KENT CAMS Information

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Camshaft Tuning Information

With nearly two decades of experience in the performance and tuning industry, KENT CAMS is the largest manufacturer of performance cams and valve train equipment in Europe. Whilst being the major force in the U.K. with over 120 dealers, their products are also exported throughout the world, supplying many famous names in motor sport.
It is not enough to just produce camshafts using the latest "state of the art" machines.
It is research and development that produces the profiles of tomorrow. Not only do they utilise the very latest in computer design technology, they also work very closely with American and Japanese design engineers to ensure they get the very best design technology from around the world.

Why does a performance cam work?

There is only one way to increase the performance of an engine, and that is to cram more fuel/air mixture into the cylinder, compress it and then ignite it. The bigger the bang, the more energy is released and if this energy is efficiently harnessed the higher the performance of the engine.
Many ways are employed to fill the cylinders, such as high flow air filters, multi carburettors, ported and large valve cylinder heads, supercharging and turbocharging.
However no matter what methods are used they all rely on the camshaft opening the valves high enough and long enough to enable them to get this increased mixture into the engine.
It is the enhanced "lift" and "duration" that is imparted to the valves by the high performance camshaft, that makes it an altogether different component to the standard cam.
It is usually these figures that are the measure of how "hot" or radical the performance cam is.
High performance cams are often surrounded by a good deal of mysticism, confusion and ignorance, largely brought about by the lack of reliable information from the performance cam manufacturer. It is the intention of this publication to inform, and to make cam selection easy to understand.

All the figures quoted in this publication are accurate and have been measured using the very latest in computer technology, and are correct at the time of going to the web.

Before we look at high performance cam profile design, it is probably a good idea to first see how a cam affects the valve as it is this opening and closing and how far the valve is lifted that governs the performance of any engine. It is true that the cam is instrumental in the way a valve operates. but there are other factors that play their part in determining what happens. The function of the camshaft is to lift the valve off the seat, and, as it rotates, to allow the valve spring to close it again. There are numerous ways in which engine designers have linked the camshaft to the valve. but the most common are -

Push rod and rocker arm e.g. Ford X-flow and B.L. Mini.
Finger follower e.g. Astra "J" and Ford Pinto.
Direct acting e.g. Lotus, Cosworth and Warrior

Each method of linking the cam to the valve, or valve train, as it is more correctly known, requires a different design of cam profile. It is not possible to select a push rod profile for a direct acting application, or vice versa.

Push rod profiles

Generally speaking all push rod engine profiles have less cam lift than valve lift. The rocker arm has an offset pivot rather like a lever, and as the push rod activates the arm, this motion is multiplied by the amount of offset of the pivot, and transmitted to the valve. This offset is usually referred to as a ratio. and is normally in the region of 1.5..1- This means for every .010" of cam lift. the valve will open .015" i.e. cam lift .010" x rocker ratio 1.5 = .015" valve lift. However it must be remembered when calculating valve lift, that all mechanical profiles operate with a valve clearance and this clearance must be deducted from the total lift in order to find the true valve lift. e.g. Cam lift .200" x rocker ratio 1.5 = .300" - clearance .0 1 0" = valve lift .290"

Direct Acting Profiles

This is probably the easiest of all valve trains to understand as the cam operates directly onto a bucket type follower,(so called as it looks rather like an inverted bucket) and the cam motion is transmitted via an adjustment shim to the valve. Because of the relatively compact area of this type of design it is invariably used in twin-cam applications.

Finger Follower Profiles

The vast majority of finger follower type profiles utilise an asymmetric cam profile operating on a radiused finger. The finger is pivoted at one end on an adjustable ball stud and the cam operates on a radiused pad on the finger and this motion is then transmitted to the other end of the finger where it operates the valve. The finger is designed in very much the same way as the push rod rocker arm. i.e. it also employs a rocker ratio, as the cam contact area is not in the centre of the finger. With some of the more radical race and rally profiles in Ford Pinto engines it has been found that the wipe area of the standard finger is too short and special long pad fingers are required. (part no CF12) Unlike both the push rod and direct acting set ups, there is a considerable wipe area of cam lobe over the finger, and fitting instructions must be adhered to it excessive wear to both the cam and fingers is to be avoided.

