

113 Cylinder Head Removal and Installation

GENERAL 113-1

CYLINDER HEAD, 4-CYLINDER 113-1

Cylinder head, removing (4-cylinder engine) ... 113-1

Cylinder head, installing (4-cylinder engine) ... 113-6

CYLINDER HEAD, 6-CYLINDER 113-10

Cylinder head, removing (6-cylinder engine) .. 113-10

Cylinder head, installing (6-cylinder engine) ... 113-15

GENERAL

The information given in this repair group assumes that the engine is installed in the engine bay. For cylinder head, camshaft, and valvetrain disassembly and reconditioning information, see **116 Cylinder Head and Valvetrain**.

In the procedures given below, engines are referred to by 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 the fault. See **100 Engine-General** for compression testing information.*

Special BMW service tools are required to properly remove and install the cylinder head on both the 4-cylinder and 6-cylinder engines. The special tools are used to time the valvetrain to the crankshaft and to remove the Torx (E12) head bolts. Read the procedure through before beginning the job.

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.

CYLINDER HEAD, 4-CYLINDER

Cylinder head, removing (4-cylinder engine)

For ease of use this removal procedure is broken into subsections, as follows:

- ▶ General
- ▶ Cooling system, draining
- ▶ Cylinder head cover, removing
- ▶ Intake manifold, removing
- ▶ Timing chains, uncoupling
- ▶ Cylinder head assembly, removing

WARNING —

Allow engine to cool before beginning this procedure.

▶ General

1. Disconnect negative (–) cable from battery.

CAUTION —

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

NOTE —

The battery is mounted in the luggage compartment behind the right side trim panel.

2. Working underneath vehicle, remove front exhaust pipe from exhaust manifold. See Fig. 1.
3. Disconnect vacuum hose fitting from brake booster on rear bulkhead. Plug opening in booster and hose end.

CYLINDER HEAD, 4-CYLINDER

113-2 CYLINDER HEAD REMOVAL AND INSTALLATION

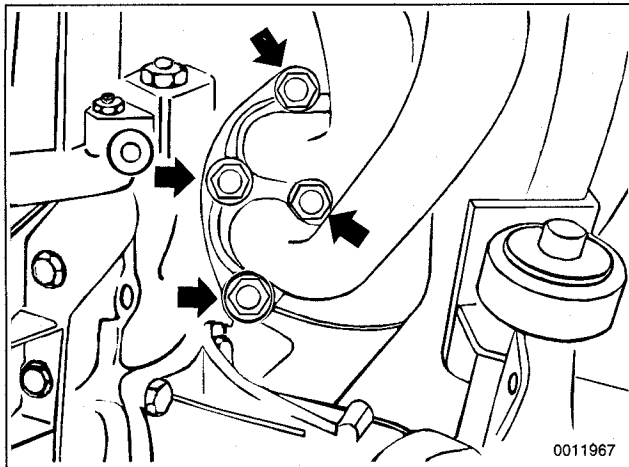


Fig. 1. Front exhaust pipe to exhaust manifold mounting nuts (arrows).

4. Remove air filter housing complete with mass air flow sensor and attached hoses and ducting. See Fig. 2.

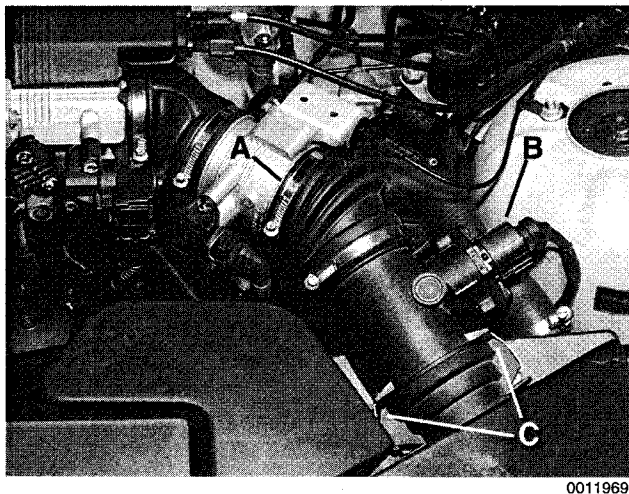


Fig. 2. Air filter housing/air intake connections on M44 engine with traction control. Clamp at throttle housing (A); mass air flow sensor connector (B); and clips at upper air filter housing (C).

► Cooling system, draining

5. Drain coolant from engine block and radiator. See 170 Radiator and Cooling System.

NOTE —

- The block drain is on the exhaust side of the engine, near cylinder no. 4.
- The radiator drain plug is on the bottom of the radiator on the driver's side. Remove small plastic lock clip to pull radiator drain plug out completely.

6. Disconnect hoses from coolant flange/thermostat housing on front of cylinder head. Unbolt thermostat housing from cylinder head.

CYLINDER HEAD, 4-CYLINDER

7. On M42 engines, disconnect hose from coolant pipe on left side of engine. See Fig. 3.

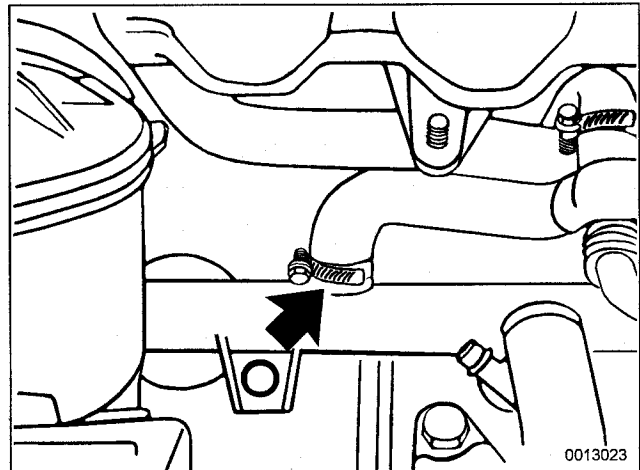


Fig. 3. Coolant hose connection beneath intake manifold on M42 engine (arrow).

8. Disconnect heater hoses from coolant flange on rear of cylinder head.

► Cylinder head cover, removing

9. Remove ignition coil pack from right strut tower. See Fig. 4.

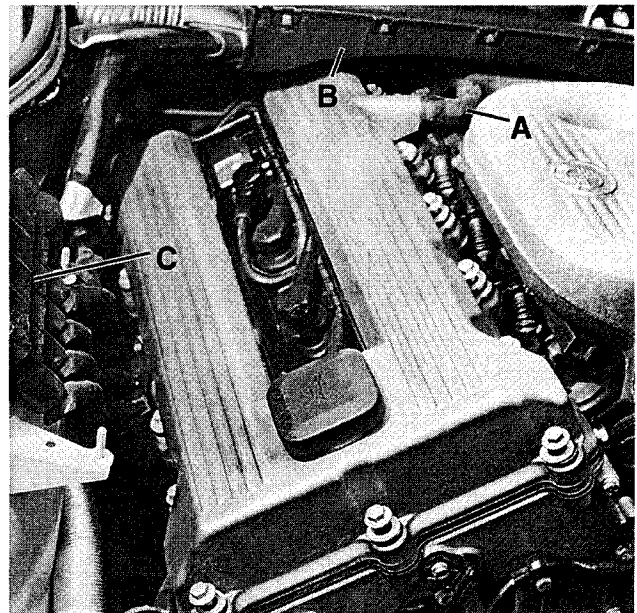


Fig. 4. Cylinder head cover showing location of engine breather hose (A), wiring harness duct (B), and ignition coil pack (C). M44 engine shown. Cover on M42 engine is similar.

10. Disconnect engine breather hose from cylinder head cover.

11. Detach wiring harness duct at rear bulkhead panel and pull complete duct forward and up to allow access to rear of cylinder head cover.
12. Remove spark plugs and spark plug wire loom.
 - Remove plastic cover from top of cylinder head.
 - Disconnect spark plug wires from spark plugs and remove spark plugs.
 - Unbolt spark plug cable harness and heat shield from right side of cylinder head cover and set aside.
13. Unscrew and remove cylinder head cover cap screws and remove cover. See Fig. 5.

CAUTION —

Two of the cover hold-down screws are under the spark plug cable duct.

NOTE —

Make note of the arrangement of cap screws, washers and rubber grommets holding the cylinder head cover in place.

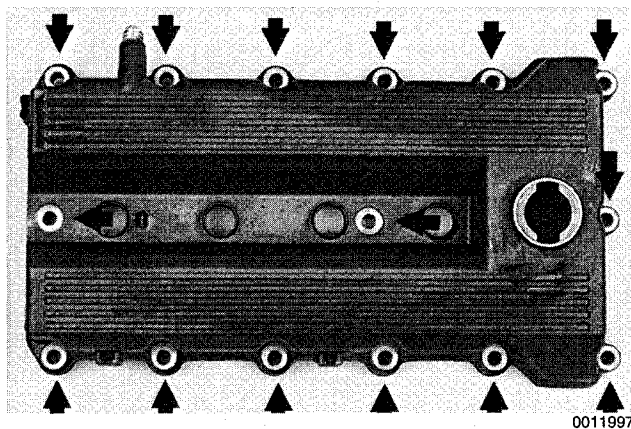


Fig. 5. Cylinder head cover mounting points (arrows).

Intake manifold, removing

14. On late engines, disconnect injector air shrouding hose from fitting at center of upper intake manifold.
15. Remove upper section of intake manifold.
 - Disconnect all cables harness connectors from throttle housing and intake manifold.
 - Disconnect fuel tank vent hose from vent valve on lower side of manifold.
 - Remove manifold support brackets. See Fig. 6.
 - Remove upper-to-lower manifold fasteners (1 bolt, 2 nuts) and separate upper manifold from lower manifold.

