10 Camshafts and followers - removal, inspection and installation

Warning:
BMW special tools 11 3 260 and 11 3 270 will be required for this operation. These tools are extremely difficult to improvise due to their rugged construction and the need for accurate manufacture. Do not attempt to remove and install the camshafts without the aid of the special tools, as expensive damage to the camshafts and/or bearings may result.

1992 models

Removal

1 Open the hood, then raise the hood to its fully open position (see Chapter 11).

2 Unscrew the securing bolts and/or nuts, and remove the alternator air ducting from the front of the vehicle.

3 Remove the secondary timing chain (see Section 7).

4 Trace the wiring back from the camshaft position sensor, then disconnect the sensor connector. Unscrew the securing bolt, and remove the sensor from the cylinder head **(see illustrations)** .

10.4a Unscrew the securing bolt . . .

10.4b . . . and withdraw the camshaft position sensor

5 Remove the tool locking the secondary timing chain tensioner in position. Withdraw the plunger and spring.

6 Unscrew the securing bolts, and withdraw the secondary chain tensioner from the cylinder head.

7 Unscrew the securing bolts and withdraw the secondary chain guide **(see illustration)** .

10.7 Withdraw the secondary chain guide

8 Withdraw the primary timing chain sprocket from the exhaust camshaft, complete with the chain. Remove the sprocket. **Caution:** *Keep tension on the chain, and tie up the end of the chain using wire or string to prevent it from dropping into the lower timing chain cover and/or disengaging from the crankshaft sprocket.* **Warning:** *To avoid any possibility of piston-to-valve contact when installing the camshaft(s), it is necessary to ensure that none of the pistons are at TDC. Before proceeding further, remove the locking rod from the timing hole in the cylinder block, then turn the crankshaft approximately 30-degrees clockwise using a wrench or socket on the crankshaft pulley hub bolt.*

9 Remove the template from the cam-shafts.

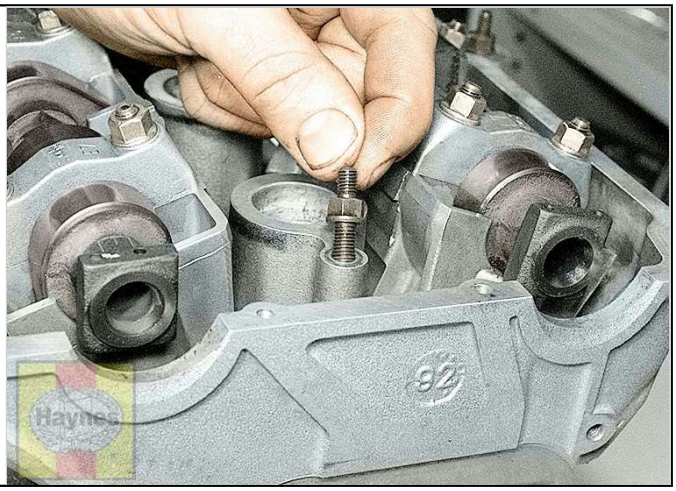
10 Unscrew the spark plugs from the cylinder head.

11 Check the camshaft bearing caps for identification marks. The caps are numbered from the timing chain end of the engine, and the marks can normally be read from the exhaust side of the engine. The exhaust camshaft

bearing caps are marked “A1” to “A7”, and the intake camshaft caps are marked “E1” to “E7”.

12 Unscrew the four camshaft cover securing studs from the center of the cylinder head **(see illustration)** .

10.12 Unscrew the four camshaft cover securing studs

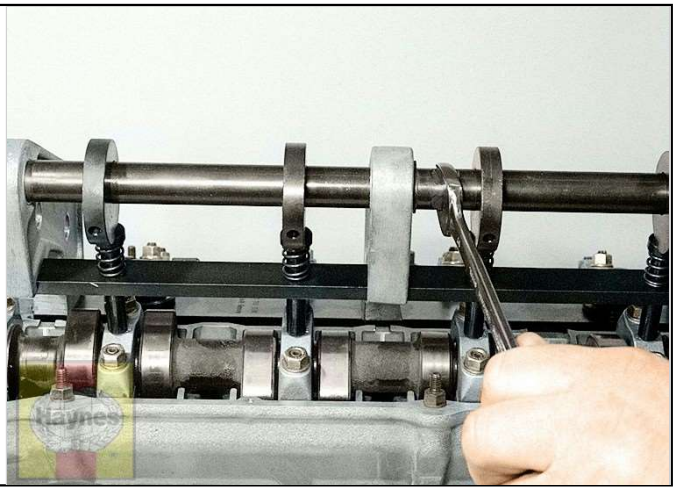


13 Assemble BMW special tools 11 3 260 and 11 3 270, and mount the tools on the cylinder head by screwing the mounting bolts into the spark plug holes. Position the tools so that the plungers are located over the relevant camshaft bearing caps (i.e., intake or exhaust camshaft) **(see illustration)** .