Obtaining the Stated Valve Lift

This would appear to be a fairly simple calculation, just multiply the cam lift by the rocker ratio and deduct the valve clearance. Unfortunately life isn't that simple. Everything that is manufactured has to have a tolerance to be cost effective and consequently the length of rocker arm, finger followers, valves and even the position of the ball studs in the cylinder head will all have small differences. All these differences can add up and work in our favour, however this often happens the other way round. This is really like good news and bad news, as these tolerances also allow us to juggle valves, rocker arms etc. to obtain the optimum lift. It is worth noting that all quoted rocker ratios can only be a guide figure due to these variations, and are calculated from brand new unmodified engines using standard valves at a standard height relative to the rocker arms or fingers.
Any variation of the valve height will alter this ratio. Generally speaking if the valve height is reduced the ratio will increase giving more valve lift, and conversely if the valve length is increased the ratio will decrease, resulting in less valve lift. (the effective valve length is increased each time the valve seats are recut).

Cam Lobe Terminology

We have seen the various methods in which the cram operates the valve, but regardless of how a particular valve train is configured, cam lobe design incorporates certain features common to all cases.
As you will see the base circle accounts for approx. 180 degrees of the cam profile and refers to the portion of the lobe that does not impart any valve motion as the cam rotates. It controls the part of the four stroke cycle where we require the valve to be closed. Theoretically the cam followers will not even run on this section of the lobe, as it is separated from it by valve clearance.

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Valve Clearances

It is important to have some slack or clearance in the valve train to compensate for any expansion or growth of the components, due to ' heat generated when the engine reaches operating temperature.
It is worth bearing in mind that any engine that produces more power will also produce more heat and this is why many performance cams run larger valve clearances than the standard or original cam, and are sometimes more noisy in operation. It Is also common for the exhaust valve to run larger cold clearances than the inlet valve, because of its higher running temperature. However much depends on the design of the cylinder head and how efficient it is at dispersing the heat produced in the combustion chamber away from the valves.

Ramp

This is the section of the profile where the clearance is gently taken up as the cam rotates and prepares the cam follower to contact the cam lobe. Ramps are found on both the opening and closing side of the profile and in the case of the standard production cam, help to reduce valve train noise. However the ideal situation in a performance engine is to get the valve open as quickly as possible, and frequently these ramps are heavily modified, often making performance cams less quiet in operation. Obviously the design of the ramps have to be taken into account when designing performance profiles as an extremely noisy cam may be acceptable in a full race engine. but would be unacceptable in a mildly tuned family saloon.
The closing ramp is usually less modified than the inlet on performance cams, as it is important to close the valve gently back on its seat. If this is not the case, the valve will tend to crash back on its seat and excessive damage to both valve and seat will result. Also the shock of this sudden collision can cause valve float. this being a situation where the valve will bounce back off its seat. thus opening the valve again just when we least want it.

Flank

The lobe flank is the section of the profile that extends from the ramp to the nose and it is this section of the profile that accelerates the cam follower to the full lift position. As the cam continues to rotate It allows the now compressed valve spring to close the valve in a controlled manner, until it rests back on its seat.The flank is a very important part of the performance profile as it controls the rate or

acceleration of the valve. As we stated before it is desirable in a high performance engine to open the valve as quickly as possible. However the flank has to take account of not only accelerating the whole mass of the valve train (valve, valve spring, valve retainers. push rods. cam followers etc.) but also has to start retarding it before the full lift position is reached. If this were not the case, the follower would no longer stay in contact with the lobe.
We therefore only have approx. 50% of the flank to accelerate the whole mass of the valve train. and the further we try to open the valve, the more resistance the spring exerts to oppose it. So it can be seen that acceleration rates are a critical factor in performance cam design.
Acceleration rates are limited by the diameter of the follower and it is easy to see why performance profiles are often on the limit of maximum acceleration, and why it is sensible to use the cam follower recommended by the manufacturer of the cam, as this will ensure that the design of the follower will be suitable for a particular profile. or range of profiles.
With the need for a quick opening, and gentle closing of the valve. often the inlet and exhaust flank will have differing rates of acceleration,and with the very tight tolerances demanded of a performance profile, it soon becomes apparent that the engine must always be rotated in the correct direction. Quite apart from any damage caused by the backlash in the timing chain being reversed, there is also a chance of the cam lobe crashing with the edge of the followers. Always ensure that the engine is correctly set-up and that there is no possibility of pre-ignition as this may cause the engine to run in the opposite direction to which it was intended. This can result in broken cam followers, smashed lobes. bent valves. etc.