NOTE —

Note locating dowel sleeves on lower to upper manifold mounting studs. Remove dowels and set aside. See Fig. 8.

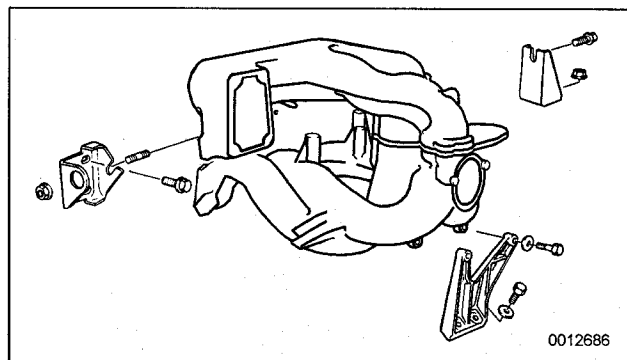


Fig. 6. Intake manifold support brackets and mounting hardware. Manifold for M44 engine shown.

16. Disconnect oil dipstick tube bracket from lower manifold section.
17. On M44 engine, relieve fuel pressure using compressed air (maximum 3 bar pressure) at schroeder valve on fuel rail. Briefly apply air pressure to force fuel back into fuel tank. See Fig. 7.

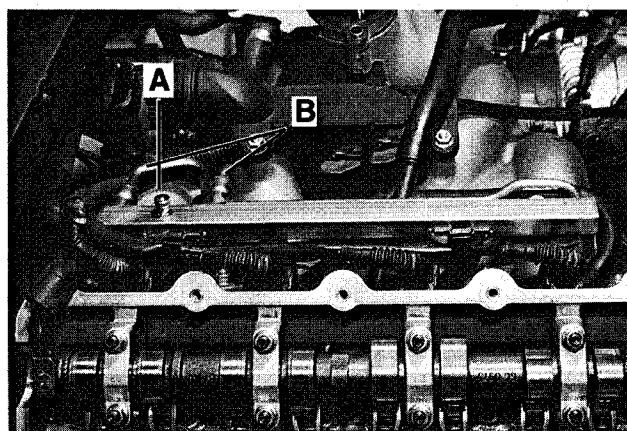


Fig. 7. M44 fuel rail air connection (A) and fuel supply and return lines (B).

18. Disconnect fuel supply and return lines from fuel rail.

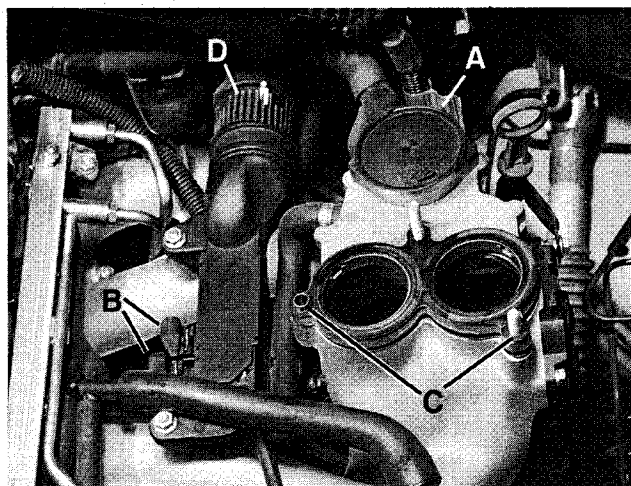
WARNING —

- The fuel system retains fuel pressure when the engine is off (up to 75 psi). Use care when disconnecting fuel lines. Unscrew the fuel tank cap to release pressure in the tank. Wrap a clean shop towel around the fitting when loosening.
- 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. Place a fire extinguisher in the vicinity of the work area.

19. Disconnect coolant hoses from vent valve on lower intake manifold. Remove crankcase vent valve from manifold.

113-4 CYLINDER HEAD REMOVAL AND INSTALLATION

20. Disconnect main engine wiring harness connector. Label and disconnect harness connectors for crankshaft and camshaft sensors. See Fig. 8.



0012504

Fig. 8. Crankcase vent valve (A), camshaft and crankshaft sensor harness connectors (B), locating bushings (C), main engine wiring harness connector (D). M44 engine shown.

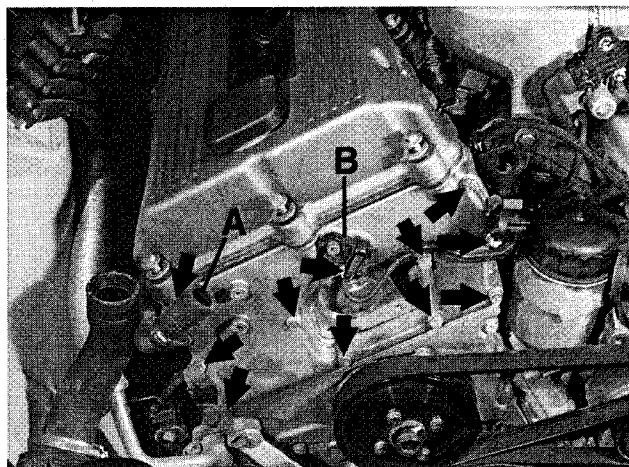
NOTE —

Early engines do not have a main disconnect at the lower intake manifold harness. If necessary, remove the cable ducting bolts and set harness ducting aside.

21. Remove lower section of intake manifold.
- Remove Y-shaped support bracket from underside of manifold. (See Fig. 6.)
 - Unbolt support brackets from alternator and starter.
 - Remove nuts holding manifold to cylinder head and pull manifold back until harness connectors for oil pressure switch and coolant temperature sensor are accessible. Label and disconnect connectors, then remove manifold and set aside.

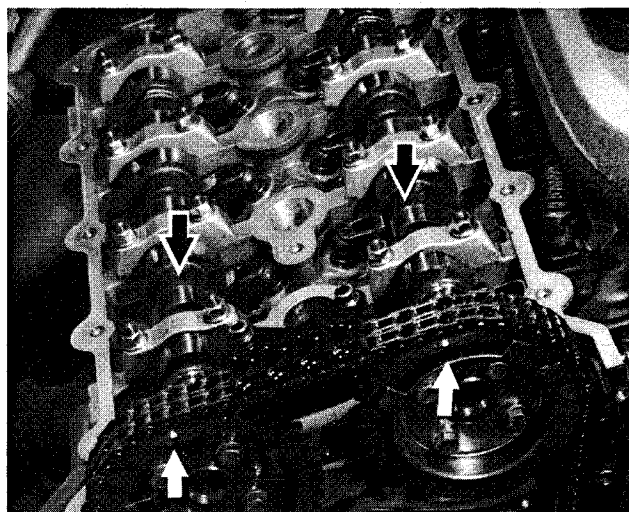
Timing chains, uncoupling

22. On M42 engines, remove thermostat housing from upper timing chain cover.
23. On late M44 engines (January 1997 and later), remove secondary air injection check-valve from front of engine and lay aside.
24. Remove cylinder identification sensor from upper timing chain cover. Remove upper timing chain cover. See Fig. 9.
25. Set engine to approximate TDC by rotating in normal operating direction until camshaft lobes at cylinder no. 1 are facing each other. See Fig. 10.



0011996

Fig. 9. Upper timing chain cover bolts (arrows). Remove secondary air injection check valve from hose (A) on M44 engine. Remove cylinder identification sensor from chain cover (B).



0011998

Fig. 10. Engine set to approximate TDC. Cylinder no. 1 camshaft lobes face in and arrows on sprockets point up (arrows).

26. Lock crankshaft in TDC position by inserting BMW special tool no. 11 2 300 through bore and into hole in fly-wheel or drive plate. See Fig. 11.

NOTE —

- If necessary, remove plug from locating bore in lower edge of bell housing to insert locking tool.

- Confirm that the locking tool has been correctly installed by trying to rotate the crankshaft.

27. Lock camshafts at TDC by mounting BMW special tool no. 11 3 240 over square ends of camshafts. See Fig. 12.

NOTE —

Check that tool is squarely seated on cylinder head gasket surface. If necessary, rotate camshafts slightly using an open-end wrench at hex on camshafts.



Fig. 11. BMW special tool no. 11 2 300 installed through bellhousing and into flywheel (arrow) to lock crankshaft at TDC.

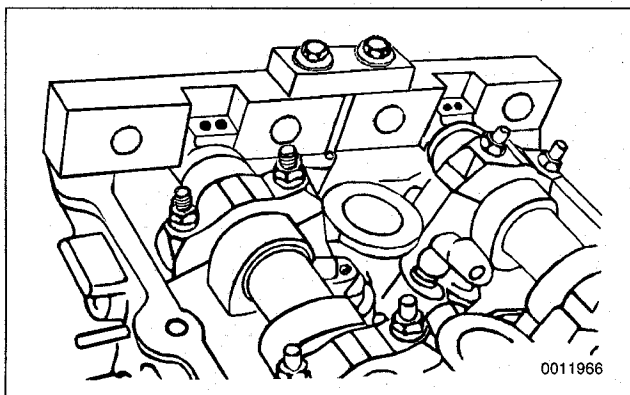


Fig. 12. BMW special tool no. 11 3 240 installed on rear of camshafts to hold them at TDC. (M44 engine shown. Other engines are similar.)

CAUTION —

The camshafts must be locked in the TDC position using the special service tool, or equivalent, before removing the timing chain. The tool holds the camshafts parallel to each other and perpendicular to the valve cover gasket surface.

28. Remove hydraulic chain tensioner from right side of cylinder head. See Fig. 13.
29. Remove mounting bolts from left and right camshaft sprockets. Then remove camshaft sprockets from camshafts. On M44 engines, note orientation of sensor wheel.
30. Remove upper bolt from left chain guide. Loosen chain guide adjusting sleeve approximately two turns. See Fig. 14.

