tighten cylinder head bolts in stages, alternately and diagonally, as shown.

Tightening Torque (M70 Engine)

- Cylinder head to cylinder block

Stage 1	30 Nm (22 ft-lb)
Stage 2	+ 60°
• Stage 3	+ 60°

113-30 CYLINDER HEAD REMOVAL AND INSTALLATION



Use protractor and pointer to tighten bolts to specified torque angle

- Install chain guides, camshaft sprockets and timing covers as described in **117 Camshaft Timing Chain**. Adjust camshaft timing.
- The remainder of installation is reverse of removal.
 - Use new gaskets when mounting intake manifold. Tighten nuts finger tight first, then torque to specification in stages working diagonally from inside to outside.
 - 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 electronic systems, be sure to install all ground wires previously removed.

Tightening Torques (M70 engine)

- Coolant drain plug to cylinder block . . . 28 Nm (20 ft-lb)
- Camshaft timing chain sprocket to camshaft 10 Nm (7.5 ft-lb)
- Camshaft timing chain tensioner to cylinder head 40 Nm (30 ft-lb)
- Camshaft timing chain cover to cylinder head/cylinder block 10 Nm (89 in-lb)
- Cylinder head cover to cylinder head/timing chain cover
- M6 10 Nm (89 in-lb)
- M7 15 Nm (11 ft-lb)
- Exhaust manifold to cylinder head (M8) 22 Nm (17 ft-lb)
- Radiator cooling fan to coolant pump 40 Nm (30 ft-lb)
- Spark plugs to cylinder head . 23 ± 3 Nm (17 ± 2 ft-lb)

