The Camshaft

An important part of your engine

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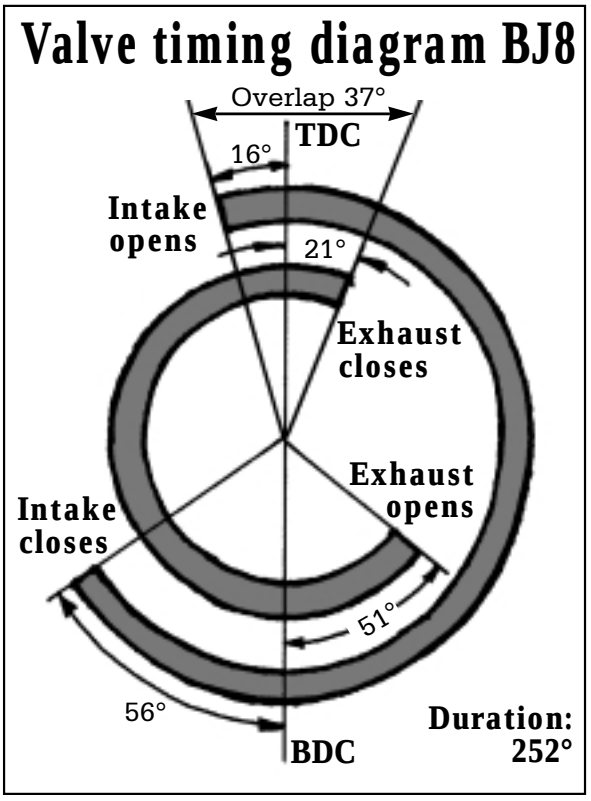
S w e d e n

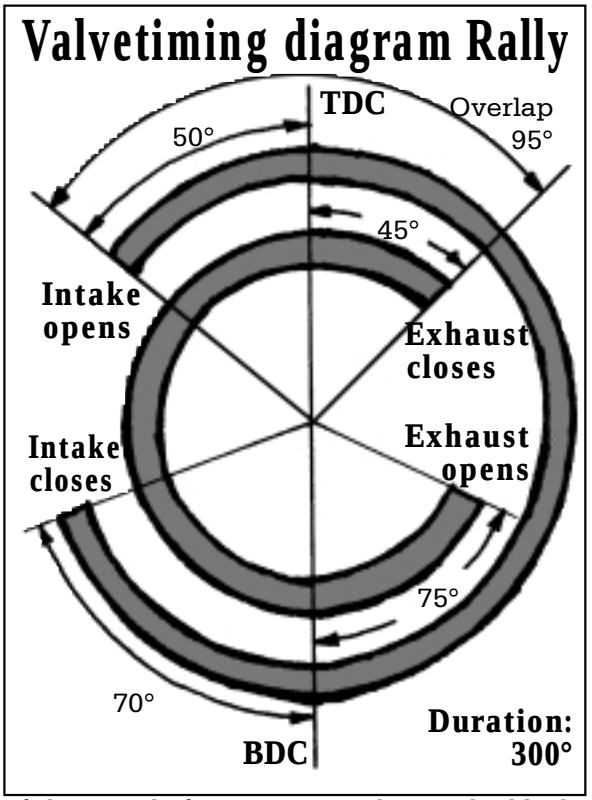
Review and translation suggestions by Mr Finespanner (unindicted co-conspirator).

The camshaft is a very important part of your engine. It regulates the opening and closing of the intake and the exhaust valves. It lacks the capability of varying the times at which it opens and closes the valves. Therefore the camshaft will always be a compromise. At low r.p.m.s and part throttle operation the engine needs a cam with a short duration and a relatively low lift of the valves in order to produce good fuel economy and a sharp throttle response. At high r.p.m.s the engine needs a long duration and a high lift of the valves, since the time to fill the cylinders is very short. On modern engines this compromise has been partly worked around. For example, BMW has a system they call "Double VANOS", which means that the timing of the cam is variable. At low r.p.m.s the cam both opens and closes the valves earlier, which increases the torque in that range. The cam is advanced. At high r.p.m.s the valves open and close later, which increases the effect in that range. The cam is retarded.