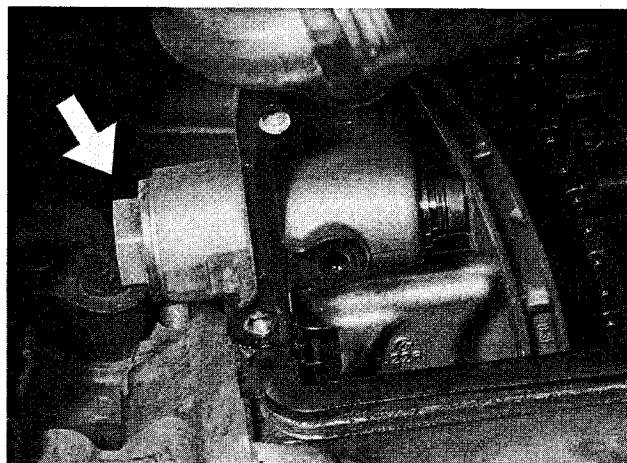


Fig. 13. Hydraulic chain tensioner (arrow).

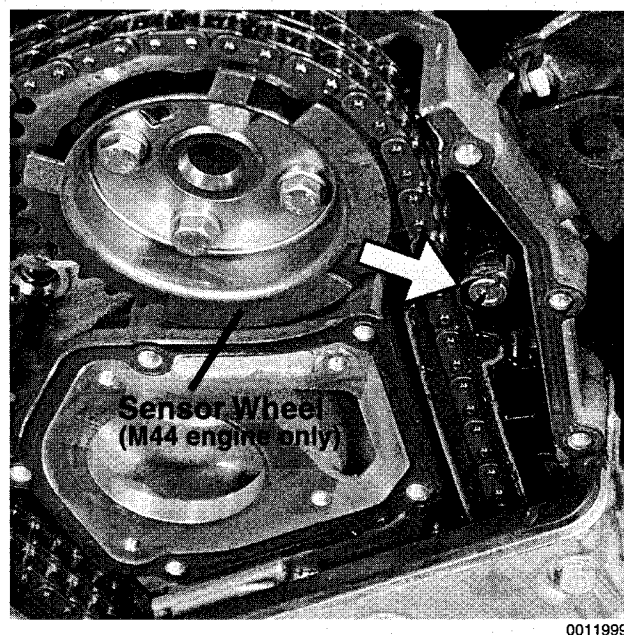


Fig. 14. Chain guide and guide adjusting sleeve (arrow). Allen-head retaining screw has been removed. Use slotted screwdriver to loosen adjusting sleeve.

NOTE —

It is not necessary to remove the cam 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. Keeping the sprockets timed will simplify installation.

◆ **Cylinder head assembly, removing**

31. Remove crankshaft locking tool (BMW special tool no. 11 2 300). Using the crankshaft vibration damper bolt, turn engine opposite its normal direction of rotation (counterclockwise as viewed from the front) approximately 45°. This prevents accidental contact between valves and pistons during installation.

113-6 CYLINDER HEAD REMOVAL AND INSTALLATION

32. Using Torx E12 socket, remove cylinder head bolts in the sequence indicated. See Fig. 15. Remove cylinder head and head gasket. Discard head bolts.

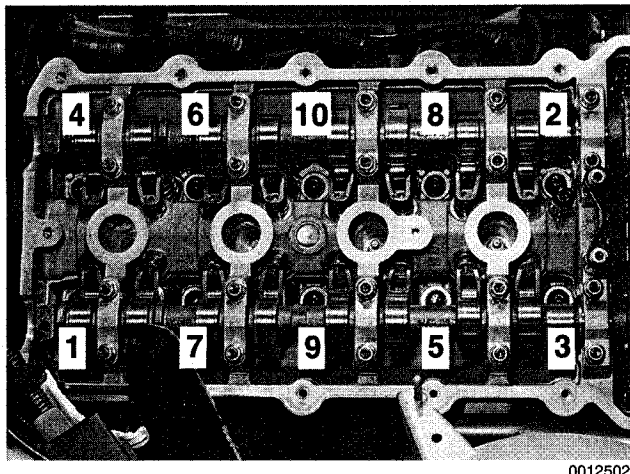


Fig. 15. Cylinder head bolt loosening sequence. Use Torx E12 socket.

Cylinder head, installing (4-cylinder engine)

CAUTION —

If the camshafts were removed/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, resulting in open valves and piston contact.

Cylinder head installation waiting times

- At or above 68°F (20°C) 10 minutes
- 50-68°F (10-20°C) 30 minutes
- 32-50°F (0-10°C) 75 minutes

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

- Remove all foreign matter and any liquid from bolt holes, then clean with a thread chaser.

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.

2. Check gasket surface of cylinder head and cylinder block for warpage using a straight edge.
3. On M42 engine: Be sure oil feed check valve and spacer are correctly positioned in block. See Fig. 16.

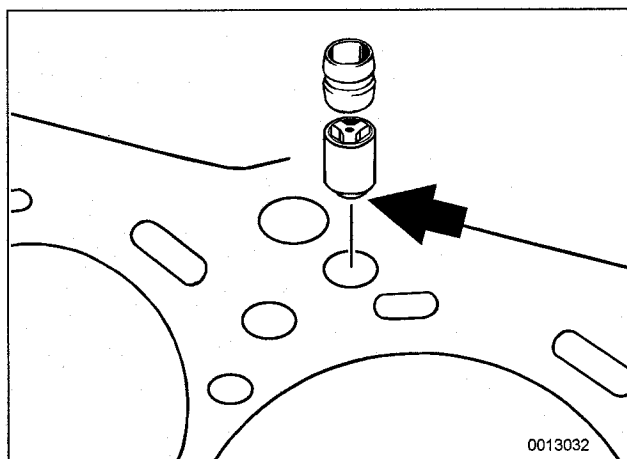


Fig. 16. Oil feed check valve and spacer used on M42 engine. Install check valve with collar (arrow) facing down.

CAUTION —

If the check valve is not installed correctly, oil flow to the cylinder head would be restricted.

4. Place new cylinder head gasket on surface of cylinder block. Check that two locating dowels are correctly positioned in block and not damaged.

CAUTION —

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

5. Place new rubber profile gasket in groove of front cover.
6. With camshafts locked in TDC position with BMW special tool as described earlier, set cylinder head in position.

CAUTION —

The camshafts must be locked in the TDC position at the rear of the cylinder head with BMW special tool no. 11 3 240 before installing the cylinder head.

Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation, is still in that position before lowering the cylinder head into position.

Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.

CYLINDER HEAD, 4-CYLINDER

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

NOTE —

Check that all washers for the cylinder head bolts are in place before installing the bolts.

8. Tighten cylinder head bolts in correct sequence. See Fig. 17.

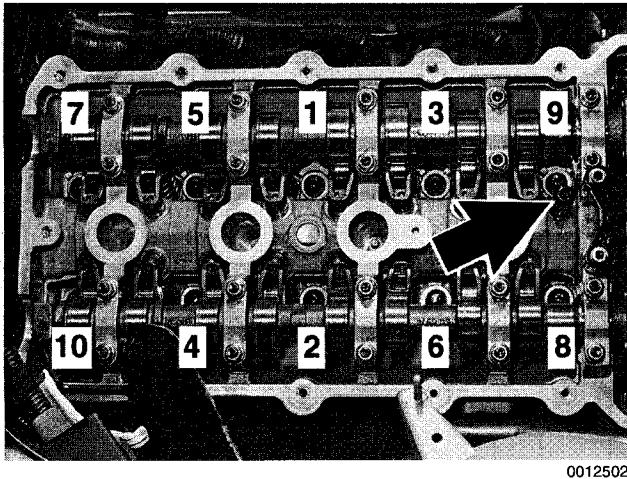


Fig. 17. Cylinder head bolt tightening sequence for 4-cylinder engines. Note oil supply tube seal (arrow) on M44 engine.

WARNING —

The bolts should be tightened in three stages as listed below. The final stages require the use of a special tool (BMW tool No. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle. See Fig. 18.

Tightening Torques

- Cylinder head to engine block (Torx E12 M10 bolts)

Stage 1	30 Nm (22 ft-lb)
Stage 2	+90°
Stage 3	+90°

9. Carefully rotate crankshaft in direction of engine rotation and lock it at TDC by inserting BMW special tool no. 11 2 300 through transmission bellhousing. See Fig. 19.

CAUTION —

Be sure timing chain does not bind on crank gear when turning crankshaft.

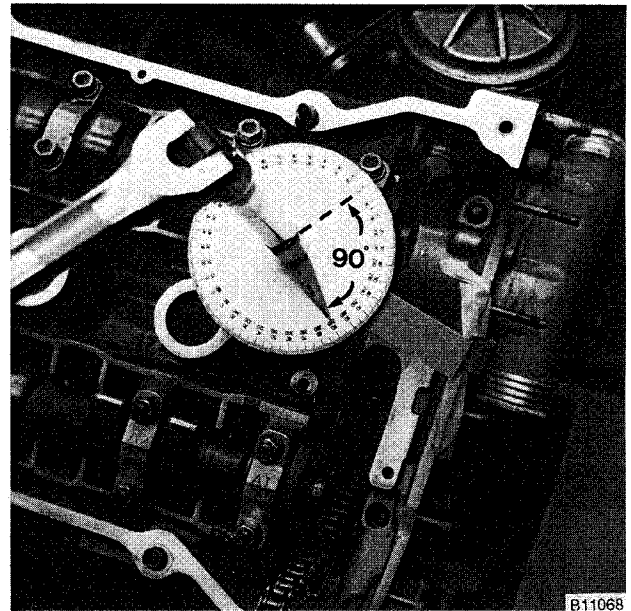


Fig. 18. Protractor and pointer being used to tighten bolts to specified torque angle (6-cylinder engine shown).

