

# BMW cylinder head overhaul

If your car's engine performs sluggishly and lacks power or if it displays signs of pre-ignition and uses more petrol than it should, then the most probable cause is an excessive build-up of carbon on the valves, piston crowns and inside the combustion chambers. If the level of carbon is allowed to reach this point it can result in an imperfect gas seal between the valves and their seats and a restricted gas flow within the exhaust ports. This can affect the compression within the cylinders, reducing engine power and consequently obliging the engine to work considerably harder in order to attain its original level of performance.

No amount of fine tuning of the carburettor or ignition timing settings can make an excessively carbonized engine perform satisfactorily; consequently the only answer is to remove the cylinder head from the car, dismantle its components and thoroughly decarbonize them. The necessary work can be carried out by the DIY mechanic but you should allow yourself at least two days in which to do it.

This article describes the procedure for decarbonizing the cylinder head on a four-cylinder BMW engine fitted with Solex carburettor(s), such as those fitted to the company's 1500, 1502, 1600, 2000 and 2002 models.

### Special tools

As well as a comprehensive selection of ordinary tools, you will require a torque wrench, a valve spring compressor and a valve grinding stick and paste. You will also need an electric drill, a wire brush and three fork-ended tools. These are used to depress the rocker arms while you remove the camshaft. BMW make special tools to do this job but they are not easy to obtain. It is worth asking at your local BMW dealer to see if you can borrow or hire some but, if you are unsuccessful, it is possible to make them. You will need three strips of steel at least 5 mm (3/16ins) thick and of sufficient length—300 mm (12ins)—to provide enough leverage to depress the rocker arms against the pressure of the valve springs. Measure the width of the top rib of the rocker arms (they may vary from model to model) then, using a hacksaw, cut a slot slightly wider than this measurement and 50 mm (2ins) long in one end of each strip of

steel. Clean up the slot with a file and round off any sharp corners to avoid the risk of cutting yourself when you use the tool. Finally, bend each strip in a metalwork vice and the special tools are ready for use.

### Cylinder head layouts and design

The four-cylinder, in-line, BMW engine is well-engineered and constructed to close tolerances. It has an overhead camshaft (OHC) which is driven at half engine speed by a duplex steel roller chain from a sprocket on the front of the crankshaft. The distributor is mounted on the rear of the head and is driven from the camshaft by a skew gear. The valve clearances are adjusted in a rather unconventional manner by an eccentric cam which bears on the valve stems and is moved by means of a nut positioned on the side of the rocker arm. The head is cast in aluminium alloy.



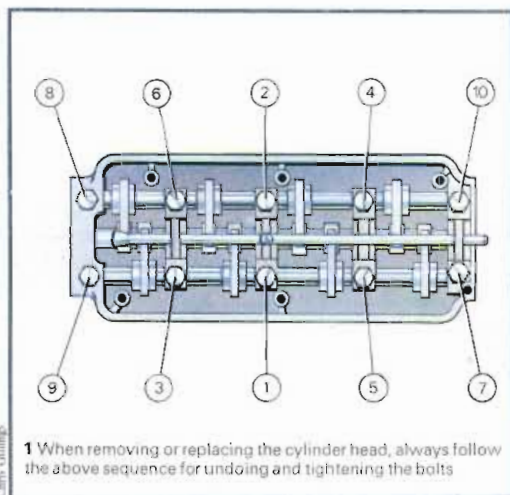
2 Undo the single mounting bolt through which the oil is pumped and lift the oil sprayer bar away from the cylinder head



3 When all of the mounting bolts have been removed, lift away the distributor drive housing from its mounting on the head



4 The water jacket plug obstructs the removal of the camshaft retaining plate and must, therefore, be undone and removed



1 When removing or replacing the cylinder head, always follow the above sequence for undoing and tightening the bolts

Chris Collins

### Removing the ancillary components

Before you can remove the cylinder head it is necessary to disconnect the various pipes and linkages that connect it to other systems. Open the bonnet and cover the tops of the front wings with protective covers to avoid damaging the paintwork. Then disconnect the battery and remove it from the engine compartment. Place a suitable (non-food) container of sufficient capacity underneath the radiator, remove the drain plug and allow the cooling system to drain. You need not drain it completely; refer to your handbook for the system's capacity and then allow half of the coolant to escape. This will ensure that the cylinder head water channels are completely empty of water.

