10 Camshafts - removal and installation

Caution:
BMW special tool 11 3 260 is needed for this procedure on M42 engines and BMW special tool 11 5 130 is required on M44 engines. Because of the high degree of precision needed to manufacture these tools, they would be extremely difficult to fabricate. Do not attempt to remove and install the camshafts on either engine without the aid of the requisite tool, or expensive damage to the camshafts and/or bearings may result.

Removal

Note:
The following procedure applies to either camshaft.

1 Remove the valve cover and upper timing chain cover (see Sections 4 and 6, respectively).

2 Position No. 1 piston at TDC, and lock the flywheel in position (see Section 3).

3 On M44 engines, rotate the engine until a pair of camshaft lobes is pointing up (the intake and exhaust lobes for the number one cylinder, for example). Using BMW special tool 11 5 130, compress each valve/valve spring assembly far enough to remove the rocker arms. After the first two rocker arms have been removed, rotate the engine again until the next pair of cam lobes is pointing up. Again, depress the valve with the special BMW tool and remove the rocker arms. And so on. Repeat this step until all rocker arms have been removed.

4 Unscrew the timing chain tensioner plug from the right-hand side of the engine. Recover the sealing ring. Withdraw the timing chain tensioner assembly from its housing.

5 Unscrew the securing bolts and withdraw the upper chain guide from the cylinder head.

6 Unscrew the upper securing bolts from the left-hand chain guide.

7 Unscrew the bolts securing the chain sprockets to the camshafts. Take care not to move the camshafts - if necessary, the camshafts can be counterheld using a 27 mm wrench on the flats provided between No. 5 and 6 cam lobes.

8 Withdraw the sprockets from the camshafts, and disengage them from the chain. Note which way the sprockets face to ensure correct installation.

9 Ensure that tension is kept on the timing chain - tie the chain up or support it using wire, to prevent it from dropping into the lower timing chain cover. **Caution:** *To avoid any possibility of piston-to-valve contact when installing the camshafts, 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 90-degrees clockwise using a wrench or socket on the crankshaft pulley hub bolt.*

10 Remove the template from the camshafts.

11 Unscrew the spark plugs from the cylinder head.

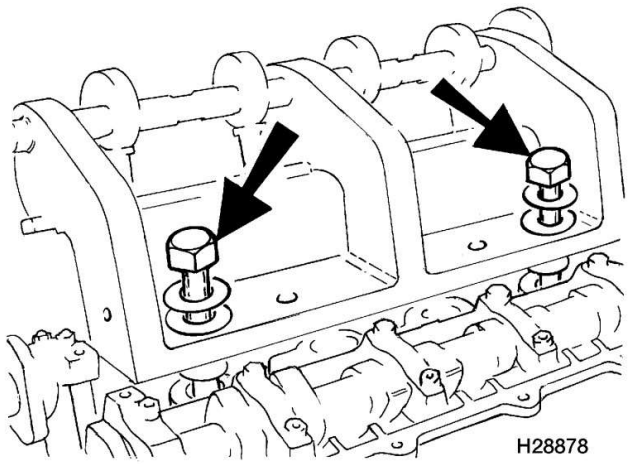
12 Check the camshaft bearing caps for identification marks. The caps are numbered from the timing chain end of the engine, and the marks can normally be read from the exhaust side of the engine. The exhaust camshaft bearing caps are marked “A1” to “A5”, and the intake camshaft caps are marked “E1” to “E5” **(see illustration)** .