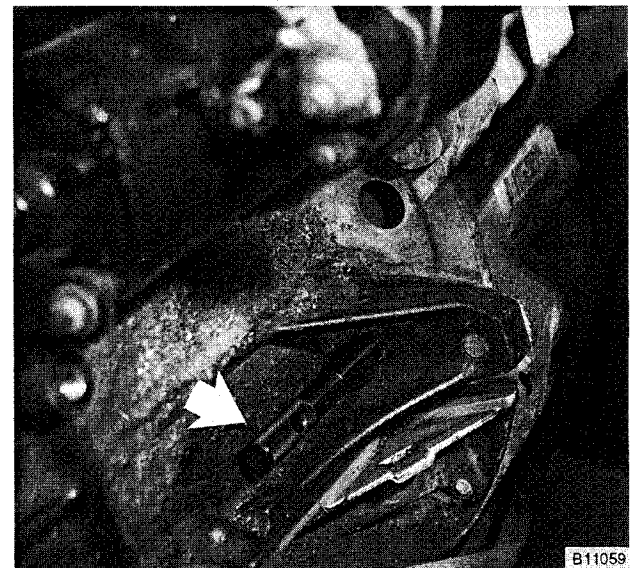


Fig. 19. BMW special tool 11 2 300 inserted through bellhousing hole and into flywheel (arrow) to lock crankshaft at TDC.

10. Turn left chain guide adjusting sleeve in until it just contacts the cylinder head (See Fig. 14.). Insert chain guide retaining screw and tighten.
11. Place chain sprockets with chains on camshafts so that arrows on sprockets point up and elongated holes in sprockets are centered to tapped holes in camshafts. See Fig. 20.

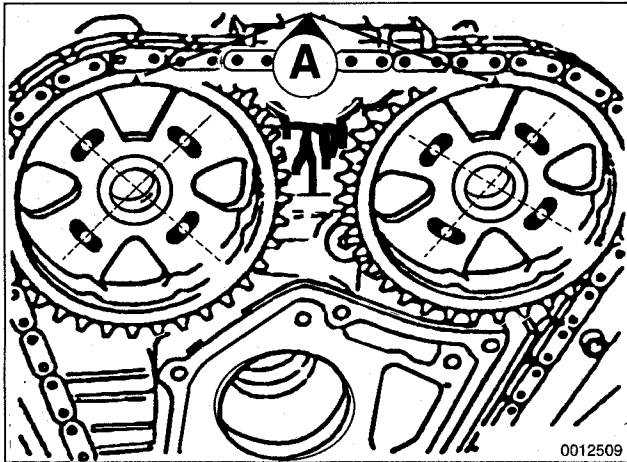


Fig. 20. Camshaft chain sprockets installed with arrows (A) pointing up and camshaft threaded holes centered in slotted holes.

12. On M44 engine: Place sensor wheel on intake camshaft sprocket so that arrow on sensor wheel points up.
13. Install and hand-tighten sprocket mounting bolts.

CAUTION —

Different hydraulic chain tensioners were used during manufacture, depending on engine type. See Fig. 21. Note that the late style tensioner can be retrofitted to the earlier engine, so be sure to identify the version of tensioner installed as installation instructions vary between the two.

14. On M42 engine: Disassemble chain tensioner by striking outer sleeve against a solid object. This will release snap ring and tensioner will separate. See Fig. 22.

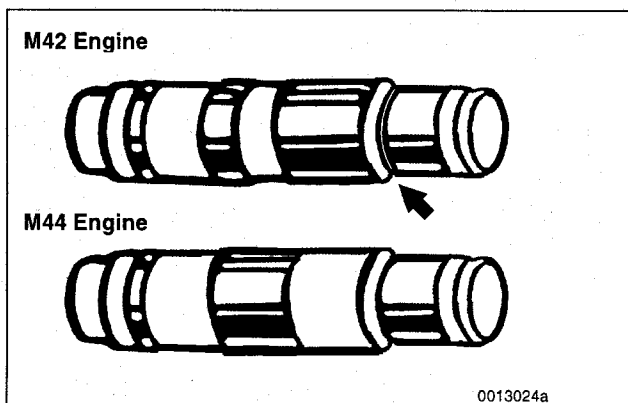


Fig. 21. Two versions of hydraulic chain tensioners. Original chain tensioner on M42 engine (top) can be disassembled. Chain tensioner on M44 engine (bottom) cannot be disassembled. Note differences in outer sleeve. Also, the M42 tensioner detent ring groove (arrow) is visible when tensioner is extended.

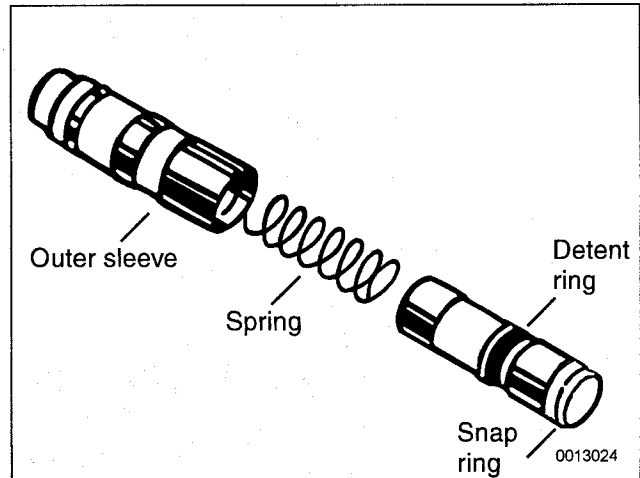


Fig. 22. Disassembled chain tensioner for M42 engine.

15. On M42 engine: Clamp tensioner piston in vice (soft jaws). Slowly compress piston, making sure detent ring fits into taper of outer sleeve. If necessary, press ends of detent ring together. Slowly continue pressing tensioner together until snap ring audibly clicks into outer sleeve. Measure overall length of tensioner to confirm correct assembly: 68.5 mm (2.7 in.).

NOTE —

The late-style tensioner on the M44 engine can be retrofitted to the M42 engine.

Tightening Torque

- Chain tensioner plug to cylinder head 40 Nm (30 ft-lb)

16. On M44 engine: Clamp tensioner piston in vice (soft jaws) and squeeze oil from it. Slowly compress piston only up to end circlip. Repeat procedure twice to ensure all oil is expelled. See Fig. 23.
17. Install hydraulic chain tensioner to cylinder head. Use a new sealing washer on tensioner when installing.
18. On M42 engine: Unlock chain tensioner by pressing chain rail against tensioner until it expands out.
19. Check that chain is free of slack. Tighten sprocket mounting bolts.

Tightening Torque

- Chain sprocket to camshaft flange . . . 10 Nm (89 in-lb)

20. Remove crankshaft locking tool from bellhousing and camshaft locking tool from rear of cylinder head.

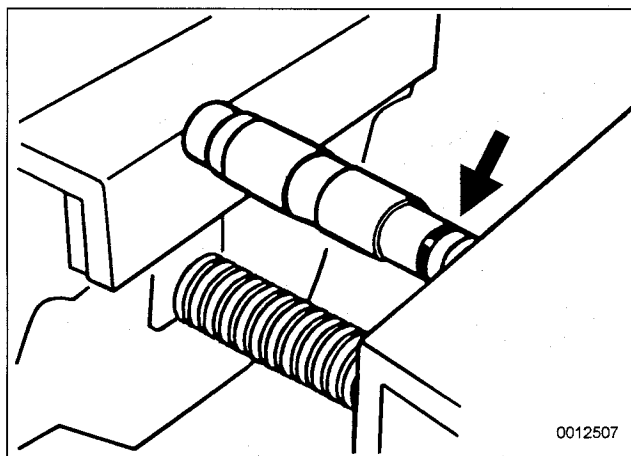


Fig. 23. When reinstalling chain tensioner on M44 engine, old oil in tensioner piston must be expelled by compressing piston in vise. When compressing piston, only compress up to end cir-clip (arrow).

21. Turn engine over by hand in direction of rotation at least two full rotations. Reinstall camshaft and crankshaft locking tools to check engine timing. Remove locking tools if no faults are found.

22. Install upper timing chain cover.

- Install gaskets and install cover using two mounting bolts. Using a screwdriver, lever down on front cover until cover gasket surface is flush with cylinder head gasket surface. See Fig. 24. Tighten two bolts.
- Install and tighten remainder of bolts.

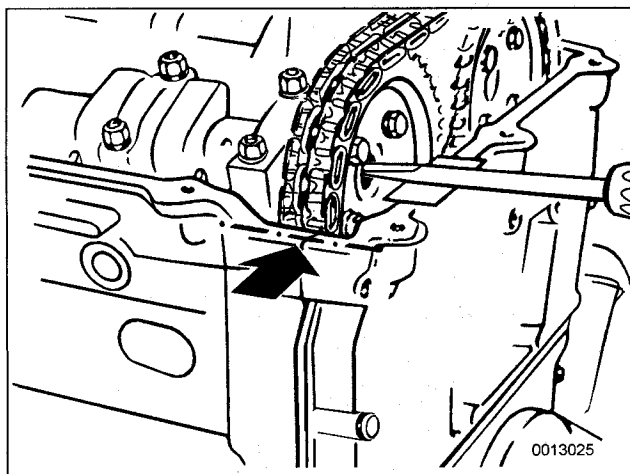


Fig. 24. Install upper timing case cover with two bolts, then press down on cover so that top surface is flush with cylinder head (arrow). Hold cover in position and tighten bolts.