The duration of a cam indicates how long the cam keeps the valves open. The duration is measured in degrees of a full revolution. The BJ8 cam has a duration of 252° for both intake and exhaust valves. The valve stays open for 252° of the 360° that constitute a full revolution. A revolution in this context equals a stroke in a four-stroke engine and can be either the intake stroke or the exhaust stroke. The earlier 3000 models had camshafts with other profiles but I will not deal with them here, since the only type that is available new is the BJ8 cam. It will make a perfect fit to the previous models as well. The factory used a cam with 300° duration for the Works Rally cars. Naturally the intake and the exhaust valves are not opened at the same time, but there is a short period that their openings actually do overlap. The intake valve opens 16° before top dead center (TDC) on the BJ8, while the exhaust valve closes 21° after TDC. This is called overlap and is also measured in degrees. The overlap of the BJ8 cam is consequently 16° + 21° = 37°. The good thing about overlap is that it helps to fill the cylinder with more fuel, thanks to the suction created by the opened exhaust valve. The overlap of the rally cam is 95°. There are some drawbacks with a long duration, among them that the quantity of unburnt fuel in the exhaust increases, and, in combination with a ported head and big carburettors, it will give rise to the small carburettor sneezes that are so characteristic of highly tuned engines. The cam gear has twice the number of cogs compared to the crank gear, which makes the cam rotate with half the speed of the crankshaft. This means that one revolution of the cam is equivalent to half a revolution of the crank. This difference in ratio means that a crankshaft degree and a camshaft degree are not the same. In order to make things easier some sensible person has decided that normally only crankshaft degrees will be used. This also applies to the distributor, which revolves at the same pace as the cam. The distributor is driven by the cam in order to be able to give a spark every second revolution of the crank for a specific cylinder. According to this the ignition is set in crankshaft degrees. Cam lift indicates how high the lifter is pushed up by the cam lobe: BJ8 0.263", rally 0.323". Valve lift indicates how far the valve is opened. This value is higher than the cam lift, since there almost always is a ratio built into the rocker arms. For Healeys the ratio of a standard rocker is 1:1.4. Valve lift: BJ8 0.368", rally 0.452". High valve lift is good, since it increases the filling ratio of the cylinder. However, high valve lift is only possible with



a long duration cam, since the opening and the closing of the valves on a short duration cam is much more violent, which increases the stress and the wear on the valves and the valve gear. At a certain point the duration will become a limiting factor of the valve lift, since the overlap mustn´t become too big. One way to work around this is to install higher ratio rockers, which lift the valves higher but without the increase in overlap as a result. The stress on lifters, cam, and valve gear will become greater, though.

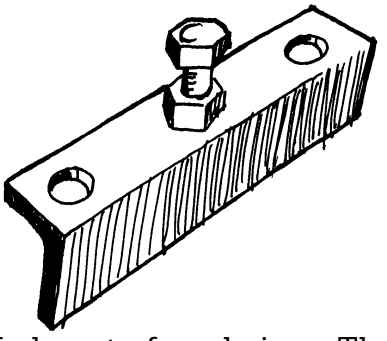


Valve timing is always counted in relation to the position of no. one piston. The opening and the closing of the valves are indicated in number of degrees before and after TDC and BDC (Top Dead Center and Bottom Dead Center). TDC is most important, since it´s the starting point of the degreeing of the camshaft in relation to the crank. If the valve timing is supposed to be correct in relation to the crank, one must check that the cam is correctly adjusted. In order to be able to do so, one must know the opening and the closing times for the intake valve. The BJ8 cam opens the inlet valve, as previously seen, at 16° before TDC and closes it 56° after BDC (ABDC). This gives us a duration of 16° + 180° (the movement between TDC and BDC) + 56° = 252°. The valve lift is at it´s maximum when exactly half the duration has passed, which in this case is 252°/2 =126°. The valve opens 16° before TDC, 126° - 16° = 110°. The cam should be adjusted accordingly so that intake valve no. one is exactly at it´s highest opened position, 110° after TDC (ATDC) of the piston in cylinder no. one. For the rally cam the corresponding value is 100°. Please observe that this is only true for symmetrically ground cams, which all 3000 cams are. Therefore I will not deal with asymmetrically ground cams in this article.