Nose

The nose is the section of the profile where maximum lift occurs and is positioned each side of the opening and closing flanks.Due to differing cam design requirements and engine designs. the nose radii of performance cams can vary considerably. Some profiles look very pointed, whilst others may appear rounded. No matter what shape the profile may be the nose radius is the most highly stressed part of the profile. and the part that is most likely to fall. This section of the lobe has the least contact area with the followers. and at the same time has to overcome the full force of the valve spring, which is trying to prevent the valve opening. Pressure well in excess of 10,000 PSI. can be exerted on the lobe nose. It is therefore obvious that only the highest quality oils should be used in performance engines. when you consider that it is only the thin oil film separating the lobe and the follower. It is film breaks down failure is inevitable.

Dwell

We have seen that the nose is the section of the profile where maximum lift occurs, but it Is also the section of the profile that reverses the direction of the valve. We know that the cam lobe controls the opening and closing of the valve, but at some point the valve has to stop before it can reverse its direction. The length of time the valve remains at its maximum height (usually measured in degrees on the crankshaft) is called the dwell angle. and as we will see later, this dwell angle period is very important when setting up the cam.

Lift and Duration

As previously stated. the performance cam is generally judged by the advertised lift and duration figures, so it is important that we look closely at these two features.

Lift

When selecting a performance cam it is important to know how much lift a particular profile will impart to the valve. Generally speaking it is true to say the more lift a cam produces the more radical the profile, but also this information is essential in determining if the camshaft will fit in the engine without need to modify other components.
When tuning any engine, it is common practice to increase the compression ratio. which means reducing the combustion chamber volume in relation to swept volume. This is often achieved by skimming the face of the cylinder head, thus reducing the clearances between piston and valves. Obviously if we increase the valve lift, we need to do some careful calculations to ensure that the valves do not contact the piston. It may be necessary to machine pockets in the piston crown . Whenever there is a possibility of valve to piston contact it is recommended that a trial engine build is carried out. using plasticine on top of the piston crowns. After rotating the engine it is then possible to measure the thickness of the plasticine and determine the valve to piston clearance. It is imperative that this clearance is not less than .060". otherwise the possibility of piston contact will result.

Cam lift can be calculated by deducting the base circle diameter from the overall lobe height.

When measuring cam lift. it is impractical to use a micrometer to determine the base circle diameter, as it is not possible to see where the opening and closing ramps start and finish. If accurate results are to be achieved the cam lift must be measured between centres using a dial indicator gauge. When using this method the cam must be checked to ensure that it is not bent. that there is no run-out in the centres, the dial indicator is set up exactly on the centre line of the cam and at 90 degrees to the checking bed, before measuring . Never check cam lift in the engines as all the engine tolerances and clearances will combine to give inconsistent and unreliable information.

As you will see by reducing the base circle diameter we are not only reducing the size of the lobe, but, because when adjusting the valve clearances the cam follower now sits closer to the centre line of the shaft, we are in fact increasing the levering effect of the lobe. and thereby increasing the lift.

It is interesting to note that many performance cams have the core turned down. In general this Is because when an existing cam is reprofiled, the base circle of the lobe is reduced to such an extent to obtain the greater lift. that it becomes smaller in diameter than the core. and if the core was not machined to a lesser diameter than that of the lobe. the cam follower would sit on the core and not the base circle of the cam. Also, even when using a new casting or blank, to obtain radical profiles the same situation often arises.

Duration

When selecting any performance cam, the term duration refers to the amount of time the valve is off its seat, and is quoted in crankshaft degrees. Generally speaking the more duration the cam has the more radical the profile, and the rougher the engine the engine will run at low speeds. However it is the subject of duration where most anomalies arise. Confusion is largely brought about by the performance cam manufacturers themselves, in not stating how the duration of their particular profiles are measured, or even resorting to measuring them in different places, so that they will conveniently fall into a particular range!