The throttle linkage consists of an adjustable steel rod located at either end by spring-loaded, ball and socket joints. To remove the linkage simply pull the rod off its mountings using firm but not excessive pressure. Next, undo the small nut which secures the choke operating cable to the choke lever on the carburettor then tuck the cable safely out of the



5 With the plug out of the way, undo the two bolts that mount the camshaft retaining plate to the head and lift it away



6 Using a suitable drift, carefully drive the rocker shafts from their interference fit housings in the cylinder head casting



7 As the shaft is driven through each housing, remove the spring, the thrust washer, the rocker and the rubber seal in that order

way towards the rear of the engine compartment.

Remove the breather pipe which runs from the rocker cover to the air filter housing by pulling it off its mounting necks, then unscrew the wing nut fitted to the top of the air filter housing and lift the housing away from the carburettor. Remember to fit a new air filter on re-assembly.

If your car is fitted with automatic transmission, disconnect the kickdown cable from the carburettor and tuck it out of the way. If the carburettor is fitted with an electrically-operated automatic choke, label the electrical lead then pull the spade connector away from its terminal on the choke body. Slacken the retaining clip, pull the fuel supply pipe away from its union and plug the end of the pipe with a plastic cap or a block of hard wood to prevent fuel from seeping out and dirt entering. Do the same to the fuel return pipe which is connected to the fuel pump.

The next job is to disconnect the radiator top hose from the inlet neck on the thermostat housing. Slacken the Jubilee clip then carefully ease the hose away from its mounting. There is no need to disconnect the hose from the radiator; tucking it well out of the way will be sufficient so long as you do not strain it in any way.

Using masking tape, carefully number each of the spark plug leads to avoid confusion on re-assembly. Pull the high-tension (HT) lead out of the ignition coil then remove each labelled HT lead from its plug. Prise open the distributor cap retaining clips then lift the cap and leads away. Undo the dipstick support bracket from its mounting on the cylinder head and remove it completely. Next, detach the interior heater hoses from their respective connections on the cylinder head and the inlet manifold.

### Disconnecting the electrical leads

Although there are only a few leads to be disconnected it is a wise precaution to label each one as you remove it in order to avoid making incorrect connections on re-assembly.

First, disconnect the low-tension (LT) lead which runs from the coil to the distributor at the distributor end by undoing and removing the nut which secures the lead to its terminal connection. Pull the leads from the water temperature and oil pressure warning light sender units; both of them are fitted with the spade type of terminals.

### Disconnecting the exhaust system

The exhaust downpipe is secured to the manifold by a two-piece triangular flange which is fastened by three bolts. As these bolts are subjected to extremes of temperature they may be corroded in position so it is a good idea to soak the threads liberally in rust-penetrating fluid some time before attempting to undo them. Undo the three bolts, which screw into tapped holes in the manifold half of the flange.



8 When the shaft is almost out of the cylinder head and all of the rocker components have been removed, withdraw the shaft

Nelson Hargreaves



9 To ensure that all the parts are replaced in the correct order, lay out each shaft with all of the relevant components as illustrated



10 With both of the shafts removed, the camshaft can be withdrawn from its three bearing bosses by pulling it away



11 Carefully examine the three journals for wear. If any of them are as bad as this, the shaft will have to be replaced

The exhaust downpipe is braced by a bracket held behind one of the bolts which hold the gearbox mounting plate in position and this bracing bracket must be released from underneath the car. Raise the vehicle on a suitable jack and support it securely on axle stands. Working from underneath the car, undo the bolt that retains the exhaust bracket and it will then be possible to lower the exhaust sufficiently to allow the cylinder head to be removed.