In order to be able to determine TDC and maximum valve lift exactly, a degree wheel, a piston stop and a dial indicator are needed. It´s easier to degree the cam with the engine mounted in an engine stand and before the head is installed. The degree wheel goes onto the crank, preferably in such a manner that it can be locked and unlocked without disturbing the crank. Make a pointer out of heavy gauge wire, clothes hanger size is OK, and attach it to the block with one of the bolts for the cam gear cover. Install the piston stop across cylinder no. one, into the threaded holes for the head studs. Rotate the crank in a clockwise direction until the piston stops against the piston stop and mark the position of the pointer on the degree wheel with a fine felt pen. Then rotate the crank counter-clockwise until the piston stops again and mark the position. Uninstall the piston stop and rotate the crank all the way around in a clockwise direction until the pointer is located exactly between the two felt pen marks. You have now determined the exact position of TDC. Carefully loosen the degree wheel, without rotating the crank, and set the zero of the wheel to the pointer. The reason of this procedure is to arrive at the exact location of TDC. It is practically impossible to decide the exact position in any other way, since the circular movement of the crank affects the position of the piston. Near TDC and BDC the crank can be rotated several degrees without a visible effect on the position of the piston. The same can be said about the point of maximum valve lift, which is determined in the following way: Install a dial indicator by the means of a magnetic stand on the surface of the block, in such a manner that an extension can be led through the hole for no. one intake valve:s lifter. For this purpose a special lifter has to be prepared. Take a standard lifter, put it in a lathe and skim the top off until a flat surface of around 3/8" has been created. Look at the lifter as you rotate the crank. Stop rotating when the lifter is at it´s lowest. It is then located on the base circle of the cam lobe. Turn the crank slowly in a clockwise direction until the lifter reaches it´s maximum, stop there and note the reading of the dial indicator. Turn the crank counter-clockwise until the dial indicator reads 0.100 " below the maximum figure. Turn the crank forward again until 0.050" below maximum is reached and mark the position of the pointer on the degree wheel with the felt pen. Continue moving the crank forward past maximum lift until the dial indicator once more reads exactly

Piston stop

Seen from underneath.



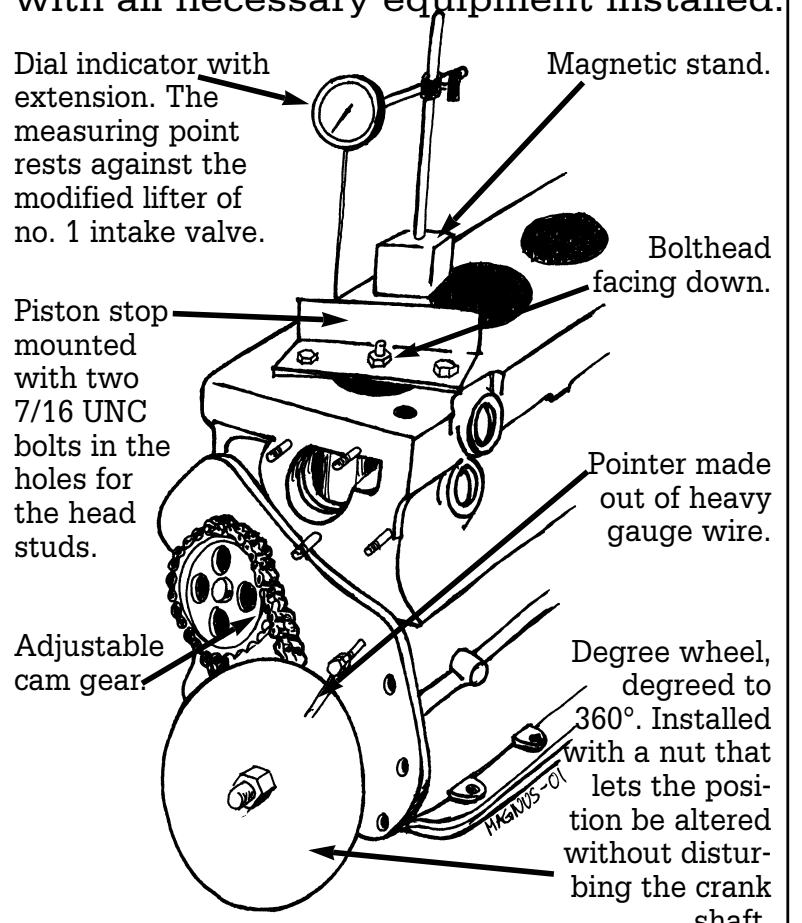
Made out of angle iron. The bolt is held in place by two nuts and constitutes the actual stop for the piston.