Imagine for a moment a camshaft set up in an engine with a valve clearance of 020", the engine is rotated and we measure where the valve opens and closes to obtain our duration figures. If we now reduce the clearances to .010", we now force the cam follower to sit closer to the cam lobe, and consequently as the lobe rotates it will open the valve sooner and not allow the spring to close the valve until later, thus greatly increasing the duration.

To quote a duration figure without quoting the checking height at which it was measured is quite meaningless.

At Kent Cams they have standardised on a checking height that will most closely give a true representation of what is actually happening at the valve. By using a common checking height. comparison between profiles is now practical.

Overlap

We have looked so far at the effect of a single lobe. However (excluding twin cam setups) it is usual to have both the inlet and exhaust lobe on the same shaft. and the angle by which the respective lobes are separated plays an important part in the engines performance.This angle is referred to as the lobe centre angle, and is measured from the centre line of the inlet and exhaust lobes . The closer the lobe centres are together the greater the overlap. By altering this angle we will after the position of the

inlet and exhaust valves relative to each other, and increase or decrease the amount of time both valves are open together or overlap . To determine the overlap, add the opening before T.D.C. of the inlet valve to the exhaust closing after T.D.C. i.e. inlet valve opens 40 degrees before T,D.C., exhaust valve closes 50 degrees after T.D.C., overlap = 90 degrees.Overlap is employed to allow the burnt gases escaping through the exhaust valve, to help induce the incoming charge of fuel/air mixture.
This incoming charge in turn helps force out the remaining exhaust gases. However it should be remembered that increased overlap will result in the valve remaining in the vicinity of the moving piston for longer.
This is another factor in valve to piston clearance to be borne in mind.
Because of the various constraints of lift, duration and overlap it 's not always possible to grind performance profiles on the existing camshaft, and where this is the case we have to use new castings or blanks which have much more material on the lobes. However whether or not we use an existing camshaft, or a new blank, these constraints are often such that we need to utilize every scrap of available material, and consequently often have to ignore the keyway or dowel position when grinding. It is therefore necessary to follow the fitting instructions carefully. This is explained in further detail later.

Cam Followers

In order for the cam lobe to impart motion to the valve it must run on cam follower. The follower converts the rotary motion of the lobe into linear motion and concentrates it into a point contact on top of the valve stem. Cam follower configurations vary, however, as with the cam profiles, they can be considered in three categories:

1.- Push Rod Followers

It is Important to note that most push rod profiles are ground with a very small taper on the lobe face, and that followers are not flat, but have a large radius . The cam therefore does not contact the follower in the centre, and this causes it to spin. This will distribute the wipeover area and thus reduce wear.

2.- Direct Acting Bucket Followers

These followers are commonly used in twin overhead camshaft engines. This is where the lobe operates on top of the bucket and the motion is transmitted (usually via a tappet adjusting shim) directly to the top of the valve stem.

With this type of design,

the lobe is ground parallel, and the bucket has a flat face. To avoid frictional loads, the bucket is made to spin by off-setting the centre line of the lobe in relation to the centre line of the bucket.

3.- Finger Followers

This type of follower is common in single O.H,C. engine designs. It operates by an adjustable ball stud on one end, the valve stem at the other end, and the cam lobe operating from a predetermined distance from the centre, to give an increase in leverage or rocker ratio .Unfortunately this type of design does not allow the follower to spin and therefore the frictional forces of the lobe wiping over the face of the follower are considerably greater.

With some of the more radical profiles. and especially where the cylinder head has been heavily modified, altering the height of the valve and the valve train geometry, it is often possible for the wipe area of the original follower to be too short and special long pad followers need to be used - e.g. for Pinto engines our part CF12.Obviously by fitting a higher lift cam we will increase the loads between the cam lobe and follower and it is Imperative to ensure adequate lubrication in this area.
Often the use of an up-rated oil pump can be an advantage.Remember that all that is separating the cam lobe from the follower is an oil film. and if this breaks down, cam and follower failure is inevitable.
Always use the highest quality oil and ensure that it is adequately filtered and changed regularly, as any particles of dirt larger than the oil film will get trapped between the lobe and follower causing scuffing and eventual failure.

