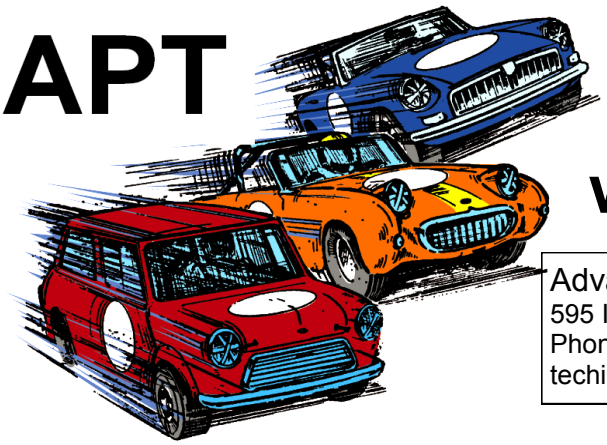
APT



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ORIGINATOR OF SCATTER PATTERN™ CAMS

Advanced Performance Technology
595 Iowa Avenue, Suite 'C', Riverside, CA 92507 USA
Phone: 951-686-0260 800-278-3278 Fax: 951-686-2831
techinfo@aptfast.com
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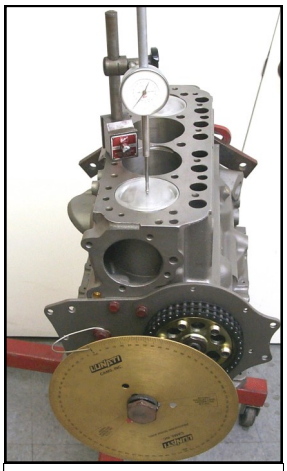
Installing & Timing Your Cam

Having spent a lot of money on an engine rebuild, the last thing you want to do is just stick the cam in without checking that it is timed correctly.
Taking your time is vitally important at any phase of an engine rebuild, something's may need to be checked 2 or 3 times.
Please don't cut corners, and if you find yourself saying: "oh that will be alright after it has run for a while" take the time to check again as it probably won't be alright.

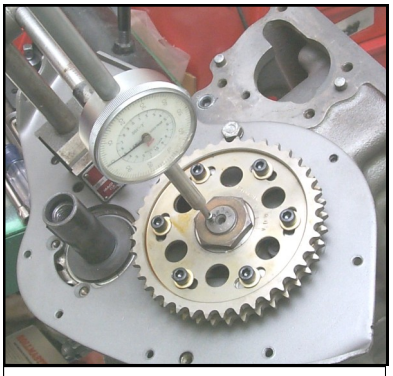
You will require a minimum of the following tools:
Straight edge (a 12 inch steel rule is normally OK)
A plunger type 'dial indicator' attached to a magnetic stand (I" inch reading 2" dia. dial)
Degree wheel, can be anywhere between 6" & 12" inches in diameter.
Most popular part number DW-7 a 7" wheel made by Iskenderian. (see bottom photo page #2)
The first part really comes under engine building, but its important so:



This photo shows the components you will need set up for the first stage of cam checking.

Cam shaft end float

After making sure the cam turns freely in its bearings, and the lobes are smeared (lightly) with break in lube, and lifters are installed if they are not able to be installed once the cam is in you are getting close to be able to check the end float of the cam.
(Too much lube could prevent the rings breaking in, don't over do it!)
Remember to fit the front engine plate with its gasket BEFORE fitting the camshaft thrust plate (yes, I do have a good reason for the emphasis!). The thrust plate is often forgotten when ordering parts, if it shows wear order a new one before you come to fit the cam.

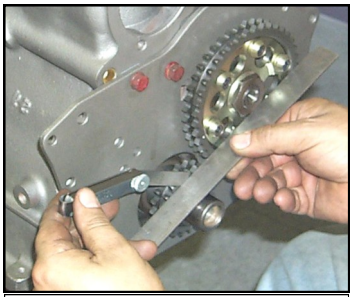


Dial indicator setup to measure camshaft end float.

Next fit JUST the cam sprocket, install the nut or bolts and just tighten a little so that the inner boss of the gear is snug against the front cam journal.
Set up your magnetic stand and indicator to measure square with the face of the gear.
While pushing and pulling on the gear along the axis of the cam watch the indicator to see how much end float you have.
Check your manual, at APT we usually like to see about three to five thou. Too loose and the cam can walk far enough to start turning the distributor shaft (helical gears remember) and can contribute to timing scatter.