23. Install cylinder head cover.

- Clean old gasket glue from sealing surfaces. Use a small amount of 3-Bond®1209 adhesive or equivalent at corners of half-moon cut-outs at back of cylinder head. See Fig. 25.

NOTE —

On M44 engines, replace seal for oil supply tube. See Fig. 17.)

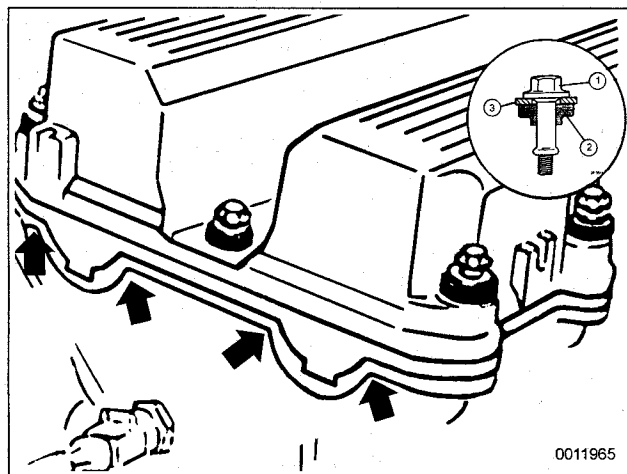


Fig. 25. Rear of cylinder head cover showing area where sealant (arrows) should be applied. Inset shows cylinder head cover mounting bolt and insulator assembly: M6 screw (1), rubber damper (2), washer (3).

Tightening Torque

- Cylinder head cover to cylinder head (M6 screws). 10 Nm (89 in-lb)

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

- Make sure all sealing surfaces are clean and free of old gasket material. Install new intake manifold gasket.
- On M44 engine: Replace seals above and below crankcase vent valve.
- When installing lower intake manifold, make sure hollow locating bushings are on two lower studs.
- Reinstall harness connectors for oil pressure switch and coolant temperature sensor before installing intake manifold. Tighten manifold nuts in stages.
- Refill cooling system as described in **170 Radiator and Cooling System**.
- Change engine oil and filter as described in **020 Maintenance Program**.
- If necessary, adjust accelerator cable.
- Run engine at approx. 3,500 rpm for about 20 seconds to allow hydraulic chain tensioner to fill with oil.
- Reconnect battery last.

Tightening Torques

- Coolant drain plug to cylinder block . . 25 Nm (18 ft-lb)
- Intake manifold support to manifold . . 15 Nm (11 ft-lb)
- Lower intake manifold
to cylinder head 15 Nm (11 ft-lb)
- Lower intake manifold
to upper manifold 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)

CYLINDER HEAD, 6-CYLINDER

Cylinder head, removing (6-cylinder engine)

For ease of use this procedure is broken into subsections, as follows:

- ▶ General
- ▶ Cooling system, draining
- ▶ Cylinder head cover, removing
- ▶ Intake manifold, removing
- ▶ Timing chains, uncoupling
- ▶ Cylinder head assembly, removing

WARNING —

Allow the engine to cool before beginning this procedure.

General

1. Working inside luggage compartment, disconnect negative (–) battery cable.

CAUTION —

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

2. Remove front exhaust pipes from manifolds. Discard nuts.
3. Remove air filter housing complete with mass air flow sensor and intake air ducting. Disconnect vacuum hoses from throttle housing.
4. On M52 and S52US engines: Remove secondary air injection check-valve from front of engine and set aside.

Cooling system, draining

5. Drain engine coolant and remove coolant hoses from thermostat housing. Drain engine block by removing block drain. See **170 Radiator and Cooling System**.

NOTE —

The block drain is on the exhaust side of the engine, near cylinder no. 5.

6. 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.

7. Disconnect heater hoses at rear of cylinder head. See Fig. 26.

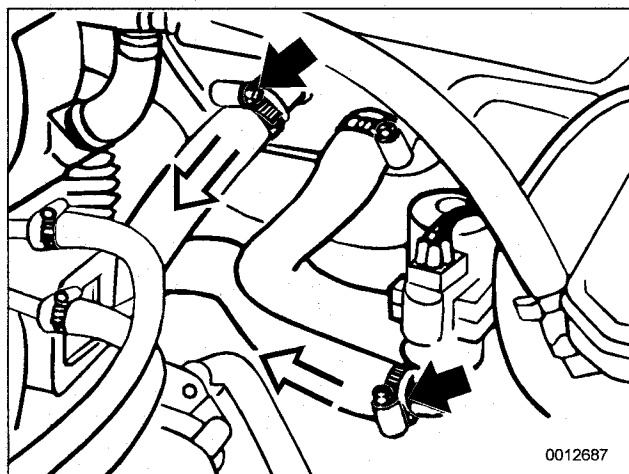


Fig. 26. Disconnect heater hoses at heater valve (A) and heater core (B).

8. Remove alternator cooling duct.

Cylinder head cover, removing

9. Remove air plenum from rear of engine compartment. See **640 Heating and Air Conditioning**.
10. Remove plastic cylinder head covers from above fuel injectors and ignition coils. Pull larger cover forward when removing. See Fig. 27.
11. Disconnect crankcase ventilation hose fitting from cylinder head cover.
12. Disconnect ignition coil harness connectors from coils. Remove ignition coils and spark plugs. See **120 Ignition System**.

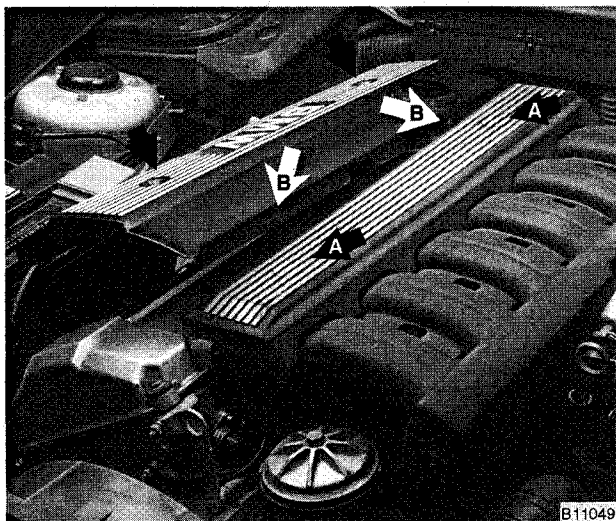


Fig. 27. Remove top engine covers by prying out plugs and removing nuts (A). Make sure rubber insulators on either side of large cover do not fall off during cover removal (B).

13. Remove hold down nuts/bolts from fuel injection harness. Pry back injector connector retaining clips and lift entire harness off engine. See Fig. 28.

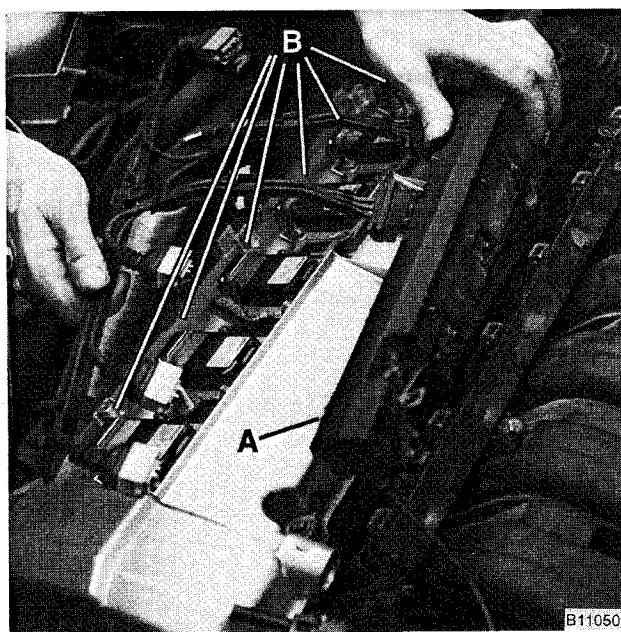


Fig. 28. Fuel injection harness being lifted off engine to be placed at base of windshield (A). Ignition coils are also visible (B). M50 engine shown, other 6-cylinder engines are similar.

14. Remove cylinder head cover mounting bolts and remove cylinder head cover.

15. Remove oil baffle cover from above intake camshaft. See Fig. 29.

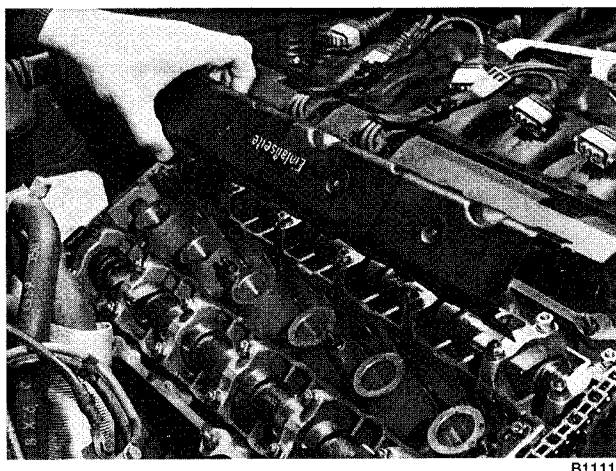


Fig. 29. Camshaft oil baffle cover being removed.

NOTE —

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

► Intake manifold, removing

16. Disconnect vacuum hose from brake system vacuum booster. Plug opening in booster.
17. Remove throttle housing mounting bolts and remove throttle housing. Set throttle housing aside without disconnecting cables or coolant hoses. See Fig. 30.