10.12 Camshaft bearing cap identification marks

M42 engine

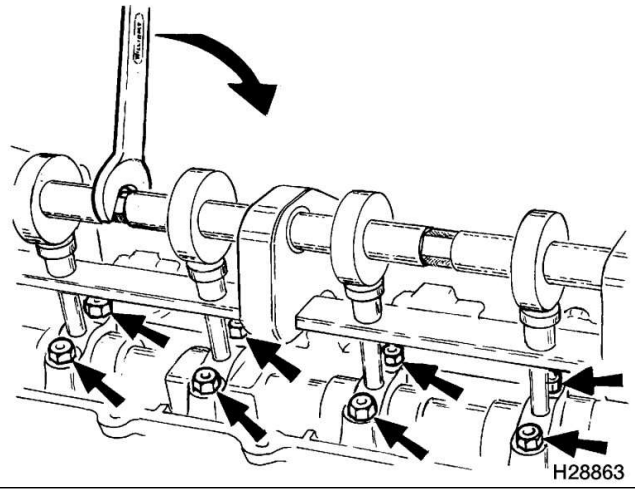
13 Mount BMW special tool 11 3 260 on the cylinder head by screwing the mounting bolts into the spark plug holes. Position the tool so that the plungers are located over the relevant camshaft bearing caps (i.e., intake or exhaust camshaft) **(see illustration)** .

10.13 Fit BMW special tool 11 3 260 to the cylinder head by screwing the bolts (arrows) into the spark plug holes (M42 engine)



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

10.14 Apply pressure to the bearing caps, and unscrew the bearing cap nuts (arrows) (M42 engine)



15 Unscrew the camshaft bearing cap nuts. **Caution:** *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 tool from the cylinder head.

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

18 Repeat Steps 13 through 17 for the other camshaft.

M44 engine

19 Loosen the camshaft bearing cap bolts gradually and evenly, remove the cam bearing caps and remove the camshafts.

M42 engine

20 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 reinstalled in their original locations.

21 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. Do not forget to mark the cam followers “Intake” and “Exhaust”. Store each cam follower in a labeled plastic cup filled with oil.

M44 engine

22 Pull each hydraulic valve adjuster straight out of the cylinder head.

Inspection

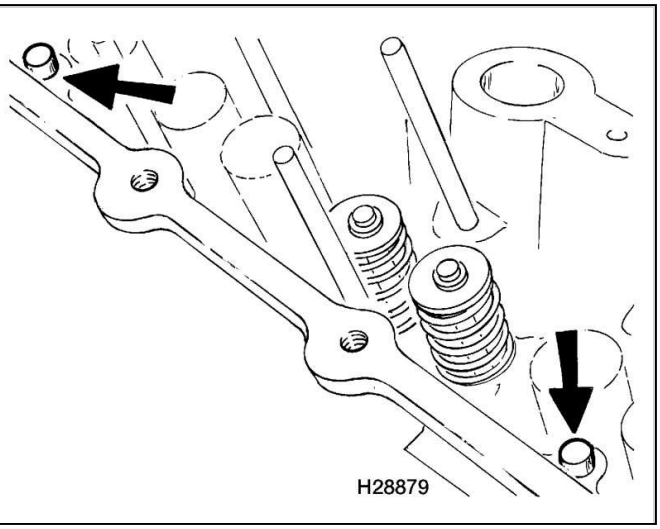
23 Clean all the components, including the bearing surfaces in the bearing castings and bearing caps. Examine the components carefully for wear and damage. In particular, check the bearing and cam lobe surfaces of the camshaft(s) for scoring and pitting. Examine the surfaces of the cam followers for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

Installation

M42 engine

24 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 5 bearing locations **(see illustration)** .

10.24 Ensure that the bearing casting locating dowels (arrows) are in position



25 The bearing casting(s) and cam followers must now be installed. The simplest method of installing these components is to retain the cam followers in the bearing casting, and install the components as an assembly.

26 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. 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 installed to the cylinder head **(see illustrations in Chapter 2B, Section 10)** . To retain the cam followers in the bearing castings, proceed as follows:

A. Apply a small amount of silicone or a similar adhesive compound to the top of each cam 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.

B. 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.

C. Leave the adhesive pads and the dowel in position until the assembly has been installed 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 installed, the marks should face each other at the timing chain end of the cylinder head **(see illustration)** . **Caution:** *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:*

10.27 Camshaft bearing casting identification mark

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

M44 engine

28 Make sure that the bore for each hydraulic valve adjuster is neither scored nor worn, then lubricate each valve adjuster and push it straight into the cylinder head.