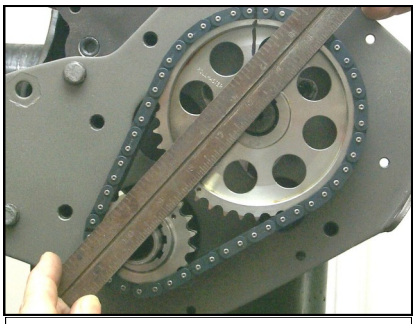
Crank and cam gear alignment

This is the last step before we get to the cam timing.
If by chance the crank key is not fitted at this point good, don't fit it yet.
Make sure two or three shims are fitted first then slide the crank gear on. If you have to force it only a plastic mallet should be used. Apart from making it easier to complete this stage this is one reason why not having the key fitted is an advantage as the fit of the gear on the shaft and later the fit of the gear on shaft and key can be checked separately.
Using a straight edge across the side of both gears (see photo) check for alignment. Use a feeler gauge as shown on the gear that has the gap to figure if shims need to be added or taken off.
Misalignment of the gears wears the chain and can lead to chain breakage, and the metal filings produced will not do your engine any good either.



If these gears run out of line that's not good for chain life, or the gears!

Fitting the gears and chain



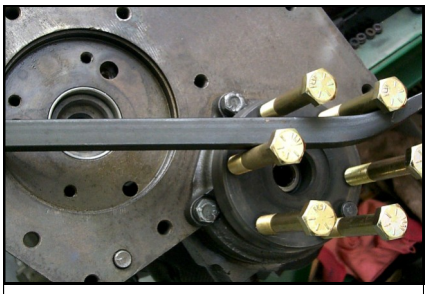
The straight edge line should go through the cam/crank shaft centers as well as the two gear 'dots'.

Most gears have two dots that have to line up with each other with the line running through the center of both gears as shown in the photo.
If using the gear set with multiple keyways on the crank gear start off using the middle of the keyways, which is marked "0"
The vernier type gear should be set so the cam gear adjustment is in the middle of the slots.
Some after market gears come without any alignment dots. This can be somewhat discerning, but in reality this is fairly easy to deal with and we will look at this a little later.

Mounting the degree wheel and the indicator

This crank bolt has a register on the front face to locate the degree wheel

Ideally all of this setting should be done with the cylinder head off. It can be done with it on, but is much harder work.
There is some more on "head on" timing methods on the last page.
It is not possible to 'guess' the true top dead center reliably, so a method is required.
We are going to look at two methods of timing the cam, but both of them require this first step of setting up the degree wheel, the most common timing method first.
The timing wheel obviously has to be fitted to the crank, usually on the snout, but can be more convenient if fixed to the back as it can stay on for the whole operation, but requires the engine to be held by the side, or standing on the temporarily fitted oil pan.
One method for mounting the wheel on the crankshaft snout is to use an old engine front pulley bolt that has been drilled and tapped from the front side for a short stud or bolt. If you have access to a lathe then a small shoulder to locate the degree wheel and hold it concentric would be a good idea. (see photo).
You will then need some fairly stout wire (1/8" gas/TIG welding rod is ideal) to make a pointer that will point to TDC on the degree wheel. This should be fixed to the engine by one of the front plate bolts, and can be seen clearly in the photo on page #1
The magnetic stand should be 'stuck' to the deck face with the indicator plunger exactly vertical in the middle of the piston if possible, and if not make sure it is in a place where piston rock does not affect the reading.
If you can always try to keep some downward pressure on the piston with your hand, just be careful not to disturb the indicator.
The engine needs to be turned backwards and forwards during the timing procedure, and with the degree wheel on the front this has to be done from the back.
You can use the teeth on the ring gear if the flywheel is fitted, but we find it easier whether the fly wheel is fitted or not to screw in at least a couple of longer than normal bolts in place of flywheel bolts. A pry bar or large screw driver will then do the job easily. If you are working on a Mini you will be able to figure a couple of options to do the same thing.



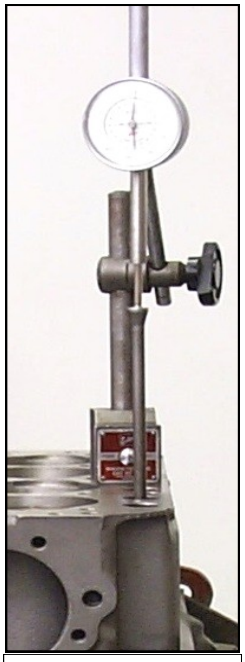
Turn the crank like this. Do <u>NOT</u> use your new ARP flywheel bolts for this

Finding the true <u>T</u>op <u>D</u>ead <u>C</u>enter procedure for cylinder #1 piston