Once you have done this, remove the axle stands and lower the car to the ground because the remaining work will be unnecessarily difficult to carry out if the car is left in the raised position. As you lower the car, make sure that the exhaust pipe does not become trapped or damaged.

#### Disconnecting the alternator and removing the fan

The next step is to loosen the alternator mounting and adjustment bolts and swivel the alternator assembly towards the engine. When you have done this you can withdraw the fan belt over the fan blades. Knock back the tab washers on the fan itself and remove the securing bolts, taking care not to damage the core of the radiator, then lift away the fan and the belt pulley from the hub of the water pump.

#### Removing the timing gear

This stage of the job should be tackled slowly and carefully as it is essential to remember the exact sequence so that you can set up the valve timing correctly on re-assembly.

Undo the seven nuts which secure the light alloy rocker cover in position—making sure that you make a careful note of which three nuts also secure the wiring harness clips—and lift the rocker cover off its mounting studs.

The upper section of the timing cover is held in position by eight bolts and must now be removed. The engine earthing strap is fitted under one of the bolts. Make a note of which it is then lift the strap away and place it where it will not get in the way of the remaining work. When all of the bolts have been removed, lift away the upper section of the timing cover assembly. You may find that it is difficult to remove; if so, tap all round the edges of the joint with a wooden hammer handle or a similar object in order to break the seal. On no account must you attempt to prise the cover away by inserting a screwdriver blade or any similar implement between the faces of the joint as this could cause considerable damage to the soft alloy and ruin the oil sealing properties of the joint. Tapping the casing with a metal tool will also have an adverse effect as it can easily result in the casting being cracked.

Before removing any more components, the piston in number one cylinder (nearest to the cooling fan) must be set at top dead centre (TDC) on its compression stroke. This can be checked by first checking that both valves on number one cylinder are closed and that the marks on the



12 Similarly, check the bearing journals in the head. A worn journal such as this can be built up and then machined

rotor arm and the distributor body are exactly in alignment. The final adjustment can be made by looking at the timing marks on the lower timing chain cover and the crankshaft pulley. The second notch on the pulley, counting in the direction of crankshaft rotation, should line up with the pointer on the timing cover. If it should be necessary to rotate the engine to set number one piston in the correct position, this can be done by using a 30 mm socket and a tommy bar on the crankshaft pulley securing nut. Using paint, mark the position of the distributor body in relation to the distributor drive housing assembly, then detach the vacuum hose and undo the pinch bolt. You can now carefully lift the distributor out of its housing and place it to one side.

The chain tensioner spring and plunger should be removed at this stage and they are contained inside a tube-shaped housing that is cast into the lower timing cover. Undo the large hexagonally-headed plug, using a spanner of the correct size then withdraw the chain tensioner spring together with the plunger.

Using a small screwdriver and a hammer, knock back the ears of the tab washers which retain the camshaft sprocket mounting bolts. Undo and remove the four bolts but, at the same time, hold the camshaft drive chain in tension to avoid the possibility of its suddenly slipping off the teeth of the crankshaft sprocket or of the sprocket and chain falling into the lower section of the timing cover. Leave the sprocket inside the chain and then carefully wire the two to a convenient point such as that which is provided by the timing chain tensioner housing.

#### Removing the cylinder head

You are now ready to remove the cylinder head from the engine. Working in reverse of the sequence shown in fig. 1, gradually slacken the 10 cylinder head retaining bolts and, when they are all finger-tight, remove them completely.



**13** From each valve, remove the collets, the spring retaining cap, and the spring. Keep all the components together for re-assembly



**14** Withdraw the valve from its guide and, as you do so, check the sideways play of the valve stem to assess the wear in the guide



**15** Using a wire brush gripped in the chuck of an electric drill, clean all traces of carbon from the combustion chambers

The head, complete with the manifolds and carburettor(s) can now be lifted away from the cylinder block for overhaul.