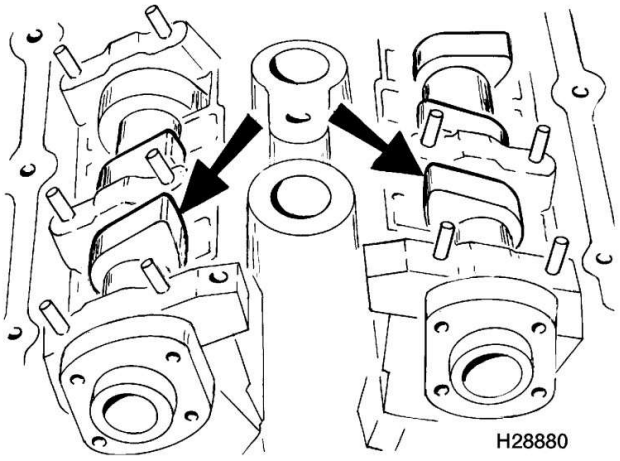
All engines

29 First identify the camshafts to ensure that they are fitted in the correct locations. The camshafts are stamped in front of the rear square flanges. The exhaust camshaft is marked “A” and the intake camshaft is marked “E”.

30 Ensure that the crankshaft is still positioned 90° clockwise from the TDC position (see Step 9).

31 Oil the bearing surfaces in the bearing casting. 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 **(see illustration)** . 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.

10.31 Position the camshafts to that the tips of the front cam lobes (arrows) face one another



32 Place the bearing caps in position, noting that the caps carry identification marks. The exhaust camshaft caps are marked “A1” to “A5”, and the intake camshaft caps are marked “E1” to “E5”. Place the bearing caps in their original locations as noted before removal.

33 On M42 engines, reassemble BMW special tool 11 3 260, and install it to the cylinder head as during removal.
Caution: *Again, do not attempt to install the camshafts without the aid of the special tools.*

34 Apply pressure to the relevant bearing caps on M42 engines by turning the eccentric shaft on the tools using a wrench.

35 With pressure applied to the bearing caps on M42 engines, install the bearing cap securing nuts, and tighten them as far as possible by hand.

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

37 Once the bearing cap nuts have been tightened on M42 engines, unbolt the tools used to apply pressure to the bearing caps.

38 Repeat this procedure to install the other camshaft.

39 Install the spark plugs.

40 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. **Caution:** *Note the precaution given in the* **Caution** *in paragraph 27 before proceeding.*

41 Turn the crankshaft back 90-degrees counterclockwise to the TDC position, then re-engage the locking rod with the flywheel to lock the crankshaft in position.

42 Manipulate the camshaft sprockets until the timing arrows on the sprockets are pointing vertically upwards, then engage the chain with the sprockets.

43 Place the sprockets on the camshafts, ensuring that the sprockets are installed facing the correct direction as noted before removal, then install the sprocket securing bolts.

44 Tighten the sprocket securing bolts to the specified torque - if necessary, the camshafts can be counterheld using a 27 mm wrench on the flats provided between No. 5 and 6 cam lobes.

45 Install and tighten the left-hand chain guide upper securing bolt.

46 Install the upper chain guide and tighten the securing bolts.

47 Install the timing chain tensioner (see Steps 25 through 29 in Section 7).

48 Remove the template used to lock the camshafts, and remove the locking tool from the flywheel.

49 On M44 engines, install the rocker arms. Rotate the engine until a pair of camshaft lobes is pointing up (the intake and exhaust lobes for the number one cylinder, for example). Using BMW special tool 11 5 130, compress each valve/valve spring assembly far enough to install the rocker arms. After the first two rocker arms have been installed, rotate the engine again until the next pair of cam lobes is pointing up. Again, depress the valve with the special BMW tool and install the rocker arms. And so on. Repeat this step until all rocker arms have been installed.

50 Install the upper timing chain cover and the valve cover (see Sections 6 and 4).

51 The remainder of installation is the reverse of removal. **Caution:** *As described in the* **Caution** *in 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

Caution:
When the engine is first started, it must be run at a speed of 3500 rpm for 20 seconds as soon as it starts - this is to ensure that the tensioner is primed with oil.