Camshafts and Understanding the numbers.

(Lifted from the Sunbeam Alpine Owners Club Ltd UK Forum)

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Welcome to this new thread on cams. Make no mistake, if you are carrying out an engine rebuild and want to tune your unit to make more power then choosing the right cam is critical.

Everything else depends on this one component to an extent that is frightening. It alters the whole nature of the engine for better or more likely in most cases, for worse. Your carburetion, distributor and timing and headwork will go completely to pot if you get this wrong. I've seen it happen so many times now to people who are very knowledgeable. If they can get it wrong what chance do the rest of us have?

The Alpine engine is not a very good candidate for cams with very extended durations for the simple reason that the bottom end is not that good at revving. I doubt whether anyone has built an Alpine motor that could take more than 6500 rpm reliably. Certainly the 1592 has the best chance being a square unit, but the longer stroke 1725 probably won't go even this far. Using a cam with extended duration can help breathing potential but it places the peak torque band much higher up the rev scale such that good throttle response is hard to come by below about 3000rpm.

What this means is that below 2000 rpm the engine will splutter and miss if you apply large throttle openings or try to drive slowly in a high gear.
The car will not like it at all. You will find that slowly but surely you will come to dread driving in town or hitting a tailback on the motorway.

Since this will ultimately spoil the driving experience making this sort of mistake is to be avoided at all costs so we will look at the numbers to see what they mean so when people start saying fit a 280 degree cam we will know what they mean. Hope you stay with us on this one.

When the Otto cycle 4 stroke internal combustion engines were first invented, the manufacturers were principally concerned with reliability.
Performance hadn't appeared on their radar at all. If the thing ran and stayed together for a reasonable length of time then all was well.
Gradually metallurgy and lubrication technology improved and then the race for more power began in earnest.

The valve timing for these early engines was quite simple though.
At top dead centre (TDC) the inlet valve began opening and then at bottom dead centre (BDC) it would be fully closed. This timing was always measured in crankshaft degrees and equated to 180 degrees of timing. However it soon became clear that extending these timings either side of TDC and BDC resulted in more power. Doing the same with the exhaust timing also helped to create a scavenge effect, particularly if the overlap of inlet and exhaust is allowed.

Lets fast forward now to the sixties and look at some competitors products that the Rootes group were taking on in the market place.
In fact we'll look at my old Traveller engine of 1098 cc displacement
This unit was also used in the Midget albeit with twin SU's but crucially the cam timing was the same.

The inlet valve opens at 5 deg. before Top Dead Centre (BTDC) and closes 45 degrees after Bottom Dead Centre (ABDC) This means that the total inlet valve duration is 5 + 45 + 180 = 230 degrees

Looking at the exhaust timing we see the exhaust opens 51 deg before BDC. (BBDC). It then closes at 21 degrees after TDC (ATDC).
This means that the exhaust duration is 51 + 21 + 180 = 252 degrees.
Having a longer exhaust duration gives improved breathing potential which the A series needs because of the 5 port head design where cylinders 2 and 3 share Siamesed inlet and exhaust ports.
Another thing we can see from these numbers is that there is some overlap of the inlet and exhaust valve.
The inlet valve is opening at 5 degrees BTDC but the exhaust won't be closed until 21 degrees ATDC so there is 5 + 21 = 26 degrees of overlap where both valves are open together. The pull of the exhaust gases rushing away down the exhaust manifold helping to pull some more mixture into the cylinder and aid the breathing potential of the engine.

Now this is very much a pudding engine, typical of most family cars of the period. The engine produced it's peak power low down in the rev band and was quite flexible but not exactly a ball of fire.

The strange thing is that some years later British Leyland produced a truly exceptional performance car which was a real road burner. The MG Turbo Metro. This engine was the A + unit of 1.3 Litre displacement which was the A series swansong. With stiffened crankcase and bigger bearings it powered a new breed of cars into the 90's.
In the MG it produced an amazing 93 HP, rocket ship stuff. But the Camshaft timing was inlet 230 degrees, exhaust 252 degrees.
It looks the same doesn't it? Well the profile was the same but the whole cam was advanced by 4 degrees compared with my pedestrian Morry (sic).

So we now get this from the A+ unit.
Inlet opens at 9 degrees BTDC, closes at 41 deg ABDC note the 4 degree difference in timing.
Duration is still 230 degrees though 9 + 41 + 180.

The exhaust timing opens at 55 deg BBDC, closes 17 deg ATDC so that duration is still 55 + 17 + 180 = 252 degrees.
The inlet/exhaust overlap is 9 + 17 = 26 which is still the same.