10.13 BMW special tools 11 3 260 and 11 3 270 fitted to cylinder head

14 Apply pressure to the camshaft bearing caps by turning the eccentric shaft on the tools using a wrench **(see illustration)** .

10.14 Turn the eccentric shaft using a wrench to apply pressure to the bearing caps



15 Unscrew the camshaft bearing cap nuts. **Warning:** *Do not attempt to unscrew the camshaft bearing cap nuts without the special tools in place, as damage to the camshaft and/or bearings may result.*

16 Release the pressure on the special tool shaft, then unbolt the tools from the cylinder head.

17 Lift off the bearing caps, keeping them in order, then lift out the camshaft.

18 The camshaft bearing casting can now be lifted from the cylinder head. This should be done very slowly, as the cam followers will be released as the casting is lifted off - if the casting is lifted off awkwardly, the cam followers may fall out. Do not allow the cam followers to fall out and get mixed up, as they must be fitted to their original locations.

19 With the bearing casting removed, lift the cam followers from the cylinder head. Identify the followers for location, and store them upright in a container of clean engine oil to prevent the oil from draining from inside the followers **(see illustration)** . Do not forget to mark the cam followers “Intake” and “Exhaust”.

10.19 Store the cam followers in marked cups of clean engine oil

20 Repeat the procedure on the remaining camshaft.

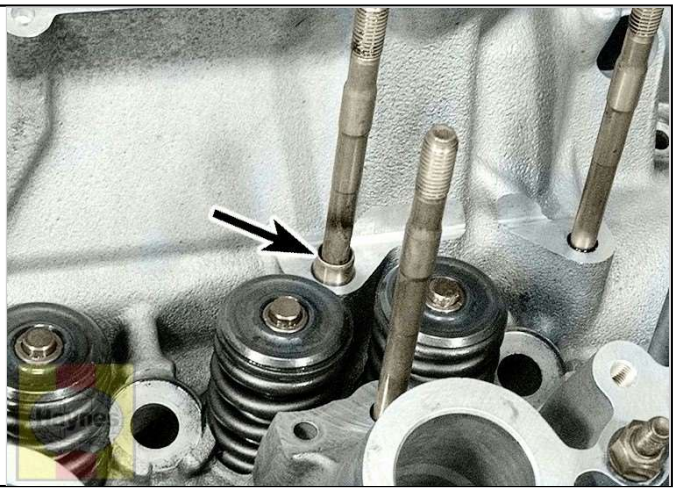
Inspection

21 Clean all the components, including the bearing surfaces in the bearing castings and bearing caps. Examine the components carefully for wear and damage. In particular, check the bearing and cam lobe surfaces of the camshaft(s) for scoring and pitting. Examine the surfaces of the cam followers for signs wear or damage. Replace components as necessary.

Installation

22 If the camshaft lower bearing castings have been removed, check that the mating faces of the bearing castings and the cylinder head are clean, and check that the bearing casting locating dowels are in position on the studs at No. 2 and 7 bearing locations **(see illustration)** .

10.22 Bearing casting locating dowel (arrow) on cylinder head stud at No. 2 bearing location



23 The bearing casting(s) and cam followers must now be refitted.

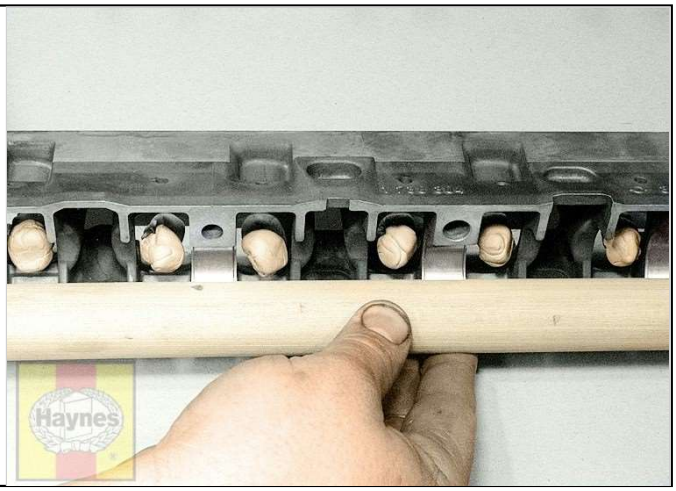
24 The simplest method of installing these components is to retain the cam followers in the bearing casting, and install the components as an assembly.