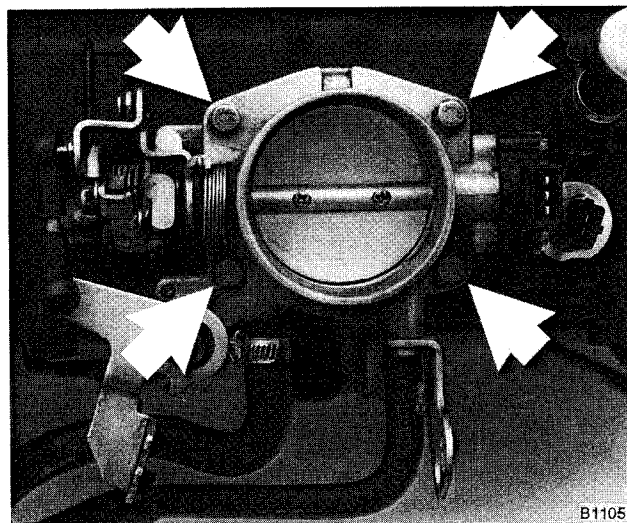


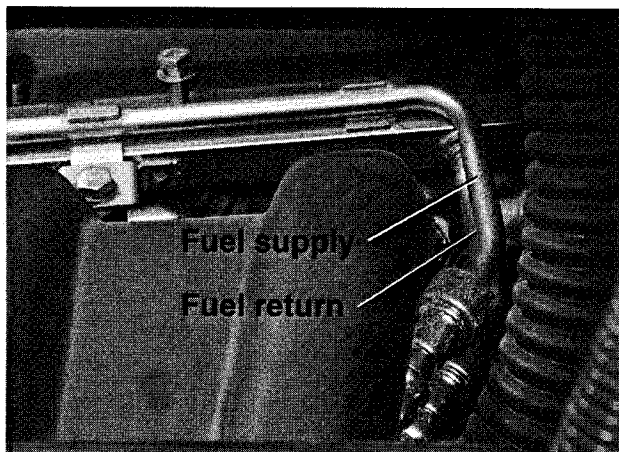
Fig. 30. Remove 4 corner bolts (arrows) from throttle housing and unbolt complete assembly from intake manifold. Remove complete throttle assembly without disconnecting connectors, hoses or cables. (M50 engine shown.)

113-12 CYLINDER HEAD REMOVAL AND INSTALLATION

18. Working from underside of intake manifold, disconnect harness connectors, vent hoses, and air bypass hose(s).
19. Working at rear of intake manifold, label and disconnect fuel supply and fuel return lines. Remove fuel line hold down bracket to free lines. See Fig. 31.

NOTE —

On M52/S52US 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.



0012699

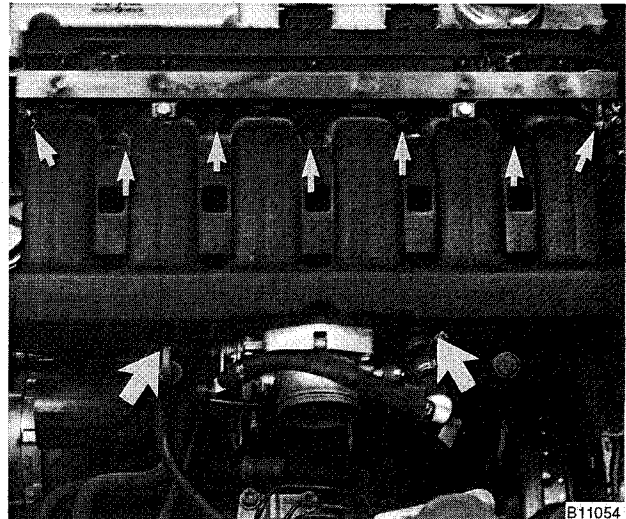
Fig. 31. Fuel lines at intake manifold on M52/S52 engine. Use BMW special tool 16 1 050 to release locking fittings at ends of fuel lines.

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 gradually. Avoid spraying fuel.
- 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.

20. Remove mounting screws and release wiring harness duct at rear bulkhead and move aside. Remove wiring harness brackets from bulkhead.

21. Detach oil dipstick guide tube from manifold. Disconnect vent hose at base of dipstick.
22. Remove intake manifold from engine by removing seven mounting nuts from above and two support bracket bolts from below. See Fig. 32.



B11054

Fig. 32. Intake manifold nuts and support bracket bolts (arrows).

CAUTION —

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

Timing chains, uncoupling

23. Remove VANOS unit from front of cylinder head. See VANOS section in **117 Camshaft Timing Chain**.
24. Set engine to approximate TDC by rotating in normal operating direction until camshaft lobes at cylinder no. 1 are facing each other. Arrows on camshaft sprockets should be pointing up.

NOTE —

To confirm that the crankshaft is set to the TDC position, check that the O/T mark (0° TDC) on the front lower timing chain cover is aligned with the vibration damper. See Fig. 33.

25. Lock crankshaft at TDC.
 - Insert BMW special tool no. 11 2 300 through transmission bellhousing and into hole in flywheel or drive plate. See Fig. 34.

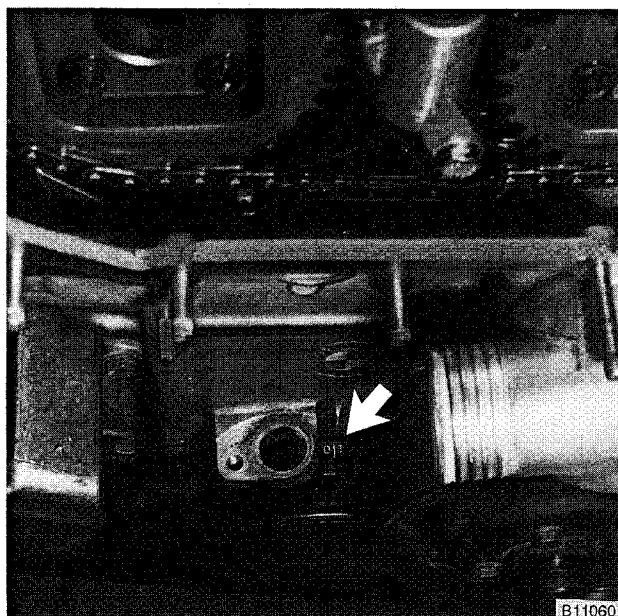


Fig. 33. Crankshaft is positioned at TDC when notch on front timing chain cover is aligned with O/T mark on vibration damper.

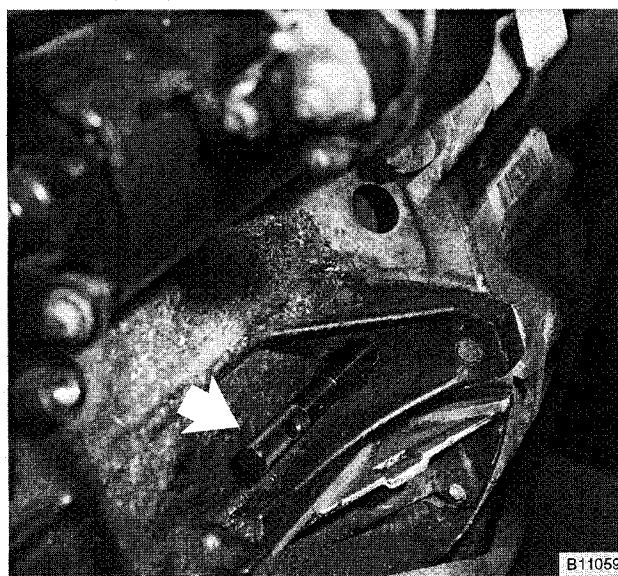


Fig. 34. Crankshaft locking tool (BMW special tool 11 2 300) inserted through bellhousing hole and into flywheel (arrow).

26. Lock camshafts at TDC.

- Remove three cylinder head cover mounting studs from across rear of head, if applicable.
- Mount BMW special tool no. 11 3 240 over square ends of camshafts. Check that tool is squarely seated on cylinder head gasket surface. If necessary, rotate camshafts slightly using a 24 mm wrench at hex on camshaft(s). See Fig. 35.

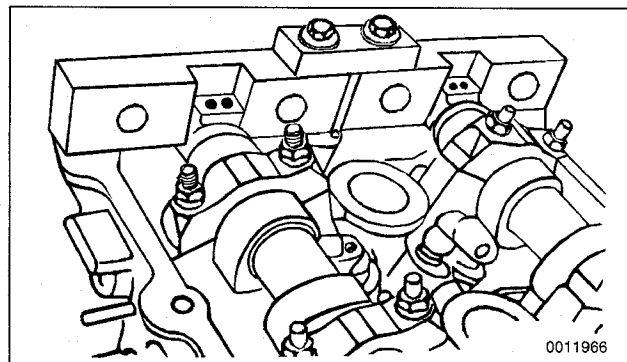


Fig. 35. Camshaft locking tool (BMW special tool no. 11 3 240) installed on rear of camshafts. (M44 engine shown. Other engines are similar.)

CAUTION —

The camshafts must be locked in the TDC position using the special service tool before removing the timing chain. 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.

- 27.** Depress secondary timing chain tensioner and lock it down by inserting BMW special tool no. 11 3 292. Alternatively, a stiff piece of wire can be used. See Fig. 36.