One thing this proves to me is that substantially there is little in difference between these camshafts yet there is a universe in difference between the performance output of these two units. From 48 HP to 93 HP. If you don't need a hot camshaft to produce a power increase of nearly 100 percent then something clearly deserves looking at here because this is no accident.
In our next instalment we will look at our old arch enemy the MGB.

After the sheer beauty of the MGA the "B" was a styling disaster. It would be hard to come up with a more boring design if your life depended on it.
From any angle this is the Frumpsville of the sportscar world.
Not one single panel was attractive to look at. So did it have an exciting engine then?
Hardly, the B unit of 1800cc was boredom exemplified. An asthmatic 5 port head of cast iron in true BL porridge engineering expertise.
Looking at the cam timings we have the following:
Inlet opens at 16 deg BTDC, closes at 56 deg ABDC so duration is

16 + 56 + 180 = 252 deg. pretty much porridge as before.
The exhaust timing is exh opens at 51 deg BBDC and closes at 21 deg ATDC so exhaust duration is 51 + 21 + 180 = 252 again. Very stodgy. Nothing to help that asthmatic head.

The inlet / exhaust overlap is 16 + 21 = 37 deg. a bit better than the A series but hardly adventurous for a sports car. This is a car that looks like porridge, performs like porridge, suspension is pure porridge with lever arm dampers at the front AND rear. How did they shift so many ?
People must love porridge cos they snapped them up in their thousands.

I drove a friends MGB to a party once and the driving experience was instantly forgettable. Nothing to excite the senses at all, pure pure porridge. The Alpine blows it into a cocked hat in every department. Sorry if I upset anyone here (especially in the Surrey group) but that's how I feel about the B. Total and utter indifference.
Next post we'll look at the Macho Tr's to see what muscle lies beneath their infinitely more attractive bodywork.

Ok on to the TR's, I'm sure you all know that the engine which powered the TR range of sportscars started life as a Tractor engine, then finding itself plonked into the Standard Vanguard, a big heavy brute of a car.
Of 2 litre capacity it was a very rugged and powerful unit that lacked any sort of refinement, with a noisy and vibration filled delivery of power.
What it lacked in refinement though it more than made up with character and sheer pulling power. This was the sort of stuff that put hairs on your chest (and that's only the women drivers !!!)
Let’s look at the TR2 thru to the 4

Inlet starts 10 deg BTDC, closes 50 deg ABDC so inlet duration is 10 + 50 + 180 = 240 This gives a lot of useful low revs pulling power. Must pull like a train (or perhaps a tractor).

Exhaust starts at 50 deg BBDC closes 10 deg ATDC. A mirror of the inlet with 240 deg of duration. Pretty dull and grey here methinks. An overlap of just 20 degrees is very staid. Not a car to go drag racing in perhaps.

But then look at the TR4A this is positively daring in extremis.
Inlet opens at 24 deg BTDC closes 56 deg ABDC so duration is 260, really hot stuff for the first time.
Exhaust opens 61 deg BBDC then closes at 29 deg ATDC so exhaust duration is positively sparkling at 270 deg. Inlet exhaust overlap is 53 deg

This is real bravado. You'd expect this engine to breathe very well but equally at home in the higher rev range but not quite such a stump puller as the earlier models. The 4 A was the real performer of course and the cam shows where it came from. Obviously the result of much testing by Triumph and a great result. Personally I find the TR4 A IRS the most desirable of the TR's and it was a superb sports car that only had 1 flaw AFAIC. Scuttle shake, lots of it, but then so did all the rest except the Alpine. Our car is so taut, don't you just love it? Still hats off to the TR4A, at last we find a real sports car.
Finally, next post we'll look at the Alpine.

So now we come to the Series 1 Alpine, actually it is also the Series 2, 3 and early 4's, mine included, which all share the same camshaft.
Looking at the timings we get the following:
Inlet opens at 14 deg BTDC and closes 52 ABDC so duration is 246 degrees.

Exhaust opens 56 BBDC, closes at 10 ATDC so duration is again 246
Overlap is 24 degrees.
On the face of it this is pretty much the same sort of pudding as the MGB isn't it.?

Well, it is a mild cam, for sure, but the road tests showed that the early Series cars were just as fast as the last Series 5's. In fact this cam allows the engine to produce great gobs of torque between 2,000and 3,000 r.p.m.but with no loss of pull beyond this until the red line. This is where the famed hill climbing ability came from. The engine also breathes well and responds very favourably to boring and raising the compression ratio. In fact the main advantage of having an alloy head pays great dividends. You can run seriously high CR's without the fear of detonation. High CR's mean high power.
Reading the numbers of this cam actually tells you very little about the way the engine makes its power.