Hydraulic Followers

There is nothing special about hydraulic followers, their function is exactly the same as the other followers we have discussed the only difference being that they adjust the valve clearances automatically by the use of hydraulic pressure.Many modern engines employ hydraulic followers. the advantage being that as they are self adjusting, should remain silent and maintenance free under normal conditions. Also because they are under hydraulic pressure they are in constant contact with the cam lobe (i.e. zero clearance) making it much easier to constantly predict exactly when a valve opens and closes, and thus reduce emissions.
However the use of hydraulic followers in performance engines is limited and whilst they are suitable for most fast road applications, the demands made by the more radical profiles and higher engine speeds, bring their use into question. Because of the inherent response time of the hydraulic mechanism, it may not be able to evacuate its oil quickly enough and consequently jacks itself up. This is not a desirable feature in any performance engine. as at best it will prevent the valves from seating, and often it overpumps to such an extent, that the valve springs coil bind on full lift and the rocker arm. having nowhere to go, will break.

It should now be easy to see why. when fitting any performance cam. that the cam manufacturers recommended followers are used. They will ensure that the dimensions of the follower are compatible with the acceleration rates of the particular cam. and often manufacture them from superior materials with additional surface treatments.

Valve Springs

The selection of the Camshaft and the type of profile employed will have an influence upon several other areas within the engine, but one component of prime importance is the valve spring.It is the function of the cam profile to open the valve. The valve spring provides opposing force in order to control this motion whilst the valve is opening, and to push the valve back on to its seal after the cam has moved over the nose.To achieve the correct valve motion. it is essential that the valve train remains in constant contact with each adjacent component,and the cam itself. from the time the opening ramp takes to up the clearance, until the closing ramp returns to base circle. Throughout this period any separation of the valve train (valve bounce etc.). will have severe Implications on both performance and survival.This requirement can be likened to the propulsion of a ball struck by a bat or racket. whether or not the ball moves forward in contact with the bat, or is projected forward into the air depends on the force with which the ball is hit and how heavy the ball is.

In the valve train the force involved is the rate of change of the cam profile or its acceleration. The weight, or mass. to be moved being the valve assembly. When the high performance application is considered. three factors are at work. Firstly, the new camshaft selected will have profile characteristics with considerably greater accelerations than the standard profile. Secondly, the engine will probably be fitted with larger valves which may be heavier than the standard ones. giving more mass to be moved. and thirdly, by nature of the use it will be put to. and the characteristics of the new profile. the engine will be using higher RPM. This shows that the forces in the valve train whilst opening the valve (and closing) are of a greater magnitude, and hence a stronger valve spring is required.However, it can be equally damaging to use a spring of too great a stiffness, this will not only sap valuable power in the effort to open the valve at high engine speed, but can impart unduly high pressures between the cam and its follower.

The aim Is to achieve a set of harmoniously matched components which will help, rather than hinder, the engine to rev freely and smoothly to high RPM in order to produce good power, without premature wear or failure of components. For this reason we have designed a range of valve springs to specifically match our range of profiles, and we strongly recommend their use.

Spring Retainers

In most instances high performance retainers are made from light alloy, and are therefore lighter than the standard item and will reduce the valve train mass. They are also machined to accept an inner valve spring, so that double valve springs can be fitted where singles are to be replaced.

Vernier Timing Pulleys

A production engine has valve timing figures for which there is no provision for modification when building or rebuilding and valve timing is usually achieved by aligning a series of marks or dots. Because of the normal production tolerance in any manufactured item, it is almost certain that the cam timing will deviate from the ideal position, and for an engine in normal state of tune this may be perfectly acceptable.Also a point worth remembering, is that any O.H.C. engine that has had the compression ratio raised by skimming the cylinder head, will automatically have had the valve timing altered, Because the effective distance between the crank and the cam has been reduced, adjusting the belt tensioner to take out the slack. will alter the position of the cam pulley in relation to the crank.
However, for whatever reason the cam timing may deviate, any performance engine becomes much less tolerant of inaccurate timings, and accuracy is essential to achieve maximum performance.In order to adjust the valve timing. we produce Vernier timing pulleys. These are used in place of the original cam pulley. They fit on the camshaft using the

standard key in the normal way, but, because of their built in adjustment.. allow the timing to be correctly adjusted.