If you find that the cylinder head is stuck to the cylinder block do not attempt to chisel it away or insert any object between the joint faces in order to lever the head upwards as you will probably damage the mating surfaces. If you have difficulty, tap all round the edges of the joint with a soft-faced hammer and this should break the seal. When the head is free, position it on a workbench ready for overhaul.

#### Removing the manifolds

In order to gain access to the inlet and exhaust ports to clean away the deposits of carbon that have formed on their surfaces, the inlet and exhaust manifolds will have to be removed. This is a straight-forward job and you need only remove the bolts securing each manifold to the cylinder head and lift the manifold away. There is absolutely no need to detach the carburettor (or carburettors depending on how many are fitted) as it can be removed with the manifold as a single unit. When the manifolds have been removed, clean away any traces of the old gaskets from the joint faces and discard them. Always fit new manifold gaskets on re-assembly. It is false economy to re-use the old ones as they will almost certainly fail to give an adequate gas-tight seal.

#### Removing the camshaft

If you have not already made up the special tools described at the beginning of this article, do so now as you will need them during the next stage of dismantling the cylinder head.

The oil distribution tube is secured to the cylinder head by a single bolt. Remove this and lift the tube from its mounting stud (fig. 2). Slacken the lock nuts and then back off the eccentric adjusters on the relevant rocker arms until the valve clearances are all at their widest possible settings. Now turn the camshaft until only three of the eight rocker arms are exerting downward pressure on valve stems. If you

insert two of the sprocket bolts into the camshaft you can use a screwdriver inserted between them to turn the shaft. With the help of an assistant, carefully fit the three forked tools to the rocker arms that are still under tension and depress all three simultaneously sufficiently for the heels of the rockers to be clear of their respective camshaft lobes. Now, gently withdraw the camshaft from its bearings and remove the camshaft thrust plate. You can then withdraw the special tools. Finally, undo the two mounting bolts and remove the camshaft guide plate from its mounting.

#### Removing the rocker arms and shafts

The distributor drive gear housing covers the rear ends of the two rocker shafts so that the first step is to remove the housing. Undo the four mounting bolts and pull the housing away from the cylinder head (fig. 3). Make a careful note of the location of both the self-sealing washer and the oil seal, then pull each of the rocker arms to one side. Next, using a screwdriver or a pair of thin-nosed pliers, remove all of the locating circlips from both of the rocker shafts. Using a suitable drift, drive out each rocker shaft so that it emerges from the front of the cylinder head (fig. 6). Always use a drift of slightly smaller diameter than the shafts themselves to avoid the danger of the drift becoming wedged in the shaft's bearings. As each shaft is removed, collect the springs, thrust washers, rockers, circlips and collars and keep them in the exact order in which they were removed so that they can be re-assembled in their original positions.

#### Removing the valves

Adjust the valve spring compressor to the relevant setting, compress each of the valves in turn and remove the retaining collets, the spring cap, the spring itself and the valve spring lower cup (fig. 13). When this has been done, pull the rubber oil seal off the valve stem, release the compressor and withdraw the valve through the combustion chamber (fig. 14) taking care not to damage the chamber.

#### Inspecting the cylinder head

Carefully inspect the cylinder head for signs of cracks, especially across and between the valve seats and between the combustion chambers. If any cracks are found, there are a number of repair firms which will be able to weld the cracks for you for a modest charge. If the head gasket has been "blowing" it is possible that the cylinder head will have become warped so either check the face with a straight edge, such as a steel rule, or take it along to an engineering firm and have them check it on a surface plate. If the distortion is not too severe, the head can be reclaimed by surface grinding but if it has become distorted beyond the manufacturer's accepted limits you will have to obtain a replacement from your local dealer.