These are the degree wheels we use in the APT shop. The Lunati wheel has a separate lockable hub a Mini flywheel bolt holds it to the crank on BMC engines

Turn the engine to what you guess to be TDC and set your indicator to zero.
Now adjust your degree wheel/pointer to read TDC, lock the wheel up tight. Our final adjustment will be the wire pointer. (Yours might look something like the one in the photo to the right, look hard you will see it).
Turn the engine in the direction of normal rotation until the piston drops 20 thou and record the number shown by the pointer/degree wheel.
Turn the engine back, past your 'zero' until the piston drops <u>20</u> thou, record the number again from the degree wheel, the mid point between these two numbers is where the true TDC is located.
(mathematically add the two numbers and divide by 2 eg. 98 + 110 = 208/2 = 104).
Using the above example where the last number was 110 move the crank 104 degrees towards TDC then carefully bend your pointer so it points to TDC.
Not a bad idea to run through the procedure again to check accuracy.
We are going to use exactly the same method to find the peak of the cam lobe.
NOTE about degree wheels
Some are split into strange sections, some in 90 degree segments, whatever the case you should use it as though it was a 360 degree protractor.

Finding the position of the cam relative to TDC

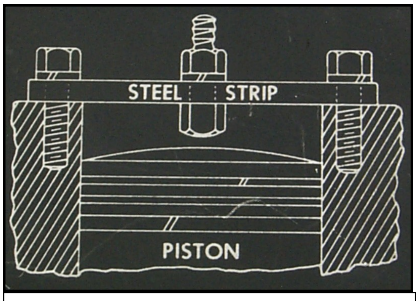


Reading lift on cylinder #1 inlet lobe. Remember this is normally the second hole from the front.

Firstly put a push rod down cylinder #1 inlet lifter hole (usually the second lifter hole).
Mount the indicator so the plunger is in the cup, and get everything set so it is exactly vertical in both planes
The figure we need should be on your spec. sheet provided by the cam manufacturer.
It is usually listed as: time engine to full lift on #1 intake ??? Degrees after top dead center
Or sometimes: inlet lobe centerline ??? Degrees
The number usually falls between 102 & 108 degrees for all engine/cam combinations.
So with everything set turn the engine in the direction of rotation until you find what you think is the center of the lobe, set your indicator to zero.
Continue turning the engine in the direction it runs until the indicator drops 20 thou, record the number from the degree wheel.
The turn the engine backwards past zero until the indicator drops 30 thou, then go back to 20 thou, record your number, (this gets the slack out of the chain and increases accuracy).
The mid point in degrees (add the two numbers divide by 2) between these 2 numbers is your cam timing. (This procedure should be starting to sound familiar now).
Keep in mind, and realize the slight change in procedure from finding TDC was to make sure the timing chain was always in tension, the way it normally drives.

Second method of cam timing

At APT we consider this next method faster (especially if you are using the vernier timing set) and also more accurate.
Follow the instructions above for getting your wire pointer set to a true top dead center, also follow the instructions for setting your indicator vertically on cylinder #1 inlet push rod.
At this point you will require from the cam manufacturer a “lift at TDC” figure. This method is becoming more popular, and if you are working on a twin cam engine you have to follow this procedure.
Some cam manufacturers/vendors cannot supply this number. This may point to a problem! This may mean they do not have design data, because they copied it!!
In just about all cases it points to them not being the designer of this cam, because if you had the design data in front of you its easy. (Over 50% of cams sold are copied)
So how come they have a cam, but not the required data?
Usually this is because they just copied someone’s cam to make their master from which to grind your cam, and perhaps worse than that, especially with old British cams is they may have copied a copy of a copy, OK for a tractor engine perhaps, but for your high performance engine spinning at thousands of RPM’s??
This lift @ TDC number will normally be in the range 0.030” - 0.080” for most cams, this number refers to the lift at the cam from the base circle on the inlet stroke.



Isky have this drawing shown on the back of their degree wheel (DW-7) which shows how a simple positive type stop can be used directly on the piston.

Back to our setup

Turn the engine until the cam follower is on the base circle (the heel of the cam) and set the indicator to zero
Now turn the engine until it starts on its intake stroke, you will see the indicator start to move, the piston will be approaching TDC
At TDC exactly stop, read your indicator, what is the recorded lift compared with the figure you are looking for?
Its actually very helpful if the manufacturer as well as supplying a lift figure for what they consider is the best timing for that cam to supply the figures for 2 degrees either side of the ideal number, that gives the installer some idea of how far off they maybe in actual degrees. This is especially useful if you need to select an offset key, or move a multi keyway gear set for which you will need to decide on a degree number that may not exactly match the quoted figure.