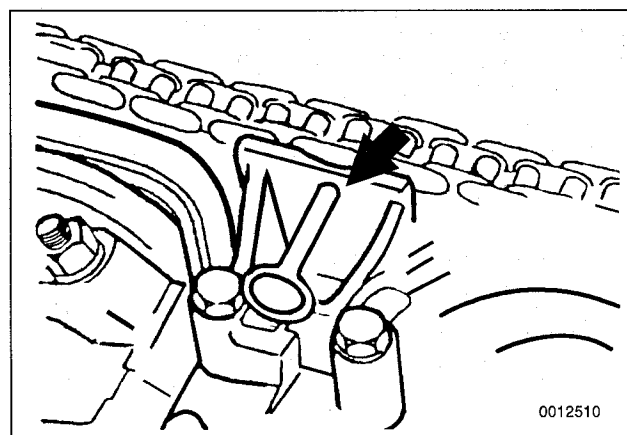


Fig. 36. Press secondary tensioner down fully and insert wire through holes (arrow) to lock. Timing chain tensioner varies depending on engine (M52 engine tensioner shown).

- 28.** Remove mounting nuts from front of intake camshaft sprocket. Remove camshaft sprocket, thrust washer(s), and where applicable, spring plate.

NOTE —

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

113-14 CYLINDER HEAD REMOVAL AND INSTALLATION

29. Remove mounting nuts from front of exhaust camshaft sprocket. Remove secondary sprockets together with timing chain from front of camshafts.

CAUTION —

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

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.

30. Unbolt secondary timing chain tensioner from top of cylinder head.
31. Remove primary timing chain tensioner from side of cylinder head. See Fig. 37.

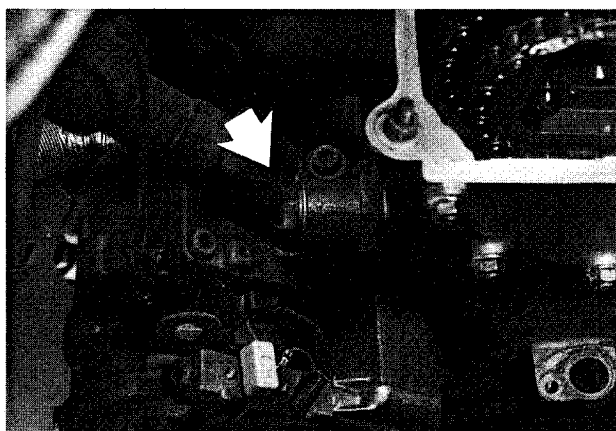


Fig. 37. Primary timing chain tensioner (arrow).

WARNING —

Remove tensioner slowly—it is under spring pressure.

32. Remove timing chain guide (Torx E8 socket). See Fig. 38.
33. Lift primary chain sprocket off exhaust camshaft. Remove sprocket from chain. Suspend chain using stiff wire.

► Cylinder head assembly, removing

34. Remove two mounting bolts holding cylinder head to lower timing chain cover (Torx E8 socket). See Fig. 39.

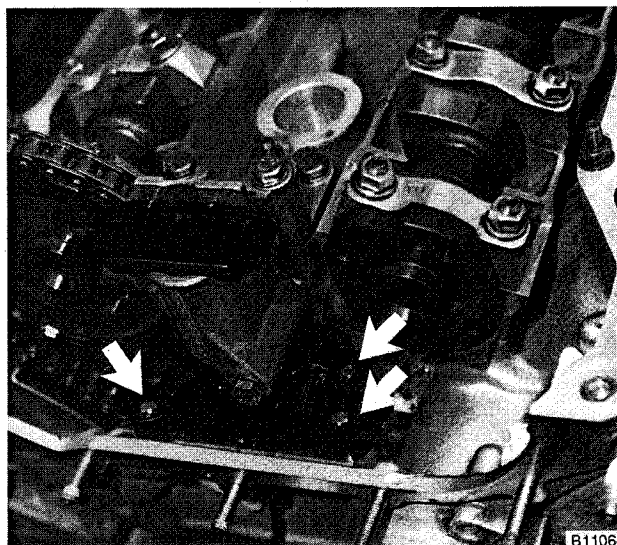


Fig. 38. Timing chain guide mounting bolts (arrows). M50 engine shown.

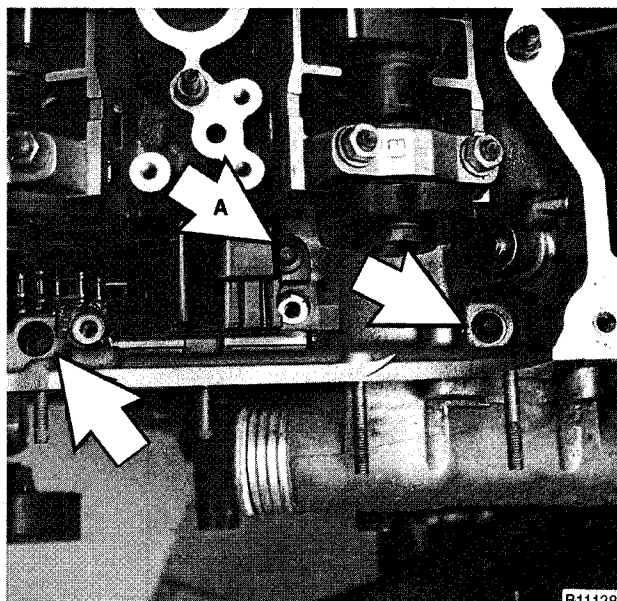


Fig. 39. Cylinder head-to-timing chain cover mounting bolts (arrows). (Bolt A also retains secondary chain tensioner.)

35. Using BMW special tool no. 11 2 250 or an equivalent tool, loosen cylinder head bolts in several stages. See Fig. 40. Discard head bolts.

CAUTION —

Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.

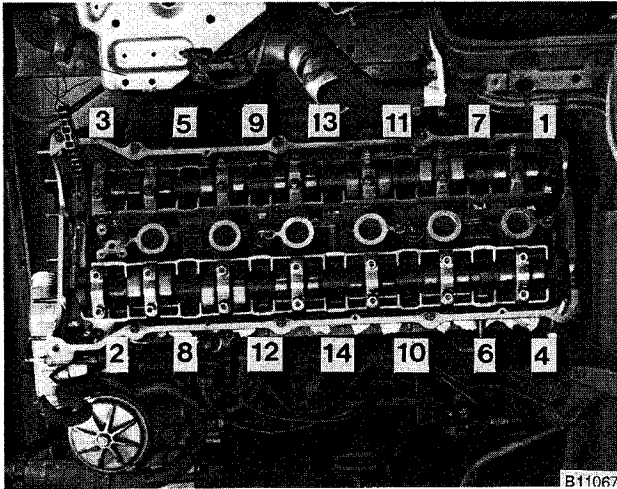


Fig. 40. Cylinder head bolt loosening sequence.

NOTE —

BMW special tool no. 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.

36. Remove crankshaft locking tool (BMW special tool no. 11 2 300). Using the crankshaft vibration damper bolt, turn engine opposite its normal direction of rotation (counterclockwise as viewed from the front) approximately 45°. This prevents accidental contact between valves and pistons during installation.

NOTE —

Guide cam chain to keep it from jamming when turning the crankshaft.

Cylinder head, installing (6-cylinder engine)

CAUTION —

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.

Cylinder head installation waiting times

- 68°F (20°C) and higher 10 minutes
- 50-68°F (10-20°C) 30 minutes
- 32-50°F (0-10°C) 75 minutes

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

- Remove all foreign matter and any liquid from bolt holes, then clean with a thread chaser.

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.

2. 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.

3. Place new cylinder head gasket on cylinder block. 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. The cylinder head gasket will fit correctly in only one orientation.

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

CAUTION —

- The camshafts must be locked in the TDC position at the rear of the cylinder head with BMW special tool no. 11 3 240 before installing the cylinder head.

- Make sure the crankshaft, which had been rotated approximately 45° opposite the direction of engine rotation, is still in that position before lowering the cylinder head into position.

5. Lightly lubricate new cylinder head bolts. Loosely install bolts and their washers, then thread them in until they are finger tight. Install cylinder head-to-lower timing chain cover bolts finger tight.

CAUTION —

Torx-type cylinder head bolts should not be reused. They are stretch-type bolts and must always be replaced whenever loosened.

113-16 CYLINDER HEAD REMOVAL AND INSTALLATION

NOTE —

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.

6. Tighten cylinder head bolts in correct sequence. See Fig. 41.

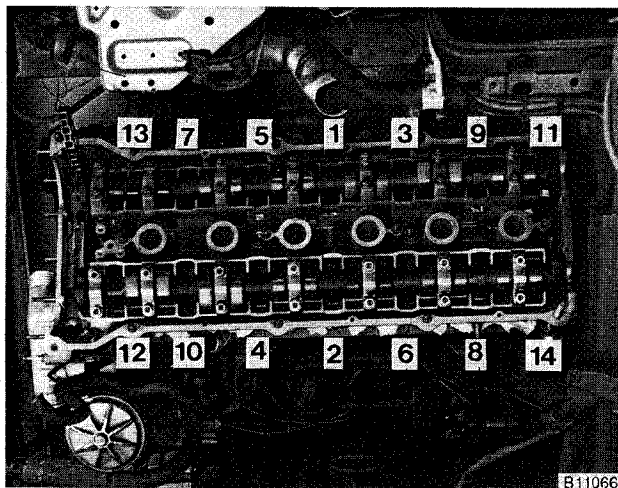


Fig. 41. Cylinder head bolt tightening sequence for M50 engine.