25 Oil the bearing casting contact surfaces of the cam followers (avoid allowing oil onto the top faces of the followers at this stage), then fit each follower to its original location in the bearing casting.

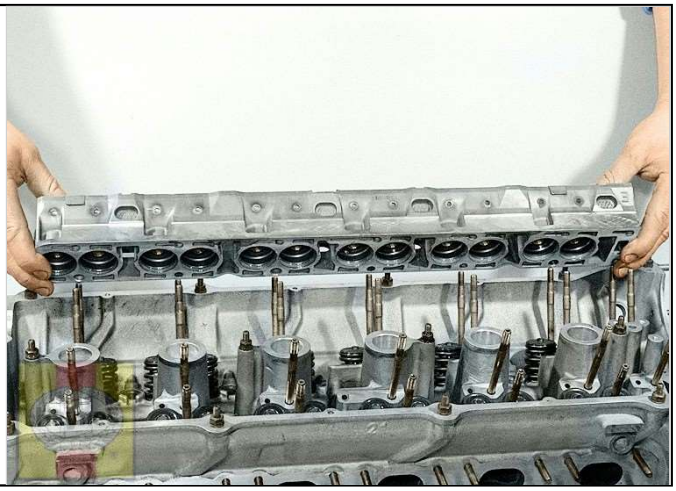
26 Once all the followers have been fitted, they must be retained in the bearing casting, so that they do not fall out as the assembly is refitted to the cylinder head **(see illustrations)** .

10.26a Apply a small amount of silicone or a similar adhesive compound to the top of each can follower. The adhesive should protrude beyond the lower bearing surface of the casting. Do not use excessive amounts of adhesive, as there is a risk of contaminating the oil passages in the bearing castings

10.26b Press a wooden dowel (such as a length of broom handle) onto the top surface of the adhesive pads so that the pads stick to the dowel, holding the cam followers in the bearing casting. Ensure that no adhesive is pressed out between the surfaces of the cam followers and bearing casting



10.26c Leave the adhesive pads and the dowel in position until the assembly has been refitted to the cylinder head, then remove the dowel, and carefully remove the adhesive from each follower. It is essential to ensure that no trace of adhesive is left on the followers or on any of the engine components - serious engine damage could result if the oil passages become contaminated



27 With the cam followers retained in the bearing casting, install the casting to the cylinder head. Note that the exhaust side casting is marked “A” and the intake side casting is marked “E”. When the castings are refitted, the marks should face each other at the timing chain end of the cylinder head. **Warning:** *The cam followers expand when not subjected to load by the camshafts, and therefore require some time before they can be compressed. If the camshaft installation operation is carried out rapidly, there is a possibility that the “closed” valves will be forced open by the expanded cam followers, resulting in piston-to-valve contact. To minimize this possibility, after installing the camshaft(s) observe the following delays before turning the crankshaft back to the TDC position:*

Temperature	Delay
Room temperature (68°F)	4 minutes
50°F to 68°F	11 minutes
32°F to 50°F	30 minutes

28 First identify the camshafts to ensure that they are fitted in the correct locations. The intake camshaft has a small cut-out in the top of the front flange, and the exhaust camshaft has a plain front flange.

29 Ensure that the crankshaft is still positioned 30-degrees clockwise from the TDC position (see **Warning** at the end of paragraph 8).

30 Position the camshaft on the cylinder head, so that the tips of the front cam lobes on the exhaust and intake camshafts face one another. Note also that the square flanges on the rear of the camshaft should be positioned with the sides of the flanges exactly at right-angles to the top surface of the cylinder head (this can be checked using a set-square), and the side of the flange with holes drilled into it uppermost.

31 Place the bearing caps in position, noting that the caps carry identification marks. The exhaust camshaft caps are marked “A1” to “A7”, and the intake camshaft caps are marked “E1” to “E7”. Place the bearing caps in their original locations as noted before removal.

32 Re-assemble BMW special tools 11 3 260 and 11 3 270, and install them to the cylinder head as during removal. **Warning:** *Again, do not attempt to install the camshafts without the aid of the special tools.*

33 Apply pressure to the relevant bearing caps by turning the eccentric shaft on the tools using a wrench.

34 With pressure applied to the bearing caps, install the bearing cap securing nuts, and tighten them as far as possible by hand.

35 Tighten the bearing cap nuts to the specified torque, working progressively in a diagonal sequence.

36 Once the bearing cap nuts have been tightened, unbolt the tools used to apply pressure to the bearing caps.

37 Repeat the procedure on the remaining camshaft.

38 Install the spark plugs, and install the camshaft cover securing studs to the cylinder head.

39 Install the template used to check the position of the camshafts. If necessary, turn the camshaft(s) slightly using a wrench on the flats provided until the template can be fitted. **Warning:** *Note the precaution given in the warning at the end of paragraph 27 before proceeding.*

40 Turn the crankshaft back 30-degrees counterclockwise to the TDC position, then re-engage the locking rod with the flywheel to lock the crankshaft in position.