Timing a cam with the cylinder head on

The large section screws into the sparking plug hole, and the center portion is adjusted to just stop the piston getting to TDC Adding a locknut to the top of the screw might be beneficial

This is obviously a little more difficult. You will require a ‘positive’ type piston stop like the one in the photo. You can also make one if you have access to a lathe. Just bore out the front of a sparking plug and press in a piece of brass the required length to stop the piston just before it reaches top dead center.
The basis of this method is turn the engine until it touches the stop, record your number, turn back the other way until it hits the stop, record your number and split the difference.
You can also use this same general method with the head off.

continued

See the photo of the drawing shown on the back of the Isky 7" inch degree wheel APT #DW-7
The positive stop method is sometimes considered the most accurate method as it always it always pushes the piston/ con rod hard down onto the crank pin and so removes the possibility that a reading is taken while the con rod is pulled up against the bottom of the crank pin.

How to deal with no timing dots on the cam gears

This is really an affliction of some after market timing gears, and hopefully one day it will be a thing of the past.
Turn the crank to the degree figure you are looking for (from your spec. sheet) the time to at full lift figure. If you don't have specs. use 103 degrees ATDC
Using your indicator (on the cam) turn the cam so it is at full lift.
Take note of the position of the key on the crank and the cam.
Hold the chain and sprocket assembly so you can hold it in front of the engine, squint through the sprocket bores and try and juggle the assembly so the keyways in the gears line up with their respective keys and you can slide the gears on hopefully without moving anything too much.
This will certainly get you very close. Now use one of the two checking procedures.

APT manufacturers their own special chilled iron cam follower for BMC 'A' & 'B' series engines.
Part number CF-04
Also available for Triumph 1147—1500, GT6, TR6
Part number CF-10 4 cylinder
Part number CF-11 6 cylinder
These have the oil drain hole.
Face hardness is Rc63 and is manganese phosphate coated for easy break in when used with cam lube and ZDDP in the oil.

A few last thoughts on cam timing

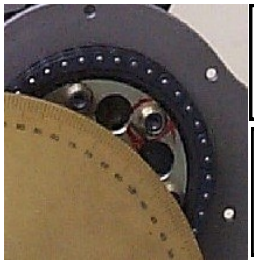
Before pulling the gears off to adjust the timing use a marker to draw a line across the chain and the gear. That way you always have a reference as to where you started, if you fumble the gears!!
If timing the cam also has to fit with a carefully controlled budget then keep in mind the order of "expense". Offset keys (or perhaps changing the gears around in the case of a Triumph) is the least expensive.
Somewhat middle of the road is using a multi keyway set of gears, if you can find them, they have become somewhat scarce recently. With regard to accuracy/repeatability with the above two methods remember you will also be pulling your timing wheel off each time you want to make an adjustment.
The vernier gear sets are the fastest and most accurate method by far, and for that reason if you are paying someone to build your engine by the hour then the vernier gear will usually work out cheaper because of the amount that will be billed for time with either of the first two methods will come to more than the difference in the cost of the gears.
Vernier gears are certainly the method of choice if using the cam lift at TDC method.
Lastly, with the vernier, as you make your adjustments there is no need to lock up all 6 allen bolts each time. Just find the locking bolt that is not covered by the degree wheel at the rotation point that you want to read your numbers at, mark it with a felt pen, lock and unlock only this one bolt, and only lock up all the others when you are done. (shown bottom left).

Still stuck? Call us when you are sitting in front of it.

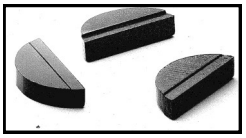
Marking the chain and gears when setting up the multi keyway or regular gears is so important we have included this photo

Oil and break in

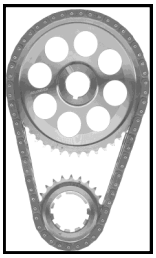
Very briefly, do not use synthetic oil for cam break in. Use a high ZDDP break in oil. Do not use a regular oil (virtually no ZDDP) and then add a separate bottle of ZDDP, you have absolutely no idea what you will end up with! Detergent for example is antagonistic to ZDDP.
After break in continue to use an oil produced with ZDDP for flat tappet cam engines.
Synthetic oils with ZDDP are available for after break in use if you desire.



Left: The text refers to working with just one lock screw while adjusting, Marked RED



Offset keys 'A'& 'B' series



Offset keys are the least expensive way to time your cam. A & B series They range from one degree to 9 degrees in offset. The down side maybe is that you either have to have one of each size in your tool box, or wait for one in the mail.

BRITISH MOTOR TRADE ASSOCIATION

David Anton Owner