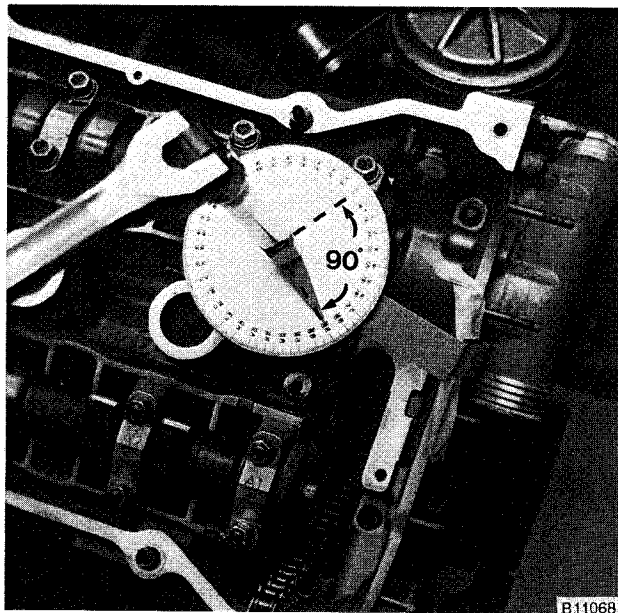


Fig. 42. Protractor and pointer being used to tighten bolts to specified torque angle.

WARNING —

The bolts should be tightened in three stages as listed below. The final stages require the use of a special tool (BMW tool No. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle. See Fig. 42.

7. Install and tighten cylinder head-to-lower timing chain cover bolts.

Tightening Torques

- Cylinder head to engine block (Torx E12 M10 bolts)
 - Stage 1 30 Nm (22 ft-lb)
 - Stage 2 +90°
 - Stage 3 +90°
- Cylinder head to lower timing chain cover 10 Nm (89 in-lb)

8. Carefully rotate crankshaft in direction of engine rotation and lock it at TDC by inserting BMW special tool no. 11 2 300 through transmission bellhousing. Guide primary timing chain to keep it from jamming on crank gear.

9. Mount primary chain sprocket to primary chain so that arrow on sprocket faces up. Mount sprocket to exhaust camshaft so tapped holes in camshaft are on left most side of elongated holes in sprocket. See Fig. 43.

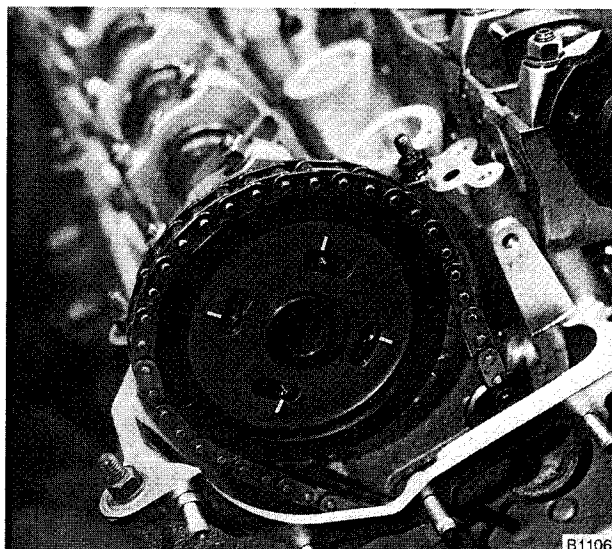


Fig. 43. Primary chain sprocket correctly aligned to exhaust camshaft. Camshaft holes should be on left most side of sprocket holes.

10. Install timing chain guide and secondary chain tensioner. Tighten mounting bolts.
11. Install as an assembly, secondary chain sprockets and chain so that arrow(s) on sprocket(s) are pointing up. Center mounting holes in sprockets to bolt holes in camshafts. See Fig. 44.
12. Install thrust washers and spring plate (if applicable) to sprockets. See Fig. 45.

CYLINDER HEAD, 6-CYLINDER

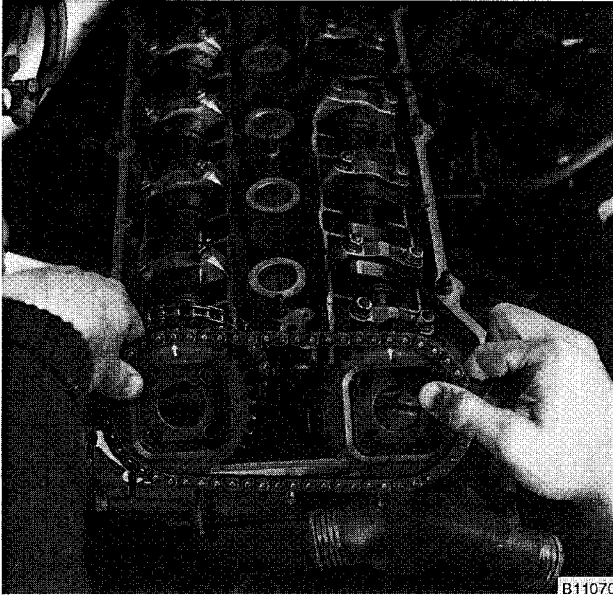


Fig. 44. Secondary chain sprockets and chain being installed. Attach sprockets with arrows pointing up and elongated holes centered.

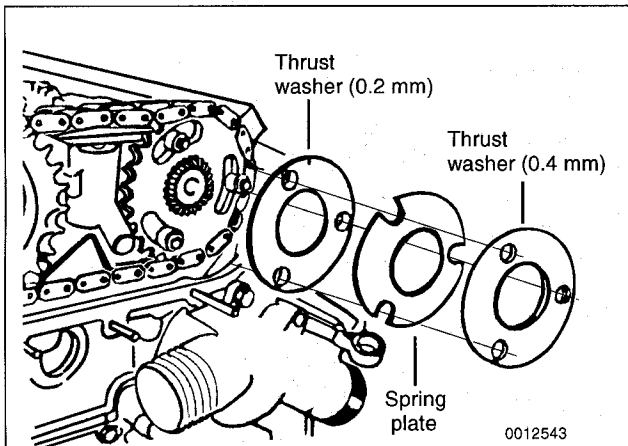


Fig. 45. VANOS spring plate and thrust washers on later engines.

CAUTION —

Mount intake camshaft sprocket so that collar side of the sprocket faces camshaft.

13. Install and tighten exhaust camshaft sprocket mounting bolts finger tight only. Tighten intake camshaft sprocket mounting nuts to specified torque.

Tightening Torque

- Intake camshaft sprocket mounting nuts (M6) 10 Nm (89 in-lb)

14. Install BMW special tool no. 11 3 390 into primary timing chain tensioner sleeve. Thread tool in finger tight until slack is removed from chain.

NOTE —

BMW special tool no. 11 3 390 is a dummy primary chain tensioner and simulates the function of the tensioner.

15. Install VANOS unit as described in **117 Camshaft Timing Chain**.

CAUTION —

Special installation instructions apply when mounting the VANOS unit to the cylinder head. Be sure to follow the procedure found in **117 Camshaft Timing Chain**.

16. Slowly unlock and release secondary chain tensioner.
17. Preload primary chain by tightening BMW special tool no. 11 3 390 (dummy chain tensioner) to 1.3 Nm (11 in-lb). Then tighten exhaust secondary camshaft sprocket mounting bolts in two stages.

Tightening Torque

- Secondary timing chain sprocket to exhaust camshaft (Torx bolts)

Stage 1	5 Nm (44 in-lb)
Stage 2	22 Nm (17 ft-lb)

18. Remove flywheel locking tool from transmission bellhousing. Remove camshaft locking tool from rear of cylinder head.
19. Turn engine over by hand at least two full crankshaft rotations. Reinstall camshaft locking tool and flywheel locking tool to make sure all adjustments are still correct. If settings are correct, remove locking tools.
20. Remove BMW special tool 11 3 390 (dummy chain tensioner) from side of cylinder head.
21. Install primary chain tensioner so that cutout in tensioner piston engages chain rail. See Fig. 46. Using new seals, install and tighten access plugs in VANOS control unit.

Tightening Torques

- Access plugs to VANOS control unit. 50 Nm (37 ft-lb)
- Primary camshaft timing chain tensioner to tensioner sleeve 50 Nm (37 ft-lb)

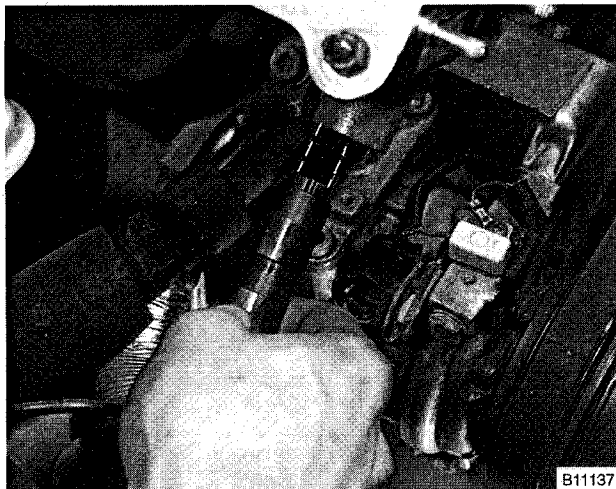


Fig. 46. Primary chain tensioner being installed. Piston cutout must engage chain rail.

22. Install intake cam cover and then install cylinder head cover. Check for correct seating of half-moons in back of cylinder head cover. Use a small amount of 3-Bond® 1209 or equivalent sealant at corners of half-moon cut-outs.

Tightening Torque

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

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

24. Installation of remaining parts is reverse of removal. Refill cooling system as described in **170 Radiator and Cooling System**. Change engine oil and filter as described in **020 Maintenance Program**. Check adjustment of accelerator cable. Additional tightening torques are given below. Reconnect battery last.

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

- Make sure all sealing surfaces are clean and free of old gasket material. Install new intake manifold gasket.
- Reinstall 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 Program**.
- If necessary, adjust accelerator cable.
- Reconnect battery last.

CAUTION —

To prevent damaging engine electronic systems, be sure to install all ground wires previously removed, including the ground wires at the cylinder head for the ignition coils.

Tightening Torques

- Coolant drain plug to cylinder block . . 25 Nm (18 ft-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)