16 When properly cleaned, the combustion chambers should look like the one on the left. Compare it with the uncleaned chamber



17 Using the correct grade of grinding paste, carefully lap the valves into their seats. Patience is required for this operation



18 When the valve is properly lapped in, the seat should show a thin, unbroken grey line around its circumference as illustrated

#### Removing carbon deposits and grinding-in the valves

The above processes are described in detail in a number of previous articles so for guidance and specific instructions on renovating and decarbonizing the cylinder head and the valves refer to the On The Road Index. Caution is necessary, however, when working on alloy cylinder heads. The alloy is relatively soft and is easily scored so, when removing deposits of carbon, never use a hard steel scraper or any implement which could damage the surface of the head. It is also worth polishing the combustion chambers, the ports and the tops of the pistons after they have been cleaned.

#### Re-assembling the cylinder head

Re-assembling the cylinder head is mainly a matter of reversing the dismantling procedure. There are, however, one or two points which are important and must not be overlooked. The rocker shafts are provided with cut-outs in them to allow the cylinder head retaining bolts to pass through the head casting and, when re-fitting the shafts, the cut-outs must be perfectly lined up with the bolt holes or it will not be possible to insert the bolts.

Remember when re-fitting the distributor drive gear housing that the special sealing washer is fitted to the inlet rocker shaft and that the self-sealing washer is placed under the bolt head which lies immediately below.

#### Re-fitting the cylinder head

Again, this operation is largely a reversal of the dismantling procedure. Make sure before fitting the head to the cylinder block, however, that the pistons are positioned a little way down the cylinder bores so that there is no chance of the valves touching the pistons when you rotate the camshaft for timing purposes before its drive has been re-connected. The camshaft chain guide must be engaged correctly with the stop on the upper section of the timing cover assembly.

Always use completely new gaskets and oil seals throughout and make sure that you buy the correct gasket set for your particular model and year by quoting the engine and chassis numbers when you make your purchase. Coat both sides of the head gasket round the area of the timing cover with gasket cement and allow it to partially set before re-fitting the cylinder head and make sure that you fit the gasket the right way up. It will usually be marked to facilitate this. Tighten the cylinder head retaining bolts in the sequence shown in fig. 1 to 7 kg/m (54lb/ft).

#### Setting the valve and ignition timing

If you have set number one piston at TDC on the compression stroke during the dismantling process as described previously, setting the valve timing will present no problems. Loosen the wire holding the sprocket and timing chain (see above) and then rotate the camshaft, using the method described earlier, until the dowel is at its lowest possible point. Now position the sprocket and chain on the camshaft. If the setting is correct, a mark on the sprocket should align exactly with a lug that is cast in the top of the cylinder head. When you are satisfied with the setting, fit the bolts and tab washers, tighten them to the torque specified in your workshop manual and bend over the ears of the tab washers. To set the ignition timing, refer to pages 97 to 102.

#### Setting the valve clearances

The last major stage of the overhaul is to adjust the valve clearances. Set number one piston at TDC on the compression stroke, as described previously, then you can adjust the clearances on the valves of number one cylinder. Looking from the driver's seat, the inlet valves are on the left and the exhaust on the right. To adjust the clearances, which should be 0.15 mm (0.006ins) on both the inlet and the exhaust valves, slacken the adjuster lock nut and insert a thin steel rod into one of the holes on the eccentric cam and rotate the adjuster cam until the correct feeler blade is a tight sliding fit between the rocker and the valve stem. Never attempt to insert the feeler blade between the camshaft lobes and the slide pads on the rocker arms. When the clearance is correct, tighten the lock nut without allowing the adjuster cam to move. Check the clearance of the remaining valves with each piston at TDC on the compression stroke.

After you have driven your car for 1,000 kilometres (600 miles) re-check the valve clearances and re-torque the cylinder head retaining bolts.

Carrying out a top-end overhaul on a BMW OHC in-line four-cylinder engine is within the scope of the experienced DIY mechanic. If you carry out the work carefully and correctly you will be rewarded by a car that is capable of optimum performance and uses less petrol.