Rocker Assemblies

On a push rod configuration, the high RPM used by a modified engine, is often outside the reliable scope of the standard rocker assembly, and the minimum that should be done in this area is to replace any alloy parts with steel.The ultimate in rocker assemblies is the roller type which utilises steel posts with alloy steel shafts, and special light weight rockers filled with dual needle roller bearings and a hardened roller tip. Not only does this assembly reduce friction but has the added advantage of reducing valve guide wear. because of the rolling action over the top of the valve stem, unlike the sliding action of the conventional rocker arm. These assemblies also come in a variety of rocker ratios making them equally suited to fast road as well as full race applications.

Chain Drives

Engines which have cam in the block configuration, often feature a simplex (single row) chain to drive the camshaft. This can be another problem at high engine speeds, because of the stresses put on the chain when the engine accelerates hard, and on the over-run when the motion is reversed, A chain mechanism which is grossly over stressed will quickly stretch and wear sprocket wheels. This is overcome by changing the standard equipment for a "duplex", (double width) chain and sprocket. In most cases these can be fitted with no modification. and have a much longer service life.

Adjustable Fuel Pressure Regulators

An ingenious device used to richen the fuel mixture on EFi engines, without the need to replace expensive electronic equipment. It simply replaces the existing regulator and can be mechanically adjusted to increase or decrease fuel pressure. The rising fuel rate facility creates enrichment and performance to meet the requirements of a high performance camshaft.

Fitting Instructions

Fitting Camshafts and other Performance Parts

Before any attempt is made to fit a high performance camshaft or any other related product. it is worth considering a few points.By undertaking a camshaft swop or similar modification the engine builder is attempting to change the existing engine. for one with completely different characteristics. Because he has selected the individual components and the type of modifications himself. this makes the proposed new set-up a combination of his own making. This is very important to appreciate, as it means not only taking credit for the successful outcome, but the scrupulous checking and preparation involved as well. It is all too easy to think of the improved performance to come rather than the problems that will occur, if the various clearances and other aspects are not checked.The person ultimately responsible for the success or failure of an engine build is the engine builder. Every aspect of the assembly must be checked and double checked to ensure that the new assembly is made up of compatible parts which will work well together. It is for this reason that we have available a large range of performance cam kits for popular engines. When ever possible these should be used, as they provide a matched kit of parts which are compatible with one another and will potentially be easier to fit.

Several factors will affect the fitment of a new camshaft. These are the golden rules:

* When the old camshaft is removed, various other items will have to be removed from the engine, such as the timing wheels, tensioners and covers etc. Ensure that the sequence and manner in which they are removed is noted in order that they may be replaced correctly. Mark the items removed if required.

* Check the condition of the camshaft removed and cam journal bearings, if they are scored or otherwise worn they should be replaced and properly prepared before the new camshaft is fitted.
* Fit the new camshaft with plenty of Cam Lube oil to lubricate the bearing surfaces. Never force any item that will not fit.
* All items in the surrounding assembly of parts should be in good serviceable condition. Any that are damaged or worn in any way should be replaced, i.e. items such as valves, guides, rockers. ballstuds, oil feed pipes etc.
* Cam followers must always be replaced when the camshaft is changed. Failure to do so will cause any surface wear or imperfections on the old followers to mark the new camshaft and will result in immediate wear, and failure of the lobes. Surface defects on the old followers may be microscopic and therefore invisible to the eye - Always fit new cam followers.
* When assembling the valve train components, always use Cam Lube. This is a specially formulated start-up lubricant that provides a highly protective film during the first few seconds after start up. This ensures that no scuffing takes place and that the mating parts 'bed-in" together for a long service life.
* During the assembly rotate the engine at appropriate intervals and ensure that the new parts fit and work in the manner that they were intended. If the engine meets with resistance when it is being turned investigate it - do not force it.
The principle areas that should be checked are as follows -
1. Coil binding of valve springs. If the cam lift and valve spring are poorly matched binding can occur. When the cam is at full lift the gap between the coils should not be less than .040", this may only be achievable by machining down the spring seat by the required amount.
2. Spring retainer fouling. With increased valve lift. the clearance between the bottom of the retainer and the top of the valve guide (or stem seal) will have been reduced or removed altogether. This clearance must be restored to not less than .060" by machining the top of the valve guides. It is often easier to check this clearance before fitting the valve springs and the use of a thin wire dummy spring (such as found on the Ford X/flow rocker assembly) makes checking much easier.
3. Valve to piston clearance. The relationship between the piston and valve will also change when modifying the engine, larger valves with greater lift & duration will bring them into closer proximity to the piston. This clearance is a little more tedious to check as a visual inspection is not usually possible. Plasticine should be placed on top of the piston under the valve area and the engine rotated, the plasticine can then be removed and its thickness (and thus the clearance) measured. The clearance should be in the region of .060" -.080", and once again is achieved by a machining operation to the piston crown and allowing .040" side clearance on the valve head diameter.
The foregoing are the main areas where problems are likely to occur, However a further check on all relevant areas
where contact could take place, must also be carried out.