41 Manipulate the exhaust camshaft primary chain sprocket until the timing arrow on the sprocket is pointing vertically upwards, then engage the chain with the sprocket.

42 Fit the sprocket to the exhaust camshaft, aligning the sprocket so that the tapped holes in the camshaft flange are positioned at the left-hand ends of the elongated slots in the sprocket.

43 Install the secondary chain guide and tighten the securing bolts.

44 Install the secondary chain tensioner and tighten the securing bolts.

45 Temporarily install the tool to lock the secondary chain tensioner in position, then install the secondary timing chain (see Section 7).

46 Install the camshaft position sensor and reconnect the wiring plug.

47 Install the alternator air ducting, then lower the hood. **Warning:** *Follow the procedure outlined in the warning at the end of paragraph 27, the cam followers expand when not subjected to load by the camshafts To minimize the possibility of piston-to-valve contact, after installing the camshaft(s), observe the following delays before cranking the engine:*

Temperature	Delay
Room temperature (68°F)	10 minutes
50°F to 68°F	30 minutes
32°F to 50°F	75 minutes

1993 and later models

Note:
BMW special tool No. 11 3 390 or a suitable equivalent will be required to carry out this operation.

Removal

48 Remove the secondary timing chain, and then remove the camshaft position sensor plate, (see Section 7).

49 Unscrew the primary timing chain tensioner plunger cover plug from the right-hand side of the engine. Recover the sealing ring. **Warning:** *The chain tensioner plunger has a strong spring. Take care when unscrewing the cover plug.*

50 Recover the spring and withdraw the tensioner plunger.

51 Follow the procedure outlined in steps 5 through 8 of this Section. **Caution:** *Keep tension on the primary timing chain, and tie up the end of the chain using wire or string to prevent it from dropping into the lower timing chain cover and/or disengaging from the crankshaft sprocket.* **Warning:** *To avoid any possibility of piston-to-valve contact when installing the camshaft(s), it is necessary to ensure that none of the pistons are at TDC. Before proceeding further, remove the locking rod from the timing hole in the cylinder block, then turn the crankshaft approximately 30-degrees clockwise using a wrench or socket on the crankshaft pulley hub bolt.*

52 Follow the procedure outlined in steps 9 through 13.

53 Unscrew the securing nuts, and remove the No. 1 (timing chain end) intake camshaft bearing cap. Note that the bearing cap is located on dowels.

54 Apply pressure to the camshaft bearing caps by turning the eccentric shaft on the special tool.

55 Follow the procedure outlined in steps 15 through 20.

Inspection

56 Follow the procedure outlined in step 21.

57 If necessary, the splined VANOS shaft on the front of the intake camshaft can be renewed. To do this, proceed as follows.

A. Clamp the camshaft carefully in a soft-jawed vise.

B. Unscrew the splined shaft using a hexagon key.

C. Fit the new splined shaft and tighten to the specified torque.

Installation

58 If the camshaft lower bearing castings have been removed, check that the mating faces of the bearing castings and the cylinder head are clean, and check that the bearing casting locating dowels are in position on the studs at No. 2 and 7 bearing locations.

59 Follow the procedure outlined in steps 23 through 27.

60 If both camshafts have been removed, first identify the camshafts to ensure that they are fitted in the correct locations. The intake camshaft has a triangular-shaped front flange, and the splined VANOS shaft screwed into the front (timing chain) end.

61 Ensure that the crankshaft is still positioned 30-degrees clockwise from the TDC position (see **Warning** at the end of paragraph 51).

62 Follow the procedure outlined in steps 30 through 44.

63 Fit special tool No. 11 3 390 into the primary timing chain tensioner aperture, then turn the adjuster screw on the tool until the end of the screw just touches the tensioning rail **(see illustration 9.27a)** . Note that the exhaust camshaft sprocket should now have moved counterclockwise so that the tapped holes in the camshaft flange are centered in the elongated holes in the sprocket.

64 Temporarily install the tool to lock the secondary chain tensioner in position, then install the camshaft position sensor plate and the secondary timing chain (see Section 7). **Warning:** *Follow the procedure outlined in the warning at the end of paragraph 27, the cam followers expand when not subjected to load by the camshafts To*

minimize the possibility of piston-to-valve contact, after installing the camshaft(s), observe the following delays before cranking the engine:

Temperature	Delay
Room temperature (68°F)	10 minutes
50°F to 68°F	30 minutes
32°F to 50°F	75 minutes