For the later 4's the cam was slightly reworked, probably as a result of the experience gained at Le Mans, with a special tuning camshaft for Stage 2 modifying, more of that later though. The late 4 cam is as follows:
Inlet opens at 19 deg BTDC, closes at 57 ABDC so duration is 256
Exhaust opens at 61 deg BBDC closes at 15 ATDC so duration is again 256
Overlap is 34 degrees A fair bit hotter than before.
But basically you'd be hard pushed to notice it. It certainly has never been commented on in the official road tests or from club members in recent times. This cam was rolled out across the whole of the light car range, in fact.

Now onto the Series 5 and here we get a real shock, the cam fitted to the 5's is a real scorcher, a proper performance cam, just take a look at the numbers.

Inlet opens at 29 deg BTDC, closes at 63 ATDC ……Wow, that is some duration, a stonking 272 deg of duration. This is almost a fast road cam and is actually hotter than some after market alternatives, absolutely amazing stuff.
Looking at the exhaust now we get:
Exhaust opens 69 deg BBDC and closes at 23 deg ATDC again 272 deg of duration, so fitting a performance exhaust manifold should yield good performance gains over a cast iron manifold..
Let's look at the overlap here, inlet opens at 29 deg BTDC and exhaust closes at 23 deg ATDC so overlap is a gigantic 52 degrees. How on earth Rootes got that cam timing into a production engine and managed to keep a smooth slow tick over and no loss of torque at low revs is simply beyond this writer. So all you lucky Series 5 owners really do get their cake and eat it.
Perhaps now you can see why I do not recommend changing that cam if you are tuning your engine. You simply won't find a better cam than the one you already have. And that is of course the cheapest, since you already own it.
There is so much scope for adding power to that unit without the remotest chance of embarrassing your camshaft.

For the record now we'll look at the Stage 2 cam used in the Le Mans cars.
Inlet opens at 25 deg. BTDC, closes at 59 deg ABDC so duration is 264 deg.
Exhaust opens at 63 deg. BBDC, closes at 21 ATDC so duration is again 264 deg,
Whilst overlap is 46 deg.. The numbers look very good to me, without losing any precious bottom end.

I'd bet this cam is the one to go for if you own a Series 1,2,3 or early 4.
and wish to use your car for competition. Unfortunately finding one could prove a problem nowadays..

There were a great number of different profiles ground by companies like Piper, Burton, or Howe but confusingly some of the cams made by Piper for e.g. were totally different to those marketed by Howe. In fact the Piper Street is hotter than their fast road rally model, and the fast road by other makers was actually milder than the Series 5 stock cam.

To prove the point both Peter Pescud and I have bought the new Weber 32/36 DGV 5A jetted for the Mexico 1600 GT engine. We're both using an Apollo CIS cold air intake. His engine is a bored out 1725cc with Draycott large port head and a CR of about 9.6 with Holbay pistons. He is using a cam of about 290 deg of duration although there is some doubt about this (supposedly Fast Road). The engine is reluctant to idle below about 1500 r p.m. Throttle response is woolly below about 2.000 r.p.m. The car is brisk at higher speeds with good acceleration above 3,000 r.p.m but difficult to drive around town, very fluffy and missy.

My car is a 1592 bored out 0.030 thou to give about 1640cc with Holbay pistons which give a CR of about 10.5. The head is bog standard, the cam is bog standard early Series 4 with only 244 deg of duration. In theory Peter's car should trounce mine, yet I don't think he would be very pleased if he drove it. This would be like opening a wound and rubbing salt in it. My car is like a rocket in comparison, the only thing slowing it down is the crappy non synchro 1st gearbox, but I am fixing that with a Series 5 replacement and a 3.89 diff to help even up the gearing. The engine has so much power this will hardly affect acceleration. At 80 mph in overdrive my throttle pedal movement is barely half an inch from the idle position. The performance is simply astounding. So cams are not the be all and end all. Once fitted they have to be lived with or you face a lot of work to rectify the bad result. Peter is going to fit a Series 5 unit which he has already so it will be interesting to see the result. I fear it will be difficult to catch him if he does this.
By the way a re-profiled cam has the same lift as a new one contrary to popular belief.
If you want a hot cam ask yourself what you hope to achieve first.