Cam timing

Carrying out modifications as discussed alters so many factors within the engine that the original timing marks should be
considered redundant and used only as a rough guide. A modified engine needs careful & accurate timing by the following method.The most accurate job will be arrived at with two tools i.e. a timing disc & a dial test indicator. (D.T.I.)
The timing procedures can be carried out with reference to No 1 cylinder only (ail others being ignored.) Firstly set No 1 piston at top dead centre (T.D.C.) the original T.D.C. mark is still relevant although not really accurate enough. The D.T.I. probe should be positioned down the spark plug hole to rest on the piston crown, then by turning the crank backwards and forwards an exact position will be indicated by a change in needle direction on the dial.The timing disc should be fitted to the front of the crank shaft. A bent piece of wire secured under any adjacent bolt head will act as a zero pointer and should be positioned to align with the 0 degree mark on the disc. Thus the engine is now at T.D.C. on No 1 cylinder and the timing disc zeroed.The procedure varies here a little depending on whether the engine is single or twin cam. The vast majority of engines (such as push rod & finger follower type) are of single

cam configuration ill consider these first.With a single cam engine both inlet & exhaust cams are all on one shaft. Given this fixed relationship, the inlet lobe (the most critical) is chosen for the timing process. Now rotate the crankshaft clockwise to the full lift position specified for the particular camshaft being fitted (I.e. 234 cam has full lift @ 103 degrees). Full lift of the inlet cam should occur here. This can be set by placing the D.T.1. on the top of the spring retaining cap in order to pick up the valve motion and rocking the cam in order to pin-point the change in direction of the valve, if a vernier timing pulley is fitted, this is carried out while the pulley is loose and then locked up when correct. Now a check
can be made of the opening and closing figures for the profile by rotating the engine and reading off the disc, the point at which the valves (inlet & exhaust) lift off and return to their respective seats.When timing a twin cam engine, the principle remains exactly the same. However, the inlet & exhaust lobes are separated onto the respective camshafts. This means that unlike the single cam engine there is no fixed relationship between the two, this means that the inlet camshaft is timed in the same manner as described for the single camshaft. Additionally the exhaust camshaft is then timed as a separate entity e.g. a CPL2 profile inlet cam is timed at full lift @ 110 degrees ATDC and the exhaust cam at full lift timed @ 110 degrees BTDC. Vernier timing pulleys are all the more useful for a twin cam engine and the job should end by checking the opening and closing figures as before.In all cases we recommend that after all cam swaps and modifications of this kind. a trip to the rolling road will extract the best from your modifications and ensure that the fuel mixtures, ignition timings etc. do not produce a set up that will prove damaging to the engine.

Applications, Makes and Parts

Camshaft Applications

High Torque
Gp "N"
Mild Road
Fast Road
Fast Road
Road/Rally
Rally
Tarmac Rally
Rally/Rallycross
Rally/Race
Race Hot Rod
Race
Tarmac Race
Full Race
Ultimate Race Cam

Makes

Alfa Romeo Camshafts
Audi Camshafts
Austin Rover Camshafts
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