0.050”. Mark the position on the degree wheel. Add both values on the degree wheel and divide by two. The result shows the exact point of maximum valve lift, in relation to the position of the crank. For example: the first value on the degree wheel was 90° and the other was 130°; 90° plus 130° equals 220°. 220° divided by two equals 110°. The point of maximum valve lift is located at 110° ATDC and everything is in order. On a standard engine with a standard cam, this should always correspond, providing that the cam gears and the chain have been correctly assembled. It doesn´t hurt to check it, though, in order to avoid problems caused by faulty manufacturing of these parts.

On highly tuned engines this doesn´t always correspond, at least not on some of the race cams, which have exactly the same specifications as the factory rally cam, sold by some of the suppliers. With a standard cam gear the cam will be positioned at around 85° ATDC. The engine can be run like this but not with the full effect. In order to position the cam correctly an adjustable cam gear has to be obtained. Some suppliers deliver their cams without specifying which value it should be degreed at. But we have learned how to determine the point of maximum valve lift on our own, and for the rally cam, as mentioned before, that value is 100°. Adjustment is made in the following manner: Turn the adjustable cam gear in the preferred direction and lock it. Check the position of the cam with the method above. This procedure is repeated, sometimes many times, until the exact location of the cam shaft is obtained. I mentioned before the possibiltiy of advancing or retarding the cam. This will affect the performance of the engine considerably, and to find the best setting is a question of personal taste and trial and error. Myself, I prefer the Healey engine with a rally cam retarded to 106°.

Engine mounted in stand

with all necessary equipment installed.



If you are about to rebuild your engine completely and want that extra bite out of it that a real sports car engine (in my opinion) should have, I think there should be no hesitation to use a rally cam. It doesn´t cost more then a standard cam anyway. It will require some additional modifications, though, but they are quite few and not very costly. The compression has to be raised up to 10.5:1, the head has to be ported and small pockets have to be ground into the block. It is also an advantage to use double HD8 carbs. That´s all that´s needed to get an engine with about 30- 50 horsepower more, and if you drop the HD8's it won´t even show. Forget about Fast Road cams, they differ so little from the BJ8 cam that the increase in power is hardly noticeable. If you drive carefully without overreving you will find yourself with an engine that will last very long and that will be so much more fun to drive then a standard one, without losing very much at low engine speeds or around-town driving capabilities. In my opinion the only real disadvantage with an engine like this is the increased fuel consumption.

Be sure to apply lots of camshaft lube to all the lobes and bearing surfaces before the cam is mounted into the block. It is very important to run-in the cam the first time the engine is started. The running-in of the cam should be done with a stationary car. Start up the engine and turn up the revs to between 2000 and 3000 rpm. Run the engine for about 30 minutes at this speed. It can also be a good idea to remove the inner valve springs before this operation, in order to decrease the pressure of the lifters against the cam lobes. It´s quite easy to remove and install the valves springs with the head in place but how that is done I may come back to in another article. Change the engine oil and filter after the run-in of the cam.

This was just a small survey of the camshaft. Lots and lots more can be written about it.